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Participant Handbook

Sector
Electronics

Sub-Sector
Electronics Manufacturing System

Occupation
Manufacturing

Reference Id - **ELE/Q5315, Version 1.0**
NSQF Level 4

EMS Technician

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"Skilling is building a better India. If we have to move India towards development then Skill Development should be our mission."

Shri Narendra Modi
Prime Minister of India

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Certificate

COMPLIANCE TO

QUALIFICATION PACK - NATIONAL OCCUPATIONAL STANDARDS

is hereby issued by the

ELECTRONICS SECTOR SKILLS COUNCIL OF INDIA

for

SKILLING CONTENT : PARTICIPANT HANDBOOK

Complying to National Occupational Standards of

Job Role/Qualification Pack: **"EMS Technician"** QP No. **"ELE/5315, NSQF Level 4"**

Date of Issuance : March 1st, 2019
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Authorised Signatory
(Electronic Sector Skills Council)

Acknowledgements

The need for having a standard curriculum for the Job Role based Qualification Packs under the National Skills Qualification Framework was felt necessary for achieving a uniform skill-based training manual in the form of a participant handbook.

I would like to take the opportunity to thank everyone who contributed in developing this handbook for the EMS Technician.

The handbook is the result of tireless pursuit to develop an effective tool for imparting the Skill Based training in the most effective manner.

I would like to thank the team of KontentEdge for their support to develop the content, the SME and the team at the ESSCI along with the industry partners for the tireless effort in bringing the handbook in the current format.

Electronics Sector Skills Council of India

About this Book

This Participant Handbook is designed to enable training for the specific Qualification Pack (QP). Each National Occupational (NOS) is covered across Unit/s.
Key Learning Objectives for the specific NOS mark the beginning of the Unit/s for that NOS.

- Identify the role and responsibilities of an EMS technician
- Identify the components in PCB loading list
- List the maintenance tasks
- Select the soldering components as per specifications
- Identify the correct stencil
- Use Correct Screen and Design
- Work with the PCB as per Standards
- Inspect the PCBs using microscope
- Perform cleaning of stencil and other components
- Identify the importance of altering sheets in roller
- List the do's and don'ts for applying paste
- Demonstrate attaching stencils and securing of boards
- Check printing settings and parameters
- List the tasks to be accomplished for preventive maintenance
- Identify the maintenance schedule
- List the advantages and disadvantages to SMD
- List the ESD
- Execute visual inspection of PCB manufacturing
- Define work requirements
- Identify work behaviour
- Explain communication skills
- Identify the steps to effective listening
- List the components of PPE
- Explain electrostatic discharge (ESD)

The symbols used in this book are described below.

Symbols Used


Key Learning Outcomes


Steps


Role Play


Tips


Notes


Unit Objectives


Activity


Practical

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ESSCI

1. Introduction

Unit 1.1 – Introduction to EMS technician

Key Learning Outcomes

At the end of this module, you will be able

1. Identify the role and responsibilities of an EMS technician
2. Identify the qualifications required to be an EMS technician

UNIT 1.1: Introduction to EMS technician

Unit Objectives

At the end of this unit, you will be able to:

1. Identify the role and responsibilities of an EMS technician
2. Identify the qualifications required to be an EMS technician

1.1.1 Who is an EMS Technician

Electronics manufacturing services, known as EMS, is a term used for companies that are responsible for designing, manufacturing, testing, distributing and providing return or repair services for electronic components and assemblies on behalf of the original equipment manufacturers (OEMs). This concept is also known as electronics contract manufacturing or ECM.

An EMS technician works on Surface Mount Technology (SMT) machines, circuit boards and soldering equipment. S/he is responsible for the troubleshooting and maintenance of SMT equipment. S/he also helps in the assembly of the SMT equipment and its programming.

