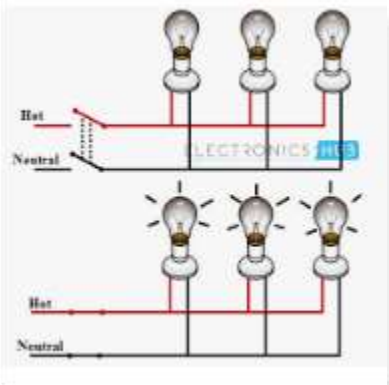
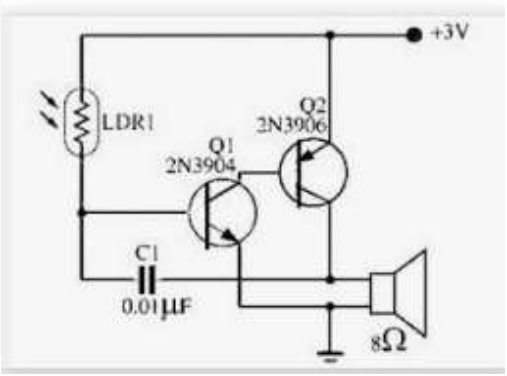
ELECTRICAL/ELECTRONICS EQUIPMENT SERVICING
Level – II

Based on April 2022, Curriculum Version 1





Module Title: Performing Electrical Wirings and Electronics Circuit

Module Code: EIS EEES2 M04 0322

Nominal duration: 120 Hours

Prepared by: Ministry of Lobar and Skill

August, 2022

Addis Ababa, Ethiopia

Table of Contents

Acknowledgement

Ministry of Labor and Skills wish to extend thanks and appreciation to the many representatives of TVET instructors and respective industry experts who donated their time and expertise to the development of this Teaching, Training and Learning Materials (TTLM).

Acronyms

AC..…… Alternating current

DC…… Direct current

OHS ……Occupational health and safety

LAP …… learning assistance program

LED……light emitting diode

PCB……printed circuit boar

ESD……electrostatic discharge

DMM……digital mustimeter

VOM……volt ohm meter

GFCI ……. Ground Fault Circuit Interrupter

Introduction to the Module

In Electrical/electronic equipment servicing filed; Performing Electrical Wirings and Electronics Circuit project helps to know termination/ connection of electrical wiring/electronics circuits, and interpret different kinds of electrical/electronic diagram, Terminate/ connect electrical wiring/electronic circuits and Test termination/ connections of electrical wiring/ electronics circuits.

This module is designed to meet the industry requirement under the Electrical/electronic equipment servicing occupational standard, particularly for the unit of competency: **Performing Electrical Wirings and Electronics Circuit**

Module units

- Electrical wiring/electronic circuit termination/connection
- Types of electrical/electronic diagrams
- Terminate and connect electrical wiring/electronic circuits
- Test termination/connections

Learning objectives of the Module

At the end of this session, the students will able to:

- Electrical wiring/electronic circuit termination/connection
- Types of electrical/electronic diagrams
- Terminate and connect electrical wiring/electronic circuits
- Test termination/connections

Module Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the information Sheets
4. Accomplish the Self-checks
5. Perform Operation Sheets
6. Do the “LAP test”

Unit one: Electrical wiring/electronic circuit termination/connection

This learning unit is developed to provide the trainees the necessary information regarding the following content coverage and topics:

- OH & S guidelines and procedures
- Tools and equipment
- Material inspection
- Termination/connection electrical wiring/electronic circuits

This unit will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Follow OH & S guidelines and procedures
- Select appropriate tools and equipment
- Check materials
- Pprepare electrical wiring/electronic circuits for connecting/termination

1.1. OH & S guidelines and procedures

Planning to perform a certain task in a safe manner. When planning work practices with colleagues it is important to keep the health and safety of workers at the forefront of issues to be considered. In workplaces where potentially dangerous machinery is operated, or dangerous situations are encountered, this is not difficult. However, when the potential threat is not so obvious, the health and safety factors may be overlooked. Poorly designed furniture, inadequate lighting, unstable filing cabinets or screens, poor ventilation, inappropriate workloads and much more can become OHS issues. When planning work practices; use the "what if" principle. Try to think of all the things that could go wrong and then what could reasonably be done to prevent them. You are not expected to eliminate risk entirely; this is not possible.

Safety Rules

There will undoubtedly be a safety program to follow for the shop or area in which you will be working. The following general safety rules are furnished as a guide.

- ✓ SUPPORT your local safety program and take an active part in safety meetings.
- ✓ INSPECT tools and equipment for safe conditions before starting work.
- ✓ ADVISE your supervisor promptly of any unsafe conditions or practices.
- ✓ LEARN the safe way to do your job before you start.
- ✓ THINK safety, and ACT safety at all times.
- ✓ OBEY safety rules and regulations-they are for your protection.
- ✓ WEAR proper clothing and protective equipment.
- ✓ CONDUCT yourself properly at all times-horseplay is prohibited.
- ✓ OPERATE only the equipment you are authorized to use.

REPORT any injury immediately to your supervisor

1.1.1. Purpose of OH &S

A health and safety policy ensures that the employer complies with the Occupational Safety and Health. Act and relevant state legislation. It provides guidelines for establishing and implementing programs that will reduce workplace hazards, protect lives and promote employee health.

1.1.2. An OHS Policy

An OHS Policy is simply a method of stating how you, your employees, contractors and visitors are expected to behave when they are on Company property or performing Company related activities. As an employer or responsible contractor, you are required by law to provide a safe system of work.

1.2. Tools and equipment

Selecting and checking appropriate materials, tools & equipment needed to perform termination/connection

1.2.1. Classification tools used for connecting/terminating wires

Splicing Tools

Pliers

Are made in various shapes and sizes and for many uses. Some are used for gripping something round like a pipe or rod, some are used for twisting wires, and others are designed to be used for a combination of tasks including cutting wire

Fig.1.1 pliers

Long Nose: It is used for holding, bending and stretching the lead of electronic component or connecting wire.

Fig.1.2 long nose

Side Cutter: It is a wire-cutting plier, though they are not used to grab or turn anything, but are used to cut wire

Fig.1.3. Side cutter

Insulation Removal

Wire Stripper. It is a pair of opposing blades much like scissors or wire cutters. The addition of a center notch makes it easier to cut the insulation without cutting the wire. This type of wire stripper is used by rotating it around the insulation while applying pressure order to make a cut around the insulation. Since the insulation is not bonded with the wire, it will be pulled easily at the end.

Fig.1.4. Wire stripper

A sharp knife: may be used to strip the insulation from a conductor. The procedure is much the same as for sharpening a pencil. The knife should be held at approximately a 60ºangle to the conductor. Use extreme care when cutting through the insulation to avoid nicking or cutting the conductor.

Fig.1.5.A sharp knife

Soldering Tools

Soldering Iron: It is a device used for applying heat to melt solder in attaching two metal parts. A soldering iron is composed of a heated metal tip and an insulated handle. Heating is often achieved electrically, by passing a current, supplied through an electrical cord, through a heating element. For electrical work, wires are usually soldered to printed circuit boards, other wires, or small terminals. A low-power iron (15-30 Watts) is suitable for this work.

Fig.1.6. Types of hand solders irons.

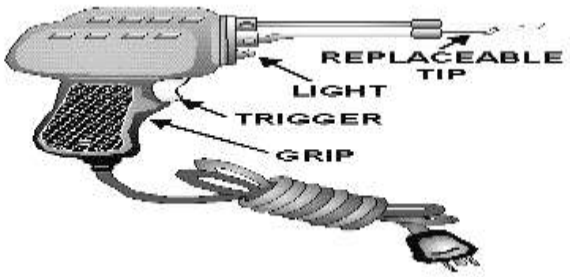


Fig.1.7. Soldering gun

http://www.youtube.com/watch?v=Sfb1Ve52ztY&NR=1

http://www.youtube.com/watch?v=COqGkYMOA44

http://www.youtube.com/watch?v=krxTfZCFptk&NR=1

Soldering Tool Stand: It is a place of the soldering iron to keep them away from flammable materials. The stand often also comes with a sponge and flux pot for cleaning the tip.

Fig.1.8. Soldering Tool Stand

De-soldering tool: It is used for the removal of solder and components from a circuit when troubleshooting, repair purposes and to save components. Electronic components are often mounted on a circuit board and it is usually desirable to avoid damaging the circuit board, surrounding components, and the component being removed.

Fig.1.9. De-soldering tool

Screwdrivers: Is a tool, manual or powered, for screwing (installing) and unscrewing (removing) screws. A typical simple screwdriver has a handle and a shaft, ending in a tip the user puts into the screw head before turning the handle. The shaft is usually made of tough steel to resist bending or twisting

Fig.1.10. Screwdriver

Multi-meter: Is a test tool used to measure two or more electrical values—principally voltage, current and resistance. multimeters combine the testing capabilities of single-task meters—the voltmeter (for measuring volts), ammeter (amps)& ohmmeter (ohms)

Fig.1.10. Multi-meter

https://www.youtube.com/watch?v=EFcwL22Ekok

https://www.youtube.com/watch?v=qFJXw2mLmf8

1.3. Material inspection

In order to make connection or termination of wires, firstly the specification of materials, tolls and equipment's needed should be checked. The importance of checking specification is that make connection/termination that meets the standard and also ensures safety.

This involves preparing for and receiving the materials according to defined procedures, and taking account of all health and safety requirements i.e. prepare your work area in readiness for the receipt of the materials which includes

- Ensuring accessibility for receipt and removal of the materials and ensuring the area is free from obstructions or potential hazards.
- Checking that materials conform to the relevant specification/s and that sufficient materials are available for the manufacturing operations being performed.
- Correcting any incorrect documentation, equipment, tools and / or materials within the limits of your responsibility, otherwise report promptly to the appropriate person

Receiving and checking incoming materials involves:

1. Working with minimum supervision
2. Preparation of work area for receipt of materials
3. Receiving materials
4. Confirming the status of the materials
5. Resolving problem within the limits of your responsibility
6. Completing any necessary documentation accurately and legibly
7. Working in ways which maintain the safety of yourself and others

1.3.1. Obtaining Materials necessary to complete the work

Remove and replace any of the following kinds of fittings, where the work does not involve work on any switchboard:

- **Soldering lead:**

Soldering lead is an alloy (mixture) of tin and lead, typically 60% tin and 40% lead. It melts at a temperature of about 200°C. Coating a surface with solder is called 'tinning' because of the tin content of solder. Lead is poisonous and you should always wash your hands after using solder.

Fig.1.11.Soldering lead

- **Wires and Cable**

A wire is a single slender rod or filament of drawn metal. This definition restricts the term to what would ordinarily be understood as solid wire. The word “slender” is used because the length of a wire is usually large when compared to its diameter. If a wire is covered with insulation, It is an insulated wire. Although the term “wire” properly refers to the metal, it is also including the insulation.

