Ethiopian TVET-System

INDUSTRIAL ELECTRICAL MACHIN DRIVE TECHNOLOGY

Level-II

Based on May 2011 Occupational Standards

October, 2019

Module Title: **Installing and terminating wiring system**

TTLM Code: EELEMD2TTLM1019

This module includes the following Learning Guides

LG16: Plan and prepare

LG Code: EEL EMD2 M05LO1-LG-16

LG17: Perform installation and termination of wiring system

LG Code: EEL EMD2 M05LO2-LG-17

LG18: Inspect and notify completion of work

LG Code: EEL EMD2 M05LO3-LG-17

LG19: clean- up

LG Code:

Instruction Sheet	**LG16**: Plan and prepare

This learning guide is developed to provide you the necessary information regarding the following learning outcome and content coverage

- Safety requirements of equipment/tools
- Reading and interpreting electrical circuit diagrams
- Types and application of termination
- Checking Wiring system and components
- Procedure of termination
- Identifying wiring system components and accessories
- Consult work coordination
- Tools equipment and Testing Device

This guide will also assist you to attain the learning outcome and contents stated in the cover page. Specifically, upon completion of this Learning Guide, you will be able to:-

- Installation is planned and prepared
- Appropriate personnel are consulted
- Wiring systems' components are checked
- Fitting Accessories are obtained in accordance with established procedures
- Locate in which specific items of accessories, apparatus and circuits are Installed
- Materials necessary to complete the work are obtained
- Tools, equipment and testing devices needed to carry out the installation work are obtained

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instruction described blew 3 to 6
3. Read the information written in the "Information Sheet 1 up to information 8".
4. Accomplish the "Self-check 1, self-check 2, Self-check 3, Self-check 4, Self-check 5, Self-check 6, Self-check 7, Self-check 8 " in page (6,13,19,25,30,35,38 and 43) respectively.
5. If you earned a satisfactory evaluation from the "Self-check" proceed to "Operation Sheet 1, Operation 2 in page -45 and 46 respectively.
6. Do the "LAP test" in page – 47 (if you are ready.

Information Sheet-1	Safety requirements of equipment/tool

1. Introduction

Safety is the number one priority in any job. Every year, electrical accidents cause serious injury or death. Many of these casualties are young people just entering the workplace. They are involved in accidents that result from carelessness, from the pressures and distractions of a new job, or from a lack of understanding about electricity. This chapter is designed to develop an awareness of the dangers associated with electrical power and the potential dangers that can exist on the job or at a training facility.

1.1 safety equipment

Generally, safety equipment is the protection that is used by workers to avoid injuries, casualties, life threatening situations etc.. Different types of safety equipment are used by workers depending upon the nature of risk involved in the work. For example, in a welding operation the dark welding helmets are used as a piece of safety equipment. In construction operations, hard hats, foot gear and coveralls are considered safety equipment. All these types of safety equipment fall under the Personal Protective Equipment (PPE) category.

- **use equipment safely**

All businesses must ensure that their equipment is used and maintained correctly to reduce the risk of accidents or damage to health and to meet health and safety requirements. Under health and safety law, employers have a duty to minimize risks to employees.

1.2 General Safety Practices

Only tools and equipment which are in good condition may be used. Tools shall only be used for the purpose for which they were designed. Employees shall make frequent inspections of tools and equipment, and immediately remove from service any items found defective.

When using hand tools, the employee shall place himself in such a position that he will avoid injury if the tool slips.

Only soft faced hammers (brass, plastic, rubber, or similar materials) shall be used on highly tempered steel tools such as cold chisels, star drills, etc. Proper eye protection must be worn when performing such an operation.

Files, rasps, and other tools having sharp tangs shall be equipped with approved handles.

Tools which are not in use shall be placed where they will not present a tripping or stumbling hazard.

Pointed tools shall never be carried edge or point up in pockets.

Tools shall not be thrown from one worker to another, or to another working location.

Extensions shall not be used on wrenches to gain leverage unless the wrench is designed to be used in such a fashion.

When cutting wire or any other material under tension, the material being cut shall be secured to prevent the ends from snapping free. Hooks, brushes, vacuums, or special tools shall be used to remove dust or chips. Compressed air shall not be used.

All machinery must be turned off when unattended. Maintenance, repairs, adjustments, and measurements must not be made while saws, lathes, grinders, and similar equipment are in operation.

Compressed air shall never be used to dust off clothing, or be directed toward another person.

Saw blades, gears, sprockets, chains, shafts, pulleys, belts, and similar apparatus shall not be operated without the proper guarding. Safety glasses, goggles, or face shields shall be worn when operating power tools.

Electrical termination is the practice of ending a transmission line with a device that matches the characteristic impedance of the line.

An electrical connector is an electro-mechanical device used to join electrical terminations and create an electrical circuit. Electrical connectors consist of plugs (male-ended) and jacks (female-ended). The connection may be temporary, as for portable equipment, require a tool for assembly and removal, or serve as a permanent electrical joint between two wires or devices

Safety practices to be observed for work on electrical equipment. The following general safety practices should be observed for work on electrical equipment:

- **Check before Act**

The scope of work and relevant circuit should be checked before starting any electrical work. Suitable lighting and adequate illumination should be provided for the workplace. The condition of tools and instruments should also be checked before carrying out electrical work.

- **Isolate and Lockout**

The circuit / equipment under maintenance should be isolated as far as practicable. The relevant isolator should be locked out. A suitable warning notice should be placed close to the isolator.

- **De-energize**

The circuit/equipment to be worked on should be checked to ensure that it is dead.

- **Others**
  - ✓ The workplace should be kept clean and tidy.
  - ✓ Keep hands away from any circuit or equipment or extraneous conductive parts that are not being worked on.
  - ✓ Unauthorized people should not stay in the work place.
  - ✓ The requirements stated in any related safety procedures and checklists should be followed.

- ✓ Electrical installations, including but not limited to those newly installed, maintained, repaired or tripped under fault conditions, should be properly inspected and tested prior to en enegization.
- ✓ Hooks, brushes, vacuums, or special tools shall be used to remove dust or chips.
- ✓ Compressed air shall not be used.
- ✓ All machinery must be turned off when unattended.
- ✓ Compressed air shall never be used to dust off clothing, or be directed toward another person.

Saw blades, gears, sprockets, chains, shafts, pulleys, belts, and similar apparatus shall not be operated without the proper guarding.
Safety glasses, goggles, or face shields shall be worn when operating power tools.
Electrical termination is the practice of ending a transmission line with a device that matches the characteristic impedance of the line.
An electrical connector is an electro-mechanical device used to join electrical terminations and create an electrical circuit. Electrical connectors consist of plugs (male-ended) and jacks (female-ended). The connection may be temporary, as for portable equipment, require a tool for assembly and removal, or serve as a permanent electrical joint between two wires or devices
An electrical connector, is an electro-mechanical device used to join electrical terminations and create an electrical circuit

1.3 POWER TOOLS

There are a few other precautions to follow when working with machinery. Some of the precautions are as follows:

- Never operate a machine with a guard or cover removed.
- Never operate mechanical or powered equipment unless you know how to operate them. When in doubt, consult the appropriate instruction or ask someone who knows.
- Always make sure that everyone is clear before starting or operating mechanical equipment.
- Cut off the source of power before trying to clear jammed machinery.
- Always keep everyone clear when hoisting heavy machinery or equipment by a chain fall. Guide the hoist with lines attached to the equipment.
- Never plug in electric machinery without knowing that the source voltage is the same as that called for on the nameplate of the machine.

Carefully inspect all portable power tools to be sure they are clean, well-oiled, and in working order before you use them. The switches should operate normally, and the cords should be clean and free of defects. Ground the casings of all electrically driven tools. Do not use sparking portable electric tools in any place where flammable vapors, gases, liquids, or exposed explosives are present.
Check to make sure that power cords do not come in contact with sharp objects. Don't let cords kink. Don't leave them where they might be run over. Don't let cords contact oil, grease, hot surfaces, or chemicals. When damaged, replace power cords. When unplugging power tools from receptacles, you should grasp the plug, not the cord.

Self-Check 1	Written Test

Name: _____ Date: _____

I. Direction: Answer the following questions.

1. What is safety of equipment?

2. What are the general safety practices should be observed for work on electrical equipment?

3. Why is it important to use equipment safely?

4. Write the precautions to follow when working with machinery?

Note: **Satisfactory rating - 4 points** **Unsatisfactory - below 4 points**

Information Sheet-2	Reading and interpreting electrical circuit diagrams

2.1 Electrical diagrams

There are a number ways to show electrical circuits. They are wiring, schematic, pictorial and layout diagrams.

There are several different types of electrical wiring diagrams. They all do essentially the same thing, which is to show you how circuits are wired. However, the variation in these diagrams shows how circuits are mapped out in different ways to accomplish different ends. The type of electrical wiring diagram you use depends on what you want to achieve with it.

An electrical wiring diagram will use different symbols depending on the type, but the components remain the same. Diagrams will show receptacles, lighting, interconnecting wire routes, and electrical services within a home. This includes circuit breaker boxes and any alarms that are wired into the system. Different switches and different types of outlets all have different symbols, and you'll need to know these symbols in order to be able to read an electrical wiring diagram. Everything within a home electrical system will be shown on one of these diagrams. This is to make sure that everything will operate correctly if the diagram is adhered to and all components are functional.

2.1.1 Electrical symbols

Electrical symbols or electronic circuits are virtually represented by circuit diagrams. There are some standard symbols to represent the components in circuits. This article gives some of the frequently used symbols for drawing the circuits. There are many electrical and electronic schematic symbols are used to signify basic electronic or electrical device. These are mostly we used for draw circuit diagrams.

Below are different kind of symbols we mentioned category wise.

- Wires
- Switches
- Sources
- Ground
- Resistor
- Variable Resistor
- Capacitor
- Inductors
- Diodes

- Transistor
- Logic Gates
- Amplifiers
- Antenna
- Transformer

Table 1 Electrical symbols

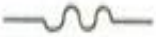
SYMBOL	DESCRIPTION
Line Systems	
	Conductor, general
	Flexible conductor
Identification of Installation Method	
	Underground line
	Overhead line
	Surface line
	In/Under surfaceline
Identification of Intended Application	
	Protective Conductor (PE)
	Signal line
	Telephone line
	Radio line
Supply Lines	
	Wiring going upward
	Wiring going down
	Wiring passing through vertically
	Junction of conductors for flush installation

Table 2 Electrical symbols

Table 26.1 Graphical symbols for electrical installations (conte'd)

SYMBOL	DESCRIPTION
Luminaires(conte'd)	
	Florescent luminaire double lamp
	Row of florescent luminaire
	Exterior luminaire (post top)
Indicating Instruments and Transformers	
	Indicating instruments
	Metre (kilowatthour-metre)
	Current transformer
	Voltage transformer
Power Supply Units	
	Convertor General Symbol
	Rectifier
	Battery (Cell)
	Inverter
Electrical Appliances (Power)	
	Electrical appliance, General symbol
	Kitchen appliance
	Electric range, general symbol
	Microwave cooker
	Baking oven
	Hotplate
	Water heater
	Washing machine

Note: Darkened symbols indicate flush [recessed] installations.

Table 3 Electrical symbols

Table 26.1 Graphical symbols for electrical installations (conte'd)

SYMBOL	DESCRIPTION
Electrical Appliances(conte'd)	
	Clothes dryer
	Dish washer
	fan
	Air conditioning
	Freezer
	Deep freezer
	Motor
	Generator
Communication appliances	
	Intercom
	Telephone exchange, general symbol
	Automatic Telephone exchange
Signalling Devices	
	Bell
	Horn
	Siren
	Call indicator panel (Number indicates call stations, for example 9 stations)
	Electric Clock
	Master Clock
	Non-automatic fire alarm device (manual fire call point)
	Fire alarm control & indicating panel
	Smoke detector

Note: Darkened symbols indicate flush [recessed] installations.

2.1.2 Types of electrical circuit

1 Schematic Diagram

The system flow is shown by a series of horizontal and vertical lines, much like a normal electrical wiring diagram. However, in this case, the lines show the flow of the system rather than the wires in the system. It's an electrical wiring diagram that's aimed more at designers and electricians who work with the theory of the circuit. Schematics will not be ideal for anyone who plans on working on the circuit as it is in the house.

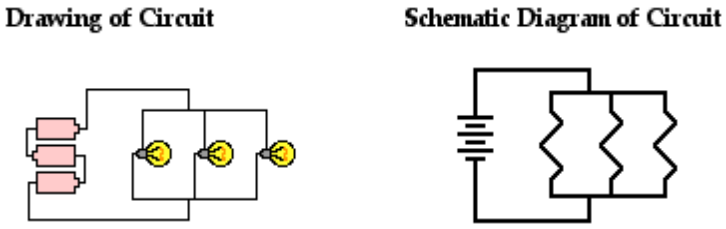


Figure 1: Schematic Diagrams

2 **Wiring Diagram**

A wiring diagram is the most common form of electrical wiring diagram. Unlike a schematic, it's concerned with the connections between the different parts of a circuit or parts of an entire electrical system. Wiring and equipment on the wiring diagram is carefully laid out to show the approximate location of equipment in the circuit and thus, within the home. This makes it far more useful as a reference and guide for anyone wanting to work on a home's electrical.

The components within the circuit are represented by a series of pictorials and these accurately resemble the components within the system so they can be easily identified. While the horizontal and vertical lines of a schematic show the circuit's flow, lines in a wiring diagram instead represent the physical wiring of the circuit.

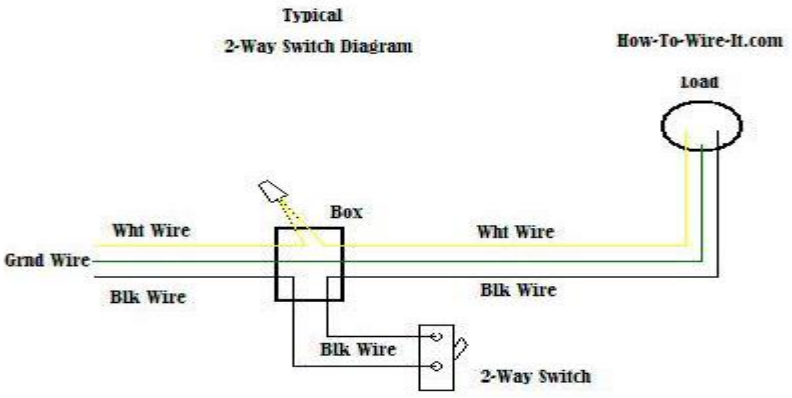


Figure 2: Wiring Diagram

3 Pictorial Diagram

The least useful of the main electrical wiring diagrams is the pictorial diagram and for this reason alone, it's not commonly used. It makes no attempt to be an accurate representation of the circuit but concentrates on the components in the circuit. Without precise knowledge, the average homeowner wouldn't be able to use it effectively.

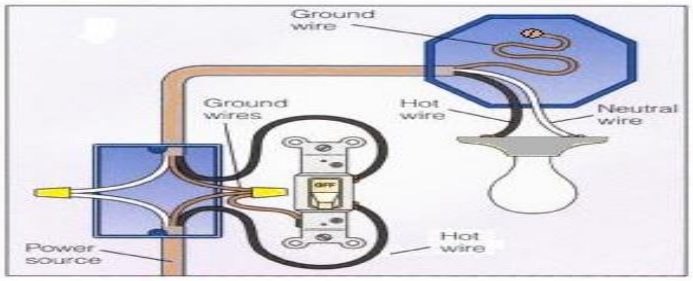


Figure 3 Pictorial Diagram

4 Layout diagram

It is an exact graphical representation of the layout of the various fixtures, equipment, utilities, and buildings of the plant

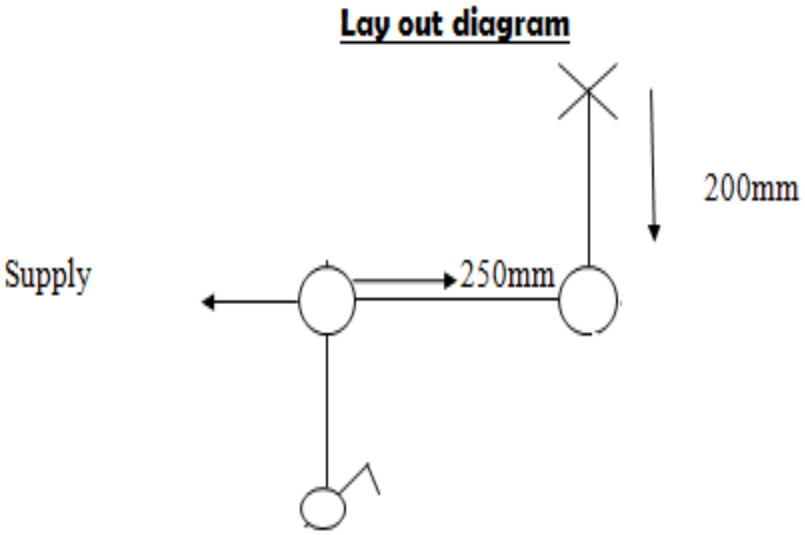


Figure 4: Layout diagram

Self-Check 2	Written Test

Name: _____ Date: _____

I. Direction: Answer the following questions.

1. What do we mean by electrical symbols?

2. What are the four electrical diagrams differentiate with example?

Note: **Satisfactory rating - 2 points** **Unsatisfactory - below 2 points**

Information sheet 3	Types and application of termination

3.1 Splicing

A splice may be considered as two or more conductors joined with a suitable connector reinsulated, re shielded and re jacketed with compatible materials... applied over a properly prepared surface. Whenever possible, splicing is normally avoided. However splicing is often an economic necessity. There can be many reasons for building splices such as:

The supplied length of cable is not sufficient to perform the intended job... only so much cable can be wound on a reel (reel ends) only so much cable can be pulled through so much conduit, around so many bends, etc.

- Cable failures
- Cables damaged after installation
- A tap into an existing cable (tee or wye splices)

In all the above cases, the option is to either splice the cable or replace the entire length. The economy of modern splicing products in many cases makes splicing an optimal choice. Whatever the reason to splice, good practice dictates that splices have the same rating as the cable. In this way the splice does not de rate the cable and become the weak link in the system.

3.1.1 Splicing steps

The previously quoted definition accurately develops five common steps in building a splice:

1. Prepare the surface The preferred method of removing insulation is with a wire-stripping tool, if available. Asharp knife mayalso be used.

Hand Wire Stripper

The procedure for stripping wire with the hand wire stripper is as follows

- ✓ Insert the wire into the center of the correct cutting slot for the wire size to be stripped. Thewire 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 untilthe gripper jaws release the stripped wire, 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 theconductor. This procedure produces a taper on the cut insulation as shown in figure 5.

Figure 5

2. Join conductors with connector(s) After the cables are completely prepared, the rebuilding process begins. If a cold shrink or premolded splice is being installed,the appropriate splice components must be slid onto the cable(s) before the connection is made. The first step is reconstructing the conductor with a suitable connector. A suitable connector for medium/high voltage cable splicesis a compression or shearbolt connector.Do not use mechanical type connectors (such as split-bolt connectors.). Connector selectionis based on conductor material: aluminum or copper.

3. Re-insulate recognized method for reinsulating is the traditional tape method. Tape has a history of dependable service and is generally available. Since tape does not depend on cable types and dimensions, it is themost versatile approach. However, wrapping tape on a medium/high voltage cable can be time consuming and error prone since the careful build-up of tape requiresaccurate half-

lapping and constant tension in order to reduce built-in air voids. Linerless splicing tapes reduce both application time and error.Studies have shown time savings of 30-to-50 percent since there is no need to stop during taping to tear off liner. This also allows the installer to maintain a constant tape tension, reducing the possibility of taped-in voids. Tape splice kits can be useful since they contain all the necessary tapes along with proper instructions. They ensure the propermaterials are available on the job,which is ideal in an emergency.Another method for reinsulating utilizes molded rubber technology. These factory-made splices are engineered for the convenience of the installer. In many cases, these splices are also factory tested and designed to be installed without theuse of special installation tools.

4. Re-shield The cable's two shielding systems (strand shield and insulation shield) must be rebuilt when constructingasplice.The sametwo methods are used as outlined in there insulation process: tape and molded rubber.Foratapesplice, the cable strand shield in gisre placed by asemi-conductive tape. This tape is wrapped over the connector area to smooth the crimp indents and connector edges.The insulation shielding system is replaced by acombination of tapes. Semi-con is replaced with the same semi-conducting tape used to replace thes trand shield. The cable's metallic shield is generally replaced with a flexible wav enmesh of tin-plated copper braid. This braid is for electrostatic shielding only and is not designed to carry shield currents. For conducting shield currents, a jumper braid is installed to connect the cables' metallic shields. This jumper must have an ampacit rating equal to tha to fthe cables'shields.

5.Re-jackete is accomplished in a tape splice by using a combination of the rubber splicing tape overwrapped with a vinyl tape In molded rubber splice, re-jacketing is accomplished by proper design of theoutersemi-conductiverubber,effectively resulting in a semi- conductive jacket.

3.2.1 Types of splices

Western Union Splice

The Western Union splice joins small, solid conductors.

Figure 5 shows the steps in making a Western Union splices.

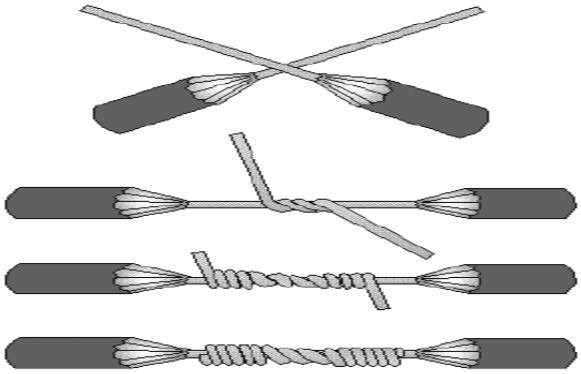


Figure 5 Western Union splices.

1. Prepare the wires for splicing. Enough insulation is removed to make the splice. The conductor is cleaned.

2. Bring the wires to a crossed position and make a long twist or bend in each wire.
3. Wrap one end of the wire and then the other end four or five times around the straight portion of each wire.
4. 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. The various types of tape and their uses are discussed later in this chapter.

3.2.2 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. 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.

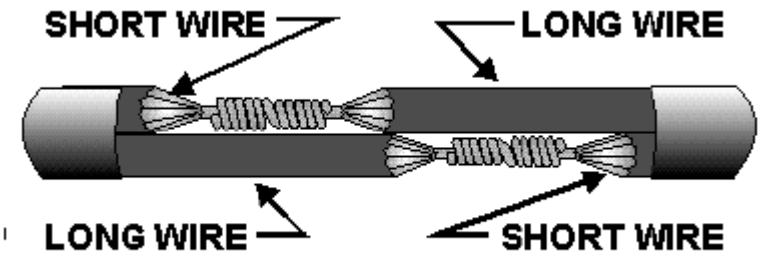


Figure 6

- **Rattail Joint**

A splice that is used in a junction box and for connecting branch circuits is the rattail joint fig 7

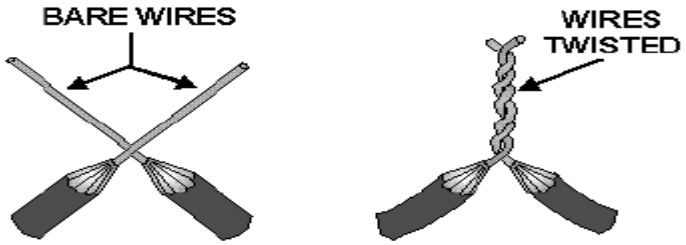


Figure 7

- **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. As shows 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 aroundthe

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.

