



Ethiopian TVET-System



INDUSTRIAL ELECTRICAL MACHIN DRIVE TECHNOLOGY

Level-II

Based on May 2011 Occupational Standards

October, 2019



Module Title: Performing Installation Works

TTLM Code: EELEMD2TTLM1019

This module includes the following Learning Guides

LG26: plane and prepare for installation

LG Code: EEL EMD2 M06LO1-LG-26

LG27: Clean-up

LG Code: EEL EMD2 M06LO4-LG-27

EEL EMD22	Version:01	Page No.2
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**Instruction Sheet-1****LG26: plane and prepare for installation**

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

- Selection of materials, tools, testing devices and safety regulation
- Reading and interpreting work instructions
- Obtaining necessary Materials to complete the work

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

- reading and Interpret Work instructions to determine with job requirements
- Selectin of Tools and testing devices needed to carry out the installation work in accordance with established procedures and checked for correct operation and safety
- Complete the work with the necessary material according to with job requirement

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below
3. Read the information written in the information Sheet
4. Accomplish the “Self-checks, in each information sheets.
5. Ask from your teacher the key to correction (key answers) or you can request your teacher to correct your work. (You are to get the key answer only after you finished answering the Self-checks).
6. If you earned a satisfactory evaluation proceed to “Operation sheets and LAP Tests if any”. However, if your rating is unsatisfactory, ask your teacher for further instructions or go back to Learning Activity.

EEL EMD22	Version:01	Page No.3
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Information Sheet-1

Selection of materials, tools, testing devices and safety regulation

1.1. Safety

Safety: Hazards may occur due to improper handling of tools and equipment's, unsafe work areas, operating machines without knowing how to operate and using materials out of their intended purpose etc.

1.1.1 Safe Work Practices

A safe work environment is not enough to control all electric hazards. You must also work safely. Safe work practices help you control your risk of death from workplace hazards. If you are working on electrical circuits or with electrical tools and equipment, you need to use safe work practices.

- Before you begin a task, ask yourself:
- What could go wrong?
- Do I have the knowledge, tools, and experience to do this work safely?

All workers should be very familiar with the safety procedures for their jobs. You must know how to use specific controls that help keep you safe. You must also use good judgment and common sense.

1.2. Control electrical hazards through safe work practices

- Plan your work & plan for safety.
- Avoid wet working conditions & other dangers.
- Avoid overhead power lines.
- Use proper wiring and connectors.
- Use & maintain tools properly.
- Wear correct PPE.

1.3. Plan Your Work & Plan for Safety

Take time to plan your work, by yourself and with others. Safety planning is an important part of any task. It takes effort to recognize, evaluate, and control hazards. If you are thinking about your work tasks or about what others think of you, it is hard to take the time to plan for safety. But, YOU MUST PLAN!

Planning with others is especially helpful. It allows you to coordinate your work and take advantage of what others know about identifying and controlling hazards. The following is a list of some things to think about as you plan.

- Work with your Partner-Do not work alone. Both of you must know what to do in an emergency.

EEL EMD22	Version:01	Page No.4
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- Know how to shut off and de-energize circuits. You must find where circuit breakers, fuses & switches are located. Then, the circuits that you will be working on (even low-voltage circuits) **MUST BE TURNED OFF!** Test the circuits before beginning work to make sure they are completely de-energized.
- Plan to lock out and tag out circuits and equipment. Make certain all energy sources are locked out and tagged out before performing any work on an electrical circuit or electrical device. Working on energized (“hot”) circuits is one of the most dangerous things any worker could do. If someone turns on a circuit without warning, you can be shocked, burned, or electrocuted. The unexpected starting of electrical equipment can cause severe injury or death.

Before ANY work is done on a circuit, shut off the circuit, lock out and tag out the circuit at the distribution panel, then test the circuit to make sure it is de-energized.

Before ANY equipment inspections or repairs even on so called low voltage circuits- the current must be turned off at the switch box, and the switch must be padlocked in the OFF position. At the same time, the equipment must be securely tagged to warn everyone that work is being performed. Again, test circuits and equipment to ensure they are de-energized.

No two locks should be alike. Each key should fit only one lock, and only one key should be issued to each worker. If more than one worker is working on the circuit or repairing a piece of equipment, each worker should lock out the switch with his own lock and never permit anyone else to remove it. At all times, you must be certain that you are not exposing other workers to danger. Workers who perform lock-out/ tag-out must be trained and authorized to repair and maintain electrical

equipment. A locked-out switch or feeder panel prevents others from turning on a circuit. The tag informs other workers of your action.

- Remove jewelry and metal objects. Remove jewelry and other metal objects or apparel from your body before beginning work. These things can cause burns if worn near high currents and can get caught as you work.
- Plan to avoid falls- Injuries can result from falling off scaffolding or ladders. Other workers may also be injured from equipment & debris falling from scaffolding & ladders. Do not do any tasks that you are not trained to do or that you do not feel comfortable doing!

1.4. General Safety Precautions

- Read and follow your department’s safe work practices guidelines.
- Employees and employers have a responsibility to work together and establish safe working practices.
- Always use the Personal Protective Equipment (PPE) necessary to protect you from exposure to potential hazards, such as;
 - ✓ Falling, flying, abrasive or splashing objects.
 - ✓ Sharp edges (use caution around when and when not to wear gloves)

EEL EMD22	Version:01	Page No.5
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- ✓ Harmful dusts, fumes, mists, vapors, or gases.
- If a hazardous situation is encountered, immediately bring it to the attention of your supervisor or designated safety coordinator.
- Keep floors as clean and dry as possible to prevent accidental slips or trips when working with or around hand and power tools.
- Clear your workspace of accumulated saw dust, debris, and volatile gases reduces the chance that sparks could cause fire or explosion.
- Avoid Horse play. Use tools for their intended purpose only.
- Handle hand tools with care.

1.5. Hand tools safety rules & regulations

The Occupational Safety and Health Administration states that most injuries on construction sites involve excavation cave-ins, power tool accidents, falls, electrical hazards, and exposure to potentially dangerous materials. Working with power tools, you can get an electric shock,

lose a finger, lose an eye, or go deaf. It's especially dangerous to use a tool that's defective, that's been modified, or that's not designed for the job. Of course, you can also get injured if you use any tool carelessly.

1.6. What the Regulations say about Hand Tools

- Each employer shall be responsible for the safe condition of tools and equipment used by employees.
- This includes tools and equipment which may be furnished by employees
- Employers shall not issue or permit the use of unsafe hand tools
- Wrenches, including adjustable, pipe, end, and socket wrenches shall not be used when jaws are sprung to the point that slippage occurs
- Impact tools, such as drift pins, wedges, and chisels, shall be kept free of mushroomed heads
- The wooden handles of tools shall be kept free of splinters or cracks and shall be kept tight in the tool

1.7. Basic Tool Safety Rules

- Maintain tools regularly
- Inspect before use
- Use the right tool for the job
- Operate according to manufacturers' instructions
- Use the right Personal Protective Equipment (PPE)
- Use guarding

1.8. Safety of each common tool

- Do not use a screwdriver as a chisel. The tool can slip and cause a deep puncture wound.

EEL EMD22	Version:01	Page No.6
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- Never carry a screwdriver in your pocket. If you fall, the tool could cause a serious injury.
- NEVER use a screwdriver to pry anything open, there are other tools in the shop for that purpose.
- NEVER strike a screwdriver with a hammer or mallet, the tips are brittle and could break and injure.
- Make sure to use the proper screwdriver for the job; NEVER use a slotted screwdriver for a Phillips screw.

1.9. Allen Wrenches, Combinations Wrenches & Adjustable Wrenches

- Always pull on a wrench; you have more control over the tool and there is less chance of injury
- Select a wrench that fits properly; loose fitting wrench may slip and round off the corner of the bolt head or nut.
- Never hammer on a wrench to loosen a stubborn fastener, unless the tool has been designed for this job.
- It is dangerous practice to lengthen the wrench handle for additional leverage; use a larger wrench.
- When using wrenches, clean grease and oil from the floor in the work area, the will reduce the possibility of slipping and losing your balance.
- Do not use a wrench on moving machinery.

1.10. Measuring device safety

When using electrical device, you should:

- Inspect the device to be sure there are no obvious safety hazards
- Be sure it is connected properly to the circuit
- Be sure not to exceed its maximum rating during measurement
- Handle the device with care

1.11. Identify different types of hand tools and their operation

1.11.1. Common Electrical hand tools: Are tools commonly used to perform electrical works. These include:

- **Screw drivers:** is a tool used to insert and tighten or to loosen and remove screws on electrical/ electronic equipment. The shape of their head into different types identifies screwdrivers. Figure 1.shows different types of screwdrivers, their head shape and symbols.

EEL EMD22	Version:01	Page No.7
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Screwdriver type	Head symbol	Head shape	screws
Slot-head			
Phillips			
Torx			
Allen Keys			

Fig 1 type of screw driver

The common screw drivers are shown below:

- **Slotted Screwdriver** is used to drive or fasten negative slotted screws.



- **Phillips Screwdriver** – used to drive or fasten positive slotted screws. It is a screwdriver that could take greater torque and could provide tighter fastenings.



- **Pliers:** used to grip wire to: pull, bend, twist or splice, cut wires. These are classified as: combination, long nose, round nose cutting, diagonal cutting, needle nose pliers
- **Side cutting pliers:** are used for cutting extra components leads and splicing wires.



Fig. 1.1 Side cutting plier



- **Long nose plier:** Consist of long, narrow tapered jaws. The jaws may be smooth or they may have serrations for improved gripping. This tool works well in confined areas where the finger accessibility is limited, for holding wires or positioning small parts. They will not withstand severe gripping or twisting forces. Long nose pliers are often used in PCB assembly to set bend allowance on components, and to assist in component insertion.

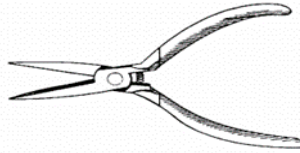


Fig. 1.2. Long nose plier

- **Round Nose plier:** are used to make loops in wire and to shape light metal.

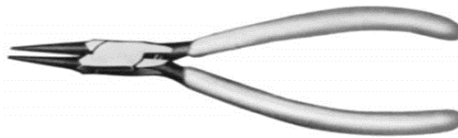


Fig. 1.3. Round nose plier

- **Slip joint plier:** designed for holding and gripping heavy hardware to insert it in a chassis, where marring of the chassis surface is of no concern. These pliers are often used to insert a strain relief and grip large nuts and bolts to hold them in place.

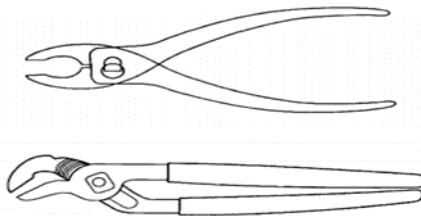


Fig. 1.4. Types of slip joint plier

- **Electrician's pocket knife:** used to remove insulation of a wire.