A cable is either a stranded conductor (single-conductor cable) or a combination of conductors insulated from one another (multiple-conductor cable). The term “cable” is a general one and usually applies only to the large sizes of conductor. A small cable is more often called a stranded wire or cored (such as that used for an iron or a lamp cord). Cables may be bare or insulated. Insulated cables may be sheathed (covered) with lead, or protective armor.

- **A conductor**: is a wire suitable for carrying an electric current.
- **A stranded conductor** is a conductor composed of a group of wire or of any combination of group of wires. The wires in a stranded conductor are usually twisted together and not insulated from each other.

Fig.1.12 stranded conductor

Basics for wire (Good intro) :
http://www.youtube.com/watch?v=BLfXXRfRIzY

- **Insulating materials**

Insulators are materials whose atoms have tightly bound electrons. These electrons are not free to roam around and be shared by neighboring atoms.

Insulators are used to protect us from the dangerous effects of electricity flowing through conductors.

List of Common some common insulator materials are

- Clay (ceramic)(porcelain) - This is the standard material for high voltage and RF insulators.
- Plastics – PVC and other plastics replaced rubber as an insulator for wires and other parts. PVC and nylon are now standard in most types of wire.
- Glass (silica, soda ash and limestone) - This material worked fine for telegraph and other low voltage apparatus. It is still used today to some degree.

- Paper/Cardboard – paper and cardboard are used as insulators in certain circumstances as these materials are cheap and can work in situations without high heat or high voltages.

- Mica - This is a good stable material even when exposed to the elements. It is a good thermal conductor while being an insulator. Sheet mica is easily stamped and shaped for electrical components. Mica is very important for the most common types of capacitors.

- **Soldering flux (paste)**

Flux is a cleaning agent to remove oxidation during soldering. Heating a metal causes rapid oxidation. Oxidation prevents solder from reacting chemically with a metal. Flux cleans the metal by removing the oxide layer.

Without flux most joints would fail because metals quickly oxidized and the solder itself will not flow properly onto a dirty, oxidized, metal surface.

Soldering flux performs three functions.

- It is an additional cleaning agent.
- It aids in tinning or coating the conductor when solder is applied.
- It ensures adhesion or connection of solder to the splice.

1.4. Termination/connection electrical wiring/electronic circuits

Preparing the circuits so that connection and termination can be taken easily and safely

Conductor splices and connections are an essential part of any electrical circuit. When conductors join each other or connect to a load, splices or terminals must be used. Therefore, it is important that they be properly made. Any electrical circuit is only as good as its weakest link. The basic requirement of any splice or connection is that it be both mechanically and electrically as sound as the conductor or device with which it is used. Quality workmanship and materials must be used to ensure lasting electrical contact, physical strength, and insulation.

Conductor Splices and Terminal Connections

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1.4.1. Insulation Removal

The preferred method of removing insulation is with a wire-stripping tool, if available. A sharp knife may also be used.

- **Stripping wire with a hand stripper**.
  - ✓ Insert the wire into the center of the correct cutting slot for the wire size to be stripped. The wire sizes are listed on the cutting jaws of the hand wire strippers beneath each slot.
  - ✓ After inserting the wire into the proper slot, close the handles together as far as they will go.
  - ✓ Slowly release the pressure on the handles so as not to allow the cutting blades to make contact with the stripped conductor. On some of the newer style hand wire strippers, the cutting jaws have a safety lock that helps prevent this from happening. Continue to release pressure until the gripper jaws release the stripped wire, and then remove.
- **Knife Stripping**

A sharp knife may be used to strip the insulation from a conductor. The procedure is much the same as for sharpening a pencil. The knife should be held at approximately a 60º angle to the conductor. Use extreme care when cutting through the insulation to avoid nicking or cutting the conductor.

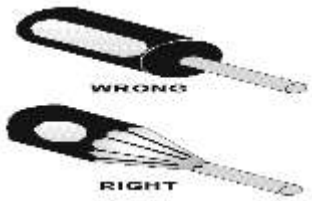


Fig.1.13 Knife Stripping

- **Wire Nut and Split Bolt Splices**

The wire nut is a device commonly used to replace the rattail joint splice. The wire nut is housed in plastic insulating material. To use the wire nut, place the two stripe

Conductors into the wire nut and twist the nut. In so doing, this will form a splice like the rattail joint and insulate itself by drawing the wire insulation into the wire nut insulation.

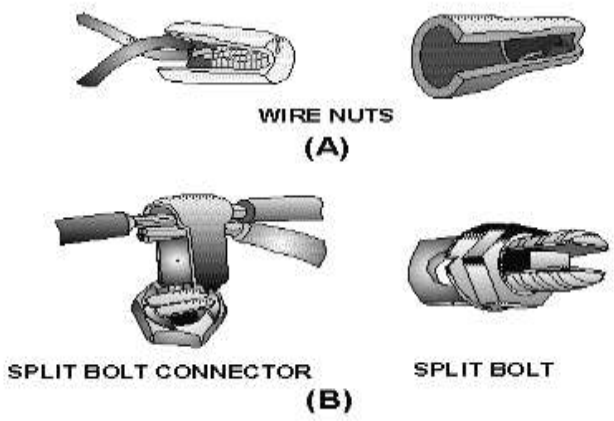


Fig.1.14 Wire Nut and Split Bolt Splices

The split bolt splice (view B) is used extensively to join large conductors. In the illustration, it is shown replacing the knotted tap joint. The split bolt splice can also be used to replace the "butted" splices mentioned previously when using large conductors.

- **Splice insulation**

The splices we have discussed so far are usually insulated with tape. The following discussion will cover some characteristics of rubber, friction, and plastic insulation tapes

- **Rubber Tape**

Latex (rubber) tape is a splicing compound. It is used where the original insulation was rubber. The tape is applied to the splice with a light tension so that each layer presses tightly against the one beneath it. This pressure causes the rubber tape to blend into a solid mass. Upon completion, insulation similar to the original is restored.

In roll form, there is a layer of paper or treated cloth between each layer of rubber tape. This layer prevents the latex from fusing while still on the roll. The paper or cloth is peeled off and discarded before the tape is applied to the splice.

The rubber splicing tape should be applied smoothly and under tension so no air space exists between the layers. Start the first layer near the middle of the joint instead of the end. The diameter of the completed insulated joint should be somewhat greater than the overall diameter of the original wire, including the insulation.

- **Plastic Electrical Tape**

Plastic electrical tape has come into wide use in recent years. It has certain advantages over rubber and friction tape. For example, it can withstand higher voltages for a given thickness. Single thin layers of certain plastic tape will withstand several thousand volts without breaking down. However, to provide an extra margin of safety, several layers are usually wound over the splice. The extra layers of thin tape add very little bulk. The additional layers of plastic tape provide the added protection normally furnished by friction tape.

- **Terminal Lugs**

Since most cable wires are stranded, it is necessary to use terminal lugs to hold the strands together to aid in fastening the wires to terminal studs . The terminals used in electrical wiring are either of the soldered or crimped type. Terminals used in repair work must be of the size and type specified on the electrical wiring diagram for the particular equipment

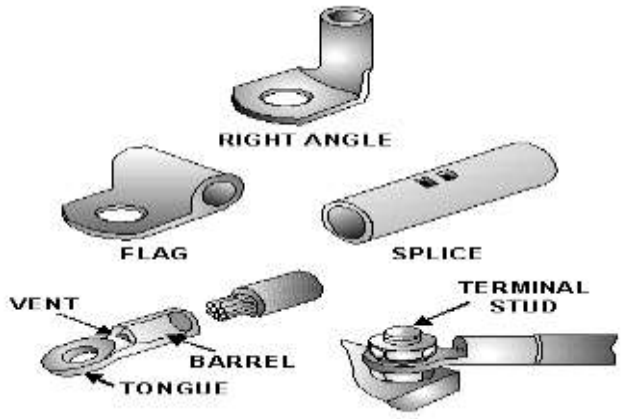


Fig.1.15 Terminal Lugs

- **Soldering**

A solder type connection allows for a strong, solid mechanical and electrical connection. Clean the connection well. For electrical circuits you must use a rosin type flux to clean all connections. Do not use acid flux that is commonly used for plumbing installation. The acid based flux will cause corrosion and inherently cause intermittent problems with the electrical signal. The choice of solder is also important. Using a solder standard 60/40 formula will meet the majority of your soldering needs. However, lead-free and high-grade silver solder is available for special applications. Also, use a soldering iron of the proper wattage. If the soldering iron is not hot enough, you may not be able heat the connection enough to get a good solder joint. This may cause what is known as a "cold" solder joint and can cause intermittent problems like opens to occur. However, if the soldering iron is too hot, you can cause damage to the components of the system near the connection. This can also cause the insulation to possibly melt causing the bare primaries to make contact with each other resulting in a short.

- **Tinning Copper Wire and Cable**

Wires to be soldered to connectors should be stripped so that when the wire is placed in the barrel; there will be a gap of approximately 1/32 inch between the end of the barrel and the end of the insulation. This is done to prevent burning the insulation during the soldering process and to allow the wire to flex easier at a stress point. Before copper wires are soldered to connectors, the ends exposed by stripping are tinned to hold the strands solidly together. The tinning operation is satisfactory when the ends and sides of the wire strands are fused together with a coat of solder. Do not tin wires that are to be crimped to solder less terminals or splices.

Self-check-1

Test-I Choose

Instruction**: Say true or false. (4point)**

_____1. Goal of OHS programs include fostering a safe and healthy work environment

_____2. Planning to perform a certain task in a safe manner

_____3. INSPECT tools and equipment for safe conditions before starting work.

_____4 ADVISE your supervisor promptly of any unsafe conditions or practices.

Test-II Match

Instruction: Match the different hand tools with their actual pictures. Write the letter on a separate sheet. (6point)

____1.Desoldering Sucker
____2. Soldering Stand
____3. For cutting wires
____4.For soldering metal
____5. Long Nose Pliers
____6. Wire Splicer

Test-III Fill the blank

Instruction: Fill in the blank with term referred by each of the following (6 point)

1. _____is a single slender rod or filament of drawn metal. .
2. _____ is a wire suitable for carrying an electric current.
3. _____is a conductor composed of a group of wire or of any combination of

Operation sheet-1

Operation Title: Conductor Splices and Terminal Connections

Purpose: To Conductor Splices and Terminal Connections

Instruction: Using the given equipment to Conductor Splices and Terminal Connections. You have given 60Minut to do the task.

Tools and requirement

- ✓ Insulation Removal
- ✓ Utility knife/stripper
- ✓ Tinning Copper Wire and Cable
- ✓ Pliers (assorted)
- ✓ wire

Procedures:

Step 1- Follow the safety procedure

Step 2- Gather all the materials needed.

Step 3- Prepare the wires for splicing. Removed about 30 mm of insulation along the run wire and about 75 mm at the end of the tap wire. Enough insulation is removed to make the splice. The conductor is cleaned.