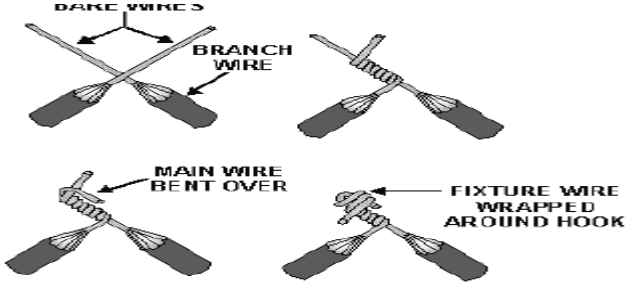


Figure **8**

- **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.

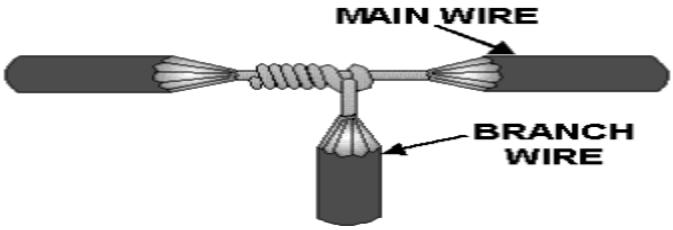


Figure **9**

3.2 Termination Types

3.3.1 Solder Type

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 standard60/40 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.

3.3.2 Crimp Type

A crimp type connection allows for quick and simple installation while still maintaining a mechanical and electrical connection fairly close to a solder type termination. Solid or stranded wire can be used in this type of termination.

Some of the key points to remember for a good clean connection are as follows:

1. Make sure you use the proper size connector for the type of cable you are using.
2. Make sure all of your cuts and stripping are clean.
3. Avoid nicks as much as possible.
4. Use the proper crimp tool; don't try to improvise with pliers, etc.

The most common crimp method involves two crimps, one on the insulation for a stronger mechanical connection and one on the conductor or shield for a good electrical connection. A crimp tool is designed specifically for this type of termination for the type of connector you are using. This allows for good connections both mechanical and electrical.

Self-Check 3	Written Test

Name: _____ Date: _____

I. Direction: Answer the following questions.

1. What is splicing

……

……

2. Write the steps of splicing

……..

……..

……

……..

3. Types of splices are ……and ……..

4. Types of Termination are……., and ,, ……..

Note: **Satisfactory rating - 4 points** **Unsatisfactory - below 4 points**

Information sheet 4	Procedure of Termination

4. Introductions

Cable Termination is the connection of the wire or fiber to a device, such as equipment, panels or a wall outlet, which allows for connecting the cable to other cables or devices. The three main areas we will discuss are termination used in Telecom,

A wire termination is the work performed to the end of a wire that allows it to connect to a device (connector, switch, terminal, etc.). There are many types of terminations in the aircraft industry, but we can boil them down into two basic categories: crimp and solder.

A crimp termination is performed when the device requires a contact or terminal. The wire insulation is stripped, and the contact or terminal is attached to the wire using a crimp tool. The tool crimps the contact or terminal onto the wire conductor. This type of termination is most often used on the aircraft wiring harnesses and circuit breaker panels

A solder termination is performed when the wire conductors attach directly to the device. This requires stripping off the wire insulation and applying flux and solder to connect the wire to the device. (Requirements for Soldered Electrical and Electronic Assemblies) gives the specific details on how to properly solder.

4.1 **Procedure of termination**

- **Soldering method and 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 that we have discussed earlier in the chapter. 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.

- **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 and quickly flow around the joint.
✓ Remove the solder *before* the iron.
✓ It should take about three seconds to heat, melt

- **Insulating**

An **insulator** on the other hand is a material which does not allow an electric current to flow. Rubber and most plastics are insulators.

- **Insulation materials**

Wires and cables (conductors) are insulated and protected by a variety of materials (insulators) each one having its own particular properties. The type of material used will be determined by the designer who will take into account the environment in which a control panel or installation is expected to operate as well as the application of individual wires within the panel. As part of the insulating function, a material may have to withstand without failing:

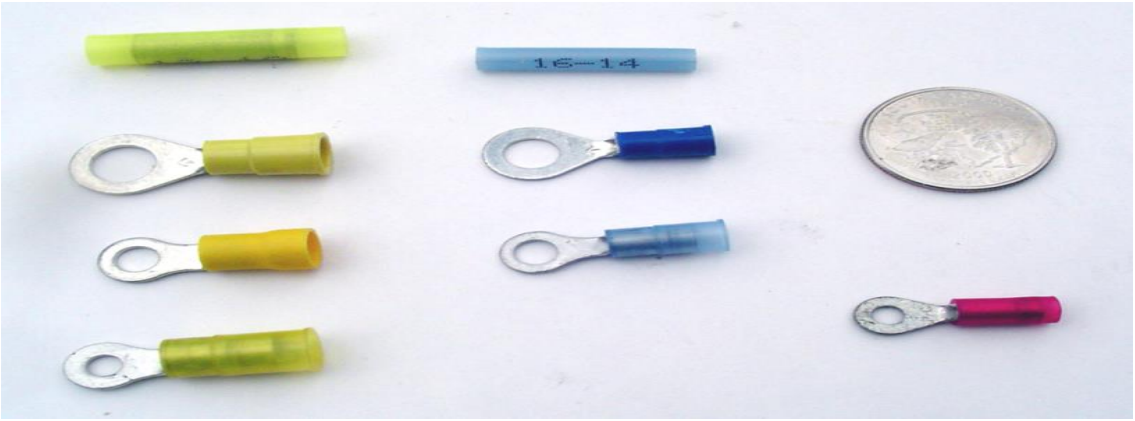
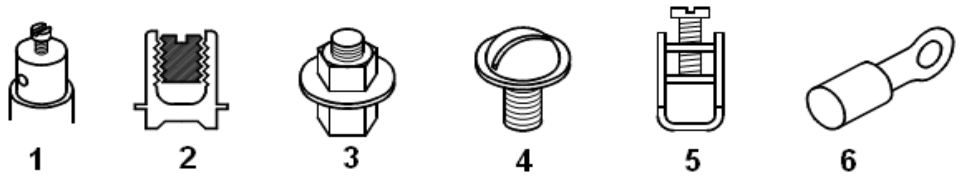


Figure Terminals, Clamps and Lugs

There are a wide variety of conductor terminals. Typical type sare asshown in Figure below



1. The screw terminal will be found in various accessories such as, lamp holders, batten holders and plug to psused in domestic premises. Ashrouded version of this terminal is probably the most commonly used type.It will be found in switches,sockets,ceiling roses and consumer units.
2. Thes plit terminal will be used in joint boxes to enable joints to be made with out having to cut conductors.
3. The post terminal will be used mainly to make connections to earth and also in such placesas the mains connection to an electric cooker or an electric motor.
4. The screw head terminal will also be mainly used to make connections to earth,and is also very popular inolder fuse boards.
5. The clamp terminal is now in common use inmain switches, MCB's, RCD's and RCBO's.
6. The lug terminal comes in an extremely wide variety of shapes and sizes.They may be bare or insulated. Methods of connecting to the cable vary as follows:
   - Ferrules,whichareusedonflexiblecablestopreventthestrandsfromspreadingoutandarethen connected using a screw or clamp terminal.
   - Large power cables where the lug is compressed on to the cable using a hydraulic type crimptool. The lug is then connected to a post or screwhead terminal.

- **terminating models**

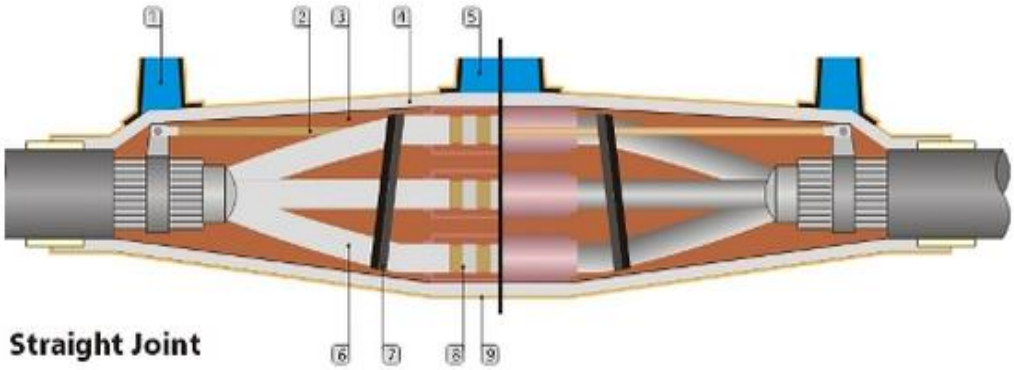


Figure terminating models

1. Riser
2. Earth continuity connection
3. C.J compound
4. Plastinet
5. Pouring gate
6. Core Insulation
7. PVC (NA) Tape
8. Ferrule
9. BOPP Tape two layers each half overlapped over plastinet

- **conductor splices and terminal connections**

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 isimportant 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.

Figure. samples of splices and terminals

- **General Wire-Stripping Instructions**

When stripping wire with any of the tools mentioned, observe the following precautions:

1. Do not attempt to use a hot-blade stripper on wiring with glass braid or asbestos insulation. These insulators are highly heat resistant.
2. When using the hot-blade stripper, make sure the blades are clean. Clean the blades with abrass wire brush as necessary.
3. Make sure all stripping blades are sharp and free from nicks, dents, and so forth.
4. When using any type of wire stripper, hold the wire perpendicular to the cutting blades.
5. Make sure the insulation is clean-cut with no frayed or ragged edges; trim if necessary.
6. Make sure all insulation is removed from the stripped area. Some types of wire are supplied with a transparent layer between the conductor and the primary insulation. If this is present, removeit.
7. When the hand strippers are used to remove lengths of insulation longer than 3/4 inch, the stripping procedure must be done in two or more operations. The strippers will only strip about 3/4 inch at one time.
8. Retwist strands by hand, if necessary, to restore the natural lay and tightness of the strands.
9. Strip aluminum wires with a knife as described earlier. Aluminum wire should be stripped very carefully. Care should be taken not to nick the aluminum wire as the strands break very easily when nicked.

Self-Check 4	Written Test

Name: _____ Date: _____

Direction: Write/List down the following

1. Different types of termination
   a) _____
   b) _____
   c) _____
   d) _____
2. General Wire-Stripping Instructions are

   _____

   _____

_____

_____

_____

Note: **Satisfactory rating - 8 points** **Unsatisfactory - below 8 points**

Information sheet 5	**Checking Wiring system and components**

5. Introduction

Electrical wiring is the electrical power distribution through the wires in a perfect manner for economic use of wiring conductors inside a room or building with better load control. Electrical wiring system is classified into five categories: Cleat wiring. Casing wiring

Perform an Electrical Safety Components Check Home electrical fires are more common than you would think.

The problems that cause electrical fires can often be detected during a home electrical inspection. Electrical Safety Foundation International recommends you conduct an electrical system inspection any time here's what we recommend you look for.

Outlets and switches

It's best to check all your outlets and switches prior to moving in any furniture, which may block problem spots. Check first to make sure all outlets are three-pronged and that all outlets and switches have plate covers. If you have babies or toddlers, count the number of outlets as well — you'll need to buy outlet plugs for all of them.

Note any looseness or signs of damage. Loose outlets or switches and cracked plates pose electrocution and fires risks. Discoloration around an outlet or switch or warmth to the touch suggests

a dangerous buildup of heat, and that switch or outlet shouldn't be used until an electrician checks it out. If you hear strange sounds such as buzzing or crackling coming from an outlet or switch, it could indicate an issue with the wiring and should be investigated by an electrician.

Light fixtures

Check all the light fixtures. Make sure any ceiling- or wall-mounted fixtures are secure. Also, check the wattage and bulbs in every light fixture. If the previous installed a bulb with a greater wattage than the fixture was designed to handle, it could overheat and ignite nearby combustible material such as a cloth or paper lamp shade.

Electrical panel

The fuses or circuit breakers in electrical panel protect you against fires by preventing electrical system from being overloaded. Make sure each fuse or circuit breaker is the right size for its circuit. The wrong size could result in overheated wiring creating a fire hazard.

Check also to see if there are Arc Fault Circuit Interrupters (AFCIs) installed in your panel. These are special circuit breakers that monitor for dangerous electrical arcs that can cause fires and trip the circuit when one is detected.

5.1 Wire /Conductor/

Conductor is the current carrying components are made of copper or aluminum. (Aluminum is less expensive but less efficient, requiring a larger conductor diameter to carry an equal electrical load when compared to a copper conductor.)

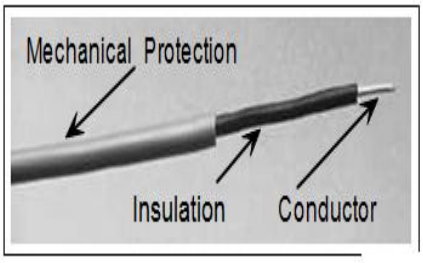
- A conductor should have a current carrying capacity not less than the maximum current demand it normally carries, be capable of withstanding the prospective fault current, and suitable for operation in the environment and at the design voltage of the installation.
- Factors to be considered in sizing of cable conductors In general, sizing of cable conductors should take into account the following factors:
    - ✓ the conductor material;
    - ✓the insulating material;
    - ✓the ambient temperature in which the cable is installed;
    - ✓the method of installation;
    - ✓whether or not the cable is affected by thermal insulating material;
    - ✓the use and type of protective device;
    - ✓the voltage drop from the origin of the circuit to the load;
- Method of sizing cable conductors In determining the size of cable conductors to be used, the steps employed, in general, are as follows:
    - ✓ Determine the design current of the circuit under consideration.
    - ✓ Choose a suitable over current protective device

- ✓ Choose suitable size of the conductors according to the current carrying capacity required.
- ✓ the ambient temperature does not exceed 35°C;
- ✓ the protective device is not a semi-enclosed fuse; and
- ✓ the cables are not in contact with any thermal insulation.

5.2 Cables and Flexible Cords

Cable Definition One or more conductors provided with insulation. The insulated conductor (s) may be provided with an overall covering to give mechanical protection. A cable consists of three parts.

1. Conductor
2. Insulation
3. Sheath (Mechanical Protection)



The most common conductor material used is copper.Aluminium is used for larger cables and its use is not permitted in domestic installations. The most common insulation used is PVC.Other

materials are used as insulation depending on what the cable is being used for and where it is being installed.

The most common mechanical protection used is PVC .Further protection is provided by installing cables in locations where they are unlikely to be damaged. Where this is not possible, cables must be installed inconduit, trunking or ducting. Otherwise a suitably armoured cable must be used. When cables are installed in conduit o rtrunking they need not have any other for mechanical protection.
The following is a list of the standard sizes used in domestic installations.

Cross sectional area is the surface area of a section of conductor.
1.5 mm^2–2.5 mm^2–4 mm^2–6 mm^2–10 mm^2–16 mm^2
The cable insulation is colour coded asfollows:
Phase (Live)–Brown
Neutral–Blue
Earth–Green/Yellow

Table: color identification

Colour identification of cores of flexible cables and cords

Number of cores	Function of core	Colour(s) of core
1	Phase	Brown
	Neutral	Blue
	Protective	Green-and-yellow
2	Phase	Brown
	Neutral	Blue
3	Phase	Brown
	Neutral	Blue
	Protective	Green-and-yellow
4 or 5	Phase	Brown or black
	Neutral	Blue
	Protective	Green-and-yellow

5.3 Over current Protective Devices

Over current protection for circuit every circuit must be protected by one or more devices for automatic interruption of the supply in the event of over current resulting from: overload, or fault. Examples of over current protective devices The following devices are acceptable as protective devices against over current:

- Miniature Circuit Breakers (MCB)
- Moulded Case Circuit Breakers (MCCB)
- High Breaking Capacity (HBC) Fuses
- Semi-enclosed Fuses
- Circuit Breakers incorporating over current release, or in conjunction with fuse.

Self-Check 5	Written Test

Name: _____ Date: _____

Direction: Write/List down the following

1 We conduct an electrical system inspection any time on

_____

_____

_____

_____

2 A cable consists of three parts.

_____

_____

_____

3. the most common mechanical protection used is……

4 what devices are acceptable as protective devices against over current:

_____

_____

_____

_____

Note: **Satisfactory rating - 10 points** **Unsatisfactory - below 10 points**

Information sheet 6	Identifying wiring system components and accessories

6 Introductions

Electricity requires an electric path to flow and there are many conducting materials used for this purpose. There are many semi conducting materials which are used to reduce the voltage and also drop the current flow. There are non-conducting materials which are used as insulation during working on live-lines. In this unit we will study how the household or industrial wiring is done and what materials are essential for household or industrial wiring. We will also study the different types of wiring and how they is done.

6.1 Wiring materials

Electrical wire is made of materials like copper, aluminum and silver. As silver is expensive, mostly copper and aluminum are used in wiring. Materials are classified into three types according to their properties:

1. Conducting materials
2. Insulating materials
3. Semiconductor material

Conducting Material

- ***Copper***

It is a good conductor of electricity. It is used in wiring materials in cables. Its has low resistance and is used for conduction of electricity at high,medium and low voltage. It is used in wiring and cable making.

- ***Aluminium***

It is light weight and cheaper in comparison to copper. Therefore,this type of conducting materialis mostly used in electrical wiring. It is silvery–white in colour and it has as oft texture.It is often used in wiring and making cable.

- **Insulating Materials**

Insulating materials are used for insulating purpose.These types of materials are bad conductors of current. For example rubber,paper,mica,wood,glass and cotton nature and number of conductors:

6.2 Wiring Accessories

Wiringaccessoriesareusedforconnectingappliances

- ***Switch***

A switch is used to make or break an electrical circuit.It is used to switch‘on’ or‘off’ the supply of electricity to an appliance.There are various switches such as

- ✓ surfaceswitch
- ✓ flushswitch
- ✓ ceilingswitch
- ✓ pullswitch
- ✓ pushbuttonswitch
- ✓ bedswitch

Surface switch *:*It is mounted on wooden boards fixed on the surface of a wall.It is of three types

1.One-way switch

2.Two-way switch

3.Intermediate switch

One-way switch: It is used to control single circuits and lamp

Two-way switch: It is used to divert the flowof current to either of two directions.

The two-way switch can also be used to control one lamp from two different places as in the case of stair case wiring

I**ntermediate switch**: It is used to control a lamp from more than two locations.

Flush switch*:* It used for decorative purpose. *Bed switch:* As the name indicates, it is used to switch‘on ’the light from any place, other than switch board or from near the bed.This switch is

connected through a flexible wire.

- **Lamp holder**
  Is of two types
  - ✓ Pendantholder
  - ✓ Batten holder

Pendant holder

It is used to provide a tapping to the pendant lamp–holder through the flexible wire or a connection to a fluorescent tube

Socketoutlet/plug

The socket outlet has an insulated base with the moulded or socket base having three terminal sleeves.

- **Main switch**

To control the electrical circuit a main switch is used. Through the main switch,the power in a building is controlled completely.

Fig. 3.9 Bed switch

Fig. 3.11 Batten holder

Fig. 3.12 Ceiling rose

Fig. 3.14 Main switch/ Main MCB

Fig. 3.9 Bed switch

Fig. 3.11 Batten holder

Fig. 3.12 Ceiling rose

Fig. 3.14 Main switch/ Main MCB

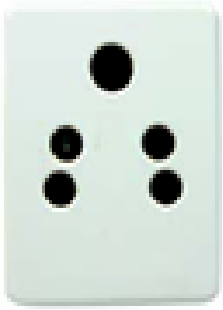


Fig. 3.13 Socket

Fig. 3.5 One-way switch

Fig. 3.6 Two-way switch

Fig 3.7 Intermediate switch

Fig. 3.8 Flush Switch

Fig. 3.10 Pendant holder

Self-Check 6	Written Test

Name: _____ Date: _____

I. Direction: Answer the following questions.

1 Wiring. Materials are classified into three
……. .,
……..and
…….

2 Lamp holder is of two types
……..,
……

Note: **Satisfactory rating - 5 points** **Unsatisfactory - below 5 points**

Information sheet 7	Consulting work coordination

7 work coordination process

Team coordination is a process that involves the use of strategies and patterns of behavior aimed to integrate actions, knowledge and. goals of interdependent members, in order to achieve common goals

7.1 coordination in an organization

Co-ordination is the unification, integration, synchronization of the efforts of group members so as to provide unity of action in the pursuit of common goals.

Management seeks to achieve co-ordination through its basic functions of planning, organizing, staffing, directing and controlling

7.2 Important Elements of Coordination | Benefits

- Balancing: Efforts, jobs and activities of all departments must be balanced. ...
- Timing: Timing involves scheduling of operations in a suitable order. ...
- Integration: Integration refer to the unification of all unrelated and diverse activities in such a manner as to accomplish the job efficiently

- **need for coordination**

Coordination helps to bring together the human and material resources of the organization. It helps to make optimum utilization of resources. These resources are used to achieve the objectives of the organization. **Coordination** also minimizes the wastage of resources in the organization

The **four** common **elements** of an organization include

- ✓ common purpose,
- ✓ coordinated effort,
- ✓ division of labor, and
- ✓ hierarchy of authority

- **Role of Consultant.**

The consultant's primary role is to assist your work with certain areas of your inclusiveness work. While the consultant may act as an educator, a catalyst for deeper change, a resource, or a facilitator, the leadership of the process remains within your organization

- **Consulting effectively**

Eight Steps to Consultancy Success

1. Build a balanced relationship. ...
2. Clarify the role. ...
3. Define direction. ...
4. Practice scope control. ...
5. Get them up and running quickly. ...
6. Cement trust with the team. ...
7. Provide feedback. ...
8. Be vigilant

Key skills Consulting Firms Look For

- Academic Success. Academic success is a hygiene factor for a job in Consulting. ...
- Work Experience. ...
- Leadership and Initiative. ...
- Perfect Presentation. ...
- Consulting Fit. ...
- Commercial Awareness. ...
- A Natural Communicator. ...
- Self-awareness

Self-Check 7	Written Test

Name: _____ Date: _____

I. Direction: Answer the following questions.

1. Why do we need for coordination?

2 The four common elements of an organization include

_____

_____

_____

_____

3 Eight Steps to Consultancy Success are

_____

_____

_____

_____

_____

_____

_____

_____

Note: **Satisfactory rating - 10 points** **Unsatisfactory - below 10 points**

Information sheet 8	Tools equipment and Testing Device

8.1 basic electrical tools and their uses

- **Pliers**

Pliers are available in different types, shape, and sizes.They are also available in both insulatedand uninsulated handles.An insulated handle should be used when working on or near hot wires.It isalso used for cutting big and small wires

- **Screw Drivers**

A screwdriver comes in various sizes and with several tip shapes.Screwdriversused byelectricians should have insulated handles.Using a screwdriver for a particular job, the width of thescrewdriver tip should match the width of the screw slot.

- **DrillingEquipment**

Drilling equipment is needed to make holes in building structure passages ofconduits andwires

- **Sawing and Cutting Tools**

Saws commonly used by electricians include the crosscut, keyhole, andHacksaw

- **Soldering Equipment**

In doing electric wiring, splices and taps (connections made to wire) should be soldered,unless you use solderless connectors.Typical equipments available for soldering are shown below.

- **Hammers**

Hammers are used with chisels and for nailing and fitting.Below are examples of carpenter’sclaw hammer,lineman’s hammer, and machinist’sball-peen hammer.

- **Measuring Tools**

To measure wire length and other items, the electrician finds considerable use for measuringtools such as the extension or zigzag rule, push-pull rule and a steel tape as shown below.

8.2 Testing device

- **using a multimeter**

A multimeter is a device used to measure voltage, resistance and current in electronics & electrical equipment. It is also used to test continuity b/n two points to verify if there is any break in circuit or line. There are two types of multimeter: analogue and digital.