Fig. 1.5. Electrician's pocket knife

EEL EMD22	Version:01	Page No.9
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- **Wire strippers:** are small, hand-held devices used to remove insulation from wires, to prepare the wire for electrical connection during assembly or service of electronic equipment. They are classified into two types: manual and automatic. Figure 1.6 shows different types of wire strippers



Wire strippers types	Manual	Automatic
Pictures		

Fig. 1.6. Types of wire strippers

- **Wrenches:** Wrench is a basic tool that is used to exert a twisting force on bolt heads, nuts, studs, and pipes. The special wrenches designed to do certain jobs are, in most cases,

There are four types of wrench

- Open-end wrenches
- Box wrenches
- Combination wrench
- Adjustable wrenches

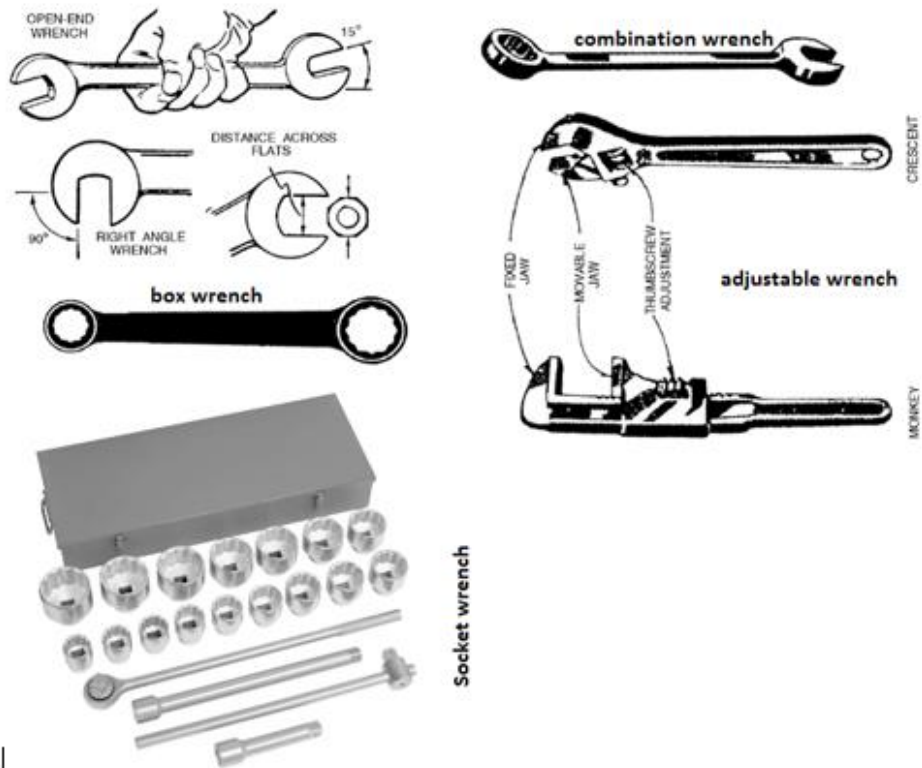


Fig 1.7. Types of wrench

1.12. Measuring instrument

- **Multimeters**

Use of electrical test equipment

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



Fig 1. 8. Multimeter

EEL EMD22	Version:01	Page No.11
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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.

Wattmeter: is used for measuring powers in AC circuits. For DC circuits, powers can be found simply from multiplying voltage by current. A wattmeter consists of a current coil, connected in series with the line like an ammeter, and a potential coil, connected in parallel with the line like a voltmeter. The connection is shown in the Figure 4. There is a shunt switch for the current coil similar to an ammeter, while the potential coil has no shunt switch.

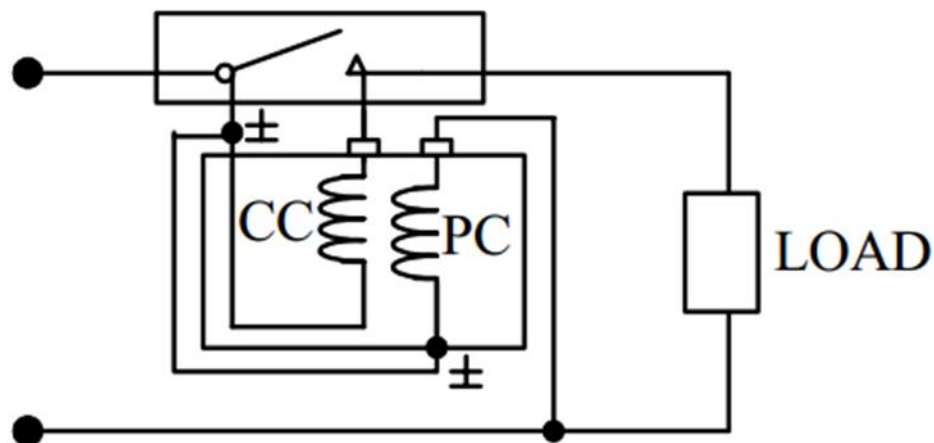


Fig 1.9. Wattmeter

- **Pressure gauge**

Electronic pressure measurement contributes

to the safe, accurate and energy-saving control of processes. Alongside temperature measurement, it is the most important and most commonly used technology for monitoring and controlling plants and machinery. Particularly in pneumatics and hydraulics, measurement and control of the system pressure is the most important prerequisite for safe and economic operation.



In process systems two of the most important process variables to measure are temperature and pressure. The common pressures measured are the hydrostatic pressure of a liquid column and the atmospheric pressure.

- **Industrial thermometer**

Temperature measurement in today's industrial environment encompasses a wide variety of needs and applications. To meet this wide array of needs the process controls industry has developed a large number of sensors and devices to handle this demand. In this experiment you will have an opportunity to understand the concepts and uses of many of the common transducers, and actually run an experiment using a selection of these devices. Temperature is a very critical and widely measured variable for most mechanical engineers. Many processes must have either a monitored or controlled temperature. This can range from the simple monitoring of the water temperature of an engine or load device, or as complex as the temperature of a weld in a laser welding application. More difficult measurements such as the temperature of smoke stack gas from a power generating station or blast furnace or the exhaust gas of a rocket may be need to be monitored. Much more common are the temperatures of fluids in processes or process support applications, or the temperature of solid objects such as metal plates, bearings and shafts in a piece of machinery.

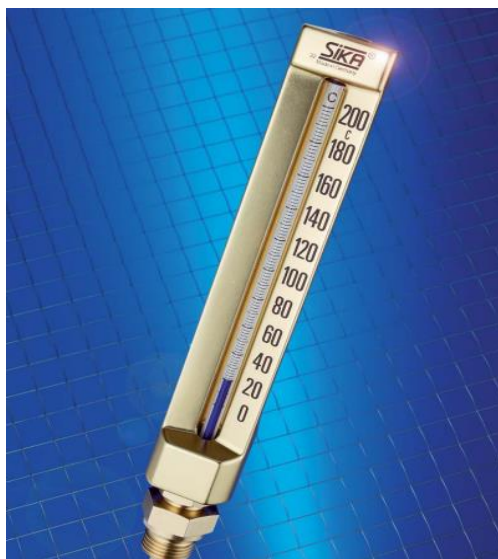


Fig 1.10. Industrial thermometer

- **Frequency meter**

The different types of frequency meters employ various combinations of fixed and moving coils, fixed coils and moving iron, and resonant circuits to produce a deflection of the pointer which depends upon the frequency. The design is such that a high degree of sensitivity to frequency changes and of insensitivity to waveform or changes in line voltage, temperature, or other possible disturbing factors is obtained. The vibrating-reed type of frequency meter is not used on United States naval ships except in some old installations. Frequency meters for

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60-Hz circuits usually cover a frequency range of from 55 to 65 Hz. Those for the variable frequency alternating-current systems used for the electric propulsion of some naval ships are of much wider range.



Fig .1.11. Frequency meter

- **Flow meters**

Flow meters are an integral tool for measuring the flow of liquid, gas, or a mixture of both in applications used in the food and beverage industry, oil and gas plants, and chemical/pharmaceutical factories. There are many different types of flow meters available on the market. Fluid characteristics (single or double phase, viscosity, turbidity, etc.), flow profile (laminar, transitional, or turbulent, etc.), flow range, and the need for accurate measurements are key factors for determining the right flow meter for a particular application.

Additional considerations such as mechanical restrictions and output-connectivity options also impact this choice. The overall accuracy of a flow meter depends to some extent on the circumstances of the application. The effects of pressure, temperature, fluid, and dynamic influences can potentially alter the measurement being taken.

EEL EMD22	Version:01	Page No.14
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Fig 1.12. Flow meters

- **Lux meters**

The Light meter is a high-precision measuring instrument for the precise measuring of the illuminance and the incidence of light on a particular area. The measurement is performed via a photoelectric cell and the measuring result is indicated in four measuring ranges on the LC display. The voltage supply is ensured by a 12V alkaline battery of the type A23. Do not expose the device directly to water or humidity; the housing is not water-proof! Clean the exterior of the device only with a dry and lint-free cloth. Do not use cleansing agents!



Fig 1.13. Lux meters



Self-Check -1	Written Test
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Name: _____ **Date:** _____

Directions: Answer all the questions listed below.

Part I: If the statement is correct write true if the statement is in correct write false

1. _____ each employer shall be responsible for the safe condition of tools and equipment used by employees.
2. _____ Safety planning is not an important part of any task
3. _____ Cable lags are used for connecting the cable/wire to electrical appliance
4. _____ Voltmeter for measuring differences of potential (voltage) between two points in an electrical circuit.
5. _____ Ammeter Measure magnitude of electrical resistance flow in an electrical circuit.

EEL EMD22	Version:01	Page No.16
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Num	Picture of tool	Name and its application
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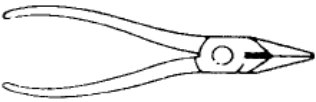


Note: Satisfactory rating – 3points

Unsatisfactory - below 3

Directions: Answer all the questions listed below

PART II: write the name of the hand tool and application

EEL EMD22	Version:01	Page No.17
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1		
2		
3		
4		
5		
6		

Information Sheet-2

2.1. Introduction

Success fully performing electrical work requires the ability to read and interpret many Different types of drawings and diagrams. Understanding circuit symbols and components is Another one of the basic building blocks needed to become an electrician. If an electrician misinterprets drawing or diagram when wiring a house,

devices could be incorrectly installed or even missed altogether. Knowing how to properly take information from an electrical drawing or diagram and apply it to the real world is essential for electricians.

2.2. Control Components System

Power distribution system = Used in large commercial and industrial applications Power may be distributed through switch, switchboards transformers and panel boards Industrial application is used for a variety such as heating cooling, motor –driven machinery.