Step 4- Bring the wires to a crossed position and make a long twist or bend in each wire.

Step 5- Wrap one end of the wire and then the other end four or five times around the t main branch portion of each wire.

Step 6- Press the ends of the wires down as close as possible to the main branch portion of the wire. This prevents the sharp ends from puncturing the tape covering that is wrapped over the splice.

Step 7- Covering that is wrapped over the splice by soldering technique

Quality Criteria: use service manuals and service information for maintenance.

Precautions: use the given necessary tools, test instruments.

LAP Test -1	Installing wiring system

Name: _____ Date: _____

Time started: _____ Time finished: _____

Instruction I: Given necessary templates, tools and materials you are required to perform the following tasks within 4hours.

Task-1 Perform western union splice

Task-2 Solder the Project

Task-3 Wrap with Insulation Tape

Unit two: Types of electrical/electronic diagrams

This learning unit is developed to provide the trainees the necessary information regarding the following content coverage and topics:

- Electrical/electronic diagram
- Interpret electrical symbols
- Electrical/electronic diagrams by types and kinds.
- Circuit diagrams and standard operating
- Electrical/electronic schematic

This unit will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Selecting correct electrical/electronic diagram
- Identifying and interpreting electrical Symbols
- Segregating electrical/electronic diagrams by types and kinds.
- Checking and validating circuit diagrams standard operating procedures
- Drawing and identifying electrical/electronic schematic

2.1. Electrical/electronic diagram

Electronic prints fall into two basic categories, electronic schematics and block diagrams. Electronic schematics represent the most detailed category of electronic drawings. They depict every component in a circuit, the component's technical information (such as its ratings), and how each component is wired into the circuit. Block diagrams are the simplest type of drawing.

As the name implies, block diagrams represent any part, component, or system as a simple geometric shape, with each block capable of representing a single component (such as a relay) or an entire system. The intended use of the drawing dictates the level of detail provided by each block. This chapter will review the basic symbols and conventions used in both types of drawings.

2.2. Interpret electrical symbols

Of all the different types of electronic drawings, electronic schematics provide the most detail and information about a circuit. Each electronic component in a given circuit will be depicted and in most cases its rating or other applicable component information will be provided. This type of drawing provides the level of information needed to troubleshoot electronic circuits.

Electronic schematics are the most difficult type of drawing to read, because they require a very high level of knowledge as to how each of the electronic components affects, or is affected by, an electrical current. This chapter reviews only the symbols commonly used in depicting the many components in electronic systems. Once mastered, this knowledge should enable the reader to obtain a functional understanding of most electronic prints and schematics.

Figure 2.1 and Figure 2.2 illustrate the most common electronic symbols used on electronic schematics.

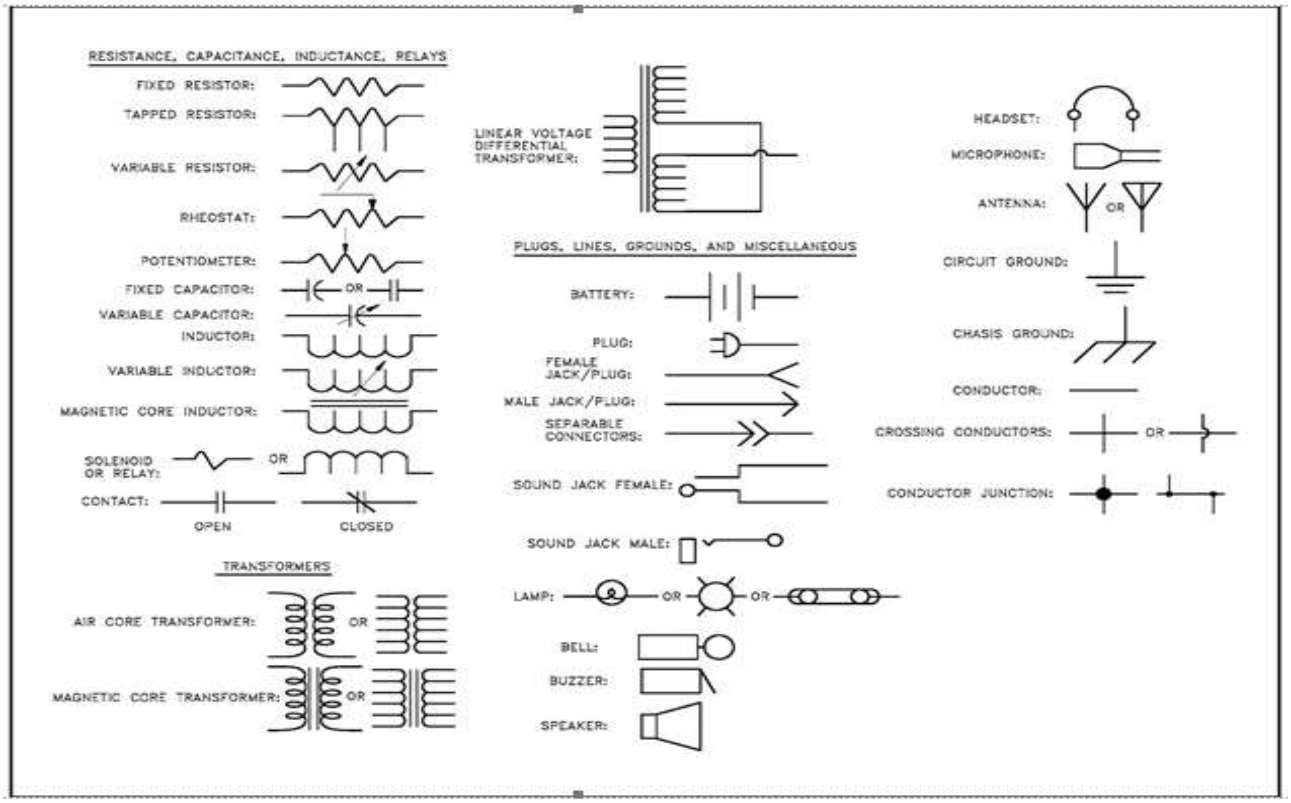


Figure 2.1 electronic symbols

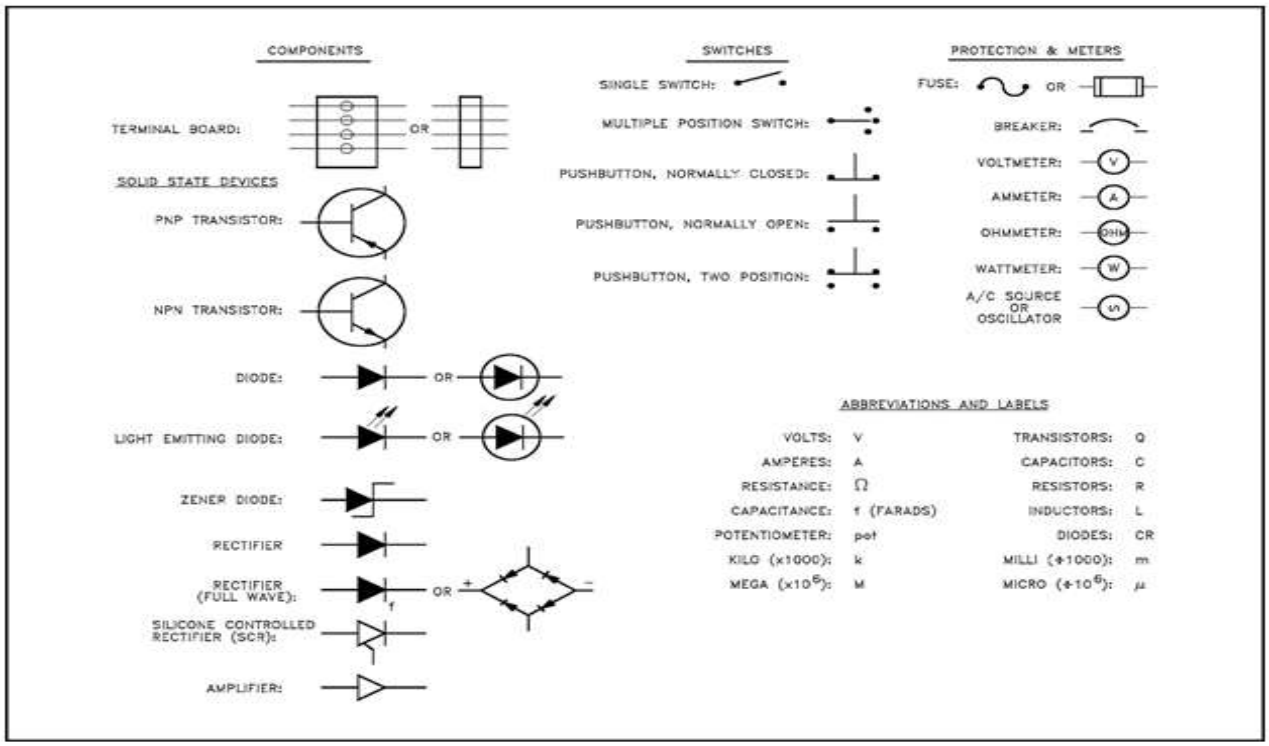


Figure 2.2 electronic schematics.

2.3. Electrical/electronic diagrams by types and kinds.

Electrical diagrams can be used to make new electrical installations and they can be used to locate electrical problems and it will also be helpful to modify the existing circuit. Electrical diagrams are used to troubleshoot the problems and to make sure that all connections are correct

2.3.1. Wiring diagram

A wiring diagram is drawn by using symbols, these symbols represent the devices of an electrical control panel. It shows the wiring between the components the lines represent the wires and they are marked with numbers or letter-number combinations. Wiring diagrams are used by the equipment manufacturers to install wires in electrical equipment such as switchboards and panels. The wiring diagram shows the interconnection wiring between the electrical equipment. These diagrams show the functional device in their correct relative physical locations. Lines are used to representing the single conductors, multiple conductors that are installed in the same channel are shown as a single line with radial branches and the representation of the conductor is labeled with an identifying number.

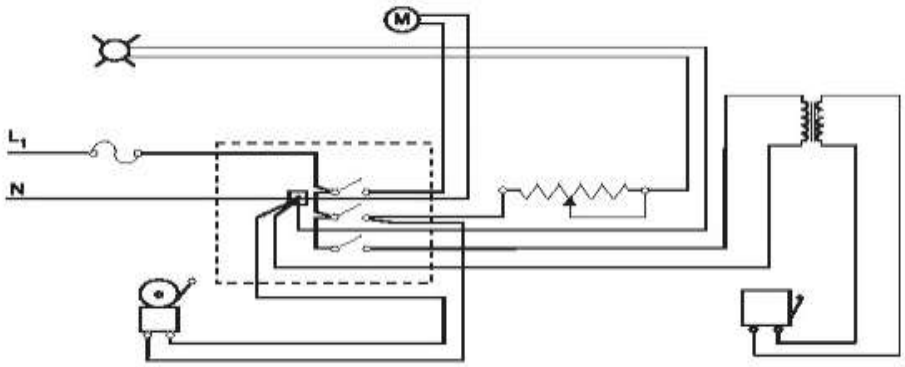


Figure 2.3 wiring diagram

2.3.2. Single line diagram

It is also known as one-line diagram which is mostly used in an industrial power system. Mostly single line diagrams are used to represent the complex power system, these diagrams will show all the electrical components in the power system and their interconnections. Single line diagrams can be used to determine the power system problems it can be useful to determine which circuit interrupters must be opened to safely isolate the electrical apparatus.