- ✓ Analogue has needle style gauge
- ✓ Digital has LCD display

Test equipment is necessary for determining proper set-up, adjustment, operation, and maintenance of electrical systems and control panels.

Hand-held DMM

Portable Analog Multimeter

Voltmeters: For measuring differences of potential (voltage) between two points in an electrical circuit. The instrument is connected in parallel with the circuit being measured. Ranges vary from a few tenths volt to a few thousand volts. Instruments are capable of measuring both A.C .and D.C voltage.

Ohmmeters: For measuring the electrical D.C. ohm resistance of a circuit, circuit part, or component. Calibrated from zero ohms to infinite.Measures either series or parallel resistance.

Ammeters: Measure magnitude of electrical current flow in an electrical circuit. When measuring D.C. currents, some types must be inserted in series with the circuit. A.C. ammeters are of two types. One requires that it be connected in series with the circuit; the other needs only to be clamped around the current carrying conductor.

PhaseTester which doubles as a small terminal screw driver. It is a very useful tool when checking if a circuitis “live” or not.It is very important to ensure that it is not used in a dampor wet condition.When in use, current flows through the body of the user.Dampness may increase this operating current to a dangerous level.

Self-Check 8	Written Test

Name: _____ Date: _____

I. Direction: Answer the following questions.

1 What are basic electrical tools

2 What are the basic Testing device

3 The two types of multimeter……..and ……..

4 Multimeter is a device used to measure ……,…… And ……

Note: **Satisfactory rating - 4 points** **Unsatisfactory - below 4 points**

Operation Sheet 1	Safety requirements of equipment/tools

1.1 Safety requirements of equipment/tools**;**

Step 1- wear PPE.
Step 2- select required testing instrument /digital multimeter/.
Steps 3- adjust on zero reading.
Step 4- observe 0.00 reading, if not go to step 2
Step 5- clean the area.

Operation Sheet 2	Procedure of termination

1.5 **Procedure of termination;**

Step 1- wear PPE.
Step 2- select required materials, tools and instruments.
Step 3- prepare the wire for splicing
Step 4 removes insulation of conductor
Step 5 Bring the wires to a crossed
Step 6 splices the two terminals
Step 7 solders the joints
Step 8 terminate the joints with connector
Step 9 clean work areas

- By using the above procedure do the following LAP test

LAP Test	Practical Demonstration

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: Safety requirements of equipment/tools

. Task2: Procedure of termination

Instruction Sheet	LG17: Perform installation and termination of wiring system

This learning guide is developed to provide you the necessary information regarding the following learning outcome and content coverage

- OHs Police and Procedure
- Types of diagram
- Installing Wiring system standard and code
- Terminating and connecting accessories
- Installing wiring system
- Responding Unplanned events or conditions
- Approving procedure and requirement of termination

This guide will also assist you to attain the learning outcome and contents stated in the cover page.

Specifically, upon completion of this Learning Guide, you will be able to:-

- Identify Safety requirements of equipment/tools
- Reading and interpreting electrical circuit diagrams
- Identify Types and application of termination
- Perform Procedure of termination
- Identifying wiring system components and accessories

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instruction described blew 3 to 6
3. Read the information written in the “Information Sheet 1 up to information 7”.
4. Accomplish the “Self-check 1, self-check 2, Self-check 3, Self-check 4, Self-check 5, Self-check 6, Self-check 7 ” in page (6,13,21,24,28,30,and 33) respectively.
5. If you earned a satisfactory evaluation from the “Self-check” proceed to “Operation Sheet 1 up to operation sheet 4 in page -34, 35,36 and 37 respectively.
6. Do the “LAP test” in page – 38 (if you are ready.
7. Reference in page 39

Information Sheet-1	OHs Police and Procedure

1.1. OHS policies and procedures

Your Company Name is committed to the goal of providing and maintaining a healthy and safe working environment, with a view to continuous improvement. This goal is only achievable by adherence to established objectives striving to exceed all obligations under applicable legislation, and by fostering an enthusiastic commitment to health, safety and the environment within Your Company Name personnel, contractors and visitors.

In particular:

- Management, working in cooperation with the Joint Health and Safety Committee, will strive to take all reasonable steps to reduce workplace hazards to as low as reasonably achievable.
- Supervisors and managers are held accountable for the health and safety of all employees under their supervision. This includes responsibility for applicable training and instruction, appropriate follow-up on reported health and safety concerns, and implementation of recommended corrective action. This accountability is integrated into the performance appraisal system.
- Supervisors, workers and visitors are expected to perform their duties and responsibilities in a safe and healthful manner, and are accountable for the Health and Safety of themselves and others.
- Your Company Name is committed to providing all necessary training and instruction to ensure that appropriate work practices are followed on the job, and to promote their use off the job.
- If necessary, Your Company Name will take disciplinary action where individuals fail to work in a healthy and safe manner, or do not comply with applicable legislation or corporate policies and procedures.

What can you do to protect yourself and others from electrical hazards?

Employees can prevent shocks and injuries/electrocution from electrical hazards by:

- Following safe work practices
- Understanding electric shock and electro caution
- Recognizing potential hazards around work involving electricity
- Following OHS requirements
- Maintaining clearances around panels
- Using proper protective devices
- Eliminating access to exposed energized parts Using proper PPE
- Using proper lockout/tag out procedures
- Maintaining proper clearance from overhead lines
- Following proper procedures for confined space/enclosed space/underground electrical work
- Following manufacturer’s instructions

When you have to do maintenance work on a machine, take these four steps to protect yourself and your coworkers from injury:

1. De-energize the machine. Positively disconnect it from the power source. If there is more than one source of power, disconnect them all.

2. Lock out the disconnect switches. You must be given a lock and key for each disconnect before you begin working on the machine
3. Tag the disconnect switches. Get tags or accident prevention signs from your supervisor.
4. Test the machine to make sure it won't start and Keep the key with you

Each worker who works on the machine must lock out and tag the power disconnect. Never assume that the machine you are working on has been disconnected and Locked out unless you have done it yourself. Also remember that the current ratings off use and circuit breakers are at 15 to 30amperes for most residences. These safeguards cannot protect you against shocks. High voltage transmission and distribution lines carry a lot of electricity and if accidently touched it can be fatal. Since farm and construction workers use equipment that can reach high, these employees must be trained on the hazard supposed by high voltage overhead lines. Each year, workers who accidentally make contact with high voltage power lines are either killed or become permanently disabled. Electrically powered equipment is used daily by most workers. Power tools, metal and woodworking machines, restaurant equipment, computers and many other types of electrical equipment are found in the workplace. Failure to use the equipment correctly can create hazards to employees. Generally, there are instructions from the manufacturers on the use and maintenance of each piece of equipment. Workers need to follow the instructions while using and

- Replace broken 3-prong plugs and make sure the third prong is properly grounded.
- Never use extension cords as permanent wiring.
- Do not plug several power cords into one outlet.
- Do not disconnect power supplies by pulling or jerking the cords from the outlets.
- Always use the correct size fuse or breaker.
- Be aware that unusually warm or hot outlets may be a sign that unsafe wiring conditions exists.
- Use proper PPE for the electrical job.
- Always use ladders made of wood or other non-conductive materials when

  Working with or near electricity or power lines

1.2 Personal Protective Equipment (PPE)

Personal Protective Equipment (PPE) is anything used or worn by a person to minimize risk to the person's health or safety and includes a wide range of clothing and safety equipment. PPE includes boots (safety shoes, face masks, hard hats (helmet), ear plugs, respirators, gloves, safety harnesses and high visibility clothing.

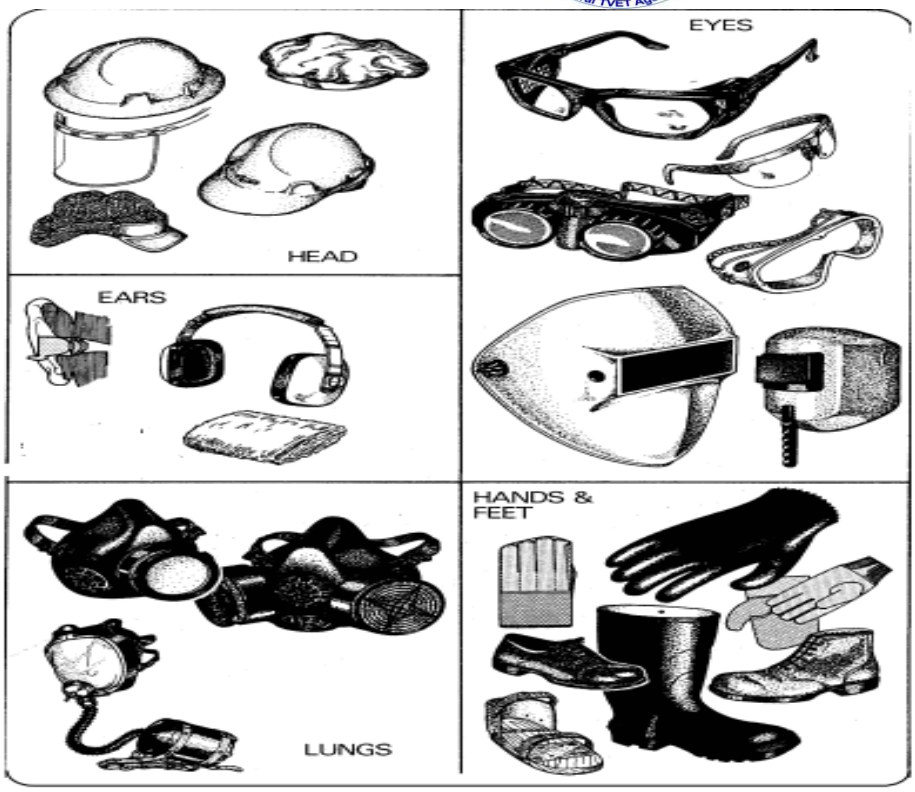


Fig1-1 Types of PPE

- **SAFETY SHOES**

Some safety shoes are designed to limit damage to your toes from falling objects. A steel plate is placed in the toe area of such shoes so that your toes are not crushed if an object impacts there. Other safety shoes are designed for use where danger from sparking could cause an explosion. Such danger is minimized by elimination of all metallic nails and eyelets and by the use of soles that do not cause static electricity.

- **GOGGLES**

Proper eye protection is of the utmost importance for all personnel. Eye protection is necessary because of hazards posed by infrared and ultraviolet radiation, or by flying objects such as sparks, globules of molten metal, or chipped concrete and wood. These hazards are ever-present during welding, cutting, soldering, chipping, grinding, and a variety of other operations. It is IMPERATIVE for you to use eye protection devices, such as helmets, face shields, and goggles (fig. 1-1), during eye-hazard operations.

Appropriate use of goggles will limit eye hazards. Some goggles have plastic lenses that resist shattering upon impact. Others are designed to limit harmful infrared and ultraviolet radiation from arcs or flames by use of appropriate filter lenses. Remember, eye damage can be excruciatingly painful. PROTECT YOUR EYES.

- **GLOVES**

Use gloves ((fig. 1-1) whenever you are required to handle rough, scaly, or splintery objects. Special flameproof gloves are designed for gas and electric-arc welding to limit danger and damage from sparks and other hot flying objects Personnel in the electrical fields are usually required to wear insulating rubber gloves. Be sure to follow all regulations prescribed for the use of gloves. Gloves must not be worn around rotating machinery unless sharp or rough material is being handled. If such is the case, EXTREME CARE SHOULD BE EXERCISED to prevent the gloves from being caught in the machinery.

- **SAFETY BELTS AND STRAPS**

The safety strap and body belt shown in figure 1-1 are what might be called your extra hands when you work aloft. The body belt, strapped around your waist, contains various pockets for small tools. The safety strap is a leather or neoprene-impregnated nylon belt with a tongue-type buckle at each end. While you are climbing you will have the safety strap hanging by both ends from the left ring (called a D-ring because of its shape) on the body belt. When you are at working position, you unsnap one end of the safety strap, pass it around the supporting structure so there is no danger of its slipping (at least 18 inches from the top of the part on which it is fastened), and hook it to the right D-ring on the body belt.

The safety strap must be placed around a part of the structure that is of sufficient strength to sustain an Abs weight and his or her equipment, and must rest flat against the surface without twists or turns. It must not be placed around any part of a structure that is being removed. Before placing your weight on the strap, determine VISUALLY that the snap and D-ring are properly engaged. Do not rely on the click of the snap-tongue as an indication that the fastening is secure. The body belt and safety strap require inspection before use. Look for loose or broken rivets; cracks, cuts, nicks, tears or wear in leather; broken or otherwise defective buckles, such as enlarged tongue-holes, defects in safety-belt snap hooks and body belt D-rings. If you discover any of these or other defects, turn in your

equipment and replace it. Perform maintenance periodically according to applicable procedures. Remember that leather and nylon belts are treated in different manners.

When can PPE be used?

PPE is one of the least effective ways of controlling risks to work health and safety and should only be used:

• when there are no other practical control measures available (as a last resort)

• as an interim measure until a more effective way of controlling the risk can be used, or

• to supplement higher level control measures (as a back-up).

What standard of PPE is required?

PPE used at a workplace must be:

• selected to minimize risk to work health and safety

• suitable for the nature of the work and any hazard associated with the work

• a suitable size and fit and reasonably comfortable for the person wearing it

• maintained, repaired or replaced so it continues to minimize the worker's health and safety risk, and

• used or worn by the worker, so far as is reasonably practicable.

How do I choose the right PPE for the job?

Selection processes for choosing the right PPE must involve consultation with workers and their representatives and should also include:

• a detailed evaluation of the risk and performance requirements for the PPE

• compatibility of PPE items where more than one type of PPE is required (for example ear muffs with a hard hat)

• Consultation with the supplier to ensure PPE is suitable for the work and workplace conditions, and preference for PPE that complies with the relevant Ethiopian Standard or equivalent standard.

Self-check: 1	Written test

Name…… Date……

Direction I. Say true or false for the following questions

1. Supervisors and managers are held accountable for the health and safety of all employees under their supervision.
2. selected to minimize risk to work health and safety is one of standard of PPE required

Direction II. Choose best answer

1. Employees can prevent shocks and injuries/electrocution from electrical hazards by:
   A. Following safe work practices
   B. Maintaining clearances around panels
   C. Using proper protective devices
   D. All
2. Which one of the following is the **first** requirement to do maintenance work on a machine to protect yourself and your coworkers from injury:
   A. De-energize the machine.
   B. Lock out the disconnect switches.
   C. Tag the disconnect switches.
   D. Test the machine to make sure it won't start and Keep the key with you
3. ……. Is a type of personal protective device which used to protect Eye from hazards posed by infrared and ultraviolet radiation, or from flying objects such as sparks.
   A. GLOVES
   B. GOGGLE
   C. Safety shoes
   D. All

Note: **Satisfactory rating - 5 points** **Unsatisfactory - below 5points**

Information Sheet 2	**Types of diagram**

Types of electrical diagram

- Schematic diagram
- Pictorial diagram
- Wiring diagram
- Layout diagram

For detail information refer / Learning guide#1 information sheet 2/

Information Sheet 3	Installing Wiring system standard and code

3.1 Lighting Requirements

The Ethiopian Building Code Standard (EBCS-10) must be followed at all times concerning every electrical design, installation and repair; whether in commercial, industrial or residential buildings.

Lighting Requirements (EBCS under Sec 3. Illumination)

The recommended luminance for different types of interiors, tasks and workspaces are given in Table 3.5 and Table 3.6 shall be taken as the recommended minimum values on which the design and assessment of lighting installations are to be based.

1. **Lux** can be used as a measure of the brightness of a light source. Lamp illumination and design in any indoor and outdoor workplaces are expressed in lux. One lux is equal to one lumen per square meter: 1 lux = 1 lumen/m^2

2. **Lumen** is a measure of the total amount of visible light emitted by a source. It is the SI derived unit of luminous flux. A flux of 1,000 lumens, concentrated into an area of one square meter, lights up that square meter with an illuminance of 1,000 lux. However, the same 1,000 lumens, spread out over ten square meters, produce a dimmer illuminance of only 100 lux.

   Therefore, the difference between units lumen and lux is that the lux takes into account the area over which the luminous flux is spread.

3. Common Fluorescent lamp and their average Lumen output

Table 1

Type of Fluorescent lamp	Lumen Output	Average Lumen per watt
4 feet Linear 25 Watt T8	2209 lumens	88 lumens per watt
4 feet Linear 28 Watt T5	2900 lumens	104 lumens per watt
4 feet Linear 32 Watt T8	2850-3100 lumens	93 lumens per watt
4 feet Linear 34 Watt T12	1930-2800 lumens	70 lumens per watt
4 feet Linear 40 Watt T12	1980-3300 lumens	66 lumens per watt
4 feet Linear 54 Watt T5	5000 lumens	93 lumens per watt

Achieving an illuminance of 500 lux might be possible in a 24m^2 house area with four fluorescent light fixture with a combined output of 12,000 lumens. To light a factory floor with dozens of times the area of the house would require dozens of such fixtures. Thus, lighting a larger area to the same level of lux requires a greater number of lumens. The ordinary four feet Linear Fluorescent Bulbs, 40-watt, 220V, T12 has an output average of 2600 lumens.

Example:

What would be the total number of 40-watts, 220V, T12 fluorescent lamp fixtures to be installed in a 50 m^2 area of school library if it requires having a 300 lux illumination?

Given: Lux = lumen / m^2 Lux = 300 lamp = 2600 lumens per 40-watt F.L. Lumen =?

Solution: Lumen = (Lux) (Floor area in m^2)
Lumens = (300 lux) (50 m^2)
= 15, 000 lumens
Lamp = 15, 000 lumens/(2600 lumens per 40-watt F.L .)
= **5.8** or **6** set of 40-watts fluorescent lamp

Here are some examples of the Workplaces recommended illuminance provided by EBCS -10

table 2 the Workplaces recommended illuminance

Type of indoor /outdoor workplaces		**Rated Illuminance in Lux**
Hotels and restaurants	Kitchen	500
	Dining room	200
	Conference room	300
	Reception	200
School or educational establishment	Classroom/teaching room	300
	Laboratories/demonstration room	500
	Technical drawing room	700
	Corridors	100
	Staircases	100
	Libraries	300
	Canteens	200
Hospital	Infant ward general lighting	200
	Bedded area/ward	100
	Toilets	100
	Therapy rooms general lighting	300
Offices and similar rooms	Offices	500
	Reception rooms	100
	Conference and consultation rooms	300
Wood working shop	Saw mils	200
	Bench work, gluing, assembly	300
	Pattern making, polishing, varnishing	500
	Checking for defects	750
Outdoor workplace	Gates	50
	Parking areas	3
	Roofed bicycle area	20
	Foot paths	5

3.2 Conductors and Over load protection Requirements

3.2.1 Size of Conductors

The minimum nominal cross-sectional area of conductor shall be:

a)1.0mm^2 for cables and insulated copper conductors for power and lighting circuits;
b) 10.0mm^2 for bare copper conductors for power circuits;
c) 16.0mm^2 for bare aluminum conductors for power circuits

d) 0.5mm^2 for flexible cables of copper conductors for extra low voltage.

3.2.2 Neutral Conductors

For a poly-phase circuits in which imbalance may occur in normal service, the neutral conductor shall have a cross-sectional area adequate to carry the maximum connected load between the neutral and anyone ungrounded conductor. In a discharge lighting circuit, the neutral conductors shall have a cross-sectional area not less than that of the· phase conductor(s).

3.2.3 Voltage Drop – describes how the supplied energy of a voltage source is reduced as electric current moves through the passive elements of an electric circuit.

The size of conductors shall be, such that the voltage drop between the supply terminal and fixed current using equipment shall not exceed 4% of the nominal voltage of the supply line, when the conductors are carrying the full load current.

For instance if the supply voltage is 230V, then 4% of 230V is 9.2V, therefore the allowed *Voltage drop* should not exceed to *9.2V*.

For single phase circuit; to calculate the voltage drop (in mV) the tabulated value (see: EBCS Table B.2) for the cable concerned has to be multiplied by the length of the run in meters and by the current the cable is intended to carry; namely, the design current of the circuit (I_b) in amperes. Voltage drop = [(mV /A/m) (length of wire) (I_b)]

Example:

Compute the voltage drop of a 2.5 mm^2 multi-core pvc armored sheath insulated wire installed in a PVC conduit. The circuit design current is 15A and it has a 10-m long run from the circuit breaker to the current using equipment

Given:

Length of wire = 10 m Size of wire = 2.5 mm^2 I_b = 15A

Tabulated voltage drop of 2.5 mm^2 = 18 mV/A/m (EBCS- Table B.2 pp.91)

Voltage drop = [(mV /A/m) (length of wire) (I_b)]

Solution:

Voltage drop = [(18mV/A/m)(10m)(15A)] = **2700mV** or **2.7V**

Table 3 Voltage drop (per ampere per meter)

Conductor operating temperature: 70°C

Conduct or cross-sectional area	**2 cables dc**	**2 cables –single phase A.C.**			**3 or 4 cables-three phase A.C.**			
		Reference Method 3 & 4(enclosed in conduit)	Reference Method 1 & 11 (clipped/ direct on trays touching)	Reference Method 12 (spaced)	Reference Method 3 & 4 (enclosed in conduit)	Reference Method 1 & 11 (trefoil)	Reference Method 1 & 11 (flat & touching)	Reference Method 12(flat spaced)
1	2	3	4	5	6	7	8	9
mm^2	mV	mV	mV	mV	mV	mV	mV	mV
1	44	44	44	44	38	38	38	38
1.5	29	29	29	29	25	25	25	25
2.5	18	18	18	18	15	15	15	15
4	11	11	11	11	9.5	9.5	9.5	9.5

6	7.3	7.3	7.3	7.3	6.4	6.4	6.4	6.4
10	4.4	4.4	4.4	4.4	3.8	3.8	3.8	3.8
16	2.8	2.8	2.8	2.8	2.4	2.4	2.4	2.4

3.2.4. Flexible Cords

Flexible cords may be used for:

a) Electrical equipment for household or similar use having a rating of 16.0A or less at voltages not exceeding 230.0V and which is intended to be moved from place to place.

b) Electrical equipment for industrial use which must be capable of being moved from place to place for operation

c) Pendants

d) The connection of stationary equipment

e) The connection of electrical components between which relative motion is necessary

f) The connection of appliances such as ranges and clothes dryers;

g) Supplying of current for portable lamps and other devices

h) Wiring of cranes and hoists.

Flexible cord shall not be used for:

- As substitute for fixed wiring
  - ✓ Permanently secured to any structure
  - ✓ Run through holes in walls, ceilings or floors
  - ✓ Run through doorways, windows or similar openings
- At temperature above the rating of the cord
- For suspension of any device weighing more than 2.3kg unless the cord and the device assembly are marked as capable to support a weight up to 11kg.

3.2.5 Color of Conductors

Table 4 Color identification of Cores for Flexible cables and cords

Number of Cores	***Function of Core***	***Color of Core***
1	Phase	Brown
	Neutral	Blue
	Protective	Green and yellow
2	Phase	Brown
	Neutral	Blue
3	Phase	Brown
	Neutral	Blue
	Protective	Green and yellow
4 or 5	Phase	Brown or Black
	Neutral	Blue
	Protective	Green and yellow

Table 5 Color identification of Cores for Non-Flexible cables and bare conductor for fixed wiring

Function	***Color Identification***
Protective conductor (ground)	Green and yellow

Phase conductor of 1-phase circuit AC	Red or Yellow or Blue
Neutral conductor of 1-phase circuit AC	Black
Phase conductors of 3-phase circuit AC (R,Y,B)	Red / Yellow / Blue
Positive conductor of DC 2-wire circuit	Red
Negative conductor of DC 2-wire circuit	Black
Positive conductor of DC 3-wire circuit	Red
Middle conductor of DC 3-wire circuit	Black
Negative conductor of DC 3-wire circuit	Blue

3.2.6 Correction Factor of Conductors

The current carrying capacity of a conductor for continuous duty is affected by *ambient temperature*, *grouping*, *thermal insulation,* semi-enclosed fuses and *frequency*.