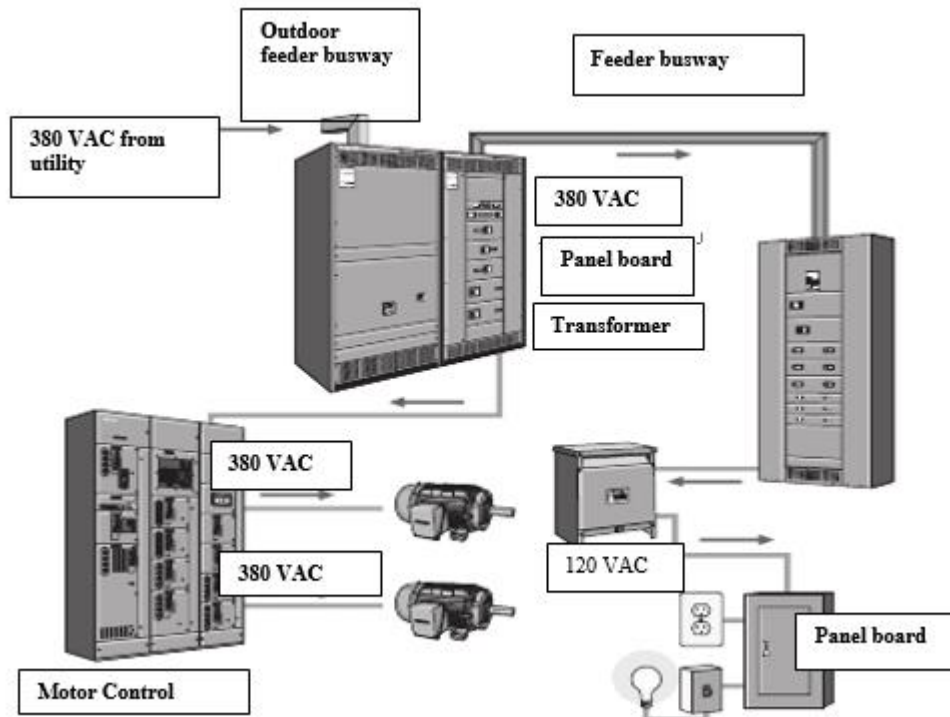
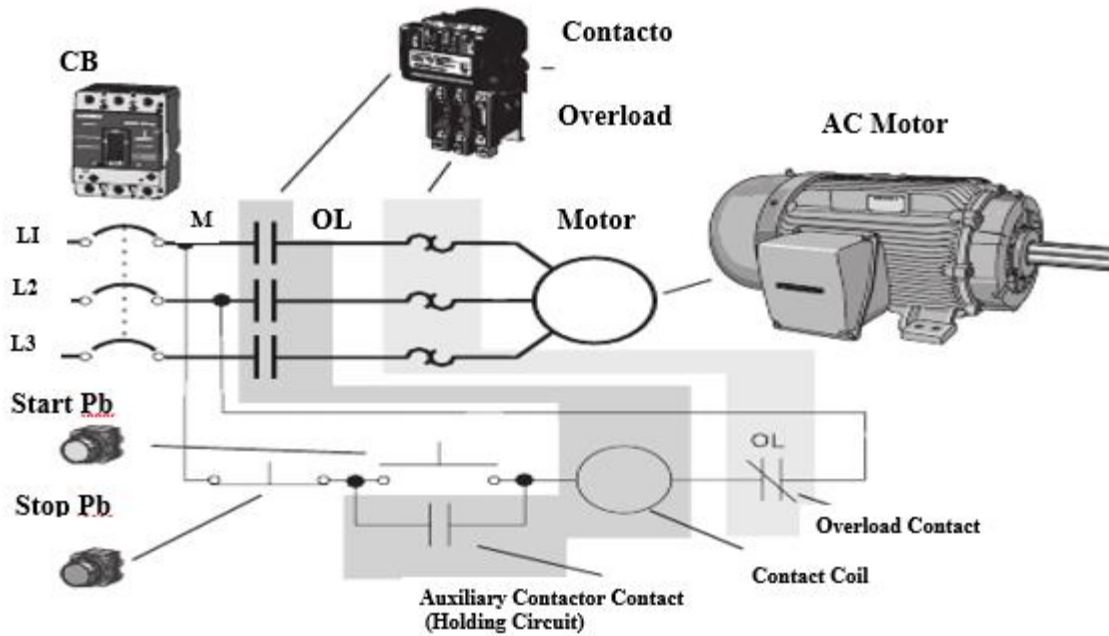


Fig 2. Control Components System

Overload relay = protect the motor by disconnecting power to the motor. Fuse/Circuit breaker are used to protect the motor



Control Panel system

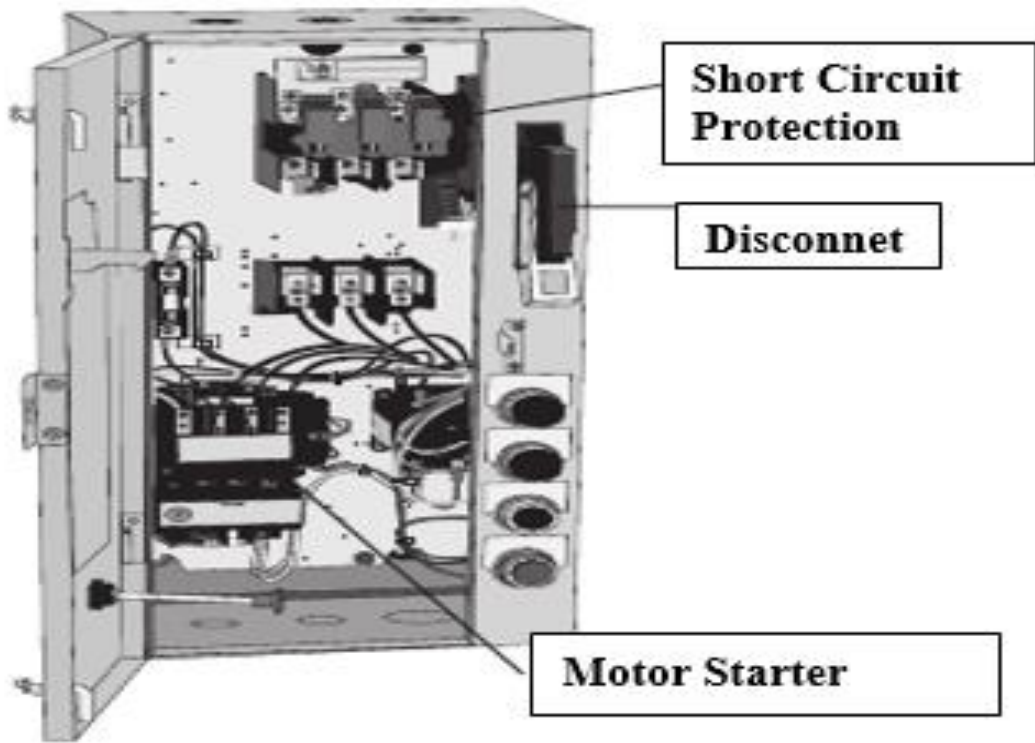


Fig 2.1. Component parts of motor control



Three-phase motor = is used throughout large, commercial and industrial facilities.

Three- phase AC power is applied to the stator through the power connections the direction three phase AC motor, rotor turns depends on the phase sequence of the incoming power supply.

Example (A) connected to motor lead T1, L2

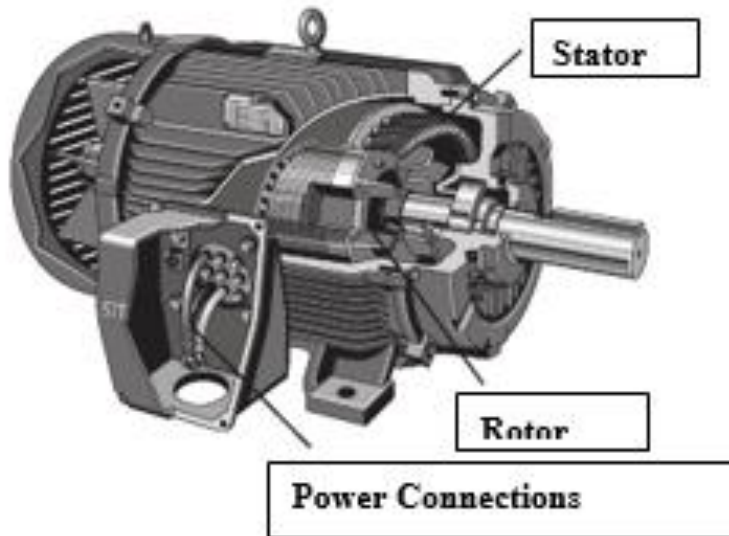
(B) connected to motor lead T2 L3

(C) connected to motor lead T3

When the power is applied through the F contact the turns in clockwise or forward direction

EEL EMD22	Version:01	Page No.21
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PARTS OF THE THREE



Wiring diagram of Forward /reverse

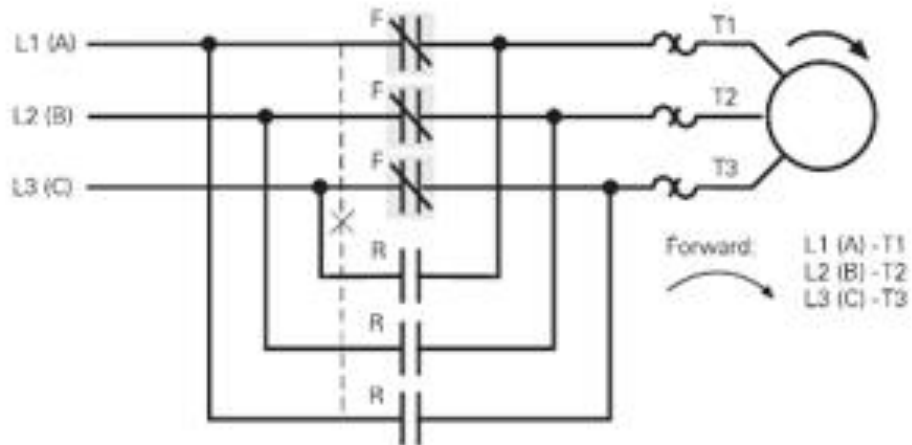


Fig 2.2. Component parts of motor control

Control Panel of motor control (TIAstar)

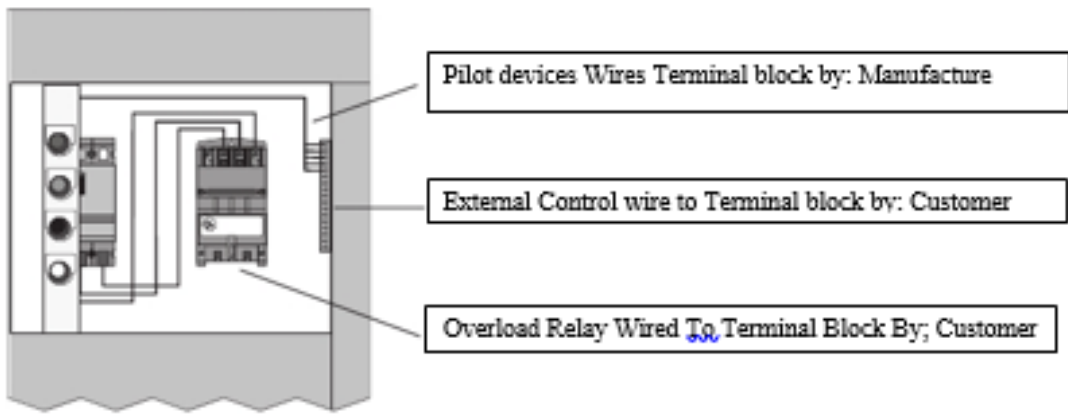
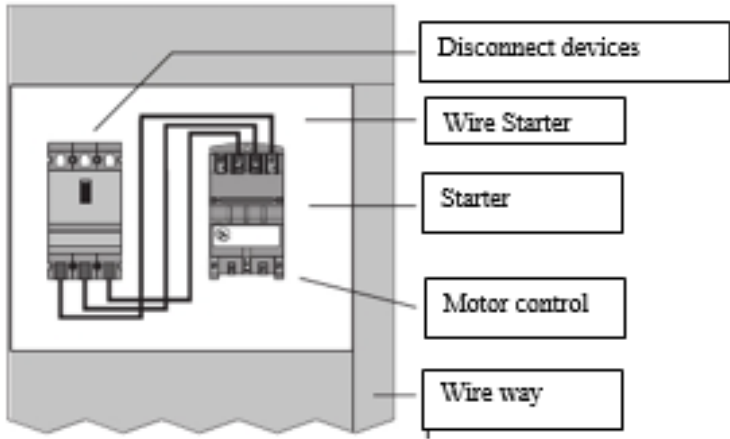