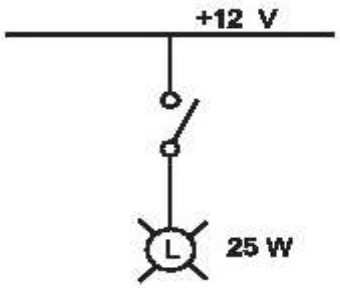


Figure 2.4 Single line diagram

2.3.3. Three-line diagram

Three line diagrams are used to get the detailed information which is related to three-phase circuitry, which can't be seen in a single line diagram. These diagrams will be helpful for the plant maintenance and the operation personnel could understand the power system operations very easily. The three-line diagrams use the same symbol as the single line diagram to represent the power system components it also has some additional symbols which are used in schematic and wiring diagrams. These diagrams will show every conductor of a power circuit as an individual line.

2.3.4. Schematics diagram

The schematic diagram uses lines and symbols to show how the parts of an electrical unit are connected. It doesn't show where the parts are located but with the help of this diagram, we could do the electrical connections. This diagram shows the internal connection and circuit element in an arrangement which will allow the technician to interpret the function and operational logic of an electrical control unit. These diagrams have symbols that are seen in a single line, three-line, and wiring diagrams it will show all terminals and connections of functional devices.

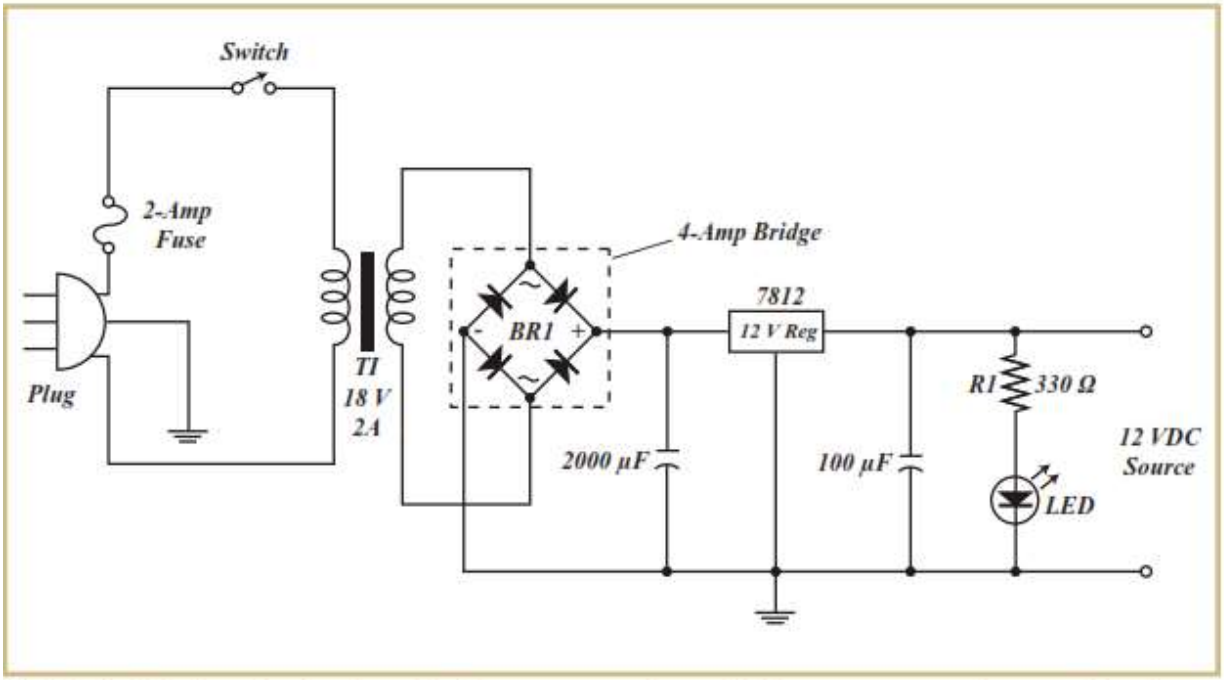


FIGURE 1—This is a simple schematic of a power supply, containing some commonly encountered symbols.

Figure 2.5 Schematics diagram

2.4. Circuit diagrams and standard operating

Circuit drawing (diagram): a simplified conventional graphical representation of an electrical circuit. Electronic schematics use symbols for each component found in an electrical circuit, no matter how small. The schematics do not show placement or scale, merely function and flow. From this, the actual workings of a piece of electronic equipment can be determined. Figure 3 is an example of an electronic schematic diagram.

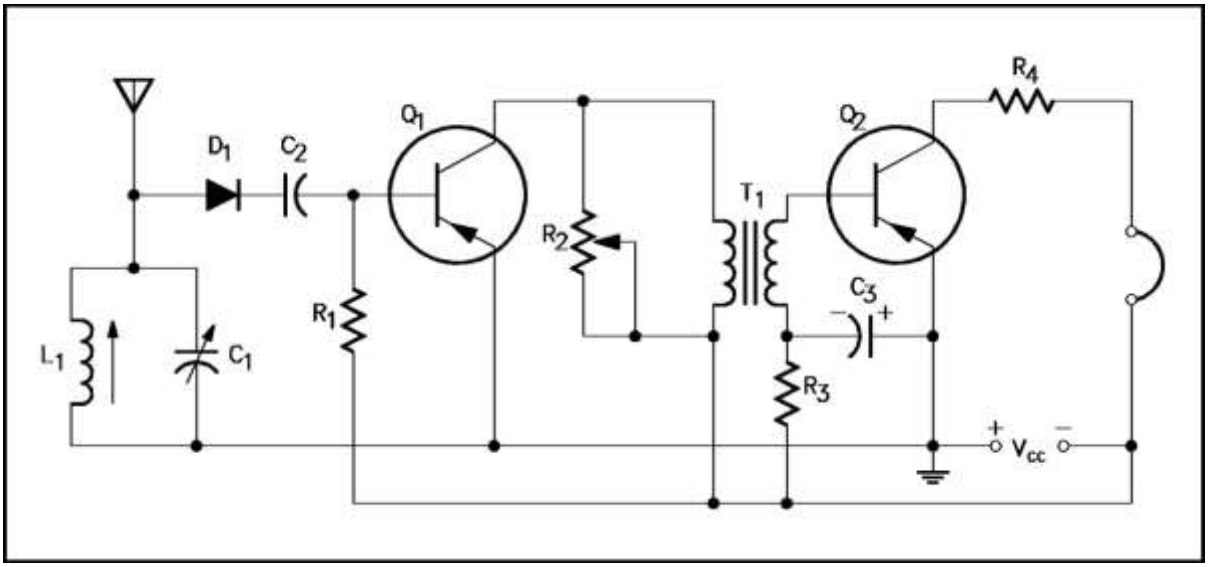


Figure 2.5 Circuit diagram

2.5. Electrical/electronic schematic

Internal schematic –This diagram will only show the internal circuits of a single physical device

External schematic diagram – These diagrams will show the internal circuit of the physical device and it will also show the external circuits that conduct input and output signals into and out of the devices.

Ladder diagram

These diagrams are specialized schematics which is commonly used to document industrial control logic systems. These diagrams are most commonly used for understanding and designing

system control logic. A ladder diagram is a top-down logical line schematic because it moves from power input at the top through sequential operations. Ladder diagrams are used to draw relay control circuits, ladder diagram is different from the wiring diagram because the ladder diagram is more schematic and shows each branch of the circuit on a separate horizontal row. These diagrams will describe the function of each branch and the resulting operations. Ladder diagrams have two vertical lines the left one is connected to the voltage source and the right one to the ground. In the vertical lines, a set of horizontal rows represents different branches of the control circuit.

Elementary diagrams

These diagrams will show all the operational elements and all of the circuits of a complete electrical control system. It is also used to represent the complete control circuit of an electrical sub-station.

Logic diagram

It shows the logic for complex circuits, processes, or devices it uses block type and standardized logic-function symbols to represent highly complex functions that are performed either by integrating processing modules or by individual devices. These diagrams will be useful to the users to understand the related logic function of the device without the specific knowledge of their internal operations. These diagrams use blocks and logic function symbols to represent complex functions and every block will contain a logic symbol that describes the function of the block. Straight-line represents the path of process control signals. The points were these signal paths enters and leaves the block is the input and output signals of the block.

Riser diagram

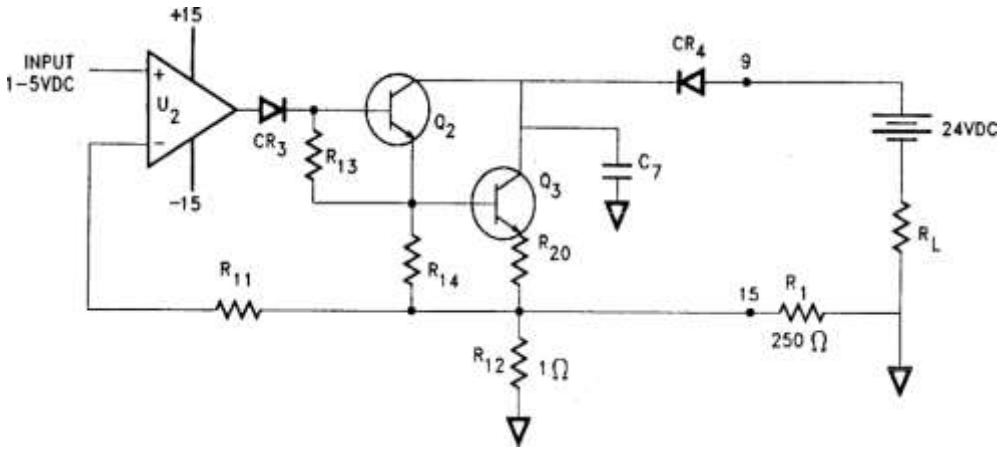
Riser diagram is a single line diagram that shows the entire electrical circuit from the service entrance up to the smallest circuit branch. It shows the size of wire in each branch, size of the service entrance conductors and the conduit and size of the protective device for the main circuit breaker and each branch. It got the name riser diagram because it shows the path of wiring or raceways from one level of the building to the other, it won't show the location of the equipment in a room or area. These diagrams are used because they are easy to understand

Self-check-2

Test-I Fill in the blanks.