The following image shows an EMS technician working with a printed circuit board (PCB):

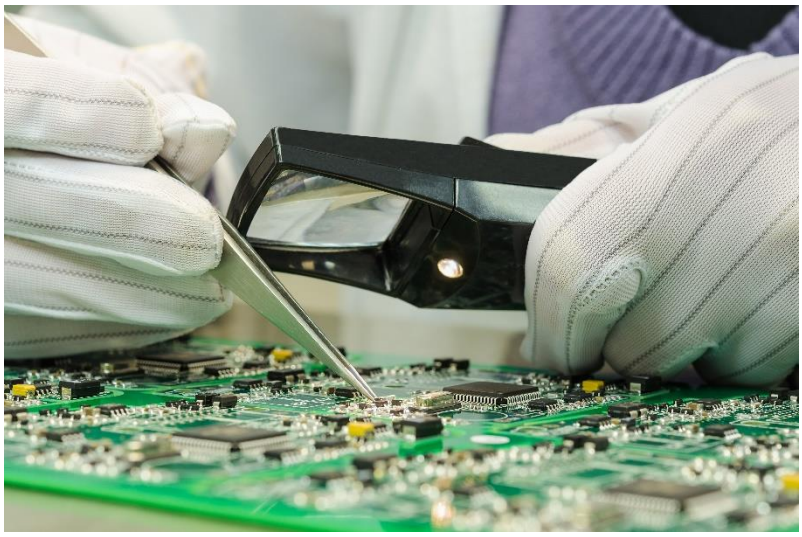

Fig. 1.1.1: An EMS technician working with a printed circuit board (PCB)

1.1.2 Role and Responsibilities of EMS Technician

An EMS technician monitors and maintains equipment that are used to create electronic circuits with SMT. In SMT, electronic components are mounted directly on circuit boards, which are then used in different industries. They also adjust equipment to achieve production schedules and quality control.

The following figure lists the responsibilities of an EMS technician:

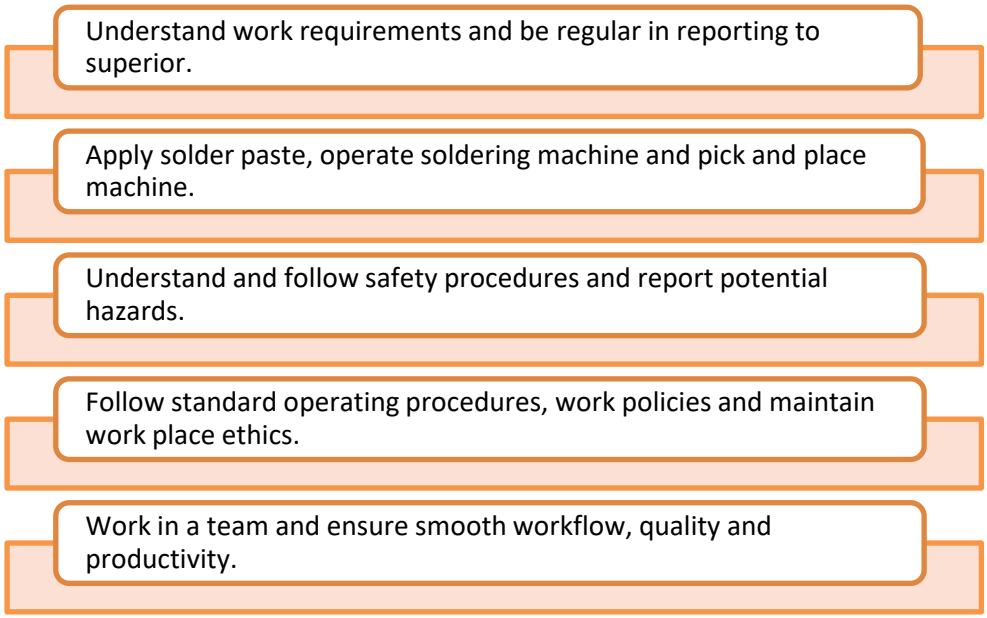

Fig. 1.1.2: Responsibilities of an EMS Technician

1.1.3 Pre-requisites for an EMS Technician

The job of an EMS technician involves working in a process driven environment. A good EMS technician must have the following qualities:

- Good eyesight
- Visual accuracy
- Attention to details
- Ability to work for long duration, mostly in a standing position

The EMS technician requires to possess some skills which are essential for his/her job. The following figure lists the skills required for EMS technician:

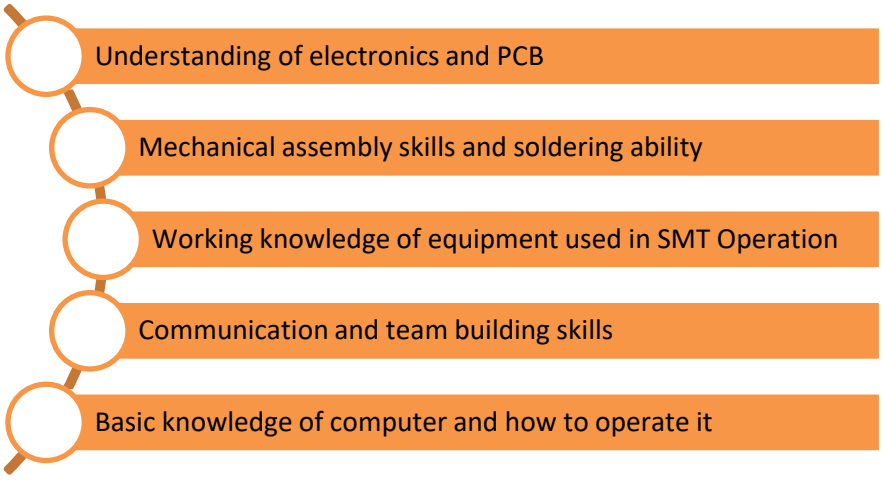

Fig. 1.1.3: Skills required for EMS technician

The technician must be qualified enough to be fit for the job role. The minimum qualification required is 12th standard, with science background or a degree of ITI/Diploma. Minimum age required for this role is 18 years. The individual should have adequate decision-making ability to take care of some problems such as:

- Repetitive defects
- Machine failure
- Potential hazards
- Process disruptions
- Repair and maintenance of machine

Activity

1. Write three responsibilities of an EMS technician apart from his job role.
   a. _____
   b. _____
   c. _____

2. List essential skills required for an EMS Technician.
   a. _____
   b. _____
   c. _____
   d. _____
   e. _____

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2. Operate Reflow Oven Soldering Machine

Unit 2.1 – Basics of PCB and Loading List

Unit 2.2 – Loading Program for PCB Assembly

Unit 2.3 – Reflow Oven Soldering Machine Operation

Unit 2.4 – Electro Static Discharge (ESD) Precaution and Contamination Prevention

Unit 2.5 – Maintaining Records

ELE/N5304

Key Learning Outcomes

At the end of this module, you will be able to:

1. Identify the components in PCB loading list
2. Explain the steps of PCB assembly process
3. Explain how to load program for the assembly process
4. Demonstrate the operation of reflow oven machine
5. Manage operating temperature, time profile and reflow settings
6. Inspect assembled boards before loading and the soldered boards after soldering process
7. List the causes of ESD and its effects on electronics
8. Apply correct measures for ESD protection
9. Explain contamination prevention practices
10. Manage the records for reflow operations

UNIT 2.1: Basics of PCB and Loading List

Unit Objectives

At the end of this unit, you will be able to:

1. Explain PCB and its types
2. Identify the components in PCB loading list

2.1.1 PCB

The first task for an EMS technician in his/her daily schedule is to check the PCB loading list. Hence, knowledge about PCB and its components is a must for the technician.

A PCB is the board found inside common electronic gadgets. It is used to support the electronic components mechanically and connect them electrically together by copper traces. All electronic devices such as mobile phone, radio, computer, key board, car dash board, video player, video games, calculator use PCBs. Connections between the components are created via copper connections called routes which become passage for electrical signals.

Generally, there are three types of PCBs: single-sided, double-sided and multi-layered. In the single-sided boards, the components are mounted on one side. The following image shows single-sided PCB:

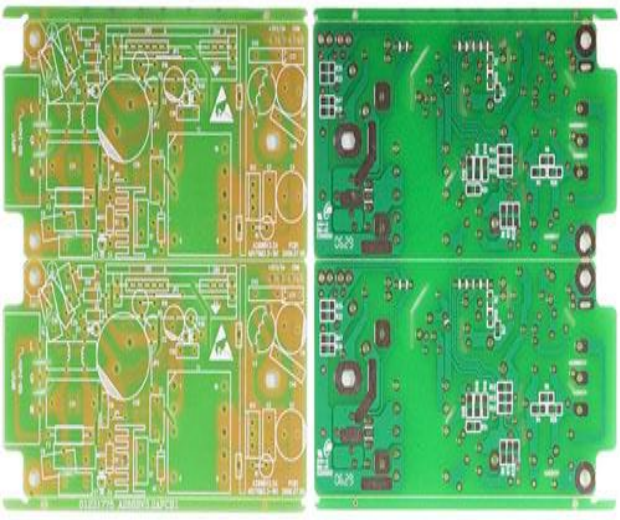


Fig. 2.1.1: Single-sided PCB

When, for a single-sided board, the number of components becomes too much or the circuits become complicated to be placed on a single sided board, double-sided boards are used.