Fig 2.3. Component parts of motor control

Self-check 2	Written Test
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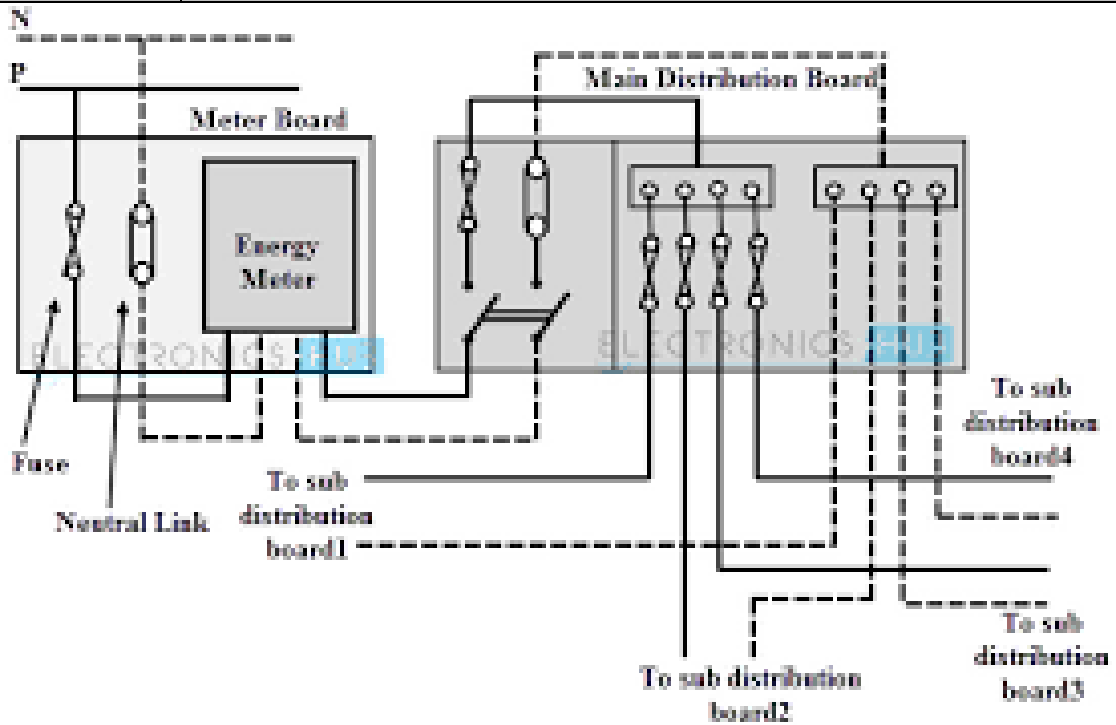
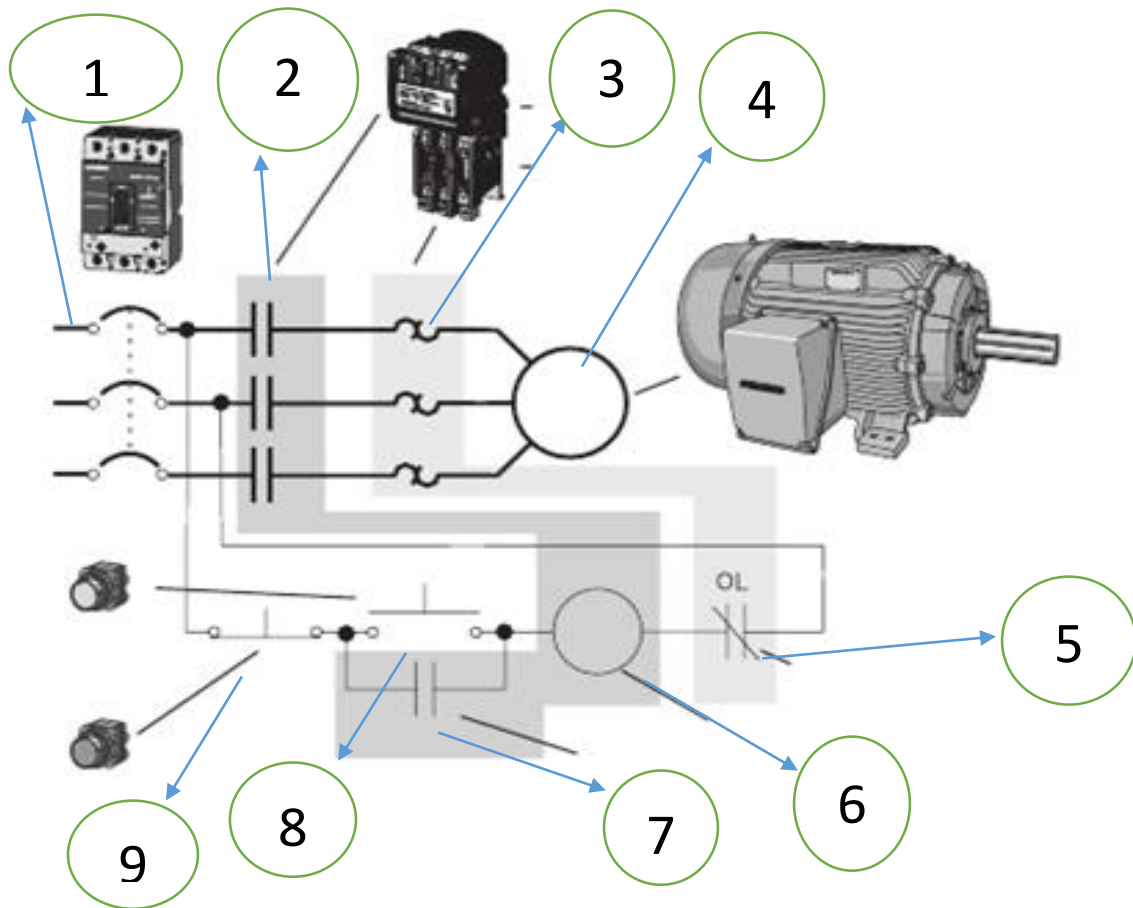


Fig 2.4. 3-phase wiring installation



Directions: Answer all the questions listed below.

Part I: Write the name of the symbol

- | | |
|----------|----------|
| 1. _____ | 6. _____ |
| 2. _____ | 7. _____ |
| 3. _____ | 8. _____ |
| 4. _____ | 9. _____ |
| 5. _____ | |

Referees: - *Electric Machinery Sixth Edition*

Information Sheet-3	Obtaining necessary Materials to complete the work
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3.1. Introduction

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

EEL EMD22	Version:01	Page No.25
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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 are done.

3.2. Identifying and selecting the wiring materials and components

3.2.1. 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 materials

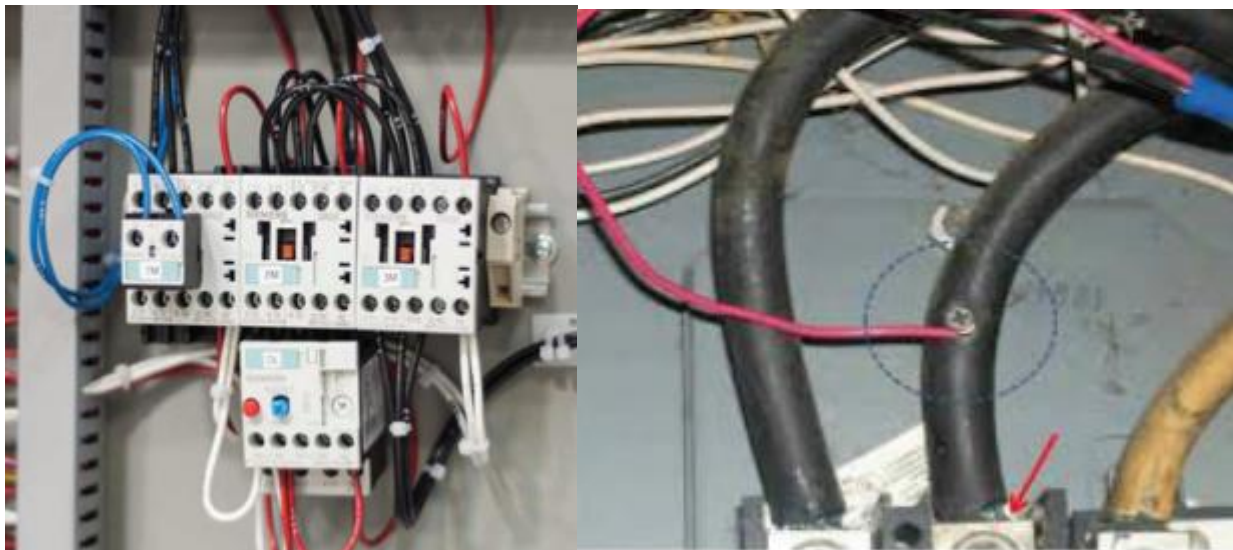


Fig 3. Wiring materials

1. Conducting Material

- a) **Copper** It is a good conductor of electricity. It is used in wiring materials in cables. It has low resistance and is used for conduction of electricity at high, medium and low voltage (Fig. 3). It is used in wiring and cable making.



Fig 3.1. Copper

- b) Aluminum** It is light weight and cheaper in comparison to copper. Therefore, this type of conducting material is mostly used in electrical wiring. It is silvery–white in color and it has a soft texture. It is often used in wiring and making cable(Fig.3).



Fig 3 .2. Aluminum

2. **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.

- **Wiring Accessories** Wiring accessories are used for connecting appliances.

(a) 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 for industrial such as

- push button switch
- Toggle Switch

- Slide Switch
- Rotary Switch

(b) Holders: A lamp holder is advice used to hold the lamp there are different lamp

1. Pendant holder (Fig. 3.3)
2. Batten holder (Fig. 3.3)



Fig 3.3. Holders

(c) Socket outlet/plug: The socket outlet has an insulated base with the moulded or socket base having three terminal sleeves (Fig. 3.4).



Fig 3.4. Socket outlet/plug

(d) 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. 3.5).



Fig 3.5. Main switch

(e) PVC casing-capping wiring: PVC capping is done in order to cover the wires. It includes casing also. This casing-capping wiring is also known as open wiring, as it is done outside the wall.

Materials required for PVC casing-capping wiring (Figs. 3.6) include

1. wire
2. casing enclosures made up of plastic
3. capping made up of plastic
4. T. Joints VIR (Vulcanized Indian Rubber) or PVC (Polyvinyl chloride) insulated wire
5. junction box
6. elbow casing and capping joints



Fig 3.6. PVC casing-capping wiring

Wooden casing-capping wiring is old fashioned. Now PVC or VIR insulated wires are enclosed within the PVC casing enclosure and PVC capping is used to cover the casing.