1. A _____ is used to show the function and connections of different parts of a circuit.
2. A square block labeled U2 on a schematic is probably a(n) _____.
3. The _____ is used to show the physical location of the wires and components in the equipment.
4. In schematics, outputs are usually on the _____ side of the drawing.
5. A capacitor next to the diode bridge in a power supply is marked C1 1000 50 V. The capacitance value of this component is _____ microfarads.
6. A transformer that has a turns ratio of 2:1, primary to secondary, with an input voltage of 230 V, will have an output voltage on the secondary of _____.
7. Switches in schematics are always shown in the _____ state.

Test-II Refer to Figure to answer the following



a. How many resistors are there in the circuit?

b. How many transistors are there? and are they PNP or NPN transistors?

c. What is CR_4?

d. How many power supplies are there feeding the circuit and its components?

e. How many capacitors are in the circuit?

f. Q_2 will conduct when the output of U_2 is a positive or negative voltage?

Test-III Matching

Instruction: select the correct answer for the give choice

For questions 8 through 15, match the description with the letter corresponding to the correct symbol in the following figure. (*Note:* Not all of the letters will be used.)

_____ 8. Chassis ground

_____ 9. Variable resistor

_____ 10. Air-core transformer

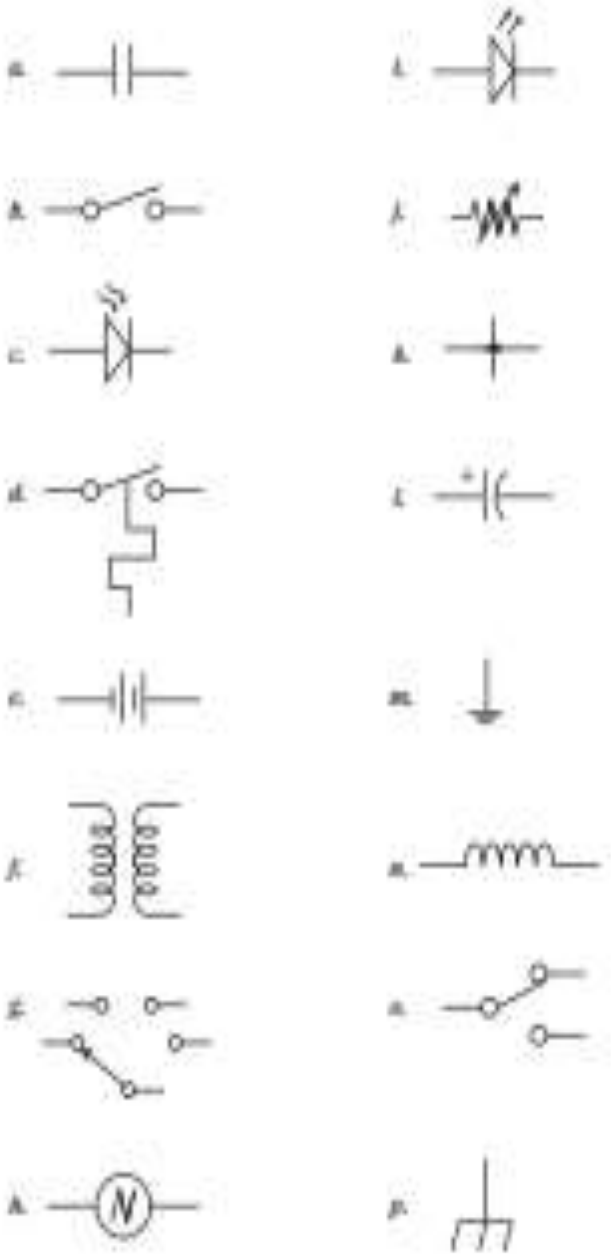
_____ 11. Single-pole, double-throw switch

_____ 12. Thermal switch

_____ 13. DC voltage source

_____ 14. Inductor

_____ 15. Polarized capacitor



Unit Three: Terminate and connect electrical wiring/electronic circuits

This learning unit is developed to provide the trainees the necessary information regarding the following content coverage and topics:

- Safety procedures
- Termination and connection
- Correct sequence of operation
- Termination/connection

This unit will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Observe Safety procedures
- Use methods of termination and connection
- Follow correct sequence of operation
- Task confirmation of termination/connection

3.1. Safety procedures

- **Clothing:** provides protection from electric arcing/flash burns, flying objects and electric Shock. Ideally, clothing should cover the body completely.
- **Safety helmets**: should be non-conductive. They provide protection from overhead wires, Structures and falling objects.
- **Safety glasses**: provide protection from electrical arcing and flying objects.
- **Insulating gloves**: provide protection from electric shock. They should be worn when Accidental contact with live conductors is possible, but they must never be the sole means of insulation.
- **Safety footwear**:- should be non-conductive. It provides protection from electric shock and falling objects.

Fig.3.1. types of PPE

3.1.1. OHS policies /Occupational Health and Safety

Occupational health and safety can be important for moral, legal, and financial reasons. In common-law Authorities, employers have a common law duty (reflecting an underlying moral obligation) to take reasonable care for the safety of their employees.

The goals of occupational safety and health programs include fostering a safe and healthy work environment. OHS may also protect co-workers, family members, employers, customers, and many others who might be affected by the workplace environment.

Health, safety and welfare legislation has increased the awareness of everyone to the risks involved in the work- place.

The employer has a duty to care for the health and safety of employees. To do this he must ensure that:

- The plant, tools and equipment are properly maintained.
- The necessary safety equipment – such as personal protective equipment, dust and fume extractors and machine guards – is available and properly used;
- The workers are trained to use equipment and plant safely.
- Take reasonable care to avoid injury to themselves or others as a result of their work activity.

3.1.2. Personal Protective Equipment

Your employer is required to provide personal protective equipment. Some of the items of PPE you may use in the electrical and electronics industry are given below.

Table 3.1:- Safety Equipment

No.	Equipment	Description	Picture
1	Hard hat	used in workplace environments such as industrial or construction sites to protect the head from injury due to falling objects	
2	Safety shoes	Protective, safety footwear is essential to ensure safe and healthy feet.	

3	Gloves	Are rubber insulating gloves worn by hands to provide the mechanical protection needed against cuts, abrasions, punctures and electrical injuries	
4	Fire extinguisher	Are commonly sold at hardware stores for use in the kitchen or garage, are pressurized with nitrogen or carbon dioxide (CO_2) to propel a stream of fire-squelching agent to the fire.	

3.2. Termination and connection

A pin connection: works essentially like a lapped joint. It transfers vertical and horizontal shear loads and cannot resist any bending or moment (rotational) forces. Many pin connections might look like they are designed to rotate but do not actually function as points of rotation for the structure.

A clamp: is a fastening device used to hold or secure objects tightly together to prevent movement or separation through the application of inward pressure.

Plugs: a device for making an electrical connection between an appliance and the mains, consisting of an insulated casing with metal pins that fit into holes in a socket.
"the cable is fitted with a two-pin plug"

Soldering: is a process in which two or more items are joined together by melting and putting a filler metal (solder) into the joint, the filler metal having a lower melting point than the adjoining metal.

3.2.1. Basic methods in electrical termination/connection

Electrical terminations may be made up by one of four basic techniques:

1. Soldering,
2. Welding,
3. Mechanical Joining, or
4. Dlf-fusion bonding.

They may also be generally classified as (I) permanent joints, in which one or more lead ends must be destroyed to separate them;(2) seml-permanent joints, in which special tools are required to separate the two leads, which may then be rejoined, and (3) quick-disconnect joints, such as plug-in connectors.

Soldering Methods

Solder joints made by hand one at a time with a heated soldering iron comprise the most widely known methods used for electrical terminations. However, reliable soldering is a complex process in which consideration must be given to the materials to be soldered, fluxes, solder composition, joint preparation, heating time and temperature, contamination, amount of solder and flux, post cleaning and many other factors. Solder Joints of a quality satisfactory for many applications need not consider all these factors in great detail, and unfortunately many people believe that "anybody can make a solder Joint."

There are three basic classifications of soldering

Soft Solder is Common

The soft-soldering process is common in the electronics and plumbing industries. This method creates electrical connections and bonds electronic components onto circuit boards. It is also used to join copper pipe and connectors. Solder used in the soft-soldering process for electronics is often made of a mixture of tin and other types of metal. To ensure a tight fit when bonding plumbing, add an acid substance, called flux, to ensure the solder connects the pipes. Soft soldering uses either an electric or gas-powered soldering iron in most cases. The bond created via this method is weaker than the bond created with some other forms of soldering.

Hard Solder is Stronger

Hard soldering creates a stronger bond compared to soft soldering and involves higher temperatures to melt the solder material. This material is normally brass or silver and requires the use of a blowtorch to melt. Use hard soldering with silver solder when joining pieces of copper, brass or silver.

Brazing Involves High Temperatures

Brazing involves a solder material that melts at a higher temperature compared to soft and hard soldering. Brazing is similar to hard soldering because the pieces of metal being bonded together are heated, but not melted, during the bonding process. Once you have the base metals heated,

place solder material, called brazing filler metal, between the surfaces, It instantly melts. the joint between the base metals through a process called capillary action.

Soldering the joint

- Clean the iron tip on the damp sponge.
- Melt a little solder on the tip of the iron. This helps to transfer the heat to the joint.
- Touch both parts to be soldered
- Wire and pin.
- Feed the solder in from the opposite side. It will melt & quickly flow around the joint.
- Remove the solder before the iron.
- It should take about three seconds to heat, melt

Welding Methods

A complete survey of welding methods was made, including some methods not generally considered usable for small electrical terminations. The purpose of including the latter methods was to investigate the possibility of modifying or adapting them for small electrical terminations.

3.2.2. Mechanical Terminations

Mechanical terminations include

- wire wraps,
- crimped connections in many variations,
- the Term-point clamp,
- the taper tab or pin, and
- spring-loaded mechanical clips.

Most of the mechanical terminations have the disadvantage of requiring more space than other types. This space requirement is due either to physical size of the termination elements, or to space required around the termination for the tools used to make the joint.

The wire wraps method, however, has been developed to a point where relatively high packaging density can be achieved.

Crimped terminations generally cannot be repaired or replaced if they are used in a high density package. Even in cases where packaging density is low, time-consuming procedures are required, removal or replacement of adjacent components may be required, and splicing is often necessary.

Taper tabs or pins, and spring-loaded mechanical clips require undue space, and are used more often in electrical rather than electronic assemblies.

3.2.3. Types of Splices

There are six commonly used types of splices. Each has advantages and disadvantages for use.

- Western Union Splice:-The Western Union splice joins small, solid conductors.