- **Ambient temperature correction factors (C_a)**
- **Cable grouping correction factors (Cg)**
  - ✓ Widely spaced cables dissipate heat easily
  - ✓ A closely packed cable cannot easily dissipate heat and so its temperature rises

  Because of this, cables installed in groups with others (for example, if enclosed in a conduit or trunking) are allowed to carry less current than similar cables clipped to, or lying on, a solid surface which can dissipate heat more easily

- **Thermal insulation correction factors (Ci)**

  ✓ The use of thermal insulation in buildings, in the forms of cavity wall filling, roof space blanketing, and so on, is now standard. Since the purpose of such materials is to limit the transfer of heat, they will clearly affect the ability of a cable to dissipate the heat buildup within it when in contact with them.

Steps in cable/wire size computation

- Calculate the expected (design) current in the circuit (I_b)
- Choose the type and rating of protective device (fuse or circuit breaker) to be used(I_n)
- Divide the protective device rated current by the ambient temperature correction factor (C_a) if ambient temperature differs from 30°C
- Further divide by the grouping correction factor (C_g)
- Divide again by the thermal insulation correction factor (C_i) if applicable
- Divide by the semi-enclosed fuse factor of 0.725 where applicable
- The result is the rated current of the cable required, which must be chosen-from the tabulated current carrying capacity (I_t) given in the Tables under Section 4. of EBCS -10.

3.3 Over-current protection Requirements

Over-current Protective Device (EBCS under Sec 9. Protection and Control)

Every electrical apparatus and unearthed conductors shall be protected by one or more devices as may be necessary for automatic and/or manual interruption of the supply in the event of any fault and shall be provided with:

- protection against fault current
- protection against overload current

- protection against under voltage
- protection against earth fault
- manually-operable control device

3.3.1 Over-current devices –
the safety device that provide over-current protection of either the load or source circuit. The over-current protective devices shall ensure safe operation and shall have interrupting capacity sufficient for the voltage employed and for the anticipated fault current which must be interrupted. The rating or setting of over-current devices shall not exceed the allowable ampacity of the conductors which they protect except:

- If the rating of the fuse of circuit breaker is not available the ratings or settings given in may be used;
- In case of equipment wire, flexible cord or tinsel cord which will be considered as being protected by 16.0 A over-current device.

Fuse – is a type of very low resistance conductor that provides over-current protection through a metal strip that melts when too much current flows on it.

(EBCS 9.5) – Only fuses and fuse holders of proper rating shall be used, and no bridging or short circuiting of either component shall be permitted. Where plug fuses are used in branch circuits, they shall be of such a type and so installed that they are non-interchangeable with a fuse of larger rating

A fuse having a fuse link which is likely to ·be removed or replaced while the supply is connected shall be of a type such that it can be removed or replaced without danger.

Circuit breaker – is an automatically operated electrical switch designed to protect an electrical circuit from damage cause by overload or short circuit. Some circuit breaker has bi-metallic element that can detect a fault condition or over-current flow which will drive the breaker into trip off position resulting to interruption of the current flow.

- Circuit breakers shall be of the trip-free type.
- Indication shall be provided at the circuit breaker and at the point of operation to show whether the circuit breaker is open or closed.
- Circuit breakers shall open the circuit in all unearthed conductors by the manual operation of a single handle and by the action of over-current.
- Circuit breakers shall be of such design that any alteration by the user of either the tripping current or the time will be difficult.

2. Earth Fault Protection (EBCS 9.4.2) – Earth-fault protection shall be provided to de-energize all normally earthed conductors of a faulted circuit in the event of an earth fault in those conductors.

3. Control Devices (EBCS 9.7) Control devices shall have ratings suitable for the connected load of the circuits which they control and with the exception of isolating switches, shall be capable of safely establishing and interrupting such loads.

- Control devices used in combination with over-current devices or overload devices for the control of circuits or apparatus shall be connected so that the over-current or overload devices will be dead when the control device is in the open position, except where this is impracticable.
- Control devices, with the exception of isolating switches, shall be readily accessible.
- Control devices, unless located or guarded so as to render them inaccessible to unauthorized persons and to prevent fire hazards, shall have all current-carrying parts in enclosures of metal or other fire-resisting material.
- Where electrical equipment is supplied by two or more different transformers or other sources of voltage, then:

(a) a single disconnecting means, which will effectively isolate all unearthed conductor supplying the equipment, shall be provided integral with or adjacent to the equipment;or

(b) each supply circuit shall be provided with a disconnecting means integral with or adjacent to the equipment, and the disconnecting means shall be grouped together.

4. Switches – an electrical device that can break an electrical circuit, interrupting the current or diverting it from one conductor to another. A switch can be manually operated or automatically activated.

- Single-throw knife switches shall be mounted with their bases in a vertical plane so that gravitational force will not tend to close them.
- Double-throw knife switches may be mounted so that the throw will be either vertical or horizontal. (b) If the throw in (1) above is vertical, a positive locking device or stop shall be provide do ensure that the blades remain in the open position when so set unless it is not intended that the switch be left in the open position.
- Manual single-throw switches, circuit breakers, or magnetic switches, shall be connected so that the bases or moving contacts will be dead when the device is in the open position except when other conditions make this requirement unnecessary.

5. Protection and Control of Miscellaneous Apparatus (EBCS 9.8)

- Socket outlets shall not be connected to a branch circuit having over-current protection rated or set at more than the ampere rating of the socket outlets except as permitted by other Sections of this Code.
- Portable appliances need not be equipped with additional control devices where the appliances are:
  - ✓ Rated at not more than 1500 Watts; and
  - ✓ provided with cord connectors, attachment plugs or other means by which they can be disconnected readily from the circuits.
- Where switches are used to control an outlet or outlets from more than one point, the switches shall be wired and connected so that the earthed conductor runs directly to the outlet or outlets controlled by the switches.
- Except for panel boards where more than 90% of the over-current devices supply feeders or motor branch circuits, every panel board shall be protected on the supply side by over-current devices having a rating not greater than that of the panel board.
- Transfer equipment for standby power systems shall prevent the inadvertent interconnection of normal and standby sources of supply in any operation of the transfer equipment.

Table 6 Rating or setting of over-current devices protecting conductors

Ampacity of conductors	Rating or setting permitted (A)	
	Fuse	Circuit breaker
0-16	16	16
17-20	20	20
21-25	25	32
26-32	32	32
33-40	40	40
41-50	50	50
51-63	63	63
64-80	80	100
91-100	100	100

101-110	110	125
111-125	125	125
126-150	150	150
151-175	175	175
176-200	200	200
201-225	225	225
226-250	250	250
251-275	300	300
276-300	300	300
301-325	350	350
326-350	350	350
351-400	400	400
401-450	450	450
451-500	500	500
501-525	600	600
526-550	600	600
551-600	600	600

3.4 Circuit Loading and Demand Factor Requirements

- **Demand factor** – it is the ratio of the maximum demand of a system or part of a system, to the total connected load on the system, to the maximum demand of the whole system, or part of a system, under consideration.
- **Diversity factor** – the ratio of the sum of the individual maximum demands of the various subdivisions of a system, or part of a system, to the maximum demand of the whole system, or part of a system, under consideration.
- **Continuous load** – any condition in which the maximum load current in a circuit flows without interruption for a period of not less than 3 hrs.
- **Current calculation** – When calculating the currents from loads expressed in watts or volt-amperes, to be supplied by a low voltage A.C. system, the voltage divisor to be used shall be 230V or 380V as applicable.
- **Voltage drop** – voltage drop in an installation shall be based upon the calculated demand load of the branch circuits and shall satisfy the requirements of clause EBCS Sec 4.5.4.
- **Maximum circuit loading** – for loads other than motors, the total on consumer's service, feeder or a branch circuit shall be 80% of the circuit rating when the load is a continuous one.
- **Use of demand factor**
  - ✓ Where two or more loads are so installed that only one can be used at any one time, the one providing the greatest demand shall be used in determining the calculated demand.
  - ✓ Where feeder supplies loads of a cyclic or similar nature such that the maximum connected load will not be supplied at the same time, the ampacity of the feeder conductors shall be based on the maximum load that may be connected at any one time.
  - ✓ The ampacity of conductors of a feeder or branch circuit shall not exceed the ampacity of the conductors of 'the service or of the feeder from which they are supplied.

Self-check: 3	Written test

Name …… Date…….

Direction I Choose best answer for the following question

1. An automatically operated electrical switch designed to protect an electrical circuit from damage cause by overload or short circuit.
   A. Fuse *C.* switch
   B. Circuit breaker *D.* Control Devices
2. According to EBCS coding system in single phase supply the phase line should be
   A. Green C. Blue
   B. Yellow D. Brown
3. Which one of the following color is does **not** represent of live /phase/ in three phase supply
   A. Black C. Yellow
   B. Red D. Blue
4. Steps in cable/wire size computation
   A. Calculate the expected (design) current in the circuit (I_b)
   B. Choose the type and rating of protective device (fuse or circuit breaker) to be used(I_n)
   C. Divide the protective device rated current by the ambient temperature correction factor (C_a) if ambient temperature differs from 30°C
   D. All
5. Conductors and Over load protection Requirements
   A. Size of Conductors C. Voltage Drop
   B. Neutral Conductors D. All

Note: **Satisfactory rating - 5 points** **Unsatisfactory - below 5 points**

Information Sheet 4	**Terminating and connecting accessories**

The required is to controlling one lamp from one positions by using one way switch controlling one lamp from one location by using single pole single though (SPTS) switch. As we see fig 1.2 the switch is used to on/off the lamp, if the switch is ON the lamp is ON and also if the switch is OFF the lamp gets OFF.
The phase line should be connect first with switch.

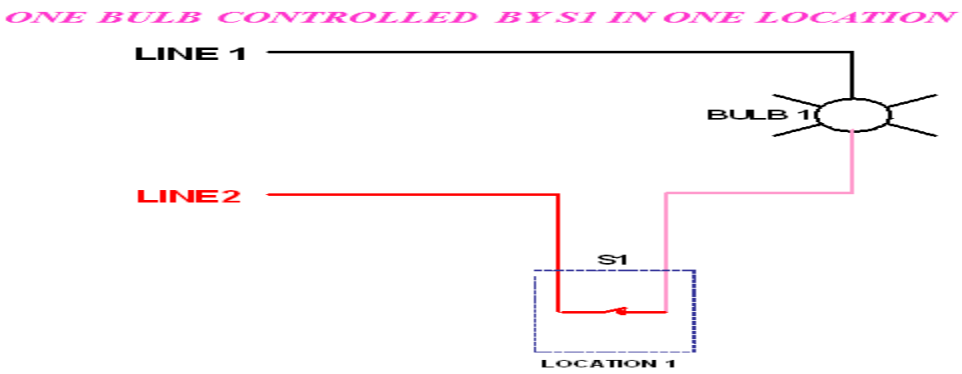


Fig 1.2

In the fig 1.3 required is to controlling two lamp from one positions by using one way switch controlling two lamp from one location by using single pole single though (SPTS) switch. As we see fig 1.3 the switch is used to on/off the lamps, if the switch is ON the lamps is ON and also if the switch is OFF the lamps gets OFF.

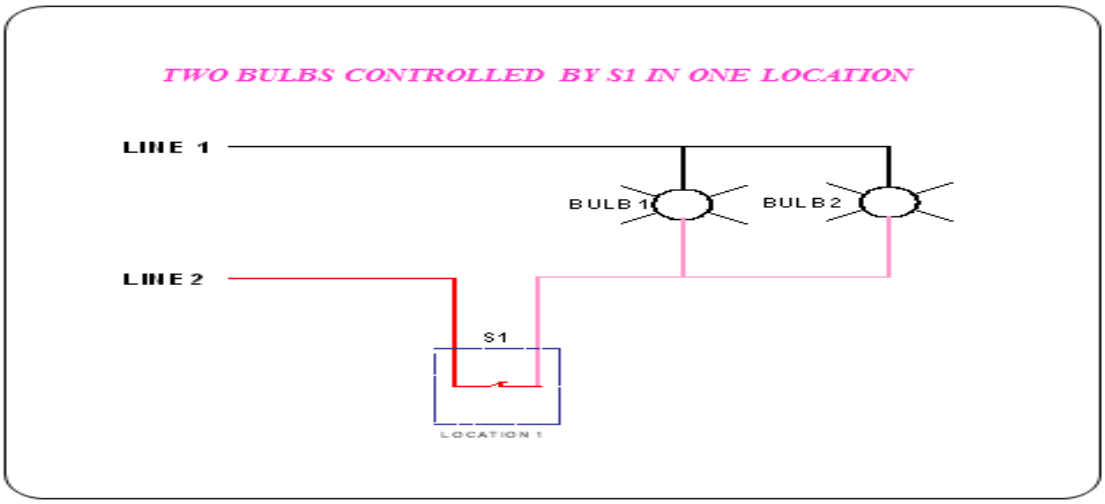


Fig 1.3

In the fig 1.4 required is to controlling one lamp from two positions by using two way switch controlling one lamp from two location by using two way switch. As we see fig 1.4 the switch 1 and switch 2 independently is used to on/off the lamp.

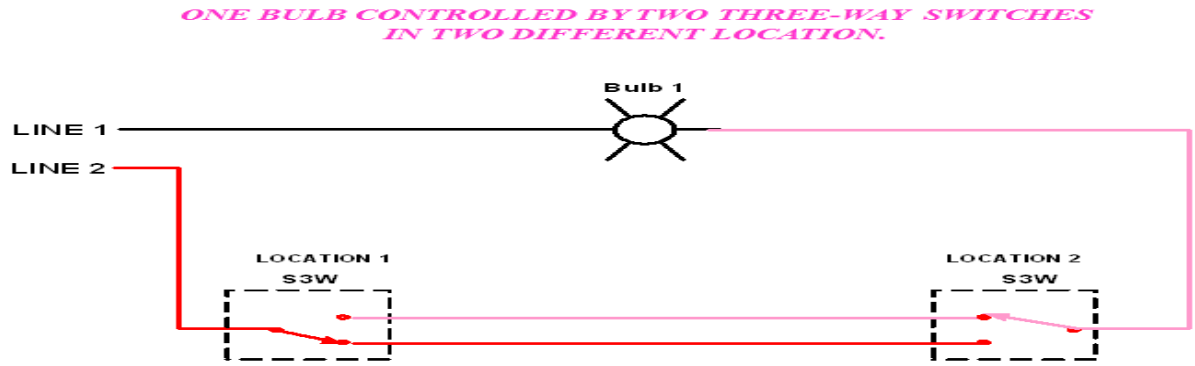


Fig 1.4

In the fig 1.5 required is to controlling one lamp from three positions by using two way switch and intermediate switch controlling one lamp from three location . The switch 1 , switch 2 and switch 3 independently is used to on/off the lamp.
Switch 1and switch 3 are two way switch and switch 2 is intermediate switch.

ONE BULB CONTROLLED BY TWO THREE-WAY SWITCHES AND ONE FOUR-WAY SWITCH IN THREE DIFFERENT LOCATION.

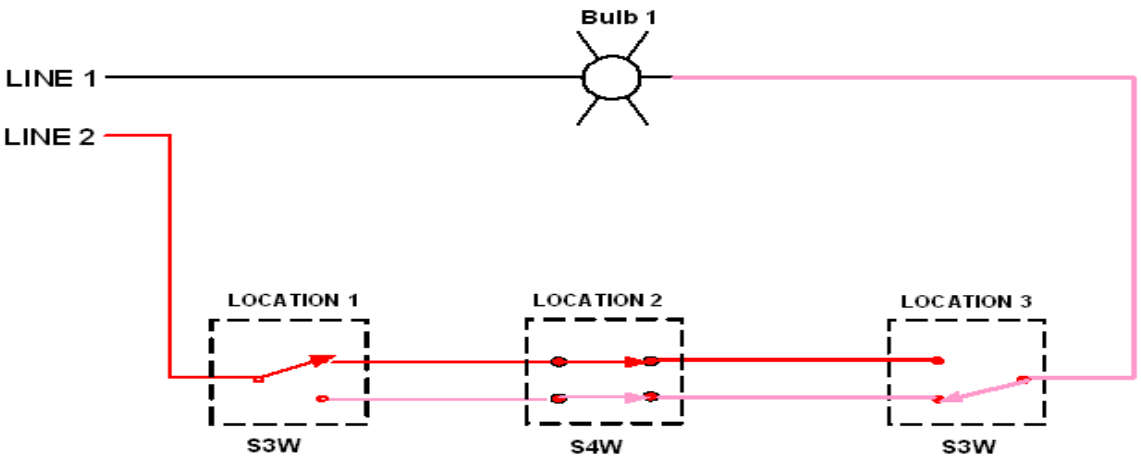


Fig 1.5

Self-check: 4	**Written test**

Name …… Date……..

<u>Direction</u> I true or false

1. The phase line should be connect with switch before lamp
2. Lamp is connect next to switch
3. Two way switch is used to control a lamp from two position.
4. Single way switch is used to control lamp more than two position.

Information Sheet 5	Installing Wiring system

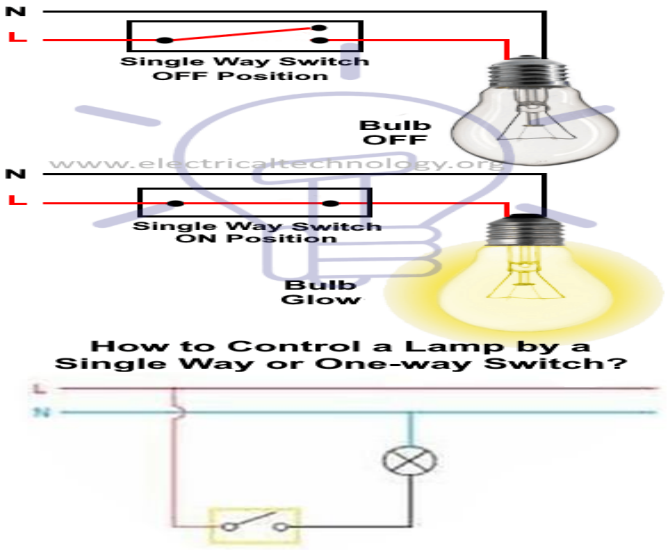
5.1 Introduction

5.1.1Select materials from drawings The main diagram the electrician will work to is the scaled layout drawing, often called a plan. From this the electrician can count up the amount of accessories and items of equipment needed for the job. Cable lengths can also be calculated using the scale and likely cable routes shown on the drawing.

5.1.2 Marking out before starting actual installation work, the job has to be marked out. The drawing is used to show where all accessories and items of electrical equipment are to be fitted. It is important to install all equipment in the correct position. If a socket or switch is not placed where it should be it could end up hidden behind a cupboard or radiator. When marking out, the position of accessories, equipment and cable drops are drawn on to the wall with a pencil or chalk.

5.2 Single way switch

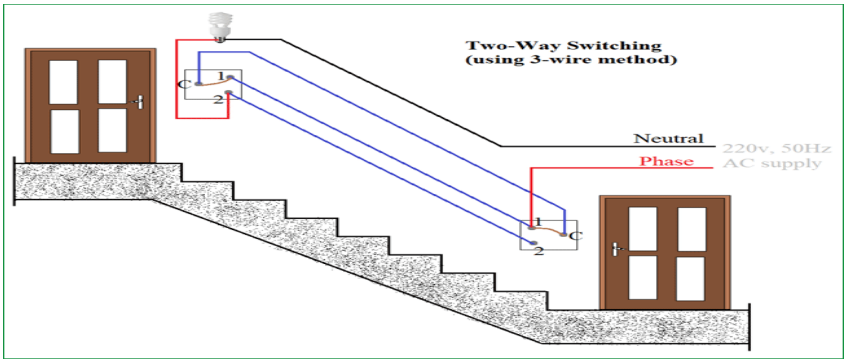
Below is a simple step by step tutorial with schematic and wiring diagram which shows how to wire a light switch to control the bulb/lamp from single place with the help of one way or single way switch?
Requirements:
Single Way Switch (SPST = Single Pole Single Through) x 1 No
Lamp (Light Bulb) x 1 No
Short pieces of cables x 3 No
This is just like a series circuit i.e. all the components are connected in series. Just connect the Neutral wire directly to the light bulb and then connect the light bulb to the switch through middle wire. And then connect the live wire to the switch as shown in fig below. Fig given below shows the basic connection of light switch and their position i.e. when the switch is OFF, the circuit acts like an open circuit and the bulb won't glow. To switch on the bulb, switch S1 must be closed to complete the circuit and glow the light bulb.



Also note that home wire colors may vary according to different areas. In addition, always use and connect the earth wire (direct naked wire to switches, and electrical appliances from earth link in the distribution board to reduce the risk of electric shock and hazard) which is not shown in the figures above.

5.3 Two way light switch

In installing, we will show you how to make 2-way switching connection. A 2-way switching connection means you can control an electrical equipment like bulb by two switches placed at different places, generally used in the staircase. Two way switch can be operated from any of the switch independently, means whatever be the position of other switch(ON/OFF), you can control the light with other switch.

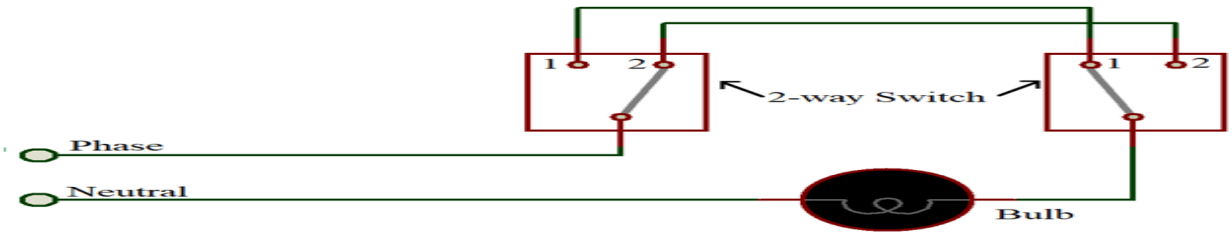


Required Components

Two 2-way switches, Bulb, AC supply, **c**onnecting wire

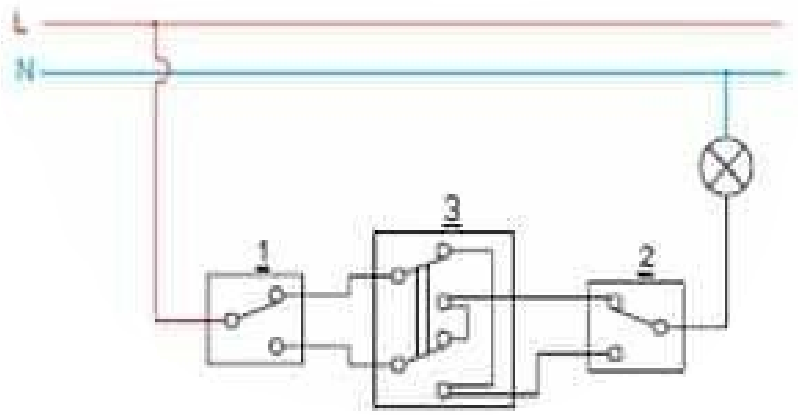
As you see in the Schematic Diagram of 2 way switch circuit below, you will find that the phase/live is connected with the common of the first 2-way switch. PIN1 & PIN2 of the first switch is connected with the PIN1 & PIN2 of second switch respectively. One end of the bulb is connected with the Common Terminal of second switch and other end of the Bulb is connected with Neutral line of AC power supply.