3.3. Miniature Circuit Breaker (MCB)

A MCB is used in new constructions instead of the older types of fuses. Circuit breakers are small devices used to control and protect the electrical panel and the other devices from overflowing of electrical power (Fig. 3.7).





Fig 3.7. Miniature Circuit Breaker

3.3.1. Industrial applications

There are many small scale industrial buildings where MCBs are used instead of the old fuses. Miniature circuit breakers are largely used in restaurants, bakeries and commercial food stores.

3.3.2. Heaters

When heaters are used at home or in the office, the MCB can be beneficial. It is known in general that heaters can be problematic sometimes, especially with distribution of electrical power. The MCB prevents possible problems, cutting off electricity in the case of overload or fault. In this case, though, you need to choose a miniature circuit breaker of the proper capacity, enabling it to handle the load of power when needed.

3.4. Conduit Wiring

Electrical conduits are used to protect and provide the route of electrical wiring in an electrical system. Electrical conduits are made of metal, plastic, or fiber and can be rigid or flexible. Conduits (Fig. 3.8) must be installed by electricians as per standard regulations. For workshops and public buildings, conduit wiring is the best and most desirable system of wiring. It provides protection and safety against fire.



Fig 3.8. Conduit Wiring

3.4.1. Types of Conduits

- **Class A conduit:** Thin layered steel sheet of low gauge
- **Class B conduit:** Thick steel sheet of high gauge

3.4.2. Materials used in Conduit Wiring

- GI (Galvanized Iron) wire
- Elbow
- Coupling
- VIR (Vulcanized Indian Rubber) or PVC (Poly Vinyl Chloride) insulated cables
- Lock nut
- Clip
- Junction Box

EEL EMD22	Version:01	Page No.30
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3.4.3. Advantages of conduit wiring

- Safe
- Better appearance
- No risk of fire
- No risk of damage of cable insulation
- Safe from humidity, smoke, steam, etc.
- No risk of shock
- Long lasting

3.4.4. Disadvantages of conduit wiring

- Expensive
- Installation is not easy
- Not easily customizable for future use
- Hard to detect faults



Fig 3.9. different conduit

Concealed Wiring: It is laborious to install this wiring. The layout of this wiring is done under the plaster of the wall of the building.

3.5. Color Code

Wiring for AC and DC circuit are color coded for identification of individual wires (Table 1).

Table 1 AC power circuit wiring color codes

EEL EMD22	Version:01	Page No.31
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Function	Label	New colour	Old colour
Protective ground	P G	Green or green-yellow	Green
Neutral	N	White	Gray
Line, single phase	L	Black or red	–
Line, three phase	L1	Black	Brown
Line, three phase	L2	Red	Orange
Line, three phase	L3	Blue	Yellow

3.6. Switch and distribution board

3.6.1. ICTP (Iron Clad Triple Pole) Switch

It is used along with the energy meter to isolate the supply of electricity automatically or manually (Fig. 3.10)



Fig3.10. ICTP (Iron Clad Triple Pole) Switch

3.6.2. Distribution Board

A distribution board is a component of an electricity supply system that divides an electrical power feed into subsidiary circuits, while providing a protective fuse or circuit

breaker for each circuit in a common enclosure. A distribution board is also known as panel board, breaker panel, or electric panel

3.6.3. Electrical Circuit

In an electric circuit the positive side of wire is connected to the negative side of a load, for example, bulb, TV, etc. and power supply is started by using a switch. The circuit is like an electrical house.

Types of Circuit Are **Open**, **Closed**, **Series** and **Parallel**

3.7. Fixing Wiring Accessories on Board

You should know the tools required for fixing the accessories on the board. You should also know the purpose of fixing the accessories. In-house wiring of the switches, holders and sockets should be fixed on wooden/sun mica boards and blocks. Therefore, it is necessary to learn how to fix these accessories. The ways to fix these accessories have been discussed in the following practical activity.

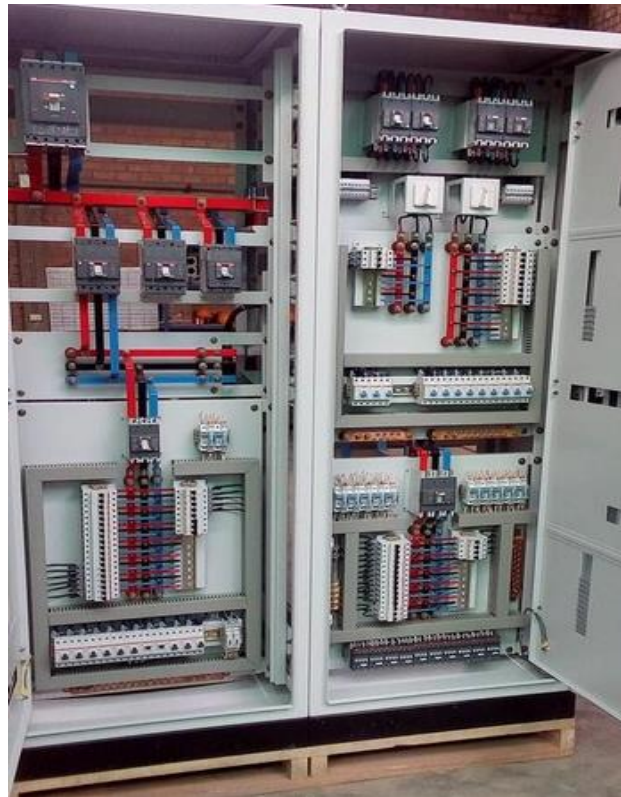


Fig 3.11. Fixing Wiring Accessories on Board

3.8 Terminal blocks

Terminal blocks are common connectors that are intended to safely and effectively bridge the gap between two different circuits. Since they typically have power delivered from a larger source that is carried by wire conductors, terminal blocks are commonly found on industrial and power management electronic devices, such as variable frequency drives, motor protection relays, power and energy meters, power supplies and converters, HVAC and traffic controls, programmable logic controllers and many others. Power is most commonly delivered by wire, so it is always an option to land these wires directly to the assembly without costly adapters that only conform to certain products. Electricians and other installers can quickly work with this simple form of equipment installation and electrical integration.

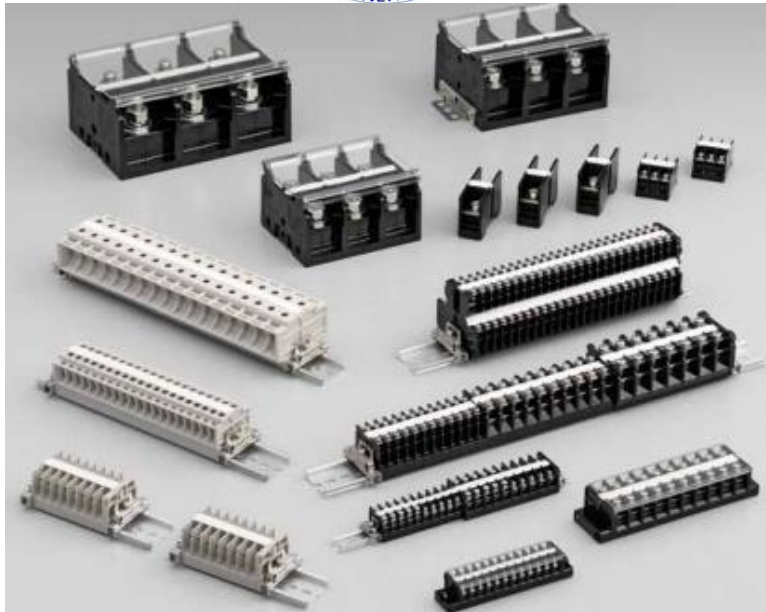


Fig 3.12. Terminal blocks

3.9 Cable lag

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Cable lags are used for connecting the cable/wire to electrical appliance, other cables, surface or mechanism these are used permanent direct-fasting method are not feasible or not required.



Fig 3.13. Cable lag

Self-Check -3	Written Test
----------------------	---------------------

Name: _____

Date: _____

EEL EMD22	Version:01	Page No.35
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Directions: Answer all the questions listed below.

Part I: If the statement is correct write true if the statement is in correct write false

1. _____ Silver is a bad conductor of electricity.
2. _____ Switches are made of conducting material.
3. _____ PVC casing and capping are used for covering the wires.

Part II. Multiple choice questions

1. -----Pendant holder is used for
 - (A) fixing the bulb
 - (B) fixing the fan
 - (C) For hanging the bulb
 - (D) to hang the fan
3. ----- A two-way switch is used for
 - (A) Control one bulb from 2 points
 - (B) control two bulbs from 2 points
 - (C) Control multiple bulbs from 2 points
 - (D) control one bulb from one point
4. _____ is used to protect and provide the route of electrical wiring in an electrical system.
 - (A) Heaters
 - (B) conduit
 - (C) Switch
 - (D) Electrical Circuit
5. _____ It is a good conductor of electricity. It is used in wiring materials in cables.
 - (a) Copper
 - (b) silver
 - (c) Aluminum
 - (d) None

Note: Satisfactory rating - 3 points

Unsatisfactory - below 3 points

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

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2. "Safety priorities for working with electricity": Department of Commerce, WorkSafe
3. "Electrical appliances and equipment – Importing, selling or hiring": Energy Safety

EEL EMD22	Version:01	Page No.36
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Acknowledgement

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We would like also to express our appreciation to the following Officials and Staff of Ministry of Education who made the development of this curriculum possible –

This **TTLM** was developed on the **September, 0919 G.C**

Industrial Electrical Machines and Drives Servicing Level-II

EEL EMD22	Version:01	Page No.37
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Learning Guide-27

Unit of Competence:	Perform Installation Works
Module Title:	Performing Installation Works
LG Code:	EEL EMD2 M06LO2-LG-27
TTLM Code:	EEL EMD2 M06 TTLM 1019v1

LO2: Install electrical machines and drives

Instruction Sheet-2	Learning Guide #-27
----------------------------	----------------------------

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

- OHS policies and procedure
- Appropriate use of PPE
- Installing Electrical Machines and drives
- Responding unplanned events or conditions

EEL EMD22	Version:01	Page No.38
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This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, **upon completion of this Learning Guide, you will be able to:**

- Appropriate **personal protective equipment** is worn in line with standard Operating procedures.
- Follow OHS policies and procedures for installation according job Requirements.
- Install Electrical machines and drives accordance to manufacturer’s instructions, requirements, without damage to the surrounding place or environment
- Responded Unplanned events or conditions accordance with established procedures

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below
3. Read the information written in the information Sheet
4. Accomplish the “Self-checks, in each information sheets.
5. Ask from your teacher the key to correction (key answers) or you can request your teacher to correct your work. (You are to get the key answer only after you finished answering the Self-checks).
6. If you earned a satisfactory evaluation proceed to “Operation sheets and LAP Tests if any”. However, if your rating is unsatisfactory, ask your teacher for further instructions or go back to Learning Activity.

Information Sheet-1	OHS policies and procedures
----------------------------	------------------------------------

1.1. Introduction

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:

EEL EMD22	Version:01	Page No.39
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- 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.