The steps in making a Western Union splice:

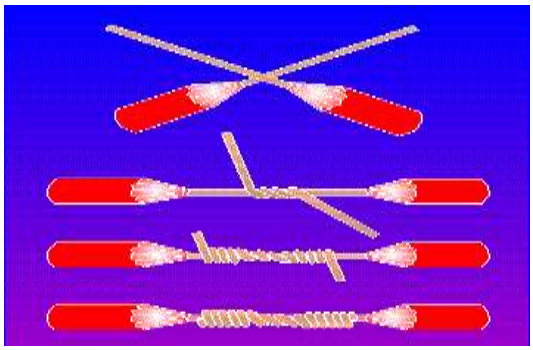


Fig.3.2. Western Union splice

- Procedure:
  - ✓ Prepare the wires for splicing. Enough insulation is removed to make the splice. The conductor is cleaned.
  - ✓ Bring the wires to a crossed position and make a long twist or bend in each wire.
  - ✓ Wrap one end of the wire and then the other end four or five times around the straight portion of each wire.
  - ✓ Press the ends of the wires down as close as possible to the straight portion of the wire. This prevents the sharp ends from puncturing the tape covering that is wrapped over the splice.

- Staggering Splices

Joining small multi conductor cables often presents a problem. Each conductor must be spliced and taped. If the splices are directly opposite each other, the overall size of the joint becomes large and bulky. A smoother and less bulky joint can be made by staggering the splices.

Figure below shows how a two-conductor cable is joined to a similar size cable by using a Western Union splice and by staggering the splices. Care should be taken to ensure that a short wire from one side of the cable is spliced to a long wire, from the other side of the cable. The

sharp ends are then clamped firmly down on the conductor. The figure shows a Western Union splice, but other types of splices work just as well.

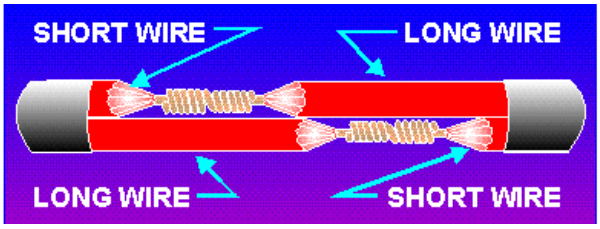


Fig.3.3. Rattail/Pig tail Joint

A splice that is used in a junction box and for connecting branch circuits is the rattail joint Wiring that is installed in buildings is usually placed inside long lengths of steel or aluminum pipe called a conduit. Whenever branch or multiple circuits are needed, junction boxes are used to join the conduit. To create a rattail joint, first strip the insulation off the ends of the conductors to be joined. You then twist the wires to form the rattail effect. This type of splice will not stand much stress.

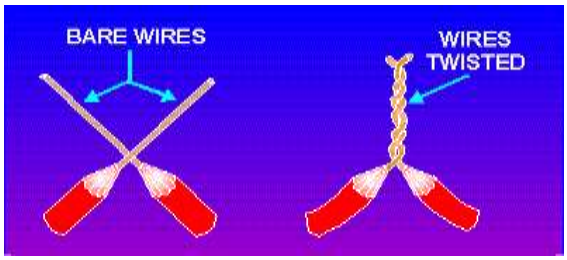


Fig.3.4. Fixture Joint

The fixture joint is used to connect a small-diameter wire, such as in a lighting fixture, to a larger diameter wire used in a branch circuit. Like the rattail joint, the fixture joint will not stand much strain.

The steps in making a fixture joint.

- The first step is to remove the insulation and clean the wires to be joined.
- After the wires are prepared, the fixture wire is wrapped a few times around the branch wire. The end of the branch wire is then bent over the completed turns.
- The remainder of the bare fixture wire is then wrapped over the bent branch wire.

- Soldering and taping completes the job.

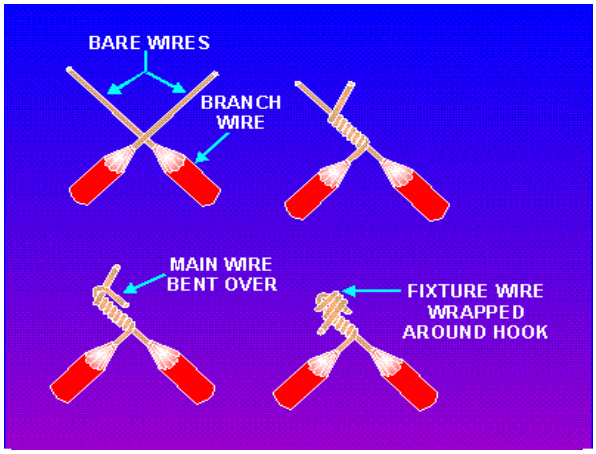


Fig.3.5. Knotted Tap Joint

All the splices discussed up to this point are known as butted splices. Each was made by joining the free ends of the conductors together. Sometimes, however, it is necessary to join a branch conductor to a continuous wire called the main wire. Such a junction is called a tap joint. The main wire, to which the branch wire is to be tapped, has about 1 inch of insulation removed. The branch wire is stripped of about 3 inches of insulation.

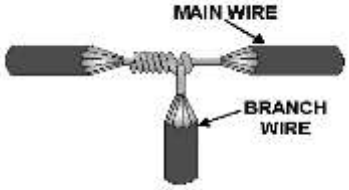


Fig.3.6. Knotted Tap Joint

The branch wire is laid behind the main wire. About three-fourths of the bare portion of the branch wire extends above the main wire. The branch wire is brought under the main wire, around itself, and then over the main wire to form a knot. The branch wire is then wrapped around the main conductor in short, tight turns; and the end is trimmed off. The knotted tap is used where the splice is subject to strain or slippage. When there is no strain, the knot may be eliminated.

Diffusion Bonding

The principal diffusion bonding methods are thermo-compression bonding and ultrasonic bonding. The three most commonly used types of thermo-compression bonding are ball bonding,

wedge bonding and stitch bonding. They all depend on a combination of heat and pressure to attain mechanical bonding. In ball bonding, a fine wire is fed through a small-diameter tube, and the exposed end is melted into a ball by a hydrogen flame. Then the ball is brought down to the area of contact under pressure

3.3. Correct sequence of operation

A procedure sets out the steps to be followed for work activities. You must consult with affected workers when developing procedures for:

- resolving work health and safety issues
- consulting with workers on work health and safety
- monitoring workers' health and workplace conditions
- Providing information and training.

3.3.1. Soldering technique

The following information will aid you in learning basic soldering skills. It should enable you to solder wires to electrical connectors, splices, and terminal lugs. Special skills and schooling are required for the soldering techniques used in printed circuit boards and micro-miniature component repair.

Soldering process

➢ Cleanliness is essential for efficient, effective soldering. Solder will not adhere to dirty, greasy, or oxidized surfaces.

➢ Heated metals tend to oxidize rapidly. This is the reason the oxides, scale, and dirt must be removed by chemical or mechanical means. Grease or oil films can be removed with a suitable solvent.

➢ Connections to be soldered should be cleaned just prior to the actual soldering operation.

➢ Items to be soldered should normally be "tinned" before making a mechanical connection.

➢ Tinning is the coating of the material to be soldered with a light coat of solder. When the surface has been properly cleaned, a thin, even coating of flux should be placed over the surface to be tinned. This will prevent oxidation while the part is being heated to soldering temperature.

- Rosin-core solder is usually preferred in electrical work. However, a separate rosin flux may be used instead. Separate rosin flux is frequently used when wires in cable fabrication are tinned.

3.3.2. Cable Termination

There is a variety of termination methods for cable. The termination method utilized depends basically on the system installed, type of cable used and type of connector; Using the proper termination method allows for good mechanical and electrical integrity.

No matter what type of termination you will be performing, the most important thing is to use the proper tools and materials for the type of termination. For example, a crimp using pliers will work, but using a crimp tool and the proper die designed for your type of cable and connector is better. Using the proper solder type and the right temperature for solder type connections will ensure a lasting connection.

We will review four basic termination techniques. This is just to provide some general guidelines. The termination method may vary somewhat based on system requirements and connector manufacture design methods.

3.4. Termination/connection

A clamp: is a fastening device used to hold or secure objects tightly together to prevent movement or separation through the application of inward pressure.

Brackets: the connections are arranged so as to switch on the electric lights if the ...all cases either a continuous circuit, or a termination at both ends in.

Electrical accessories

AC/DC source

- Equipment that will operate on either an AC or DC power source
- Battery: a DC voltage source containing two or more cells that convert chemical energy to electrical energy.
- Cell: Single unit which is used to convert chemical energy into a DC electrical voltage

Switches

A switch is used in a wired network to connect to other devices using Ethernet cables. The switch allows each connected device to talk to the others. Wireless-only networks do not use

switches because devices such as wireless routers and adapters communicate directly with one another.

Fig.3.6. Switches

Fuse

In electronics and electrical engineering, a fuse is a type of low resistance resistor that acts as a sacrificial device to provide over current protection, of either the load or source circuit. Its essential component is a metal wire or strip that melts when too much current flows through it, interrupting the circuit that it connects. Short circuits, overloading, mismatched loads, or device failure are the prime reasons for excessive current. Fuses can be used as alternatives to circuit breakers.

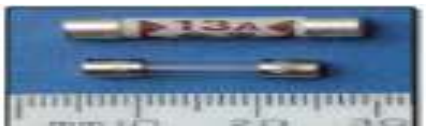


Fig.3.7. Fuse

Load

Load is a source drives a load. Whatever component or piece or piece of equipment is connected to a source and draws current from a source is a load on that source.

Table.3.2. Fitting accessory

Electric Switch	Are binary devices, they can be either completely off or completely on. a switch is an electronic device which is used to break or make the electronic circuit	

Lamp holder	Holder adapters are devices used to convert gas lamps, socket, outlets or parts of lamps to those of an otherwise incompatible device or system of lamp parts. The porcelain function of lamp holder is specially designed for use with shielded metal halide lamp	
Circuit breaker	Is an automatically operated electrical switch designed to protect an electrical circuit from damage caused by excess current from an overload or short circuit Its basic function is to interrupt current flow after a fault is detected	
switched socket outlet	A socket outlet is a female socket connected to the power wiring in the building and will accept the male plug attached at the end of the flexible cord of an appliance such as a vacuum cleaner, electric fire or electronic equipment. The general arrangement of socket outlets is similar to that of switches	

A simple circuit contains the minimum things needed to have a functioning electric circuit

- Source- a device used to supply AC or DC voltage
- Consuming- any device that consumes voltage, whatever component or piece of equipment that is connected to a source and draws current from a source is a load on that source.
- Controlling- any device having two states, on (closed) or off (open). Ideally having zero impedance when closed and infinite impedance when open.
- Protecting-a component used to open the circuit when current exceeds a predetermined maximum value.

- Connecting- a material that conducts electric current very well and used to connect a complet e path for current.