The following image shows double-sided PCB:

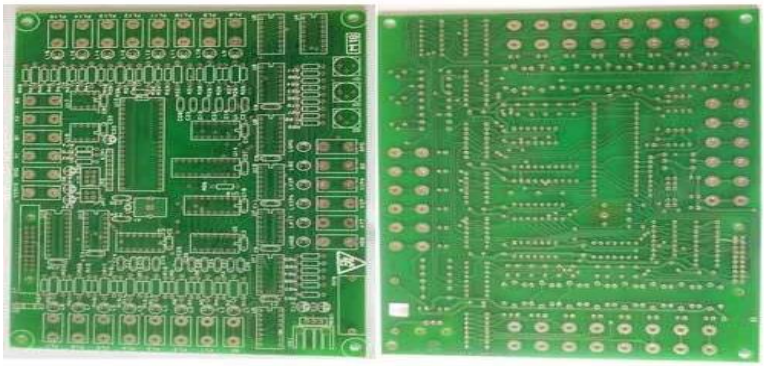
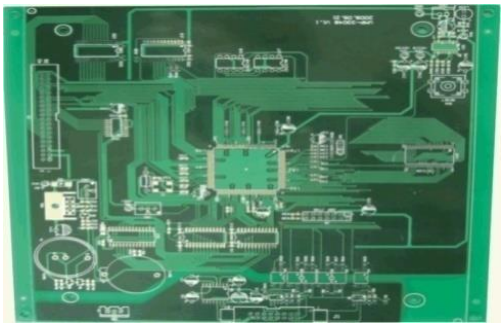


Fig. 2.1.2: Double-sided PCB

A multi-layered board consists layers of printed circuits that are separated by layers of insulation. The following images show a multi-layer PCB and its structure:



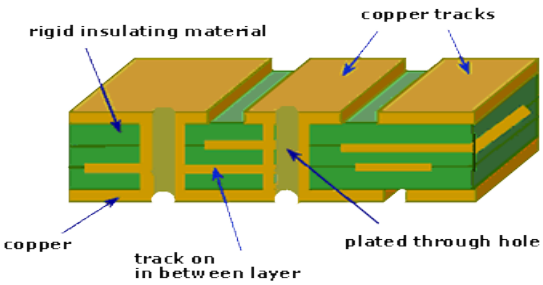
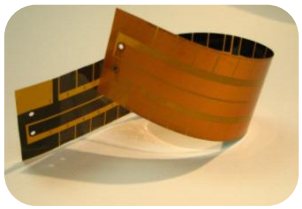
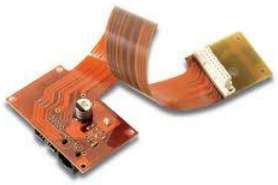


Fig. 2.1.3: Multi-layer PCB and its structure

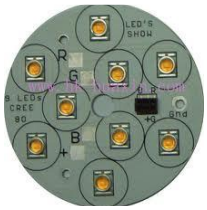
The following images show some other types of PCBs:



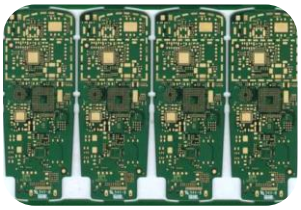
Single Side Flexible PCB



Rigid Flexible PCB



Metal Core PCB



Multi Layer PCB in Panel Form

Fig. 2.1.4: Different types of PCBs

2.1.2 PCB Loading List

The PCB loading list contains all the components that are required to be loaded on the PCB. Hence, it is essential to check the components and map them with the list. The technician must have knowledge about the electronic components so that they are loaded according to the requirement.

All the components including transistors, LEDs, ICs or any other electronic components should be mentioned in the loading list.