Note: In 2-wire control method when switches are in opposite state the light will be inn OFF state as shown in circuit below:



5.4 Controlling a light with three or more switches

For more than two switches, one or more 4-way switches are added between the 3-way switches. A 4-way switch has two positions. In the first position, the contacts are connected straight through, so that the switch has no effect. In position two, the switch cross connects the contacts on the left with the contacts on the right, in an "X" connection.



Self-check: 5	Written test

Name …… Date……

Matching

Direction Match the following <A> column with the given <B> column

A		B
1.	Single way switch	A. operated from any of the switch independently
2.	Two way switch	B. over current protective device
3.	Intermediate switch	C. Single Pole Single Through
4.	Circuit breaker	D. output device
5.	Lamp	E. have two input and two output terminal

Note: **Satisfactory rating - 5 points** **Unsatisfactory - below 5 points**

Responding unplanned events or conditions

It is essential that the unconditioned events observed in the following aspects:

- demonstrate knowledge of the Entertainment and Events Technology equipment and associated disconnection, storage and cleaning requirements
- determine work requirements and plan and organize work to fulfill such requirements
- identify, select and use tools, equipment and material to complete tasks to specifications
- disconnect equipment and cables safely and in accordance with specifications
- handle material and equipment safely
- identify and report problems promptly and handle them as directed
- prepare equipment and storage site
- complete cleaning and storage related tasks in accordance with health and safety procedures
- Perform inspection and quality checks - interpret and apply technical information to work activities
- demonstrate compliance with Occupational Health and Safety regulations applicable to workplace operations
- show compliance with organizational quality procedures and processes within the context of disconnecting, cleaning and storing Entertainment and Events Technology equipment
- Interactively communicate with others to ensure safe and effective operations

Self-check: 6	**Written test**

Name …… Date……

Say true if the sentence is correct and say false if the statement is incorrect

1. Interactively communicate with others to ensure safe and effective operations is available if unplanned condition is happen
2. Perform inspection is available to responding unplanned events.

Note: **Satisfactory rating - 2 points** **Unsatisfactory - below 2 points**

Information Sheet 7	Approving procedure and requirement of termination

7.1 How to Create an Approval Process and Workflow

In any organization, work often needs to be formally approved before it can begin. Budgets, creative projects, marketing initiatives, invoices, and many other work items all move through a series of approvals before they are considered either ready for kickoff or complete. Many organizations create specific approval processes or workflows that dictate how work should be approved (or rejected) every time to save time and ensure standardization.

7.2 What Is an Approval Process?

An approval process is the method an organization uses to approve anything from documents, invoices, budgets, and purchase orders, to a new process that a company wants to institute. Implementing an approval process can standardize an organization's internal processes, and also save time by creating a dependable, repeatable system. Approval processes are a type of workflow,

which is any sequence of work from initiation to completion, that you can create to ensure work is approved the same way every time.

Creating an approval process can simply mean defining the procedures that you will follow to approve work.

7.3 Elements of an Approval Process

While each approval process will differ based on its purpose or the organization's specific requirements, there are some general tasks that you will likely include when designing your own. These include:

- **Submission**: An approval process usually begins with someone submitting something. You'll need to create a submission portal where users go to submit their work.
- **Assign Approvers:** you'll need to identify the person or people who have the final say. If your process has multiple approval levels, define who will approve which aspects of work at each level.
- **Set Permission Levels**: Define the level of authority each user should have. Most systems have features to delineate among viewer, editor, and administrator permissions, so you can control who edits, rejects, or approves submissions.
- **Set Due Dates:** As with any project, it's important to set deadlines to keep your workflows moving and prevent work backlogs.
- **Record/Log:** Having a record of every step in the approval process is one of its greatest benefits for increasing transparency and ensuring consistency. If you plan on using an automated solution, look for a program that offers the following capabilities:
- **View User History:** See who has made changes, to what, and when.
- **Lock Record:** This will make the record uneditable, so that no user can change the log of actions.
- **Edit Record:** In some cases, you might want the record to be kept editable - for instance, if you made a mistake or need to keep certain information private from other parties. While we're on the topic of automated workflows, it's important to note that some programs also offer additional functionality that can create a more customized feel, or help disrupt some of the inflexibility that can come with automation. Some of these functions include:
- **Task Lists:** It can be helpful to build task assignment into the approval process, allowing each employee to clearly see their responsibilities, and informing management of resource allocation. Many of these elements will be present in the approval process you design, regardless of the specific project or type or organization. In the next section, we'll discuss the software programs that allow you to build approval processes and workflows, and additional features to consider.

Self-check: 7	Written test

Name …… Date…….

Say true if the sentence is correct and say false if the statement is incorrect

1. Approval processes are a type of workflow, which is any sequence of work from initiation to completion, that you can create to ensure work is approved.
2. Record/Log means an approval process usually begins with someone submitting something.
3. In any organization, work often needs to be formally approved before it can begin.

Note: **Satisfactory rating – 3 points** **Unsatisfactory - below 3 points**

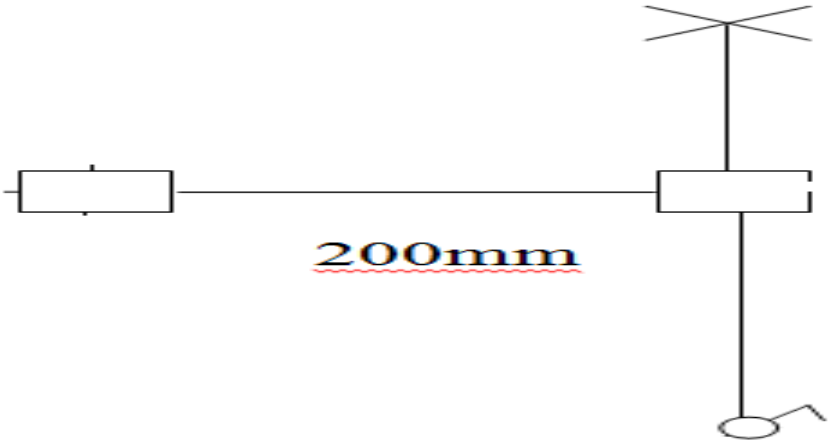
Operation Sheet 1	Install electrical installation work	2.5

Installing wiring system

Step 1 wear PPE

Step 2 Read and interpret the layout diagram

Step 3 Convert the given layout diagram into wiring diagram



Step 4 Select material, tools and instruments

Step 5 identify proper current ratings of conductor wire

Step 6 Installing electrical installation work

Step 7 Check all terminals for proper connections.

Step 8 Check the functionality of materials also check burned-out lamp and circuit breaker

Step 9 Check all enclosures for loose wires, tools and components.

Step 10 Check all wires terminated for being free of unintentional earth connections.

Step 11 Check for proper sequence of connections as per wiring diagram diagram.

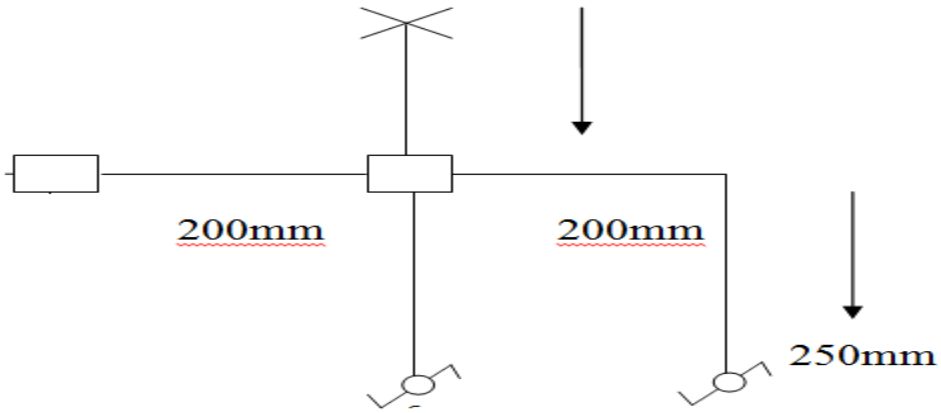
Step 12 Check for proper sealing of conduit connections, cables.
Step 13 Finaly give the powe to the system.

Operation Sheet 2	Install electrical installation work	2.5 Installing wiring system

Step 1 wear PPE

Step 2 Read and interpret the layout diagram

Step 3 Convert the given layout diagram into wiring diagram



Step 4 Select material, tools and instruments

Step 5 identify proper current ratings of conductor wire

Step 6 Installing electrical installation work
Step 7 Check all terminals for proper connections.

Step 8 Check the functionality of materials also check burned-out lamp and circuit breaker

Step 9 Check all enclosures for loose wires, tools and components.
Step 10 Check all wires terminated for being free of unintentional earth connections.
Step 11 Check for proper sequence of connections as per wiring diagram diagram.
Step 12 Check for proper sealing of conduit connections, cables.
Step 13 Finaly give the powe to the system.

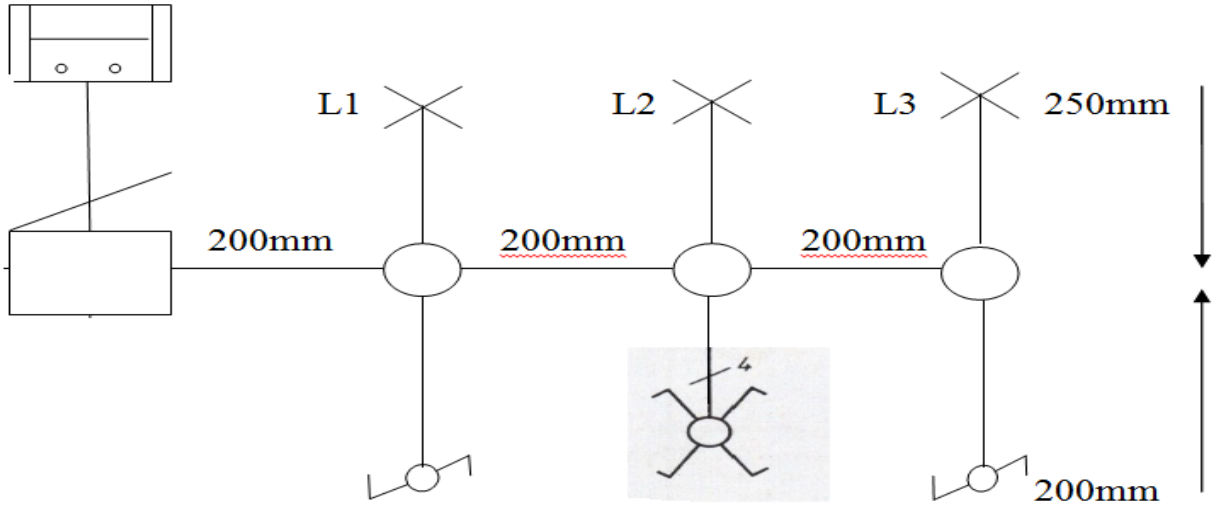
Operation Sheet 3	Install electrical installation work	2.5

Installing wiring system

Step 1 wear PPE

Step 2 Read and interpret the layout diagram

Step 3 Convert the given layout diagram into wiring diagram



Step 4 Select material, tools and instruments

Step 5 identify proper current ratings of conductor wire

Step 6 Installing electrical installation work

Step 7 Check all terminals for proper connections.

Step 8 Check the functionality of materials also check burned-out lamp and circuit breaker

Step 9 Check all enclosures for loose wires, tools and components.

Step 10 Check all wires terminated for being free of unintentional earth connections.

Step 11 Check for proper sequence of connections as per wiring diagram diagram.

Step 12 Check for proper sealing of conduit connections, cables.

Step 13 Finaly give the powe to the system.

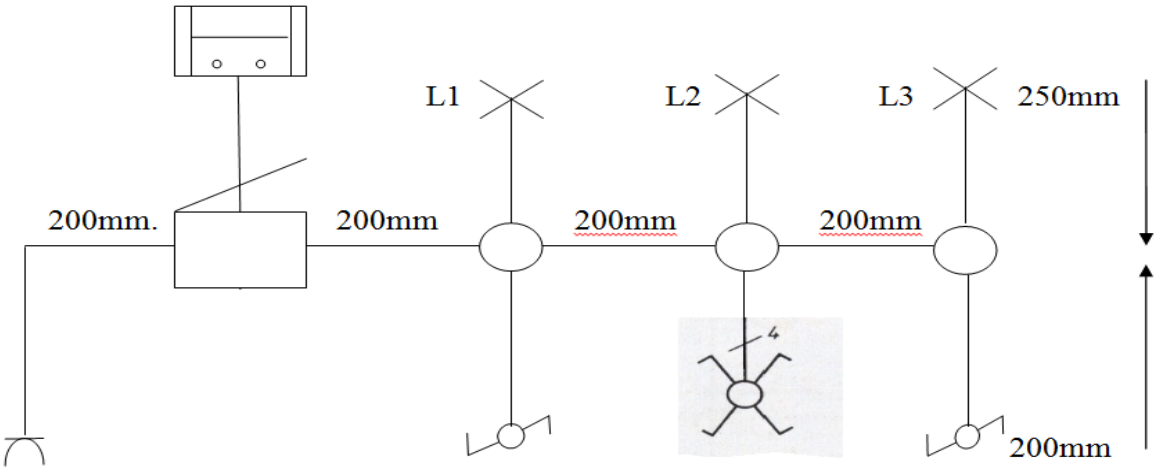
Operation Sheet 3	Installing wiring system	2.5 I n st

alling wiring system

Step 1 wear PPE

Step 2 Read and interpret the layout diagram

Step 3 Convert the given layout diagram into wiring diagram



Step 4 Select material, tools and instruments

Step 5 identify proper current ratings of conductor wire

Step 6 Installing electrical installation work

Step 7 Check all terminals for proper connections.

Step 8 Check the functionality of materials also check burned-out lamp and circuit breaker

Step 9 Check all enclosures for loose wires, tools and components.

Step 10 Check all wires terminated for being free of unintentional earth connections.

Step 11 Check for proper sequence of connections as per wiring diagram diagram.

Step 12 Check for proper sealing of conduit connections, cables.

Step 13 Finaly give the powe to the system.

LAP Test	Practical demonstration

Name …….. Date…….

Time started……. Time finished……...

Instructions: given necessary templates , tools and materials you are required to perform the following tasks with 8 hours.

Task 1: Installing wiring system

Instruction Sheet	LG18: Inspect and notify completion of work

This learning guide is developed to provide you the necessary information regarding the following learning outcome and content coverage

- Inspection of installed apparatus
- Functional test of installed apparatus
- Notification of completion work

-This guide will also assist you to attain the learning outcome and contents stated in the cover page. Specifically, upon completion of this Learning Guide, you will be able to:-

- Inspect installed apparatus
- Test the installed apparatus
- Notification of completion work

Learning Instructions:

8. Read the specific objectives of this Learning Guide.
9. Follow the instruction described blew 3 to 5
10. Read the information written in the “Information Sheet 1 up to information sheet 3”.
11. Accomplish the “Self-check 1, self-check 2, and Self-check 3, ” in page (7, 30 and 32) respectively.
12. If you earned a satisfactory evaluation from the “Self-check” proceed to other information sheet.

Information Sheet-1	Inspection of installed apparatus

1. Inspection of installed apparatus

Step 1 - before you start inspecting switch off the power and unplug the equipment**.** Never open the casing of the equipment. If you suspect there is a fault inside the casing you should seek help from someone appropriately qualified.

Step 2 - the electrical cable Run the cable slowly through your hands and feel for any lumps, cuts or rough areas. At the same time inspect all round the cable whilst working down it a little section at a time. Watch out for any areas that are discoloured, this might indicate an area of damage. Be particularly vigilant with any part of the cable that may be prone to having equipment sat on it or that may be habitually curved or twisted. These are sections that are likely to become damaged.

If any part of the outer insulation of the cable is breached, or if you have reason to believe that thewires within it may be damaged, refer immediately to Step 5.

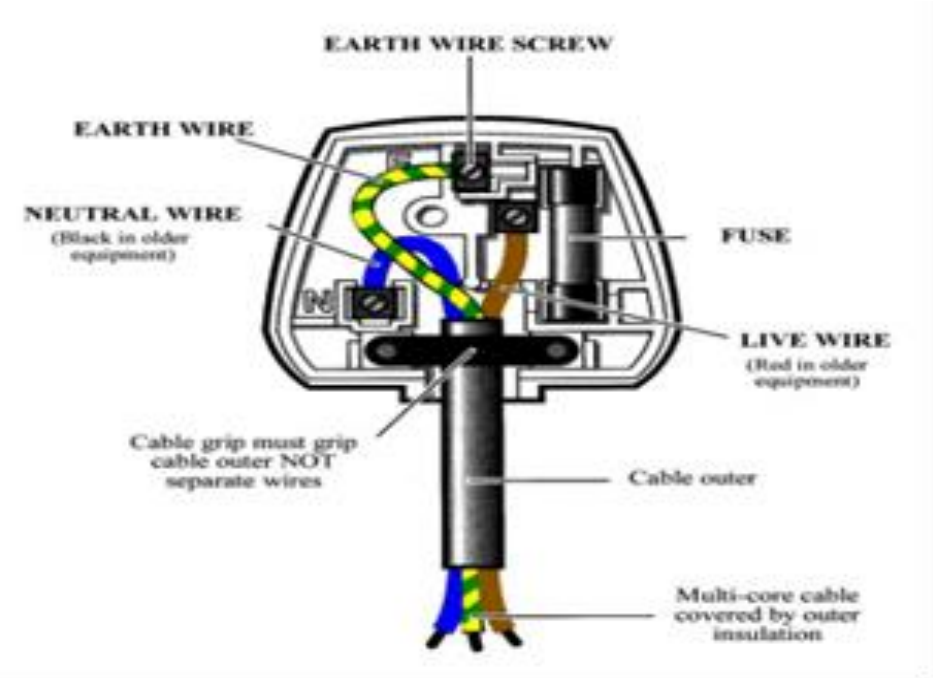
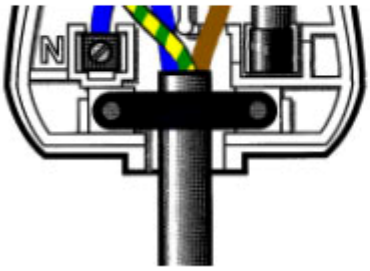


Fig 1

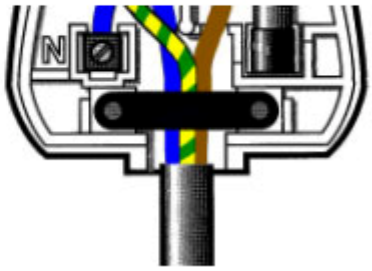
Begin your inspection of the plug by looking at the point where the cable enters it. The outer insulation of the cable should be tightly gripped by the plug cable grip and none of the thinner internal wires should be visible from the outside of the plug.

Cable Entry to the Plug

Correct:



NOT like this:



The plug casing Next look at the plug itself. The casing should not be cracked, chipped or damaged. There should be no bent pins. If the plug is not permanently bonded to the cable you should be able to open the casing using a small screwdriver. Again look closely at the point where the cable enters the plug through the cable grip, this time examining it from the inside of the plug. As before, the outer cable should be securely gripped and the thinner inner cables should emerge from the outer only beyond this point.

The wires within the plug Next examine each of the individual thinner cables. It is not necessary to unwire the plug to do this. Make sure that the BROWN wire (RED in older equipment) is connected to the LIVE terminal (usually labelled L), that the BLUE wire (BLACK in older equipment) is connected to the NEUTRAL terminal (usually labelled N) and that the GREEN and YELLOW wire is connected to the EARTH terminal (often labelled E, this is at the top of the plug). Ensure that there are no damaged parts on any of the cables and make sure that there is no excess cable that may snag or be trapped when the plug is re-assembled. If any of the smaller cables are too long you may see rub or pinch marks on the outer insulating surface. You should check the point where the inner wires are connected to the plug terminals and ensure that there is not an excessive amount of bare wire exposed. Ideally the insulating outer should cover the inner conducting wire entirely and no conducting wire should be visible. In practice this is often difficult to achieve and it may be necessary to have a gap of about one millimetre of conductor showing between the insulating material and the terminal.

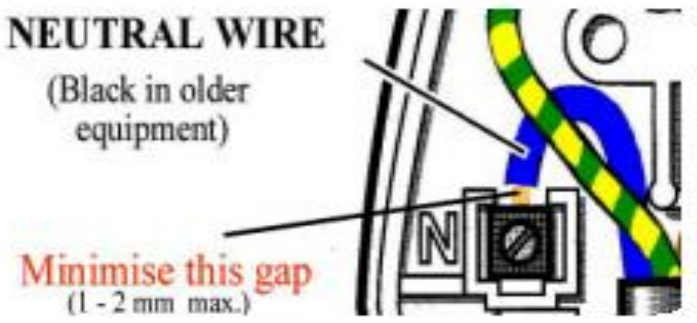


Fig 2

Finally check the connections at each terminal. Ensure that the conducting wire is securely housed and that no stray wires are sticking out. Make sure that the terminal screws are securely tightened.

What if there are only two wires inside the plug?
Remember that some appliances have a cable that contains only two wires (e.g. some desk lamps). If you see only two wires when you open the plug take a close look at the end of the cable where these wires emerge. Make sure that there isn't a third wire that has been cut off. You should also check that the two wires are connected correctly. This means that the BROWN (RED in older equipment) wire should be connected to the LIVE terminal and the BLUE (BLACK in older equipment) wire to the NEUTRAL just as they are when three wires are present. In this case the only wire that should be missing is the GREEN and YELLOW connection to the EARTH terminal.

A two wire plug:

Fig 3

Step 4 - the fuse Any plug that is designed to make a connection between a piece of equipment and a mains socket should be fitted with a cartridge fuse. In the case of sealed plugs this fuse is located in a compartment that can be opened from outside the plug. This compartment is located on the face of the plug from which the pins protrude. In unsealed plugs the fuse is located inside the body of the plug and is connected to the LIVE terminal next to the BROWN wire. When you open an unsealed plug to inspect the cables and connections the fuse should be readily visib

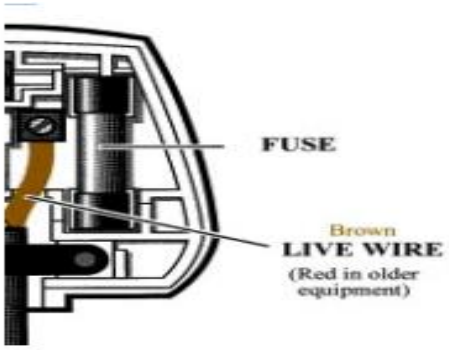


Fig 4

If you know the energy usage then the correct fuse rating can be calculated using the table below

'Wattage' of Equipment = Fuse Rating

'Wattage' of Equipment **Fuse Rating**

Up to 600 Watts	3 Amps
Between 600 Watts and 1000 Watts (1KW)	5 Amps
Between 1KW and 3KW (3000 Watts)	13 Amps

Step 5 – Putting the equipment back into service

No faults observed

If you have found no faults it is now a simple matter to reassemble the plug. Before putting the equipment back into use you should label the plug to show that an inspection has been carried out.This label should give details of the date of inspection and who carried out the inspection. Proprietary labels may be purchased, but it is perfectly acceptable to use self-adhesive labels so long as they remain attached to the plug until the next inspection.

If you found one or more faults:

If you found any of the following simple faults you are likely to be competent to correct the by yourself:

- Incorrect fuse
- Missing fuse
- Connections inside the plug are loose
- Outer cable is not gripped tightly by the cable grip.