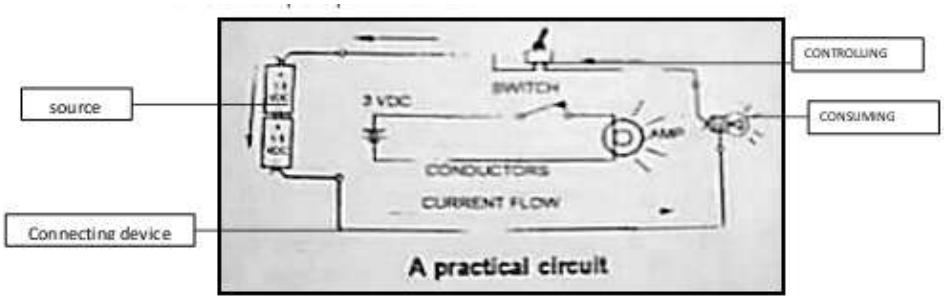


Fig.3.8. simple circuit

3.4.1. Procedure in Circuit Designing

1. Prepare all the tools and materials needed.
2. By using schematic symbol, make a simple circuit with the following:
    a. load
    b. consuming device
    c. protecting device
    d. consuming device
    e. connecting device
3. Make sure that the circuit has the following requirement that a simple circuit must have:
    a. A source of electrical potential difference or voltage.
    b. A conductive path which would allow for the movement of charges.
    c.An electrical resistance which is loosely defined as any object that uses electricity to do work.
4. Test the designed circuit by comparing it with the sample circuit.

3.4.2. Simply light circuit

Connection of one or more luminaries points (*Lights*) controlled by a simple switch. This kind of connection is used in almost all interior electrical installations.

1. Wear safety clothes
2. plan and prepare work place
3. select appropriate tools
4. Take 50cm distance between switch and main junction box and 45cm b/n main junction box and lamps
5. Put the accessories at their right position
6. connect the wires to the accessories at their right position
7. check the functionality of the circuit with multi-meter.
8. Disconnect lamp1 from the circuit and observe the result

The electrical wiring must be installed correctly and safely in accordance with electrical regulations and standards. If the electrical wiring is carried incorrectly or without confirming to any standard, devices could damage or leads to the malfunctioning of device which further causes for the reduction of device life.

Several factors have to be considered before the actual installation work to be done for residential, commercial or industrial wiring

Self-check-3

Test-I Matching

Instruction: Directions: Mach the following question column A to column B

A	B
1. Hard hat	A. safety footwear
2. Safety shoes	B. To protect eye
3. Glove	C. protect hand from injures
4. Safety belt	D. protect the head from injury due to falling objects
5. Goggle	E. protect from the probability of falling from higher working position/height

Test-II

Instruction**: Fill in the blank (12 point)**

1. _____is a fastening device used to hold or secure objects tightly together to prevent movement or separation through the application of inward pressure.
2. _____a device for making an electrical connection b/n an appliance and the mains, consisting of an insulated casing with metal pins that fit into holes in a socket.
3. _____ is a process in which two or more items are joined together by melting and putting a filler metal (solder) into the joint.

Test-III

Instruction**: Say true or false**

4. The soft-soldering process is common in the electronics and plumbing industries
5. Use hard soldering with silver solder when joining pieces of copper, brass or silver.
6. Crimped terminations generally cannot be repaired or replaced if they are used in a high density package.

Operation sheet-3

Operation Title: Connecting and terminating accessories

Purpose: To Connecting and terminating accessories

Instruction: Using the figure below and given equipment's to Connect and terminate accessories. You have given 30Minut for the task and you are expected to Connecting and terminating accessories.

Tools and requirement

- ✓ Multimeter
- ✓ Utility knife/stripper
- ✓ Wrenches (assorted)
- ✓ Allen wrench/key
- ✓ Screws (assorted)
- ✓ Pliers (assorted)

Procedures:

Step 1- Wear safety clothes

Step 2- plan and prepare work place

Step 3- select appropriate tools

Step 4- Take 50cm distance between switch and main junction box and 45cm b/n main junction box and lamps

Step 5- Put the accessories at their right position

Step 6- connect the wires to the accessories at their right position

Step 7- check the functionality of the circuit with multimeter.

Step 8- Disconnect lamp1 from the circuit and observe the result

Quality Criteria: use service manuals and service information for maintenance.

Precautions: use the given necessary tools, test instruments.

LAP Test-3	Connecting and terminating accessories

Name: _____ Date: _____

Time started: _____ Time finished: _____

Instruction I: Given necessary templates, tools and materials you are required to perform the following tasks within 4 hours.

Task 1. Control two lamps connected in parallel from three different positions

Task-2. Measure the voltage drop across each lamp

Task-3. Measure the current passing via each pass

Unit Four: Test termination/connections

This learning unit is developed to provide the trainees the necessary information regarding the following content coverage and topics:

- Electric wiring termination and electronic circuits test
- Unplanned events or conditions

This unit will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Electric wiring termination and electronic circuits test
- Unplanned events or conditions

4.1. Electric wiring termination and electronic circuits test

- **Amperage (Amps)**: a unit of measurement of electrical current flow
- **Ampere:** a unit of measurement which describes the amount of electric current passing a certain point at a particular time
- **Centimeter:** hundredth of a meter
- **Inch:** a portion of a foot, which is an English unit of linear measurement
- **Megger:** an instrument used to measure the insulation resistance of conductors or wire. It gives measurement in ohms or meg-ohms
- **Millimeter**: one-thousandth of a meter
- **Multi-tester**: an electrical measuring instrument used to measure the voltage, the resistance or the current of a circuit. It is connected either through parallel or series with the circuit depending on what to measure
- **Ohm:** the unit of measurement used to express resistance
- **Ohmmeter:** an instrument used to measure resistance in ohms
- **Volt:** a unit of measurement of electrical pressure or voltage
- **Voltmeter**: an instrument specially designed for measuring voltage
- **Wire Gauge**: used to measure the diameter of magnetic wire

Conducting testing of all completed termination/ connections of electric wiring/ electronic circuits for compliance with specifications & regulations

Quality control starts with good planning and management. An Inspection and Test Plan, which lists down the project's inspection and testing requirements, should be prepared to detail the checks required to achieve good workmanship. The plan should cover the responsibilities of each party, inspection methods, requirement references and frequency of inspections.

Objectives of testing electrical wiring/electronic circuits

- To verify proper functioning of the equipment/system after installation; and
- To verify that the performance of the installed equipment/systems meet with the specified design intent through a series of tests and adjustments.
- To capture and record performance data of the whole installation as the baseline for future operation and maintenance

4.1.1. Testing & Inspection during termination/connections of electric wiring

The purpose of these tests is to ensure that all components and systems are in a satisfactory and safe condition before start up. Preliminary adjustment and setting of equipment at this stage shall also be carried out at the same time to pave way for the coming functional performance tests. Before carrying out any test, the trainer shall ensure that the installation complies with all relevant statutory requirements and regulations. The test works shall comply with all site safety regulatory requirements currently in force, including but not limited to:

4.1.2. Functional Performance Tests

The purpose of functional performance tests is to demonstrate that the equipment/installation can meet the functional and performance requirements as specified in the General/Particular Specifications. Functional performance test should proceed from the testing of individual components to the testing of different systems in the installation.

The specific tests required and the order of tests will vary depending on the type and size of systems, number of systems, sequence of construction, interface with other installations, other specific requirements as indicated in the General/Particular Specifications. The testing of systems may have to be carried out in stages depending on the progress of work.

Part of the tests may be required to be carried out in suppliers' premises in accordance with the provisions in the General/Particular Specification. Any performance deficiencies revealed during the functional performance tests must be evaluated to determine the cause and whether they are part of the contractual obligations. After completion of the necessary corrective measures, the trainer shall repeat the tests.

4.1.3. Inspection before Test

A visual inspection shall be made to verify that the electrical installation /equipment as installed is correctly selected. The visual inspection shall include a check on the following items, where appropriate:

(a) Adequacy of working space, access, and maintenance facilities;

(b) Connections of conductors;

(c) Identification of conductors;

(d) Adequacy of the sizes of conductor in relation to current carrying capacity

(e) Correct connections of all equipment with special attention to socket outlets,

(f) Presence of fire barriers and protection against thermal effects;

(g) Methods of protection against direct contact with live parts

(h) Presence of appropriate devices for isolation and switching;

(i) Choice and setting of protective and indicative devices;

(j) Labeling of circuits, fuses, protective devices, switches, isolators and terminals;

(k) Selection of equipment and protective measures appropriate

(l) Presence of danger and warning notices;

(m) Presence of diagrams, instructions and other similar information;

(n) Connection of single pole devices for protection

(o) Method of protection against indirect contact;

(p) Prevention of mutual detrimental influence;

(q) Presence of under voltage protective devices;

(r) Erection method; and

(s) Any other appropriate inspection.

4.2. Unplanned events or conditions

Electrical tests

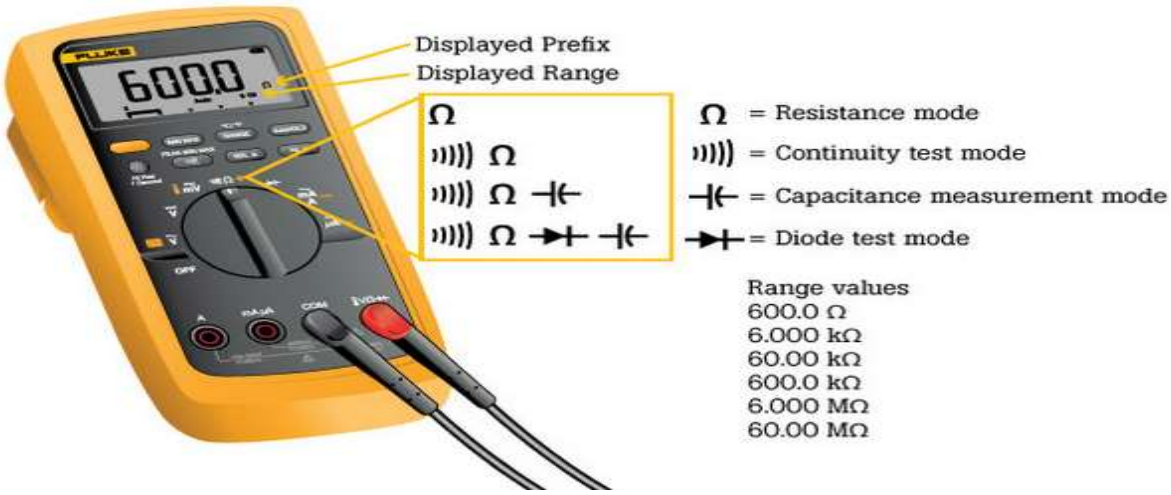


Fig.4.1. multi-meter

4.2.1. Testing Voltage

Steps of testing voltage

Power off the circuit/wiring under test if there is a danger of shorting out closely spaced adjacent wires, terminals or other points which have differing voltages

Plug the black ground probe lead into the COM socket on the meter

Plug the red positive probe lead into the socket marked V (usually also marked with the Greek letter "omega" Ω and possibly a diode symbol)

Next you need to decide whether the voltage being measured is AC or DC. If you are measuring the voltage from a mains socket outlet or the output voltage of a transformer, you need to select AC. Voltages of batteries, or the output of a power supply circuit or adapter is likely to be DC Multi--meters may have several ranges for each function. For example, the DC measuring mode may have ranges of 200mv, 2v, 20v, 200v and 1000 V in order to facilitate the measurement of a large range of voltages. Turn the dial of the meter to a range which is just above the voltage being measured, and ensure that you pick the AC voltage or DC voltage range. So for instance if you are measuring the voltage of a car battery which is approximately 12 volts, you can set the range to 20v. This gives the most number of decimal places in the reading. Setting the range to

200 volts gives less decimal places. If the meter is auto ranging, set it to the "V" setting. (See the photo near the bottom of the article for an explanation of symbols used).