The electronic components are secured on the board by drilling holes in respective positions on board, placing the components through holes and then soldering them appropriately so that the components and the copper tracks together form a circuit. The following image shows a PCB loaded with electronic components:

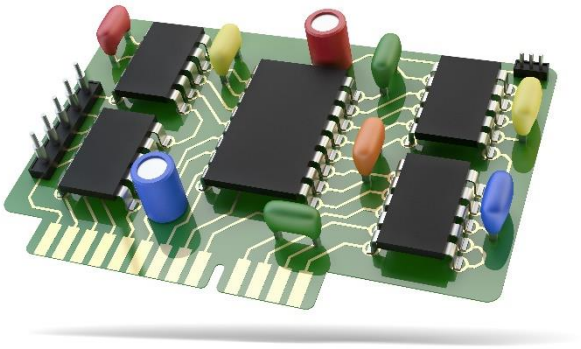


Fig. 2.1.5: Electronic components loaded on PCBs

Classification of Electronic Components

All electronic equipment are made using electronic components. Electronic components have two or more electrical terminals. These leads are then soldered to a PCB. An electronic component may be classified into active, passive or electro-mechanic. The following image shows different electronic components:

Fig. 2.1.6: Electronic components

Active Components

Active components are those which are capable of amplifying a signal or processing electrical signals. They derive power from a DC source. These include components such as transistors, diodes and so on.

Diode

A diode is a two-lead semiconductor acting as a one-way gate for the electron flow. A diode allows the current to pass only in one direction. The following image shows diode and its symbol:

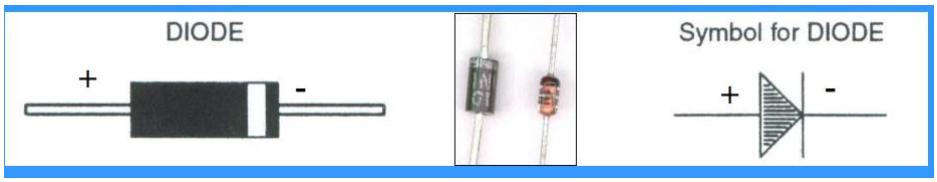


Fig. 2.1.7: Diode and its symbol

Light Emitting Diode (LED)

LEDs are used to give a visual feedback from our circuit; for example, to show that the circuit has power. These components are found everywhere, in laptop, on mobile phone, on camera, in car. Now a days, LEDs are also used for general lighting. The following images show LED and its symbol:

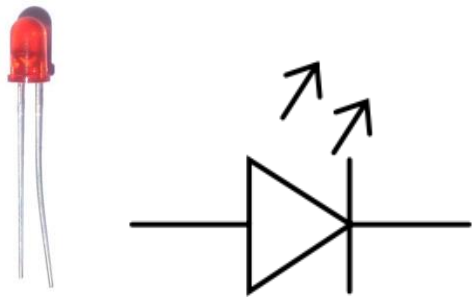


Fig. 2.1.8: LED and its symbol

Transistors

A simple way to understand a transistor is to look at it as a switch that is controlled by an electrical signal. But, instead of just two states, i.e. on or off, it can also have a state of being "a bit on" by controlling the current that goes through its base.

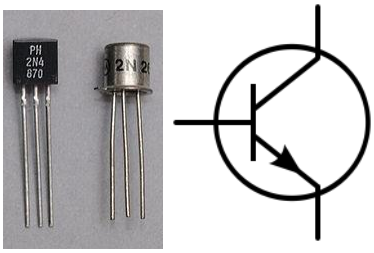


Fig. 2.1.9: Transistor and its symbol

A transistor is a three-lead semiconductor device which behaves as an electrically controlled switch, or a current amplifier. A small voltage or current applied at the control lead of a transistor, controls a larger current flowing through the other two leads. The following figure lists three types of transistors:

Bipolar Junction Transistor (BJT)	Junction Field Effect Transistor (JFET)	Metal Oxide Semiconductor FET (MOSFET)
 BJT	 JFET	 MOSFET
It is used in LED driver to control the current. The types of BJTs are: •NPN •PNP	It is used in LED Driver to control the voltage. The types of JFETs are: •N-channel •P-channel	It is also used for voltage control in LED driver. •Depletion type (n- and p-channel) •Enhancement type (n- and p-channel)

Fig. 2.1.10: Types of transistors

Integrated Circuit

An integrated circuit or monolithic integrated circuit (also referred to as an IC, a chip, or a microchip) is a set of electronic circuits on a single small chip of semiconductor material, normally silicon. ICs can be very compact, comprising up to several billion transistors and other electronic components in a small area. With advancement of technology, the width of each conducting line in a circuit is being made smaller and smaller. In 2008, the width dropped below 100 nanometers, and now it is tens of nanometers. The following image shows ICs:

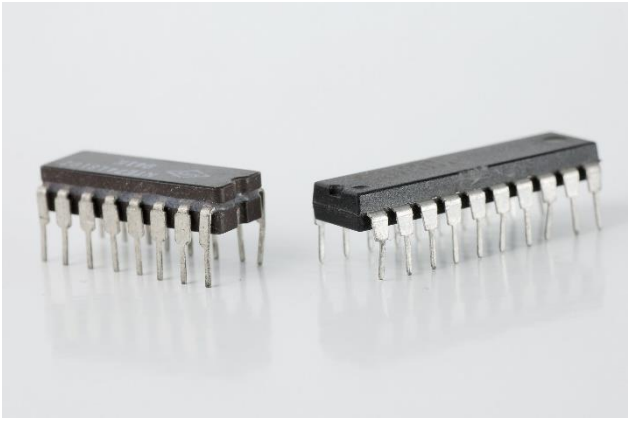


Fig. 2.1.11: ICs

The main advantage of ICs over discrete circuits is cost and performance.

- Cost is low as the chips are not made one transistor at a time, rather they are printed with all components as single units by photolithography. Moreover, packaged ICs use less materials as compared to discrete circuits.
- Performance is high as the components of the ICs switch quickly and consume less power than their discrete counterparts. This happens because of the close proximity and the small size of the components.

ICs are used in all electronic equipment such as c, mobile phones and other digital home appliances. This is made possible because of the low cost of integrated circuits.

An IC comprises of a number of basic electronic components. Essentially, an IC is an electronic circuit, fitted inside a chip. It may be an amplifier, a microprocessor, a USB to serial converter or anything.

Passive Components

Passive components are those which are not capable of amplifying electrical signal, although they may amplify the voltage or current like a resonant circuit or a transformer. Passive components include components with two-terminals, such as capacitors, resistors, inductors and transformers.

Resistor

A resistor is a passive two-terminal electrical component that implements electrical resistance as a circuit element. Resistors reduce the flow of current and lower the voltage level within the circuit. In electronic circuits, resistors are used for limiting current flow and adjusting signal levels. The following image shows a resistor and its symbol:

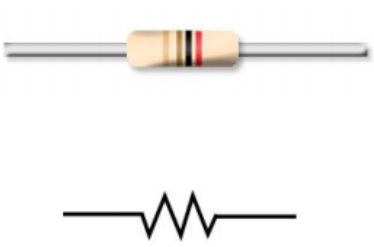


Fig. 2.1.12: A resistor and its symbol

High-power resistors with ability to dissipate many watts of electrical power as heat, are used as test loads for generators or as part of motor controls, in the power distribution systems. Resistance in the resistors with fixed resistances, may change slightly with time, temperature or operating voltage. Variable resistors can be used for adjusting the circuit elements; for example, as a lamp dimmer or a volume control, or as sensing devices for light, humidity, heat, force or chemical activity.

Resistance is measured in Ohms (Ω):

1000Ω = 1kΩ 1,000,000Ω = 1MΩ

Resistors are also rated by its power carrying capacity such as 1/4W, 0.5W, 1W, 5W etc.

Resistance Colour Coding Table

The following diagrams show colour coding table for the resistor colour codes:

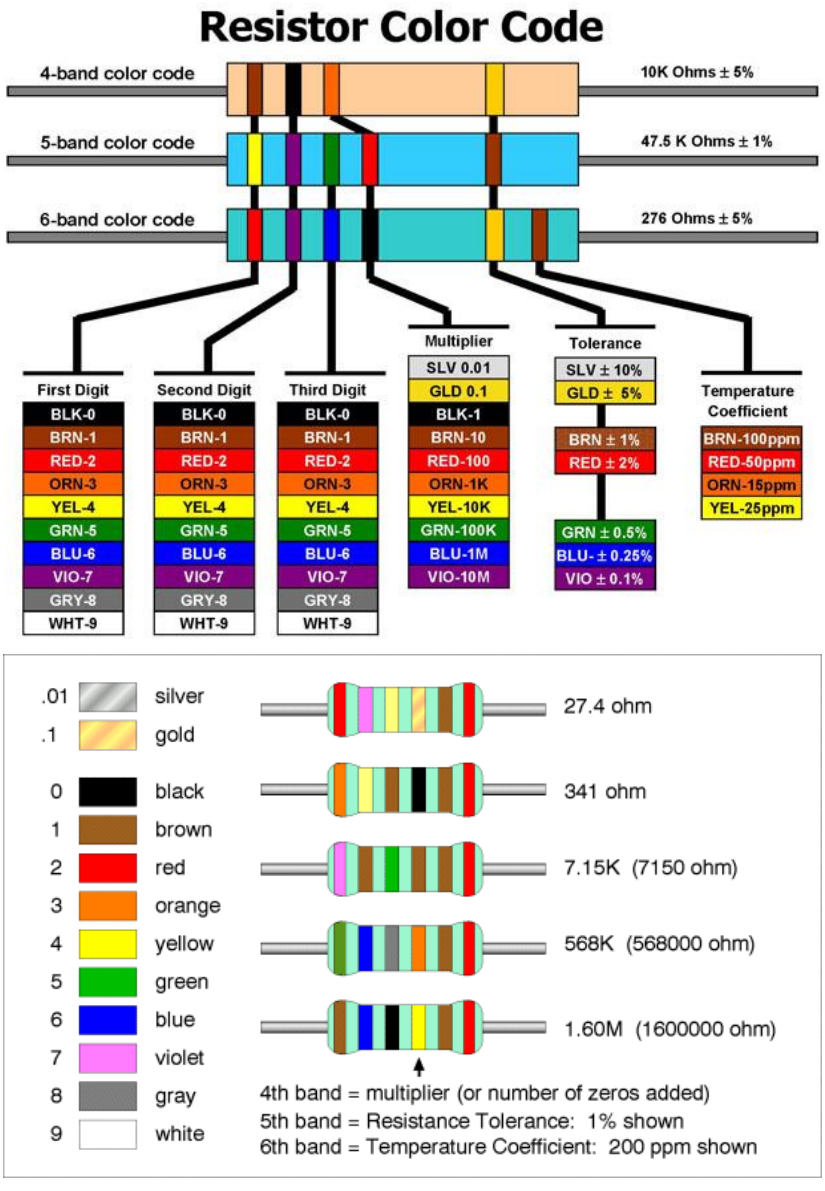


Fig. 2.1.13: Resistor colour code

Capacitor

A capacitor (originally known as a condenser) is a passive two-terminal electrical component used to store electrostatic energy in an electric field. All capacitors contain at least two electrical conductors (plate) separated by a dielectric (insulator). The conductors can be sintered beads of metal, thin films, foils or conductive electrolyte. The "non

conducting" dielectric is used to increase the charge capacity of the capacitor. A dielectric can be glass, air, ceramic, vacuums, paper, plastic film, mica, oxide layer etc. Capacitors are used in electrical circuits of common electrical devices. A capacitor stores energy, rather than dissipating energy, in the form of an electrostatic field between the plates. The following image shows a set of different capacitors:

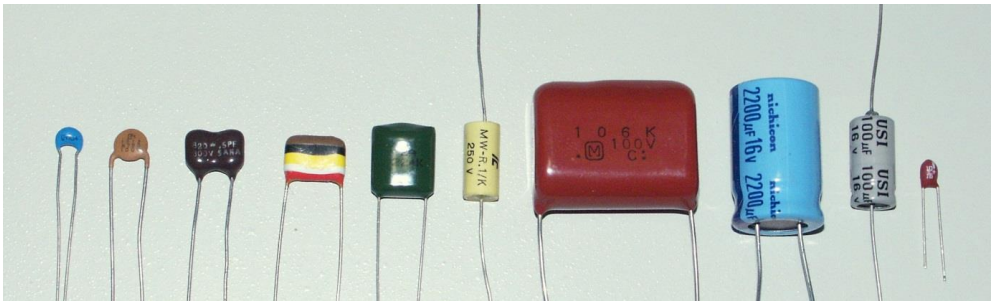


Fig. 2.1.14: Resistor colour code

It's commonly used to remove noise or make the circuit's supply voltage more stable. Capacitance is the ability of a capacitor to store electrical charge onto its two plates. Capacitance is measured in Farad (abbreviated to F).