1.2. protect yourself and others

1.2.1. 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

EEL EMD22	Version:01	Page No.40
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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
5. 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 accidentally 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.
- Keep equipment such as ladders, cranes, man-lifts, and scaffolds away from power lines and live electrical wires.
- Know where the breakers and boxes are located in case of an emergency.
- Label all circuit breakers and fuse boxes clearly.
- Label all disconnecting switches and circuit breakers to indicate their use and the equipment served.
- Always open disconnecting means before fuses are replaced. Use approved cabinets or enclosures to guard energized parts.
- Maintain access and working space around all electrical equipment as required.
- Close unused openings (including conduit knockouts) in electrical enclosures and fittings with appropriate covers, plugs or plates.

EEL EMD22	Version:01	Page No.41
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Self-check 1	Written Test
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- Do not block access to circuit breakers or fuse boxes.
 - ✓ Assume that all overhead wires are energized and have high voltage.
- Never touch a fallen overhead power line.
- Before working at heights or carrying long objects, check the area for overhead power lines.
- Don't operate electrical equipment while you are standing in water.
- Don't repair electrical cords or equipment unless qualified and authorized.
- Have a qualified electrician inspect electrical equipment that has gotten wet before energizing it.
- Lockout and tag out when electrical equipment or lines are to be serviced, maintained or adjusted.
- Post enough warning signs to make people aware of the safety hazard.

Name: _____

Date: _____

Directions: Answer all the questions listed below.

Part I: If the statement is correct write true if the statement is in correct write False

1. _____ Supervisors, workers and visitors are expected to perform their duties and responsibilities in a safe and healthful manner.
2. _____ Employees can prevent shocks and injuries/electrocution from electrical hazards by followed safety procedure
3. _____ Always do not use ladders made of wood or other non-conductive materials when working with or near electricity or power lines.

EEL EMD22	Version:01	Page No.42
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4. _____ Each worker who works on the machine must lock out and tag the power disconnect.
5. _____ Before working at heights or carrying long objects, check the area for overhead power lines

Note: Satisfactory rating - 3 points

Unsatisfactory - below 3 points

Information Sheet-2	Appropriate use of PPE
----------------------------	-------------------------------

2.1. introduction

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.

EEL EMD22	Version:01	Page No.43
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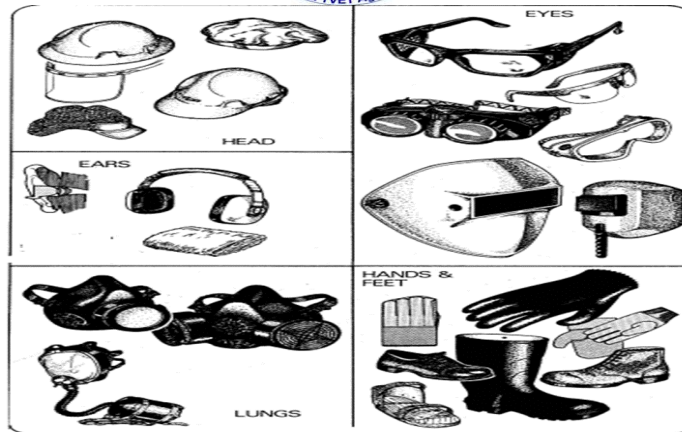


Fig 1 Personal Protective Equipment

2.2. Personal Protective Equipment

Personal Protective Equipment is an integral part of any employer’s safety program. OSHA has determined that PPE although a good way to protect employees, should be used as a last line of defense and it’s important to understand the limitations of PPE in the workplace.

Prior to using PPE, the employer must determine if other means of protection are available. OSHA uses the following sequence for employee protection:

- Engineering Controls (deals with equipment)
- Administrative Controls (deals with people or processes)
- Personal Protective Controls (deals with what you wear)

If no other method is available to protect employees, then PPE is an acceptable method. For those employees working in areas where there are potential electrical hazards, they must be provided with (and must use) electrical protective equipment that is appropriate for the specific parts of the body to be protected and for the work to be performed.

1.2.1. PPE for the Head (helmet)

Employees must wear nonconductive head protection wherever there is a danger of head injury from electric shock or burns due to contact with exposed energized parts

the following three classes are types of helmets:

- **Class G (General) Helmets** -This is equivalent to the old Class A. Class G helmets are proof tested at 2,200 volts.
- **Class E (Electrical) Helmets** - This is equivalent to the old Class B. Class E helmets are proof tested at 20,000 volts.



- **Class C (Conductive) Helmets** - This class provides no electrical insulation; the class designation did not change from the old standard.



Fig 2 helmet

1.2.2. PPE for the Eyes & Face

Employees shall wear protective equipment for the eyes or face wherever there is danger of injury to the eyes or face from electric arcs or flashes or from flying objects resulting from electrical explosion.

When working on energized parts, the possibility of arc flash exists and the employee must be protected. Dangers could include heat, flying hazards and molten metal, therefore the PPE must be durable, non-conductive, heat resistant and provide deflection qualities.

- **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), 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.

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Fig 2.1. Goggles

1.2.3. PPE for the Body (FR Clothing)

As we learned earlier, employees working in areas where there are potential electrical hazards must be provided with, and must use, electrical protective equipment that is appropriate for the specific parts of the body to be protected and for the work to be performed. This would include flame resistant (FR) clothing.

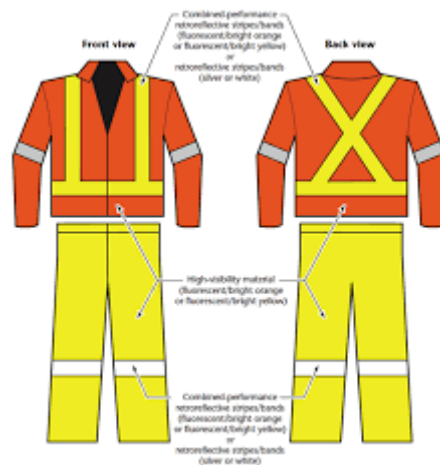


Fig 2.2. PPE for the Body

- **PPE for the Hands (Gloves)**

Since employees working on energized electrical parts are using their hands, obviously that part of the body (hands and arms) is most susceptible to electric shock and must be protected.

Insulating gloves provide an excellent means of protecting the workers from accidental electrical contact. To be effective the insulating gloves must have high insulated qualities, while also being comfortable, durable and flexible.



Because safety is involved, the employer and employee must become familiar with the differences between the various types and classes of insulating gloves available.



Fig 2.2. Gloves

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.



Fig 2.3. Safety shoes

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Self-check 2	Written test
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Directions: Answer the questions listed below.

Part I:

Instruction if the statement is correct write true if the statement is in correct write False

1. _____ppe used or worn by a person to minimize risk to the person's health or safety
- 2 _____ Goggle Proper eye protections is the most importance for all personnel
- 3 _____ Gloves that part of the body (hands and arms) are most susceptible to electric shock and must be protected
- 4 _____ helmet designed to limit damage to your toes from falling objects
- 5 _____ Safety shoes danger of head injury from electric shock or burns due to contact with exposed energized parts

EEL EMD22	Version:01	Page No.48
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Note: Satisfactory rating - 3 points

Unsatisfactory - below 3 points

Information Sheet-3	Installing Electrical Machines and drives
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You can ask your teacher for the copy of the correct answers.

3.1. INTRODUCTION

Nowadays, modern power electronics and drives are used in electrical as well as mechanical industry. The power converter or power modulator circuits are used with electrical motor drives, providing either DC or AC outputs, and working from either a DC (battery) supply or from the conventional AC supply. Here we will highlight the most important aspects which are common to all types of drive converters. Although there are many different types of converters, all except very low-power ones are based on some form of electronic switching. The need to adopt a switching strategy is emphasized in the Wrist example, where the consequences are explored in some depth. We will see that switching is essential in order to achieve high-efficiency power conversion, but that the resulting waveforms are inevitably less than ideal from the point of view of the motor.

The thyristor DC drive remains an important speed-controlled industrial drive, especially where higher maintenance cost associated with the DC motor brushes (c.f. induction motor) is tolerable. The controlled (thyristor) rectifier provides a low-impedance adjustable DC voltage for the motor armature, thereby providing speed control.

3.2. Definitions of Electrical Drives

- An electrical drive can be defined as an electromechanical device for converting electrical energy into mechanical energy to impart motion to different machines and mechanisms for various kinds of process control.
- An electrical drive is an industrial system which performs the conversion of electrical energy into mechanical energy or vice versa for running and controlling various processes.
- An electrical drive is defined as a form of machine equipment designed to convert electrical energy into mechanical energy and provide electrical control of the processes. The system employed for motion control is called an electrical drive.

EEL EMD22	Version:01	Page No.49
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3.3. ELECTRICAL DRIVES AND THEIR BLOCK DIAGRAM

An electrical drive system has the following components (Fig. 2.1).