1. . So this means the two test probes should be connected in parallel with the voltage source, load or any other two points across which voltage needs to be measured. Touch the black probe against the first point of the circuitry/wiring
2. Power up the equipment
3. Touch the other red probe against the second point of test. Ensure you don't bridge the gap between the point being tested and adjacent wiring, terminals or tracks on a PCB
4. Take the reading on the LCD display

Note: A lead with a 4mm banana plug on one end and a crocodile clip on the other end is very handy. The croc clip can be connected to ground in the circuit, freeing up one of your hands

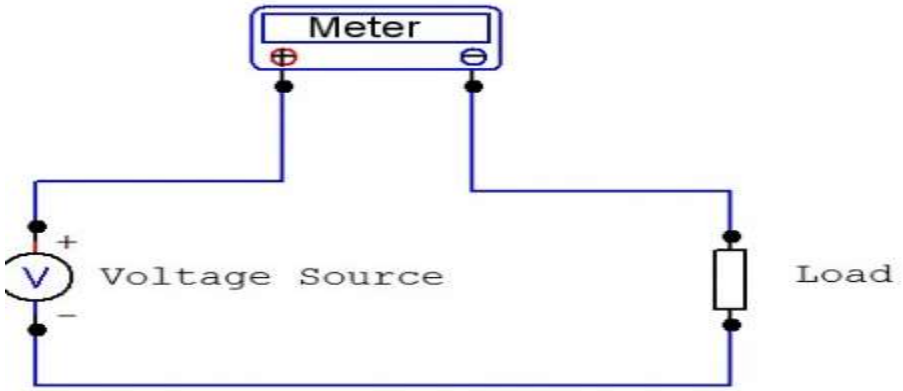
Testing Current

Steps of testing current

1. Turn off the power in the circuit being measured
2. A multi-meter must be inserted in series with the load in a circuit in order to measure current. Plug the ground probe into the COM socket and plug the red positive probe lead either into the mA socket or the high current socket which is usually marked 10A (some meters have a 20 A socket instead of 10A). The mA socket is often marked with the maximum current and if you estimate that the current will be greater than this value, you must use the 10 A socket, otherwise you will end up blowing a fuse in the meter
3. Connect the meter in series as in the diagram below
4. Turn the dial on the meter to the highest current range (or the 10A range if the probe is in the 10A socket). If the meter is auto ranging, set it to the "A" or mA setting. (See the photo at the bottom of the article for an explanation of symbols used).
5. Turn on the power
6. If the range is too high, you can switch to a lower range to get a more accurate reading
7. Remember to return the positive probe to the V socket when finished measuring current. The meter is practically a short circuit when the lead is in the mA or 10 A socket. If you forget and connect the meter to a voltage source when the lead is in this position, you

may end up blowing a fuse at best or blowing up the meter at worst! (On some meters the 10A range is un-fused)

Test leads and sockets on a DMM, setup to measure current | Source



DMM connected in series with load to measure current | Source

Fig.4.2 testing of current

Testing Resistance

Steps of testing resistance

1. Turn power to circuit OFF. If a circuit includes a capacitor, discharge the capacitor before taking any resistance reading.
2. Turn dial to Ω (resistance, or ohms), which often shares a spot on the dial with one or more other test/measurement modes (continuity, capacitance or diode; see illustration below). Notes: The display should show OL Ω. Why? In Resistance mode, even before test leads are connected to a component, a digital multimeter (DMM) automatically begins taking a resistance measurement. The MΩ symbol may appear in the display because resistance of

open (unattached) test leads is very high. When the leads are connected to a component, a DMM automatically uses the Auto range mode to adjust to the best range. Pressing the Range button allows a technician to manually set the range. Best results will be achieved if the component to be tested is removed from the circuit. If the component is left in the circuit, the readings could be affected by other components in parallel with the component to be tested.

1. First insert the black test lead into the COM jack.
2. Then insert the red lead into the V Ω jack. When finished, remove the leads in reverse order: red first, then black.
3. Connect test leads across the component being tested. Make sure that contact between the test leads and circuit is good. Tip: For very low-resistance measurements, use the relative mode. It may also be referred to as zero or Delta (Δ) mode. It automatically subtracts test lead resistance—typically 0.2 Ω to 0.5 Ω Ideally, if test leads touch (are shorted together), the display should show 0 Ω. other factors that can affect resistance readings: Foreign substances (dirt, solder flux, oil), body contact with the metal ends of the test leads, or parallel circuit paths. The human body becomes a parallel resistance path, lowering total circuit resistance. Thus avoid touching metal parts of test leads to avoid errors.
4. Read the measurement on the display.
5. When finished, turn the multimeter OFF to prevent battery drain.

Testing Continuity

A continuity test tells us whether two things are electrically connected: if something is *continuous*, an electric current can flow freely from one end to the other. If there's no continuity, it means there is a break somewhere in the circuit. This could indicate anything from a blown fuse or bad solder joint to an incorrectly wired circuit.

Steps of testing continuity

Step 1: to begin, make sure no current is running through the circuit or component you want to test. Switch it off, unplug it from the wall, and remove any batteries.

Plug the black probe into the COM port on your multimeter.

Plug the red probe into the VΩmA port.

Switch on your multimeter, and set the dial to continuity mode (indicated by an icon that looks like a sound wave). Not all multi meters have a dedicated continuity mode. If yours doesn't, that's okay! Skip to Step 6 for an alternate way to perform a continuity test.

Step 2: The multimeter tests continuity by sending a little current through one probe, and checking whether the other probe receives it.

If the probes are connected—either by a continuous circuit, or by touching each other directly—the test current flows through. The screen displays a value of zero (or near zero), and the multimeter beeps. Continuity!

If the test current isn't detected, it means there's no continuity. The screen will display 1 or OL (open loop).

Step 3: To complete your continuity test, place one probe at each end of the circuit or component you want to test.

It doesn't matter which probe goes where; continuity is non-directional.

As before, if your circuit is continuous, the screen displays a value of zero (or near zero), and the multimeter beeps.

If the screen displays 1 or OL (open loop), there's no continuity—that is, there's no path for electric current to flow from one probe to the other.

Step 4: If your multi-meter doesn't have a dedicated continuity test mode, you can still perform a continuity test.

Turn the dial to the lowest setting in the resistance mode.

Resistance is measured in ohms, indicated by the symbol Ω.

Step 5: In this mode, the multi-meter sends a little current through one probe, and measures what (if anything) is received by the other probe.

If the probes are connected—either by a continuous circuit, or by touching each other directly—the test current flows through. The screen displays a value of zero (or near zero—in this case, 0.8). Very low resistance is another way of saying that we have continuity.

If no current is detected, it means there's no continuity. The screen will display 1 or OL (open loop).

Step 6: To complete your continuity test, place one probe at each end of the circuit or component you want to test.

Doesn't matter which probe goes where; continuity is non-directional.

As before, if your circuit is continuous, the screen displays a value of zero (or near zero).

If the screen displays 1 or OL (open loop), there's no continuity—that is, there's no path for electric current to flow from one probe to the other.

Self-check-4

Test I: Choose

Instruction: Choose the correct answer and write only the letter on your answer sheet.

1. An instrument used to measure the amount of electrical current intensity in ckt.
   A. Voltmeter B. Ammeter C. Micrometer D. Ohmmeter
2. A pocket sized tool used to test the line wire or circuit if there is current in it.
   A. Test light B. Wire gauge C. Ruler D. Pull-push rule
3. A measuring tool used to measure the length of an object in centimeter& inches.
   A. Test light B. Wire gauge C. Ruler D. Pull-push rule
4. It is used to measure the diameter of wires/conductors in circular mils. It can measure small and big sizes of wires and cables.
   A. Voltmeter B. Ammeter C. Micrometer D. Ohmmeter
5. It is used to measure the voltage, resistance and current of a circuit. It connected in parallel or series with the circuit depending on what to measure.
   A. Multi-meter B. Micrometer C. Ohmmeter C. Ammeter

Test II: True or False

Instruction: Say True or False for the following question (10 point)

1. A continuity test tells us whether two things are electrically connected
2. A multi-meter must be connected in series in a circuit in order to measure voltage
3. The MΩ symbol may appear in the display b/c resistance of open test leads is very high.
4. To begin, a continuity test make sure current is running through the circuit
5. A multi-meter must be inserted in series with the load in a circuit in order to measure current

Test II: short Answer writing

Instruction: write short answer for the given

1. Write down Steps of testing voltage?
2. Write down Steps of testing current?
3. Write down Steps of testing resistance?

Operation sheet-4

Operation Title: Test termination/ connections of electrical wiring/ electronics circuits

Purpose: To Test termination/ connections of electrical wiring/ electronics circuits

Instruction: Using the figure below and given equipment's to Test termination/ connections of electrical wiring/ electronics circuits s. You have given 30Minut for the task.

Tools and requirement

- ✓ Multimeter
- ✓ Utility knife/stripper
- ✓ Wrenches (assorted)
- ✓ Allen wrench/key
- ✓ Screws (assorted)
- ✓ Pliers (assorted)

Procedures:

Test termination/ connections of electrical wiring/ electronics circuits:

Step 1- Select the ac or dc function with the selection switch on the side of the unit.

Step 2- Place the black probe of the unit under test into the (-) terminal and press down firmly.

Step 3- Place the red test probe of the unit under test in the (+) and press down firmly.

Step 4- Verify the meter reading of the tester is valid for the function tested.

Step 5- For low impedance testers the output voltage sourced should be >50 VAC/ dc.

Step 6- It is recommended to test both ac and dc functions of your test tool.

Quality criteria:

LAP Test-4	Test termination/ connections of electrical wiring/ electronics circuits

Name: _____ Date: _____

Time started: _____ Time finished: _____

Instructions: Given necessary templates, workshop, tools and materials you are required to perform the following tasks within 8 hours.

Task 1: identify the required material and equipment for electrical tests.

Task2: construct DC parallel and series circuit

Task3: measure voltage and current in DC circuit.

Task 4: tests voltage, current, resistance, continuity in DC and AC circuit.

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