After a little practice most people are able to rewire a plug if they have the correct equipment. If you do not have the correct equipment to do this job, or if you feel it is beyond your ability you should seek assistance. If the cable is damaged you should not attempt to repair this and should seek assistance.If you have identified faults during the inspection that cannot be immediately fixed then the equipment should be taken out of service until the necessary repairs can be undertaken. This can be achieved by removing it to a secure storage area. If this is not possible the plug should be removed to prevent use. In all cases the equipment should be labelled to indicate that it should not be used.

Step 6 - Keeping records The department should keep a record of all of the equipment inspected. This record should include a description of the equipment, dates of each inspection and information about who carried out the inspection. You may also find it useful to record the size of fuse the equipment should have in its plug and to keep a record of any major faults and the steps taken to repair these.

Self-check 1	**Written test**

Name ..... Date.....

<u>Direction</u> Say true or false for the following question

1. If you start inspecting switch ON the power of the equipment

2. Recording should include a description of the equipment, dates of each inspection and information about who carried out the inspection.
3. Connections inside the plug loose and Missing are can corrected by yourself:
4. If you have reason to believe that the wires within it may be damaged, refer to Putting the equipment back into service

Note: **Satisfactory rating - 5 points** **Unsatisfactory – 5 below**

Information Sheet-2	**Functional test of installed apparatus**

2.1 Functional test of installed apparatus

2.1.1 Initial Testing of an Installation

Before a utility will connect an installation to its supply network, strict pre-commissioning electrical tests and visual inspections by the authority, or by its appointed agent, must be satisfied. These tests are made according to local (governmental and/or institutional) regulations, which may differ slightly from one country to another. The principles of all such regulations however, are common, and are based on the observance of rigorous safety rules in the design and realization of the installation. IEC 60364-6-61 and related standards included in this guide are based on an international consensus for such tests, intended to cover all the safety measures and approved installation practices normally

required for residential, commercial and (the majority of) industrial buildings. Many industries however have additional regulations related to a particular product (petroleum, coal, natural gas, etc.). Such additional requirements are beyond the scope of this guide. The pre-commissioning electrical tests and visual-inspection checks for installations in buildings include, typically, all of the following:

- Insulation tests of all cable and wiring conductors of the fixed installation, between phases and between phases and earth
- Continuity and conductivity tests of protective, equipotential and earth-bonding conductors
- Resistance tests of earthing electrodes with respect to remote earth
- Verification of the proper operation of the interlocks, if any
- Check of allowable number of socket-outlets per circuit
- Cross-sectional-area check of all conductors for adequacy at the short-circuit levels prevailing, taking account of the associated protective devices, materials and installation conditions (in air, conduit, etc.)
- Verification that all exposed- and extraneous metallic parts are properly earthed (where appropriate)
- Check of clearance distances in bathrooms, etc.

2.1.2 Periodic Check Testing of an Installation
In many countries, all industrial and commercial-building installations, together with installations in buildings used for public gatherings, must be re-tested periodically by authorized agents.

2.1.3 Testing of the Wiring Installation The test to be performed before a new installation or an addition to an existing installation is connected to the supply mains are as follows.

1) Testing insulation resistance between the wiring and the earth with all fuses and lamps in and all switches 'ON'.
2) The insulation resistance between the conductors with all lamps out and all switches 'ON'.
3) Testing of polarity of non-linked pole switches.
4) Testing of earth continuity path.
5) Testing of earth resistance

1. **Testing of Insulation Resistance Between the Wiring and Earth**:- The resistance offered to leakage from conductors to earth is known as **insulation resistance** between the wiring and the earth. The values of insulation resistance are so high that they are measured in Mega-ohms.

   The aim of this test is to know weather the wires or cables used in the wiring system are sufficiently insulated to avoid leakage of current. The instrument used to test the insulation resistance is known as Megger.
   Before making an insulation resistance ensures that: -
   i. Main switch is in off position
   ii. Main fuse is taken out
   iii. All other fuses are in position
   iv. All the switches are in 'on' position
   v. All the lamps are in their position or the holders are short-circuited and
   vi. Line and neutral terminals are shorted on the insulation resistance.

The measured resistance should not be less than 50 mega-ohms divided by the number of outlets.

2. **Testing the Insulation Resistance between Conductors** :- The objective of this test is to ensure that the insulation is sound between the conductors so that there may not be an appreciable leakage between them.

In this case::-

i. The loop at the main switch is removed.
ii. All the lamps and metallic connections between the two wires of the insulation are removed from the holders.

Reset of all things remaining the same i.e. the main switch off, main fuse with drawn, all other fuses in their positions and all single pole switches in 'on' position, the terminals of the Megger are connected to the two poles or lines of the installation and insulation resistance is measured between two conductors (line and neutral conductors).

3. Testing Polarity of Single Pole Switches:- It is necessary that single pole switches should always be placed in positive side or live side so that by making switch off the lamp can be made quite dead. The reason of it is that if the switch is provided on neutral wire, then lamp holder or the fan as well as part of wiring will remain a live, even when the single pole switch is in open position, which may lead to accidents.

To ensure that all switches are placed in phase or live conductors and not in neutral conductor, this test is performed. The instrument used to test polarity of single pole switches is neon tube tester (Pocket neon testing tube) or test lamp.

4. Testing of Earth Continuity Path:- For safely all the metallic pieces or covering such as conduits, metal covers of switches, etc. must be solidly connected to earth otherwise on the damage of insulation, the leakage current will start giving serve shock to the person touching it.

For earth continuity test, main switches should be opened, main fuse withdrawn, all other switches in on position and lamps in their respective holders. One end of the earth continuity tester is connected to an independent earth and the other end is connected to the wiring say to a switch or conduit. The pointer will indicate the earth resistance, which should not exceed the value of one ohm. Higher than this value shows that the conduit or switch has not been properly earthed.

5. Testing of Earth Resistance:- The determination of résistance between the earthing plate and the surrounding ground in distribution system is of utmost important. This measurement is done by potential fall method.

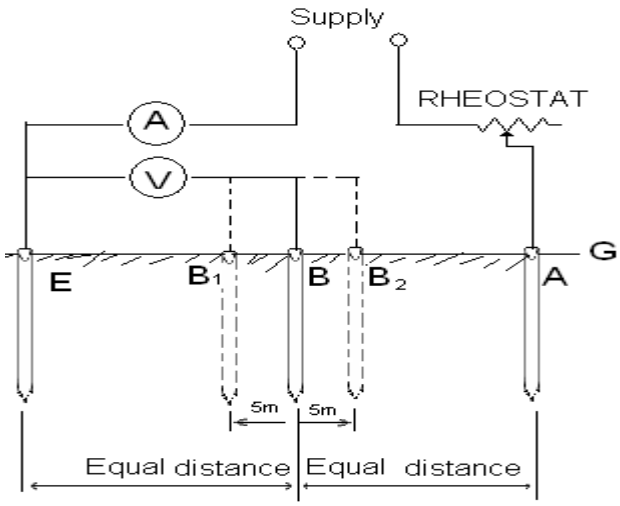


Fig.5 Testing of Earth Electrode resistance

The resistance area of an earth electrode is the area of soil around the electrode within which a voltage gradient measurable with commercial instrument exists. In fig. 1, E is the earth electrode under test, A is an auxiliary earth electrode positioned so that two resistance areas do not overlap. B is a second auxiliary electrode placed half way between E and A.
An alternating current is passed through the earth path from E to A and the voltage drop between E and B is measured.

$$The\ earth\ resis\tan ce\ R = \frac{Voltage\ drop\ between\ E\ and\ B}{Current\ throuhg\ earth\ path} = \frac{V}{I}$$

To ensure that the resistance area do not overlap, the auxiliary electrode B is moved to positions B_1 and B_2 respectively. If resistance values determined are of approximately the same magnitude in all the three cases, the mean of the readings can be taken as the earth resistance of the earth electrode. Otherwise the auxiliary electrode A must be driven in at a point further away from E and the above test repeated until a group of these readings is obtained which are in good agreement.

Inspection of Internal Wiring Installation

Internal wiring should be inspected once a year and the following points should be checked while carrying out inspection of the wiring installation.

1. **Service Connections**:- In case of overhead line, check and ensure that
   i. The lines are terminated a sufficient distance away from the building
   ii. The fuse wire of correct rating is provided on the phase line
   iii. The lead-in-wires are of size sufficient to carry the full load current

2. **Main Switch Board**:- In case of ,main switch board please check up and ensure that
   i. The voltage available is correct
   ii. The main switch is provided close to the point of commencement of supply
   iii. The fuse of correct size is provided on the live pole
   iv. The phase and neutral wires are clearly marked for identification
   v. Caution notice in English or other local language is placed.
3. **Miscellaneous**:- The points to be checked are
   i. No branch circuit feeds more than the breaker can feed
   ii. The single pole switches are provided on the live conductor
   iii. The metallic frames of all power equipment are earthed by the independent earth conductors

Fault-Tracing in Circuits and Equipment

The types of fault which may occur in an electrical circuit fall into four general groups:

1. Open – circuit fault (loss of continuity)

2. Earth fault (low resistance between live conductor and earthed metalwork)

3. Short- circuit fault (low resistance between phase and neutral conductors)

4. High- value series – resistance fault (bad joint or loose connection in conduction path)

These fault types occur in lighting and power circuits, appliances, apparatus and electric motors; variations do, occur with the type of electrical equipment. Before any fault can be found and rectified it is necessary for the electrician to adopt a method or system based on a sound knowledge of circuitry and electrical theory, and on experience. The electrician detailed to repair a fault circuit is in many ways like a doctor who makes his diagnosis on the basis of the symptoms revealed through a visual inspection or a test using the correct instruments . Haphazard tests

carried out at random seldom lead to success in the quick location of faults. The investigation must always be based on an intelligent assessment of the fault and its probable causes, judged from its effects. In many instances, faults arise from installations or circuits which do not in some way or other comply with the requirements of the IEE regulations, or else are used in such a manner that the abuse results in a fault. Most faults are easily located by following up reports such as There was a flash at the lamp; The wires got red hot; The lamp goes dim when it is switched on; or 'The bedroom light will come on only when the bathroom switch is ON ; By careful questioning, these reports will enable the electrician to locate the fault quickly and restore the circuit to normal operation again. The following are some common installation defects and omissions which eventually lead to faults';

Fault-tracing in circuits and equipment

1. The provision of double –pole fusing on two wire systems with one pole permanently earthed. This frequently occurs with final circuit distribution boards when the main and /or sub main control equipment is single pole and solid neutral.

2. Fuse protection not related to the current rating of cables to be protected . This is very often due to the equipment manufactures fitting the fuse- carriers with a fuse – element of maximum rating for the fuse- units in the equipment.

3. Connecting boxes for sheathed- wiring systems placed in inaccessible positions in roof voids and beneath floors, indiscriminate bunching of too may cables using screw- on or inadequate connections .

4. Insufficient protection provided for sheathed wiring, e.g. to switch positions and on joints in roof voids.

5. Incorrect use of materials, not resistant against corrosion, in damp situations (e.g. enameled conduit and accessories and plain – steel fixing screws).

6. Inadequate or complete omission of segregation between cables and /or connections, hosed within a common enclosure, supplying systems for extra- low voltage; or telecommunication and power and /or lighting operating at a voltage excess if extra- low voltage.

7. Insufficient attention given to cleaning ends of conduit and/or providing bushings omission of bushings to prevent abrasion of cables at tapped entries, particularly at switch positions.

8. Insufficient precautions taken against the entry of water to duct and /or trunking systems particularly where installed within the floor.

9. Incorrect use of PVC insulated and /or sheathed cables and flexible cords instead of heat-resistant type, for connections to immersion heaters, heaters, thermal- storage block heaters , etc.

10. Incorrect use of braided and twisted flexible cords for bathroom pendant fittings and similar situations subject to damp or condensation .
11. The incorrect use of accessories, apparatus or appliances inappropriate for operating conditions of the situation in which they are required to functions

12. Installation of cables of insufficient capacity to carry the starting current of motors. Causing excessive volt drop.
13. Incorrect rating of fuse-element to give protection to the cables supplying the motor.

Open-circuit faults

The instrument used to locate this type of faults is the continuity . The usual effect of this fault is that the apparatus or lamp in the circuit will not operate. The fault can be (a) a break in a wire; (b) a very loose or disconnected terminal or joint connection; (c) a blown fuse; (d) a faulty switchblade contact. The fuse should always be easily inspected. The cartridge type can be tested for continuity of the fuse-element. If the fuse has operated, the reason why it has done so must be found out . It is not enough to repair or replace the fuse and leave it at that . A broken wire or a disconnection will show on the continuity tester as an extremely high resistance in the khoum or me gohm ranges. Before each wire in the faulty circuit is tested in turn (live feed, switch- wire and neutral) all mechanical connections should be inspected (lamp holders , junction box, plug or the metal sheeting of convenient return when testing the continuity of very long conductors . In an all insulated wiring system, other healthy conductor can be used as returns for testing purposes making sure that the aright al connections are restored once the fault has been found .

Earth faults An earth fault between alive conductor and earthed metalwork will have the same effect as a direct short – circuit : the circuit fuse will blow . To trace the fault . it is necessary to isolate the live conductor from the neutral by removing all lamps etc, and placing all switches in the ON position . An isolation- resistant (IR) tester is used to trace this fault circuits should be subdivided as far as is possible to finally locate the position of the fault . The reading obtained on the instrument used will be in the low- ohms range. An earth fault on the neutral conductor seldom shows up except by an IR –to earth test on the neutral conductor in most instances this type of fault does not affect the operation of the circuit or the devices or equipment connected to it . However, it is important to rectify any such fault found, otherwise if it is ignored it may cause a shock and fire hazard .

Short – circuit fault On testing the insulation resistance between the live and neutral conductors with an IR tester, the reading will show itself in the low ohms range .again, subdivision of the installation at the distribution board , and subdivision of the faulty circuit is the only way to locate and confirm the position of the faults . Short circuits can occur as the result of damaged insulation bare wire in junction boxes and fittings , or by a conductor becoming loose from terminals and moving so as to come into contact with a conductor of opposite polarity. The result of short circuit is a blown fuse , though if there is a sufficiently current can flow to blow the circuit fuse) the result will be over heating of the conductors and sparking or arcing at the point of contact . The test involves the removal of all lamps and appliances from the faulty circuit, open all switches, and carry out an IR test between the live and neutral conductors . If the reading obtained is satisfactory , close each circuit switch in turn until the faulty conductor, a switch wire, is located. If a low or near-zero reading is obtained on the first test, the circuit will have to be disconnected at convenient points until the faulty wire is isolated .

High- value series –resistance faults This type of fault is most difficult to trace as it usually means that a connection, joint or termination has become loose . the effect of this is invariably dim lights; or motor going very slowly and heating up : in new installations the demises of the lamps may well be caused by a wrong connection in junction box resulting in two or more lamps being connected in series .

Main faults in new wiring Faults in new wiring are generally the of careless or inadvertent wrong connections which will either blow a fuse , cause lamps to operate dimly as above, not work at all

or work only when another circuit switch is placed on the ON position . If a lamp lights only when another switch in the same final circuit is ON this indicates that the live feed to the faulty lamp has been looped from the switch – wire side of the previous circuit switch instead of from the live-feed side . The fact that overloading a circuit will blow a fuse should not be overlooked .

Faults in fluorescent –lamp circuits The following tables summaries the faults , effects and the remedies associated with fluorescent –lamp circuits.

Faults in motors and circuits Table 28-4 sum arises briefly the faults . effects and remedies associated with motors and their associated circuitry and control gear. Because the voltage of low – and extra- low voltage circuits is relatively small, small, a poor or dirty contact will immediately prevent bells and similar devices from operating . These faults are thus most difficult to trace, and it is often a matter of systematic checking for continuity (zero or near –zero) readings . The prevention of faults in ELV circuits is more often than not a matter of regular periodic maintenance attention (cleaning contacts, tightening connections, etc) than anything else .

Fault –finding in fluorescent lamp fittings

NO	item	Test to be applied
1	Supply and fuse	Check supply voltage at input to fitting. Check polarity of incoming supply and ensure frame is earthed. If fuse has blown, suspect circuit or component and find the fault before replacing fuse.
2	Lamp	Check lamp in a good fitting and if proved faulty replace with a new lamp. Remember, Never try a new Lamp in a fitting which has faulty components circuit.
3	Circuit	Examine wiring inside the fitting and if possible check against the wiring diagram check insulation resistance between the circuit and the metal frame of the fitting. The resistance should be above 2 megohms . If an earth fault is found . trance the cause and replace the component.
4	ballast chokes	Examine for signs of overheating . if possible check continuity of windings and insulation resistance compare the impedance or inductance against a good replica.
5	Capacitors	Examine for leakage or damage. If possible check the capacitance and check that discharge resistor has value between ¼ -1 megaohm . the insulation resistance between case and terminals should be above 2 megaohms .
6	Sartre switches	Check operation of starter in another good circuit and , if found faulty, fit a new replacement.
7	Ambient conditions	Remember that normal fluorescent fittings may overheat if the surrounding temperature is above 30-15^{o}C . Lamp starting may be difficult with some types of circuit if the temperature is below 5 ^{o}C .

Visual Inspection

The quality of visual inspection is dependent on the experience and knowledge of the person carrying out the inspection. Visual inspection should lead testing with instruments and must of course be prior to the installation being made live. It may be necessary to inspect some parts of an installation during the construction phase as these parts may be concealed later. A checklist for a Domestic Installation might read as follows:

Fixed Wiring

1. Correct type.
2. Correct voltage rating.
3. Correct current rating.
4. Correct color coding.
5. Permitted volt-drop not exceeded.
6. Protected against mechanical damage and abrasion (scrap).
7. Non-sheathed cables protected by enclosure in conduit, duct or trunking.
8. Not exposed to direct sunlight or, if so exposed, of a suitable type.
9. Correctly selected and installed for use on exterior walls etc.
10. Internal radii of bends.

11. Correctly supported.

Flexible Cables and Cords

1. Correct type.
2. Correct voltage rating.
3. Correct current rating.
4. Correct color coding.
5. Selected for resistance to damage by heat.
6. Cable coupler used for joints.
7. Final connections to fixed apparatus as short as possible.

Terminations

1. All terminations enclosed.
2. Conductors doubled back where possible.
3. All strands securely clamped in terminals.
4. No damage to conductor.
5. Proper terminal used.
6. Braid / sheath cut back to identify core color and provide flexibility at the termination.
7. Braid / sheath not removed outside of enclosure.
8. Bare protective conductors sleeved green/yellow.
9. Insulation not clamped in terminal.
10. No mechanical damage on terminations, loose available
11. Terminations accessible for inspection, except as otherwise permitted.
12. Tightened sufficiently, mechanically and electrically sound.
13. Enclosure cover fitted properly.

Lighting Switches

1. Adequate current rating.
2. Readily accessible.
3. Installed at correct height, e.g. centered at 1100 mm.
4. Labeled to indicate purpose, where this is not obvious.
5. Single-pole switches connected only in phase conductors.
6. Earthing of exposed metalwork, e.g. metal switch plate.
7. Protective conductor terminated in an earthing terminal.
8. Not installed in the incorrect zone in a shower or bathroom.

Ceiling Roses

1. Fixed in position.
2. Protective conductor connected to earthing terminal.
3. Phase terminal shrouded to prevent accidental contact.
4. Switch wires identified as live (phase) conductors.
5. Suitable for the weight suspended.

Trunking

1. Constructed of non-combustible insulating material.
2. Securely fixed and adequately protected against mechanical damage.
3. Covers securely fixed.
4. Holes surrounding trunking made good to prevent spread of fire.

Protection

1. Distribution board correct and mounted in suitable location.
2. Earth Electrode connection accessible and correct.
3. Main switch fuse or MCB fitted.
4. Socket circuits protected by an RCD (Residual Current Device). (some exceptions)
5. Immersion heater circuit protected by an RCD.
6. Shower circuit protected by an RCD.
7. Box or other enclosure securely fixed.
8. Flush box, level with wall surface to ensure non-combustible enclosure.
9. No damage to cables by sharp edges, screw heads etc.

Socket Outlets

1. Correct type.
2. 30cm to 40cm above the floor or working surface except in shower or bathroom.
3. Correct polarity.
4. Earthing tail from metal box, to earthing terminal of socket outlet.

Joint Boxes

1. Fixed in position.
2. Accessible for inspection.
3. Protected against mechanical damage.
4. Protective conductors correctly connected.

Testing

On completion of the visual inspection the following tests must be completed where applicable: They must be carried out in the following order.

Tests before connection of the installation to the supply:

1. Continuity of all protective conductors.
2. Continuity of ring final circuit conductors.
3. Insulation Resistance of the electrical installation.
4. Protection by separation of circuits.
5. Polarity test.
6. Electrical strength test.

Tests after connection of the installation to the supply

1. Automatic disconnection of supply including earthing and bonding.
2. Functional tests.

If the installation should fail any test, the fault must be rectified before any further testing is done. That test and any preceding tests that may have been affected by the fault should now be repeated. If all is satisfactory continue with testing as above.

Continuity of Protective Conductors

This test is to ensure that:

- All protective conductors and bonding conductors are electrically sound and correctly connected and continuous throughout their length. (Remember that this includes the Main Protective Conductor and the Earthing Conductor).
- All equipment and accessories are properly connected to the protective conductor where required.
- All bonding connections and clamps are making good electrical contact.

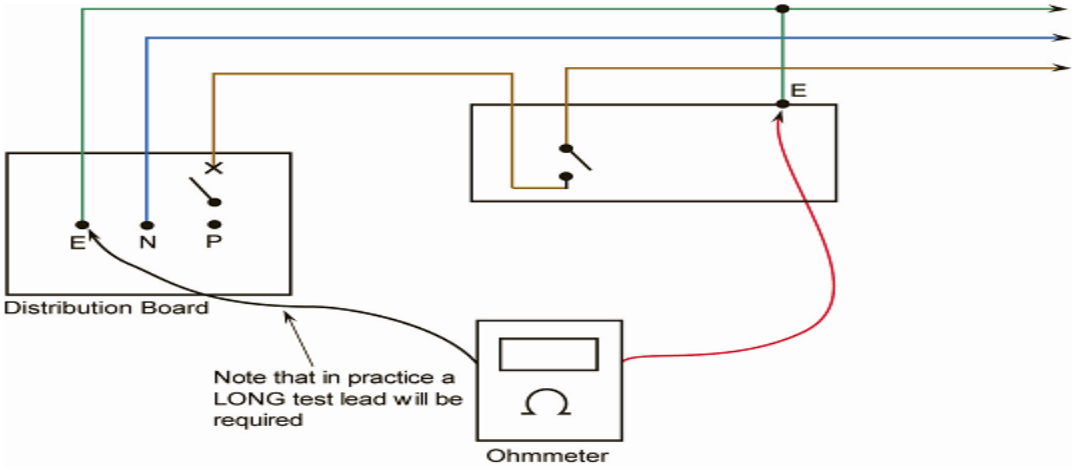


Fig 6

Protective conductor resistance equals Meter reading minus Test lead resistance

Note: When carrying out this test it is essential to be aware that parallel paths can exist through extraneous conductive parts. If this is the case the conductor under test should be disconnected from its terminal and any other conductor.