1. Electrical machines and loads
2. Motor
3. Power modulator
4. Sources
5. Control unit
6. Sensing unit

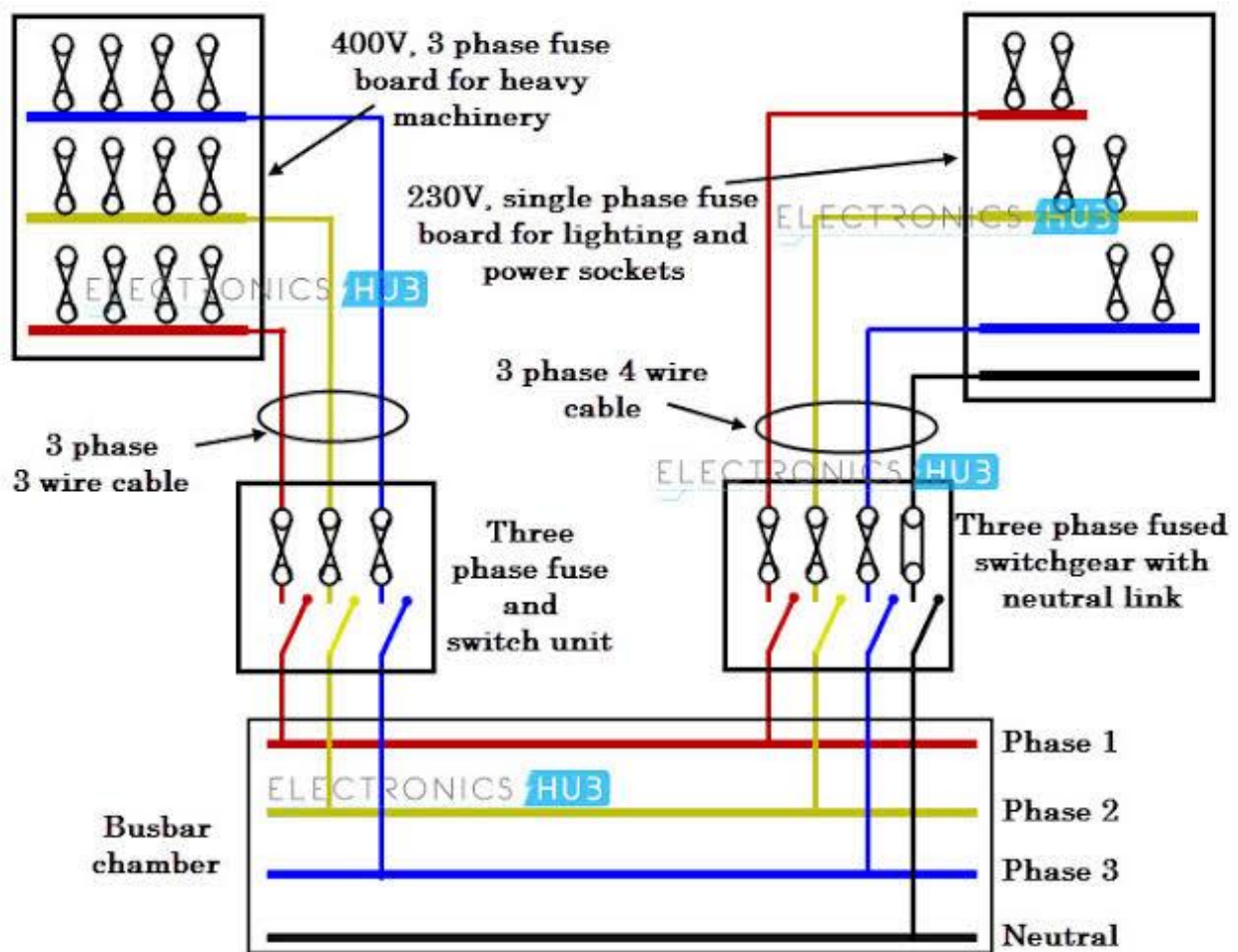


Fig 3.1. Three phase wiring system

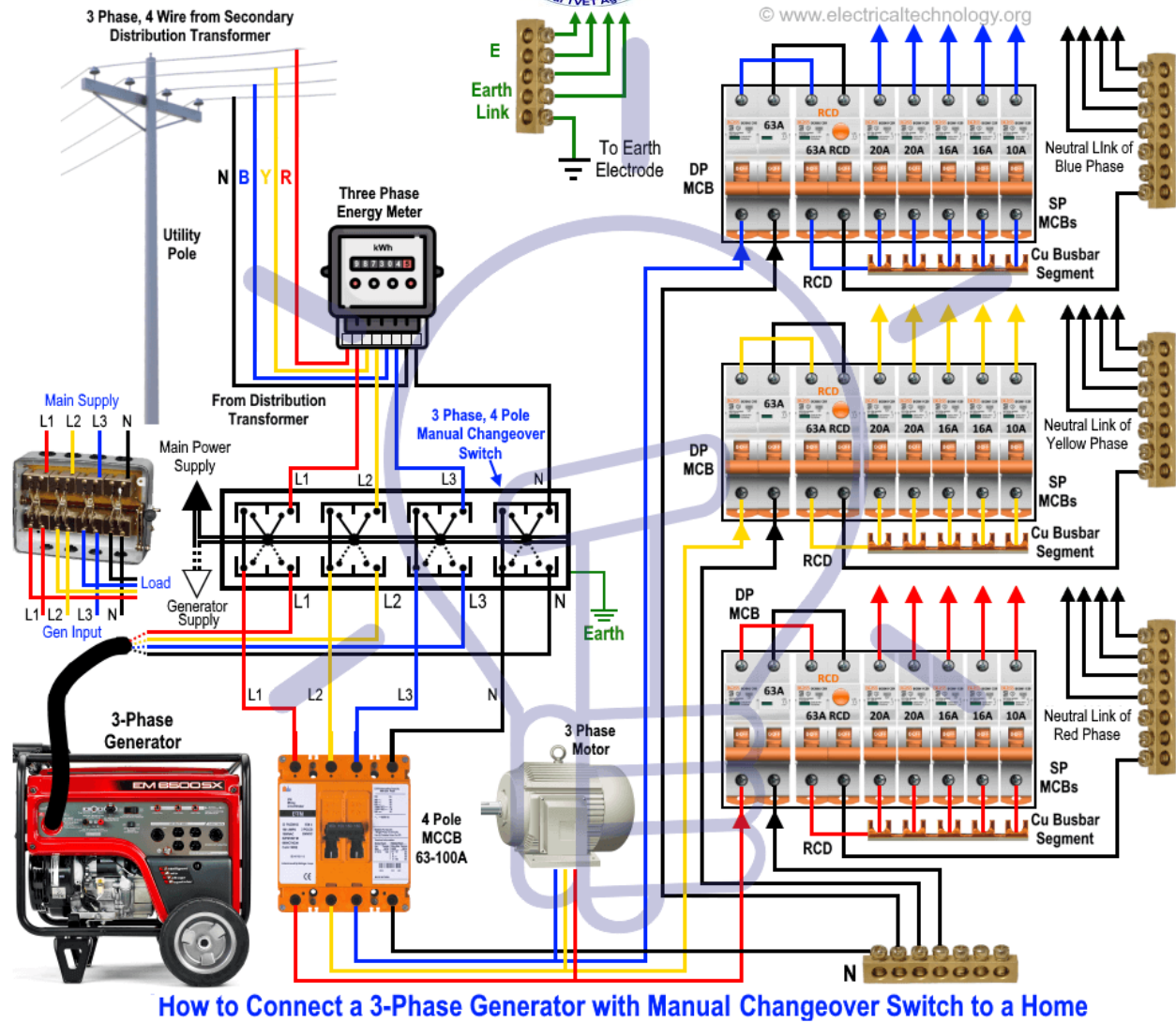
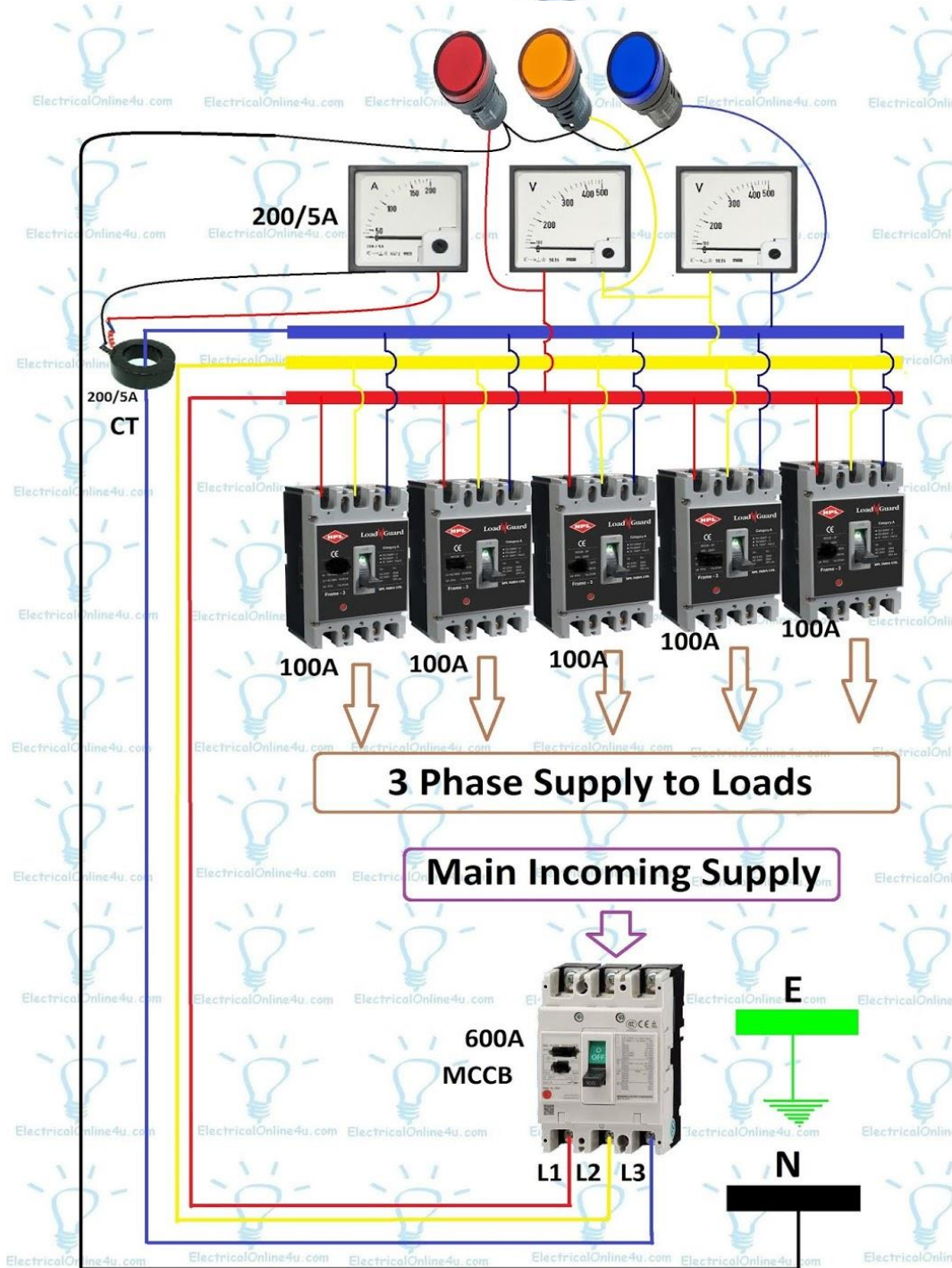


Fig 3.2. Three phase generator with manual switch



3 Phase Panel Board Wiring Diagram

Design By : Sikandar Haidar

Copyright : electricalonline4u.com

EEL EMD22	Version:01	Page No.52
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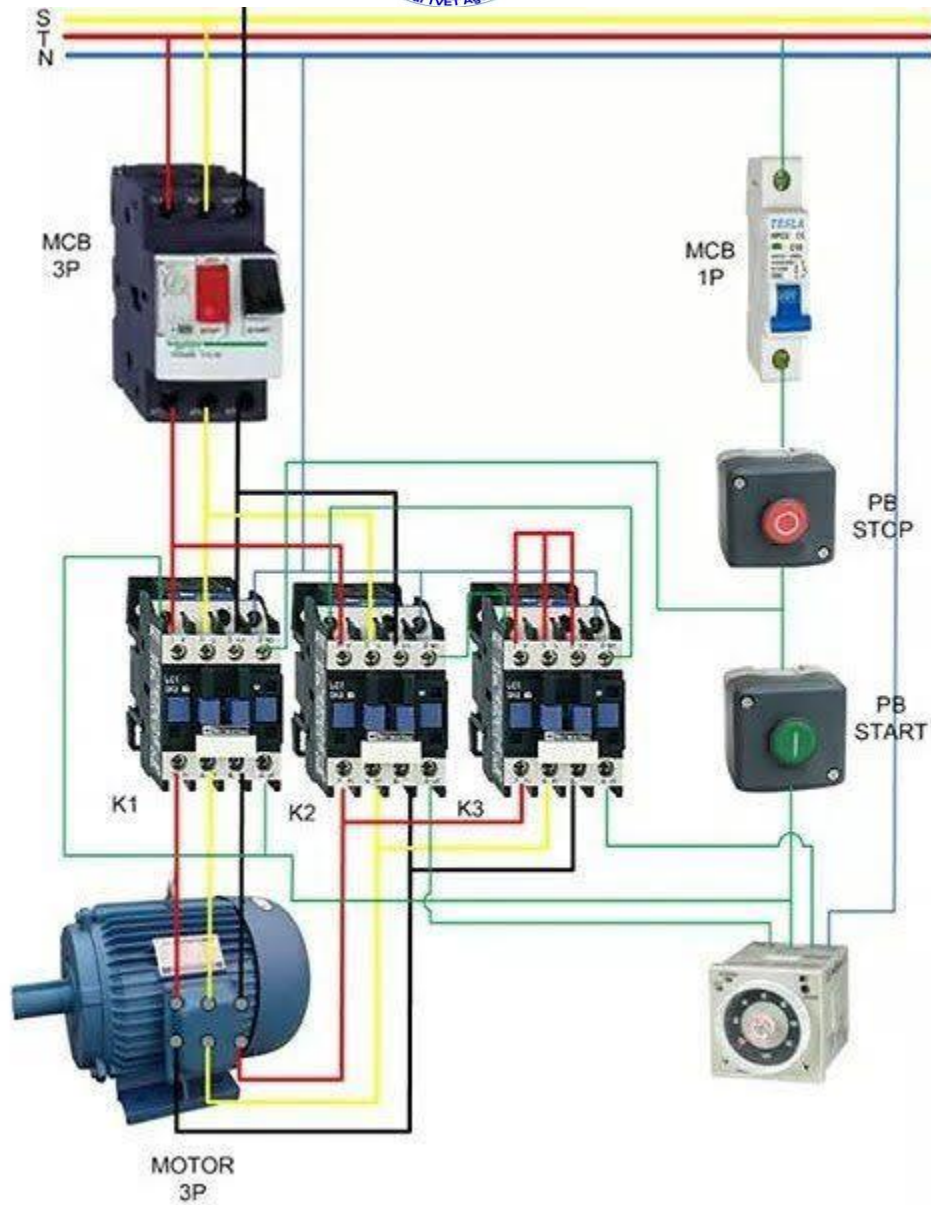