Microfarad (µF) 1µF = 1/1,000,000 = 10^{-6} F

Nanofarad (nF) 1nF = 1/1,000,000,000 = 10^{-9} F

Picofarad (pF) 1pF = 1/1,000,000,000,000 = 10^{-12} F

The following figure lists two types of capacitors:

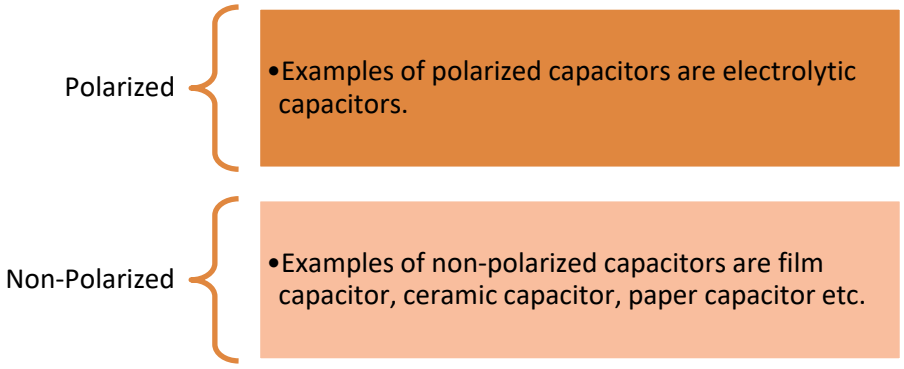


Fig. 2.1.15: Types of capacitors

Inductors

An inductor, also called a coil or reactor, is a passive two-terminal electrical component which resists changes in electric current flowing through it. It comprises of a conductor such as a wire wound into a coil. When a current passes through it, energy is stored temporarily in a magnetic field in the coil.

The following image shows inductors:

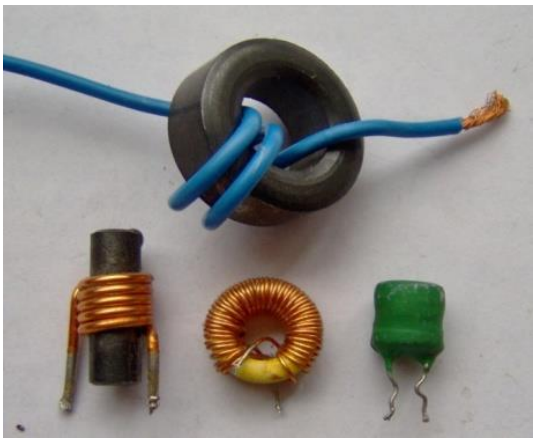


Fig. 2.1.16: Inductors

Inductance is the ratio of the voltage to the rate of change of current passing through the inductor. It is measured in henries (H). The value of inductors typically ranges from 1 µH (10^{-6}H) to 1 H.

Many inductors have a magnetic core made of ferrite or iron inside the coil, that serves to raise the magnetic field and thus the inductance. The following figure shows three types of inductors:

Fig. 2.1.17: Type of inductors

Inductors are widely used in alternating current (AC) electronic equipment, especially in radio equipment. They allow the DC to pass by blocking the AC current flow. Inductors, designed for this purpose, are called chokes. They are also used in electronic filters for the separation of signals of different frequencies. They are used to make tuned circuits along with capacitors.

Electromechanical Switches

These devices use electrical connections or moving parts to perform electrical operations. The devices that use moving parts for carrying out electrical operations, are known as electromechanical. A manually operated switch is an example of electromechanical component. The term, electromechanical, refers to devices such as relays, that enable a voltage or current to control other isolated voltages and currents by switching sets of contacts, solenoids, mechanically. Thus, it enables a voltage, actuate a moving linkage, vibrators, that convert DC in to AC with the help of vibrating sets of contacts.

The following image shows an electromechanical relay:

Fig. 2.1.18: Electromechanical relay

Activity

1. Write the measuring units of the following components.
   a. Resistor: _____
   b. Capacitor: _____
   c. Inductor: _____

2. List different types of PCBs.
   a. _____
   b. _____
   c. _____

3. Calculate the value of a 4-band resistor. The bands are as follow:
   - 1st band → Violet
   - 2nd band → Orange
   - 3rd band → Yellow
   - 4th band → Silver