Test of Main Equipotential Bonding on a Domestic System
with Metallic Incoming Services

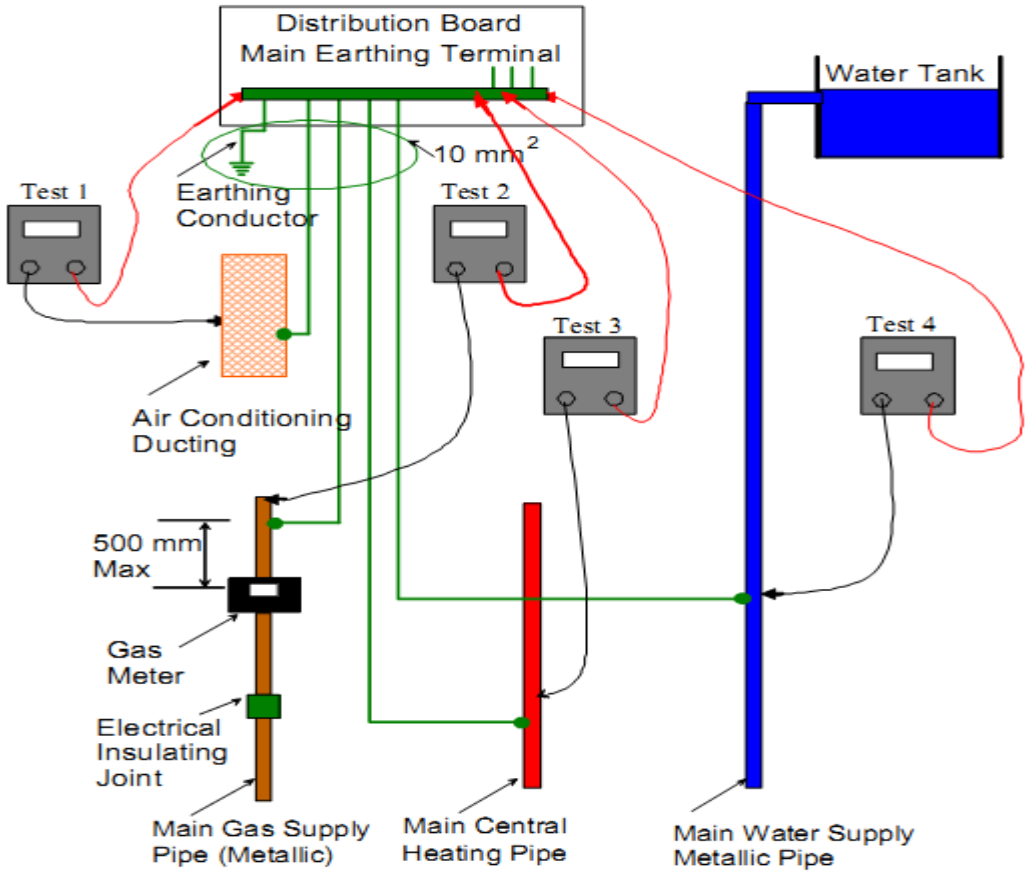


Fig 7

Test of Main Equipotential Bonding on a Domestic System

with Non-Metallic Incoming Services

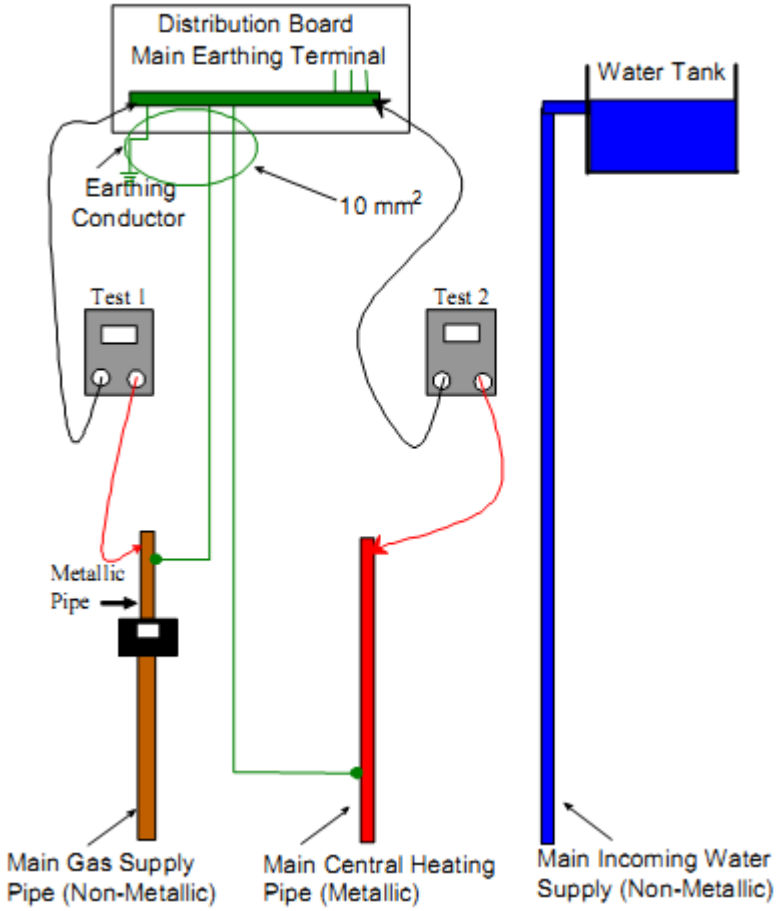


Fig 8

Test of Bathroom Equipotential Bonding System

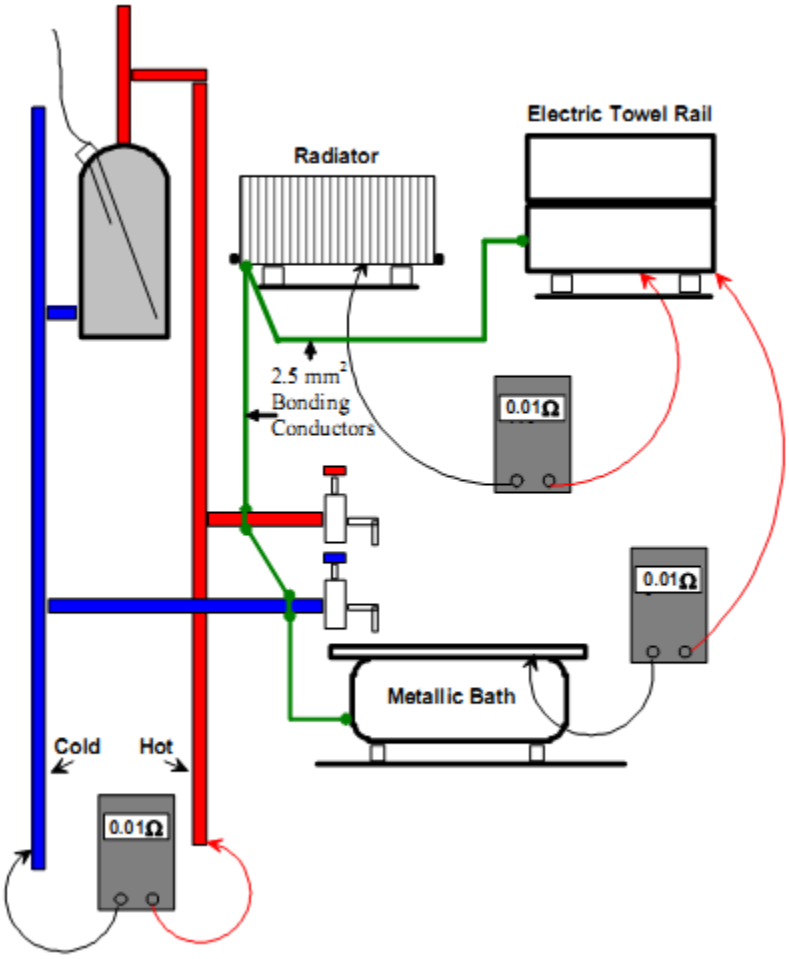


Fig 9

Test of Kitchen Equipotential Bonding System

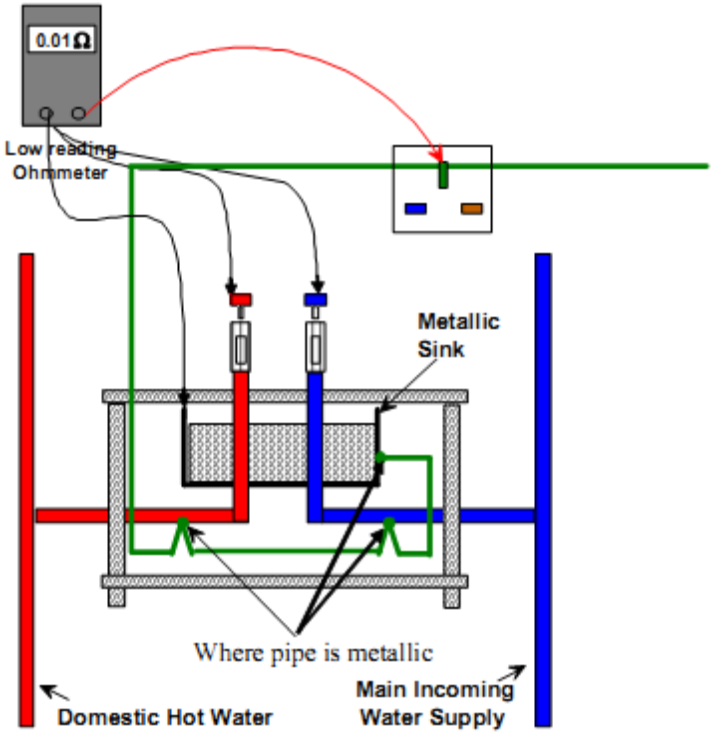


Fig 10
Continuity of Ring Final Circuit Conductors

This test is to verify that ring final circuits are:

1. Correctly wired and connected.
2. Continuous throughout. (Step 1)
3. Their conductors are not interconnected or bridged. (Step 2)

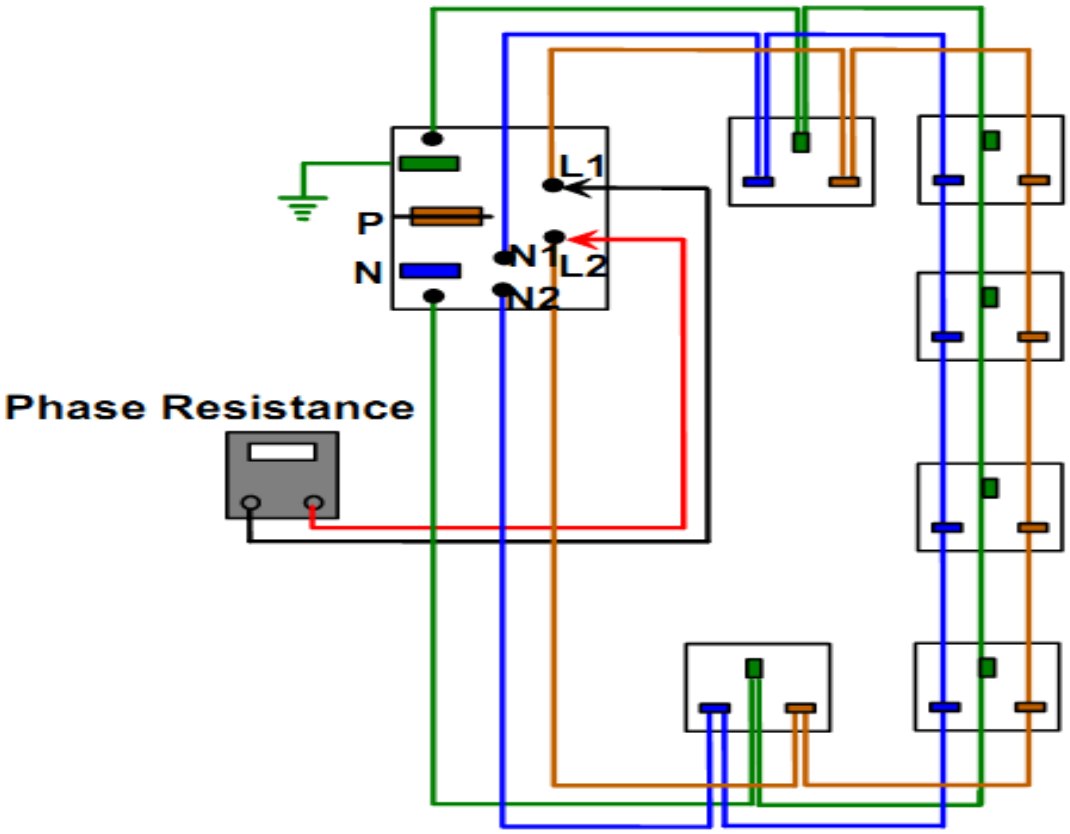
Test Instrument Required

A low reading DC Ohmmeter capable of passing a minimum test current of 200 mA. There are two steps involved in completing this test.

Method

Disconnect the phase, neutral and earth conductors from their terminals in the distribution board. Separate them from each other. Measure the resistance of each of the three loops individually and record the readings taken. The phase and neutral readings should be equal. The protective conductor may have a different cross-sectional area to that of the phase and neutral.

Test of Continuity of Ring Final Circuit Conductors



Insulation Resistance

Fig 11

This test is to ensure that there are no short circuits between live conductors or between live conductors and earth, and that there is no deterioration in insulation resistance caused by damage or dampness.

A direct voltage is applied, to test insulation resistance as the capacitive current quickly falls to zero so that it has no effect on the measurement. A high voltage is used because this will often break down poor insulation or surface leakage paths. In other words the high voltage may show up insulation weaknesses which would not be noticed at lower voltage levels. An insulation resistance tester measures the applied voltage and the resulting leakage current flow. The resistance displayed, is obtained by an internal calculation based on Ohm's Law.

$$\text{Insulation Resistance (M}\Omega\text{)} = \frac{\text{Test voltage (V)}}{\text{Leakage Current (}\mu\text{A)}}$$

As the effective capacitance of the system charges up, the leakage current reduces. A steady insulation resistance reading indicates that the cables are fully charged, and that the capacitive component of the test current has fallen to zero. If a wiring system is wet and / or dirty, the surface leakage component of test current will be high, giving a low insulation resistance reading. Insulation resistances are all effectively connected in parallel. The total insulation resistance will therefore be lower than that of each individual circuit. In a large electrical installation, the total insulation resistance may be lower than that of a smaller installation.

Warning:

Ensure that circuits are not live before commencing testing. Never turn the function dial whilst the test button is depressed. This may damage the instrument. Never touch the circuit under test during insulation resistance testing. Before testing always check the following:-

- The “battery low” indicator is not showing.
- There is no visual damage to the tester or test leads.
- Check the continuity of the test leads.

To check the continuity of the test leads:
Select the continuity function- and the lowest resistance range. Short the test leads together.

- The reading should be almost Zero Ohms.
- An over-range OR indication will mean that the leads are faulty or the instrument fuse is blown.

Select the required test voltage (250 V, 500 V or 1000 V) by rotating the function dial.
Note: - The test voltage used for low voltage installations is **500** Volts.

Pre Test Procedures and Observations

1. The installation must be disconnected from the supply.
2. The Main Protective Conductor must be disconnected from the supply neutral.
3. All fuses are intact and all MCBs and switches are closed.
4. All current using equipment including lamps, pilot lights, bell transformers, smoke alarm units, timers etc. are disconnected or otherwise excluded from the test between live conductors.
5. Note:- Where disconnection or removal of these items is impractical the control switches should be in the off position. Items left in circuit will cause false low readings.
6. Any equipment containing electronic circuitry must be disconnected or switched off in order to prevent damage by the high test voltage

Insulation Resistance between All Live Conductors and the Protective Conductor

Method

Connect all live and neutral conductors together at the distribution board and test between them and the protective conductor. The reading obtained should be 1 MΩ or greater.

An infinitely high resistance reading would be ideal.

Test of Insulation Resistance between all Live Conductors and the Protective Conductor

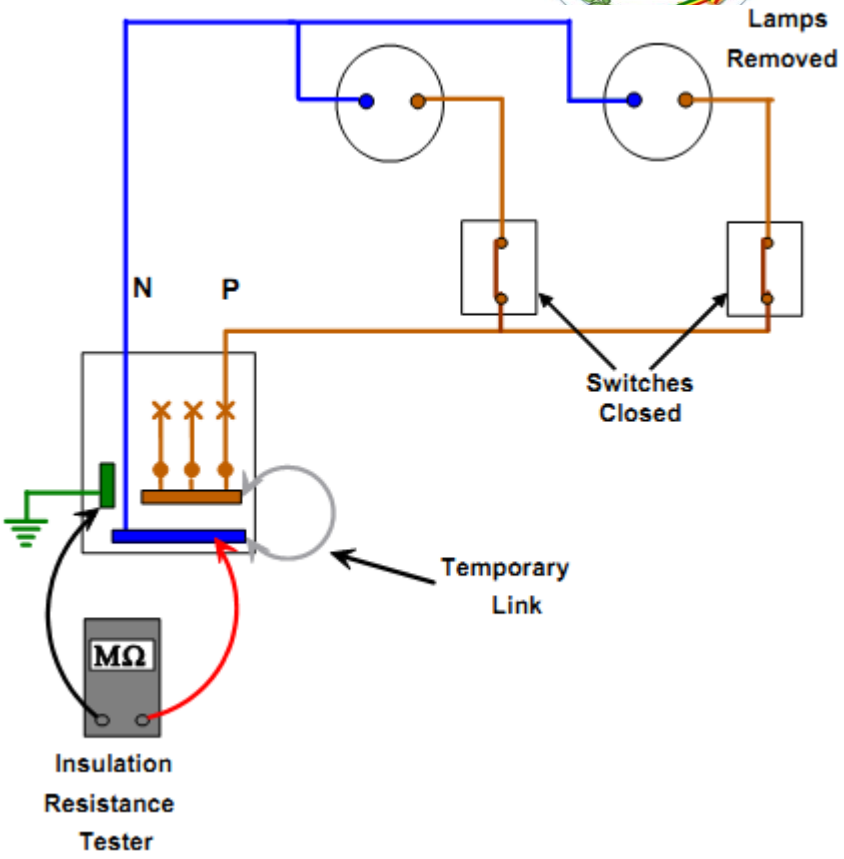


Fig 12

N.B. Do not forget to remove the temporary link.

When testing ***two way or two way and intermediate lighting*** circuits, it is essential that both of the two way switches are switched over and the test repeated at each stage. This is to ensure that all strappers and switch wire are included in the test.

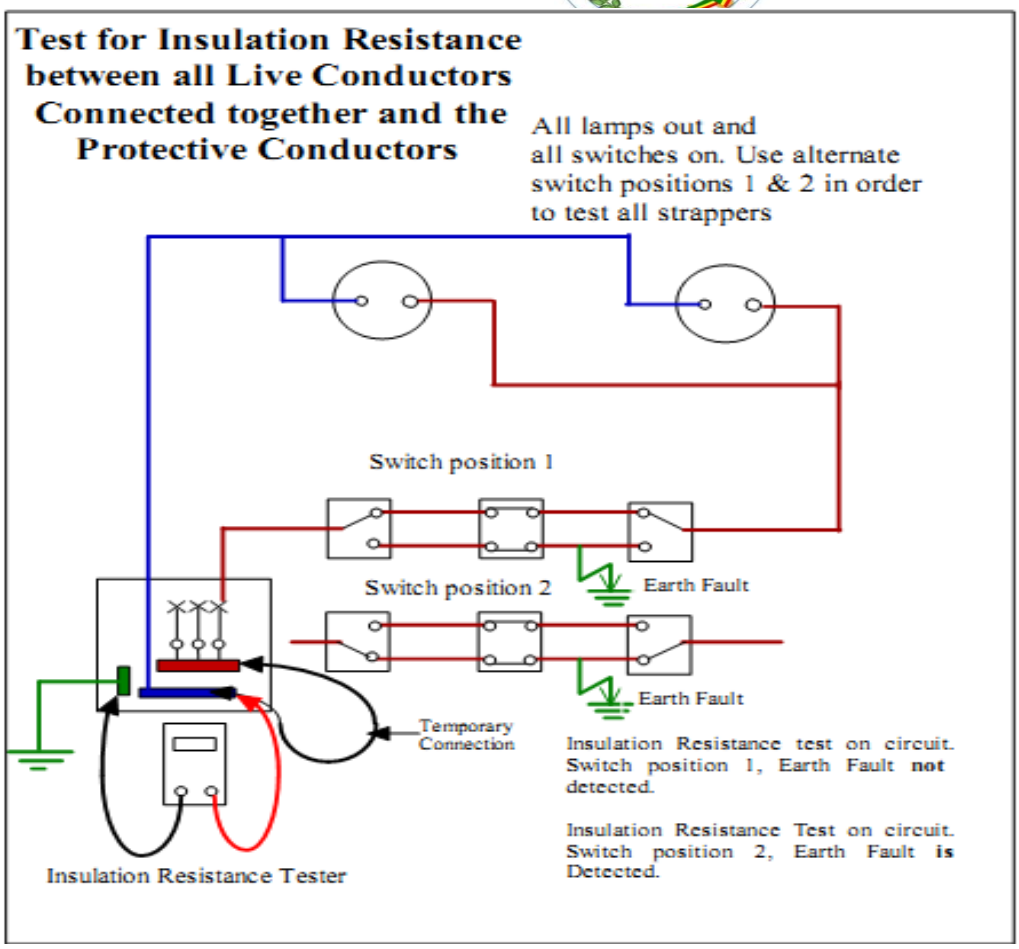


Fig 13

Insulation Resistance between Live Conductors

Method

Test between phase and neutral conductors. The reading obtained should be 1 MΩ or greater. An infinitely high resistance reading would be ideal.

Test for Insulation Resistance between Live Conductors

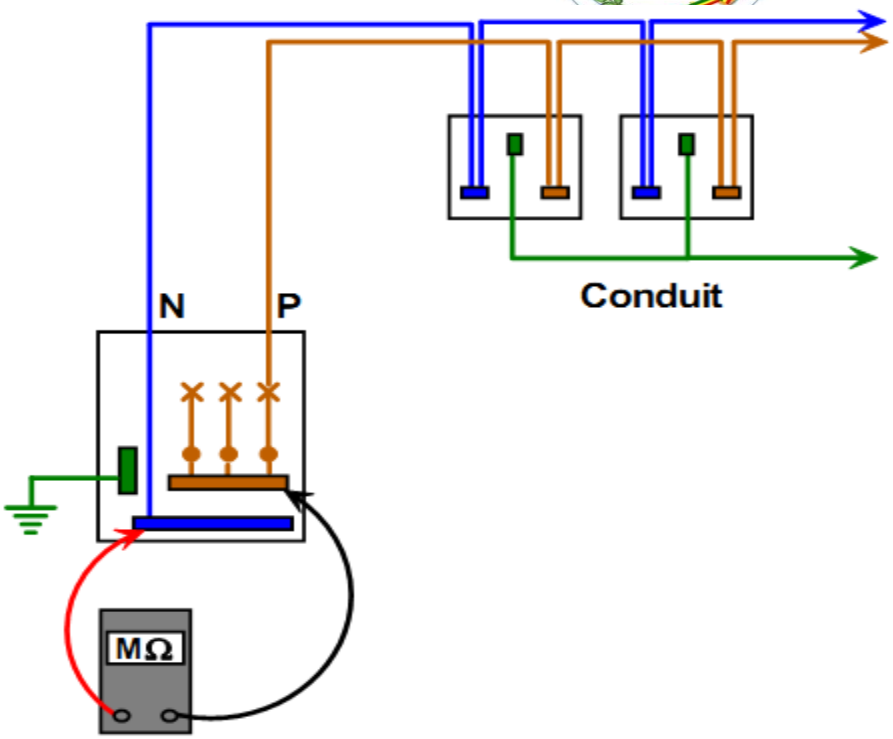


Fig 14

Polarity

This test is carried out to ensure that:

- Polarity at the main supply point is correct.
- The phase conductor is connected to fuses, single pole circuit breakers and switches.
- Incoming supply is connected to back contact of screw in type fuses.
- The phase conductor is connected to the center contact of ES type lamp holders.
- All wiring is correctly connected at socket outlets and other similar accessories.

The continuity of the protective conductor has already been verified. This test can be completed in basically the same manner. Ensure that all appliances, lamps etc are unplugged or otherwise removed. With the circuit MCB in the “off” position, connect one end of the long trailing lead to the outgoing terminal of the circuit MCB. Using the other end in conjunction with the test meter leads, take readings from the phase terminal of all the points around the circuit e.g. switches, luminaries, sockets etc. Continuity (approx. resistance of conductor involved) at each outlet ensures that polarity is correct.

If the supply is disconnected from the installation the long trailing lead may be connected to the phase busbar and the MCB should then be left in the “on” position.

Test of Polarity of Socket Circuits

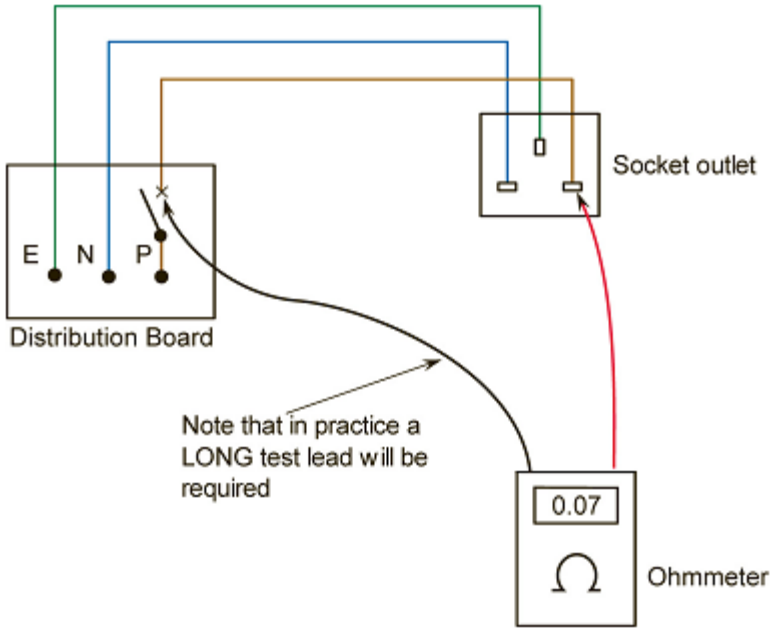
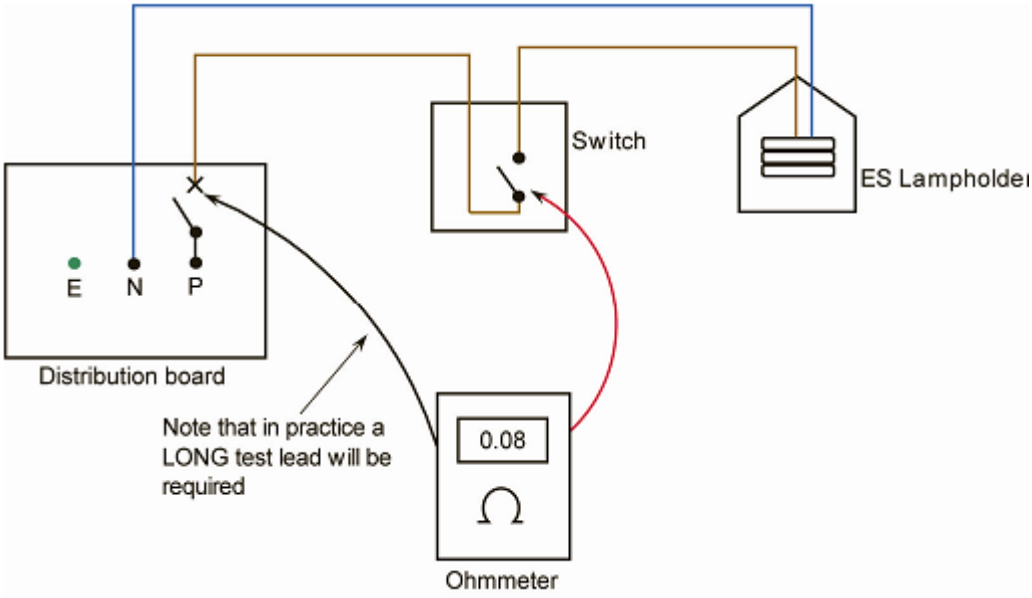


Fig 15

Test of Polarity of Lighting Circuits

This test must be done with the supply disconnected and may be carried out as follows:
Remove circuit FUSE or open MCB. Remove all lamps from relevant circuit. Connect one end of the long trailing lead to the outgoing terminal of the circuit MCB. Using the other end in conjunction with the test meter leads, take readings from the phase terminal at all the points around the circuit e.g. switches and ES lampholders. Continuity (approx. resistance of conductor involved) at each point ensures that polarity is correct.

If the supply is disconnected from the installation the long trailing lead may be connected to the phase busbar and the MCB should then be left in the “on” position.



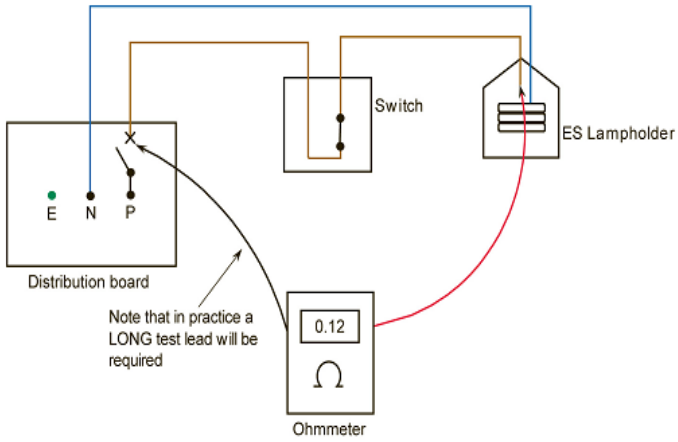


Fig 16

Note:
The circuit switch must be operated when checking polarity of ES lamp holder.

Hazards Associated with Live Testing

1. The circuit under test should be isolated prior to connecting any test equipment and then made live in order to conduct the test.
2. It is essential that all leads and crocodile clips are in good condition.
3. Care must be taken to ensure that leads do not short to each other or to earth.

Self-check 2	Written test

Name …… Date……..

Say true or false

1. Continuity test of all protective conductors must before connection of the installation to the supply
2. In Pre Test Procedures and Observations the installation must be disconnected from the supply.
3. Care must be taken to ensure that leads do short to each other to test battery cell
4. The instrument used to test the insulation resistance is known as Megger.

Matching

A	**B**
1. Open – circuit fault	A. low resistance between phase and neutral conductors
2. Earth fault	B. loss of continuity
3. Short- circuit fault	C. low resistance b/n live conductor and earthed metalwork

Note: **Satisfactory rating - 7 points** **Unsatisfactory – 7 below**

Information Sheet-3	Notification of completion work

Verification and Certification

New electrical installations and extensions to existing installations must be inspected and tested. This is done to ensure that all electrical equipment has been correctly selected, installed and interconnected. Two categories of tests must be carried out on an installation. One test is carried out prior to the installation being made live for the first time, and the other when the installation is live. Both tests must be carried out by competent persons using prescribed test equipment. They also must be carried out in a particular sequence. The results of the tests are recorded and a copy given to the installation owner.

How to notify work all notifiable work must be notified using one of the three routes
Route 1: Direct notification through Local Authority Building Control The homeowner must contact Building Control directly to ensure that a Building Control Officer visits the installation and issues a compliance certificate. The cost for this can vary depending on area.

Route 2: Self-certification through a recognized scheme

Route 3: Certification by a registered Third Party In the latest Approved Document, a provision has been made for an alternative route for installers who are not registered competent persons (Route 2) and wish to appoint a registered third-party certifier to inspect and test the work as necessary. Note that there is no process as yet to facilitate this route for building regulations notification.

The notification process: The core principle of EBCS is to keep the additional paperwork and hassle that you have to endure to an absolute minimum. To this end, we have implemented a system whereby all the responsibility of notifying the homeowner and the relevant Local Authority of the installation is handled by us – all you need to do is inform us once you have completed the installation. We do not require you to submit the BS7671 test results and certificates to us.

Who needs to be notified? It is a legal requirement that each notifiable installation carried out by a registered contractor needs to be notified to three separate bodies:

- The relevant self-certifying scheme
- The relevant Local Authority
- The householder

Self-check 3	Written test

Name ……..…….. Date……..

Direction 1 **Say true or false**

1. New electrical installations and extensions to existing installations must be inspected and tested.
2. Tests must be carried out by competent persons using prescribed test equipment.

Direction 2 Blank space

1. How to notify work
    a. ……
    b. ……
    c. ……

Note: **Satisfactory rating - 5 points** **Unsatisfactory – 5 below**

Instruction Sheet	LG19: clean- up

This learning guide is developed to provide you the necessary information regarding the following learning outcome and content coverage

- Checking and maintaining tools and equipment
- Cleaning work area
- Returning surplus materials ware house

This guide will also assist you to attain the learning outcome and contents stated in the cover page. Specifically, upon completion of this Learning Guide, you will be able to:-

- Check and maintain tools and equipment
- Clean works area
- Return surplus materials ware house

Learning Instructions:

13. Read the specific objectives of this Learning Guide.
14. Follow the instruction described blew 3 to 5
15. Read the information written in the “Information Sheet 1 up to information sheet 3”.
16. Accomplish the “Self-check 1, self-check 2, and Self-check 3, ” in page (5, 10 and 12) respectively.
17. If you earned a satisfactory evaluation from the “Self-check” proceed to other information sheet.

Information Sheet-1	Checking and maintaining tools and equipment

1. **Tool work habits**

Learning objectives: Describe the Tool Control Program. List several good tool work habits. "A place for everything and everything in its place" is just good common sense. You cannot do an efficient repair job if you have to stop and look around for each tool you need. The following rules will make your job easier and safer.

- **Keep each tool in its proper storage place.**

All divisions have incorporated a Tool Control Program as directed.

The Tool Control Program is based on the concept of a family of specialized toolboxes and pouches configured for instant inventory before and after each maintenance action. The content and configuration of each container is tailored to the task, work center, and equipment maintained. Work center containers are assigned to and maintained within a work center. Other boxes and specialized tools are checked out from the tool control center (tool room).

- ✓ Keep your tools in good condition.
- ✓ Protect them from rust, nicks, burrs, and breakage.
- ✓ Keep your tool allowance complete.

When you are issued a toolbox, each tool should be placed in it when not in use. When the toolbox is not actually at the work site, it should be locked and stored in a designated area.

- **Use each tool only for the job it was designed to do.**

Each particular type of tool has a specific purpose. If you use the wrong tool when performing maintenance or repairs, you may cause damage to the equipment you're working on or damage the tool itself. Remember, improper use of tools results

in improper maintenance. Improper maintenance results in damage to equipment and possible injury or death to you or others.

- **Safe maintenance practices**

Always avoid placing tools on or above machinery or an electrical apparatus. Never leave tools unattended where machinery are running.

- **Never use damaged tools.**

Abused screwdriver may slip and spoil the screw slot, damage other parts, or cause painful injury. A gauge strained out of shape will result in inaccurate measurements.

Remember, the efficiency of craftsmen and the tools they use are determined to a great extent by the way they keep their tools. Likewise, they are frequently judged by the manner in which they handle and care for them. Anyone watching skilled craftsmen at work notices the care and precision with which they use the tools of their trade. The care of hand tools should follow the same pattern as for personal articles; that is, always keep hand tools clean and free from dirt, grease, and foreign matter. After use, return tools promptly to their proper place in the toolbox. Improve your own efficiency by organizing your tools so that those used most frequently can be reached easily without digging through the entire contents of the box. Avoid accumulating unnecessary junk.

- **Care of hand tools**

Tools are expensive; tools are vital equipment. When the need for their use arises, common sense plus a little preventive maintenance prolongs their usefulness. The following precautions for the care of tools should be observed:

- ✓ Clean tools after each use. Oily, dirty, and greasy tools are slippery and dangerous to use.
- ✓ NEVER hammer with a wrench.
- ✓ NEVER leave tools scattered about. When they are not in use, stow them neatly on racks or in toolboxes.
- ✓ Apply a light film of oil after cleaning to prevent rust on tools.
- ✓ INVENTORY tools after use to prevent loss.

Self-check 1	Written test

Name …….. Date……..

Direction : Say true or false

1. Keep each tool in its proper storage place
2. Use each tool only for the job it was designed to do

3. Never avoid placing tools on or above machinery or an electrical apparatus
4. We can use damaged tools.

Note: **Satisfactory rating - 4 points** **Unsatisfactory - below 4 points**

You can ask you teacher for the copy of the correct answers.

Information Sheet-2	Cleaning work area

2. Cleaning work area

Work station isdefined as an area, in an office,outfitted with equipment andfurnishings for one or more work ers. Normally leather goods are operated in awork shop therefore the work station for a leather goods worker w ould be the workshop. It is necessary for a worker to prepare his work station and the pieces to bedone but be ore doing so a worker should be well aware of the safety rules andregulations.

- **Housekeeping**

Good housekeeping involves every phase of industrial operations and should apply throughout the entire premises, indoors and out. It is more than mere cleanliness.

It requires orderly conditions, the avoidance of congestion, andattention to such details as an orderly l ayout of the whole workplace, the markingof aisles,

adequate storage arrangements, and suitable provision for cleaning and maintenance. Efficient production and a good working environment are complementary.

The elimination of inefficiencies and accident hazards caused by unfavorable conditions in and about the workplace is essential in getting the job done properly and safely. The attention to these important details—which may be overlooked when management's attention is concentrated upon such amenities as good cloakrooms, canteens, rest rooms, recreational facilities, etc.—is widely referred to as "good housekeeping.

A clean, well-ordered, attractive work environment sets the tone of your establishment. It encourages tidy work habits in employees. It helps reduce fatigue. It promotes good worker-management relations. It also gives a lift to morale, which is reflected in the quality of production and overall efficiency. Good housekeeping is also a good advertisement for your company. Customers and clients have more confidence in an organization when they we work being carried out efficiently in clean, pleasant, well ordered surroundings. There's an even more important reason why good housekeeping matters — it makes the undertaking a safer place to work in.

Good housekeeping is a vital factor in preventing accidents. The great majority of all work accidents are caused during the handling of goods or materials, and by people falling, being hit by falling objects, or striking against objects in the workplace. All these causes can be reduced by good housekeeping practices in fact; good housekeeping is the only cure for hundreds of accidents that occur.

Here are some kinds of accidents commonly caused by *bad* housekeeping:

- Tripping over loose objects on floors, stairs and platforms
- Articles dropping from above
- Slipping on greasy, wet or dirty surfaces
- Striking against projecting, poorly stacked, or misplaced material
- Tearing the hands or other parts of the body on projecting nails, wire, steel strapping on bales or crates, etc.

Typical examples of poor housekeeping that lead to these accidents are:

- Excessive material, waste or chips in the working area
- Congested aisles
- Tools left on machines
- Waste containers overflowing
- Lockers and workrooms in disorder
- Acids in open containers
- Broken glass
- Electric leads or air lines across aisles
- Dirty light fittings, windows and skylights

Where housekeeping is bad, fire is a constant hazard. It can be caused by many housekeeping problems such as oil-soaked rags and clothing igniting from spontaneous combustion; dust collectors not being properly or frequently cleaned; or piles of paper and other packing materials being allowed to accumulate. Poor housekeeping can also lead to infestation by pests such as rodents and cockroaches and create serious health risks.

Elements of a Good Housekeeping

The following are the basic elements of a good housekeeping:

- **Passageways**: Wide enough for traffic movements, marked off by floor lines from work positions and storage areas.
- **Space:** Insuring sufficient room for the individual to work.
- **Storage**: Adequate and convenient space for materials and tools.
- **Materials Handling**: Layout planned for materials flow, with efficient methods and equipment.
- **Ventilation**: Good general ventilation plus local exhaust ventilation to remove air contaminants at the source.
- **Floors and Walls**: They need to be constructed with materials that are easy to clean and if needed easy to repair.
- **Lighting** Welldistributed artificial light and effective use of available daylight.
- **Amenities**: Clean, up-todate washrooms and lockers for clothing, and clean and inviting lunch room for employees to eat their meals.
- **Waste Removal**: Adequate facilities to prevent congestion and disorr.

Let us look at some of these elements in detail:

Keep Passageways Clear: Passageway space should be reserved for the movement ofperson nel, products and materials. It should be kept clean and clear and shouldnever be used for “bottlene ck” or “overflow’’ storage. This also applies to passageways and emergency exits. Blind corners should be eliminated or beadequately protect ed by warning signs.

Aisle boundary markings should be drawn to show clearly the space which has been reserved for traffic. Markings should be sufficiently wide (say a minimum of 30 mm) and of a color to make them clearly visible. Paint or durable plastic strips can be used.

Improve Storage Facilities: Tidiness and order are essential in overcoming storage problems, both in storerooms and in the yard. Good storage utilizes air space instead of floor space, and also saves time-wasting delays. It’s important to prevent stores and scraps accumulating on the floor and around machines. Never keep more stores and materials than necessary near machines and provide proper facilities (such as bins, shelves, boxes, racks, etc.) in which to store them.

Keep Floors Clean: Every year thousands of work injuries are caused by people falling. Floor conditions are responsible for many of these accidents. When floors are given the right treatment they are much easier to keep clean and hygienic.Spilt oil and other liquids should be cleaned up at once. Chips, shavings, dust, and similar wastes should never be allowed to accumulate. They should be

removed frequently, or better still, be suitably trapped before they reach the floor

Paint the Walls: Paint is one of the cheapest means of renovating walls, and a fresh coat of paint can give a boost to morale. Light-colored walls reflect light. Dirty or dark-colored walls absorb light. Dirty walls have a depressing effect and encourage dirty habits and sloppy attitudes. Choose suitable colors to paint walls, ceilings and working surfaces. See that the paintwork is cleaned down periodically. Color can be harnessed to assist with safety. For example it can be used to warn of physical hazards and to mark obstructions such as pillars. Painting handrails, machine guards and other safety equipment renders them distinctive and also prevents rust. Color can be used to highlight the hazardous parts of machinery but it can never substitute for a needed guard.

Maintain Light Fittings: Attention to light fittings should be an integral part of any good housekeeping programme. Dirty lamps and shades, and lamps whose output has deteriorated with use, deprive employees of essential light. It's been found that lighting efficiency may be improved by 20 to 30 percent simply by cleaning the lamps and reflectors.

Clean the Windows: Clean windows let in light; dirty ones keep it out. Insufficient light causes eye strain and leads to accidents because employees are unable to see properly. Ensure that windows are not blocked by stacked

Dispose of Scrap and Prevent Spillage: It's a common practice to let the floor catch all the waste and then spend time and energy cleaning it up. It is obviously better to provide convenient containers for scrap and waste and educate employees to use them. Safety will benefit, expense will be saved, and the factory will be a better place in which to work. Oily floors are a common accident and fire hazard. Splash guards and drip pans should be installed wherever oil spills or drips may occur. Prevent accidents by keeping oil and grease off the floor.

Get Rid of Dust and Dirt: In some jobs, dust, dirt, chips, etc., are unavoidable. If they can't be collected as part of the process (e.g. by enclosure and exhaust methods) you need a way to clean them up. Vacuum cleaners are suitable for removing light dust and dirt. Industrial models have special fittings for cleaning walls, ceilings, ledges, machinery, and other hard-to-reach places where dust and dirt collect. If light dust is removed by sweeping, floors should be dampened first rather than swept dry. Oiling floors occasionally with light oil helps to lay the dust but take care that slipping hazards do not occur. Remember, it is not only floors that need sweeping. Dust and grime also collect on ledges, shelves, piping, conduits, lamps, reflectors, windows, cupboards, lockers, and so on and all these places need attention.

Self-check 2	Written test

Name …… Date……..

Direction: Blank space

1. List down at least 5 elements of a Good Housekeeping
    a. ……..
    b. …….
    c. …….
    d. …….
    e. …….
2. List out examples of poor housekeeping that lead to accidents are
    a. ……..
    b. ……..
    c. ……..
    d. ……..
    e. ……..

Note: **Satisfactory rating - 10 points** **Unsatisfactory - below 5 points**

You can ask you teacher for the copy of the correct answers.

Information Sheet-3	Returning surplus materials ware house

3.1 Objectives of returning surplus materials ware house

- To ensure that surplus materials are properly identified and managed
- To ensure adequate and accurate surplus inventory records are maintained at all times
- To help accelerate the utilization and disposal of surplus materials to provide clarity about relevant activities/processes around surplus materials

3.2 Fundamentals for returning surplus materials ware house

All surplus materials should be identified, inspected, labeled, transferred to another project or returned to Logistics. This can take place during project execution or after project completion and/or cancellation. All materials planned for return shall be segregated and transferred to relevant storage facility in accordance with the following criteria:

- Items which have potential use but not part of ‘general stock’ (standard materials) and where required, having shall be returned to surplus storage facilities.
- Items which have potential use and are part of ‘general stock’ and where required, having shall be returned to standard stock storage facilities.
- All other materials should be sent to auction yards within the respective area, flagged for disposal and disposed through sale to other operators or auctioned via public tender.
- Any item that can be immediately used on another approved project or transferred to general stock shall be transferred to the next approved project at the original procurement cost.
- Surplus materials should be properly marked, labeled and preserved at all time in accordance with procedures and guidelines

Self-check 3	Written test

Name …… Date……..

Direction: Say true or false

1. All surplus materials should be identified, inspected, labeled, transferred to another project or returned to Logistics.
2. To help accelerate the utilization and disposal of surplus materials to provide clarity about relevant activities/processes around surplus materials
3. Materials should not be sent to auction yards within the respective area, flagged for disposal.
4. Surplus materials should be properly marked, labeled and preserved.

Note: **Satisfactory rating - 4 points** **Unsatisfactory - below 4 points**

You can ask you teacher for the copy of the correct answers.

Reference

- **Ethiopian Building code standards electrical installation of building**
- **https://www.smartsheet.com/approval-process-workflow**
- **http://ocw.ump.edu.my/pluginfile.php/11228/mod_resource/content/1/ST%20Guidelines%20For%20Electrical%20Wiring.pdf**
- **https://www.nibusinessinfo.co.uk/content/safety-workplace-machinery-equipment-and-tools**
- **https://media.distributordatasolutions.com/3M/2018q1/5a9ec41a8b4865eb70059fe3670116e4d63a4078.pdf**
- **https://wisconsindot.gov/dtsdManuals/traffic-ops/programs/training/slights/03-slights-electrical-wiring.pdf**
- **https://www.archsd.gov.hk/media/11269/e102.pdf**
- **https://www.ee.co.za/article/basic-electrical-installation-testing.html**
- **https://flh.fhwa.dot.gov/resources/construction/forms/wfl/documents/wflhd-470.pdf**
- **https://www.ihsa.ca/resources/tool_equip_maintenance.aspx**

Acknowledgement

The FEDERAL TVET BUREAU wishes to extend thanks and appreciation to the trainers who donated their time and expertise to the revised of this
Out Come Based Curriculum and TTLM for the TVET Program
Industrial electrical machine drive technology
Level - II.

Moreover, we are pleased to appreciate and thank ALL REGIONAL TVET BUREAU Human

Resource office programmers for active facilitation of the revision of the curriculum.

The trainers (who developed *this outcome based* curriculum and TTLM)

N0	Name	Qualification	Region	Email
1	ABERA GEBRE	Trainer	DIRADAWA	
2	TADDELE GASHAW	Trainer	SOMALI	
3	FISIHA BIREHANU	Trainer	AMHARA	
4	ESUBALEW AMSALU	Trainer	HARER	
5	HINDA IBRAHIM	Trainer	SOMALI	
6	MULU DAMANE	Trainer	ADDIAABEBA	
7	MERON HUSEN	Trainer	HARER	
8	YIMER SEID	Trainer	AFAR	
9	SHIMELS CHEKOLE	Trainer	AMHARA	
10	SERKABEBA ABERA	Trainer	DEBUB	