Fig 3.4. Industrial control and power circuit

1. Electrical machines and loads

Definition: The device which takes electrical energy is known as the electric load. In other words, the electrical load is a device that consumes electrical energy in the form

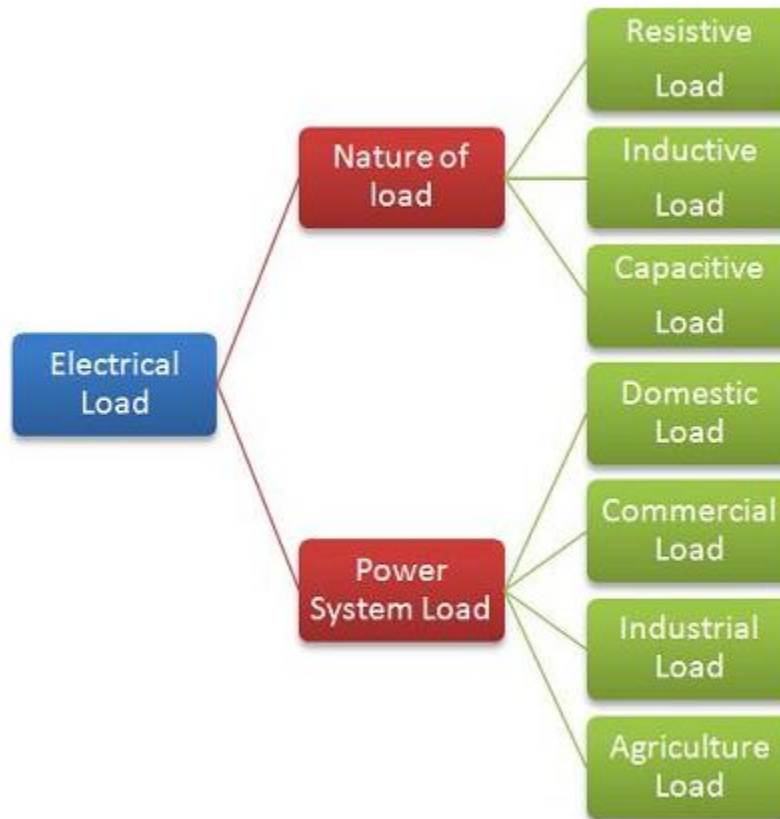
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of the current and transforms it into other forms like heat, light, work, etc. The electrical load may be resistive, inductive, capacitive or some combination between them. The term load is used in the number of ways

- To indicate a device or a collection of the equipment which use electrical energy.
- For showing the power required from a given supply circuit.
- The electrical load indicates the current or power passing through the line or machine.

The classifications of loads are shown in the figure below



- **Types of Electrical Loads**

The nature of the load depends on the load factor, demand factor, diversity factor, power factor, and a utilization factor of the system. The different types of load are explained below in details.

- ✓ **Resistive Load**

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The resistive load obstructs the flow of electrical energy in the circuit and converts it into thermal energy, due to which the energy dropout occurs in the circuit. The **lamp and the heater are the examples of the resistive load**. The resistive loads take power in such a way so that the current and the voltage wave remain in the same phase. Thus the power factor of the resistive load remains in unity.

✓ **Inductive load**

The inductive loads use the magnetic field for doing the work. The **transformers, generators, motor are the examples of the load**. The inductive load has a coil which stores magnetic energy when the current pass through it. The current wave of the inductive load is lagging behind the voltage wave, and the power factor of the inductive load is also lagging.

✓ **Capacitive Load**

In the capacitive load, the voltage wave is leading the current wave. The **examples of capacitive loads are capacitor bank**, three phase induction motor starting circuit, etc. The power factor of such type of loads is leading.

Types of Electrical Loads in Power System

The total loads of an area depend on its population and living standard of the people. The different types of the loads in a power system are as follows.

1. Domestic load
2. Commercial load
3. Industrial load
4. Agriculture load

1. Domestic Load: – The domestic load is defined as the total energy consumed by the electrical appliances in the household work. It depends on the living standard, weather and type of residence. The domestic loads mainly consist of lights, fan, refrigerator, air conditioners, mixer, grinder, heater, ovens, small pumping, motor, etc. The domestic load consumes very little power and also independent from frequency. This load largely consists of lighting, cooling or heating.

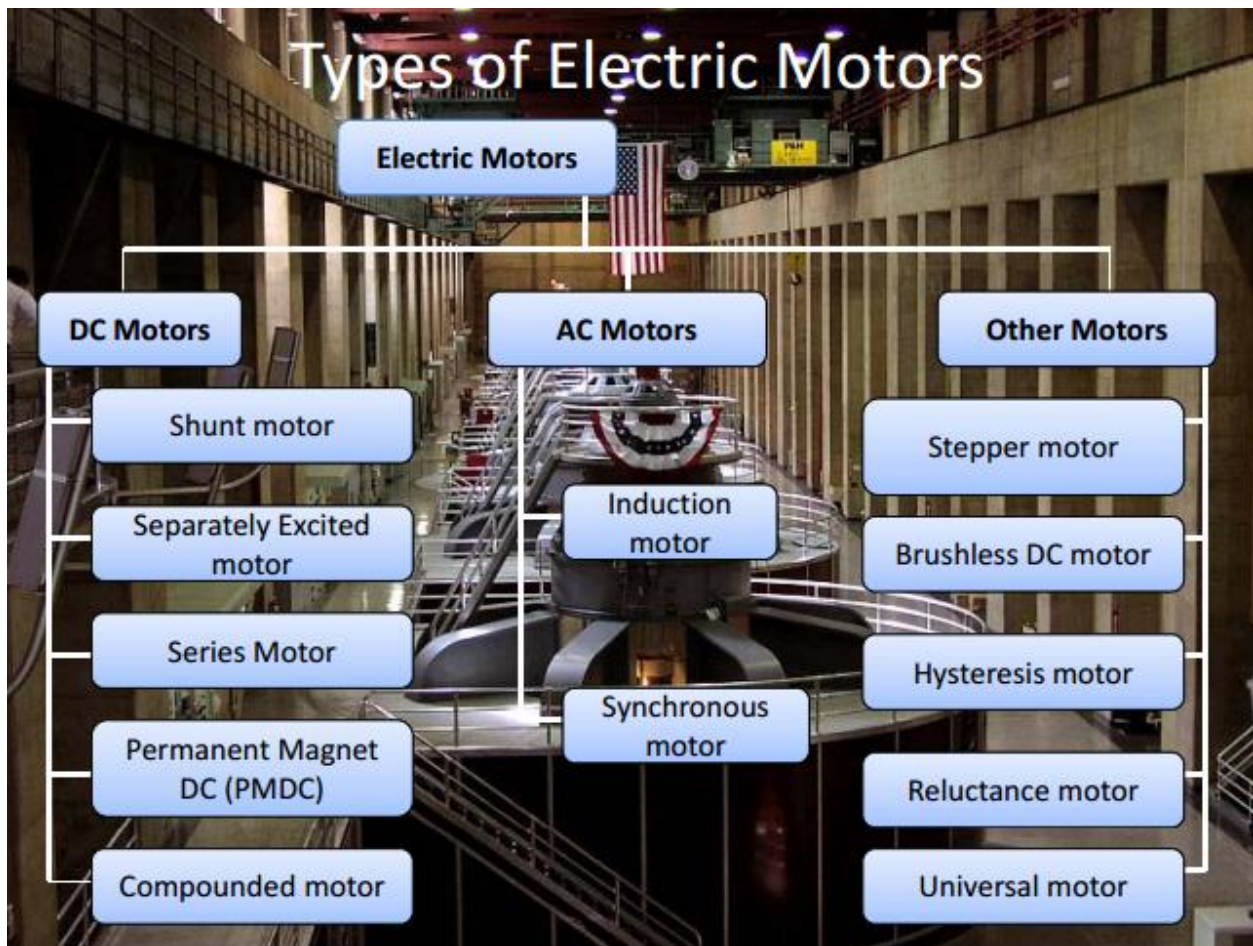
2. Commercial Load: – Commercial load mainly consist of lightning of shops, offices, advertisements, etc., Fans, Heating, Air conditioning and many other electrical appliances used in establishments such as market restaurants, etc. are considered as a commercial load.

3. Industrial Loads: – Industrial load consists of small-scale industries, medium scale industries, large scale industries, heavy industries and cottage industries. The induction motor forms a high proportion of the composite load. The industrial loads are the composite load. The composite load is a function of frequency and voltage and its form a major part of the system load.

EEL EMD22	Version:01	Page No.55
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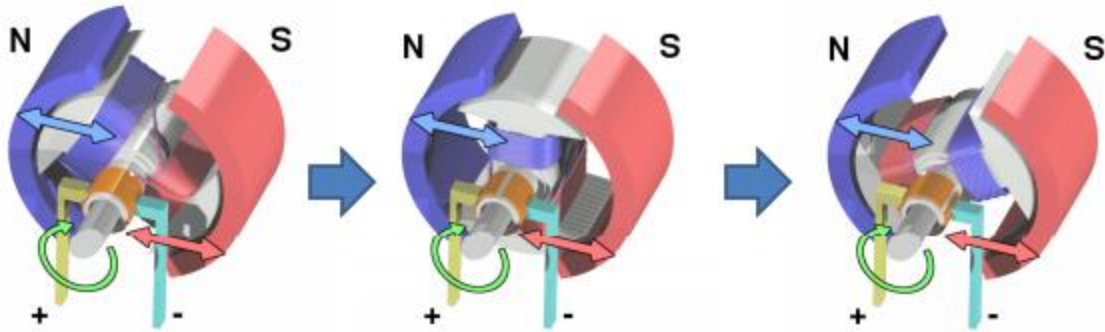
4. **Agriculture Loads:** – This type of load is mainly motor pumps-sets load for irrigation purposes. The load factor of this load is very small e.g. 0.15 – 0.20.

2. motor



DC Motors

1. **Shunt DC motor:** The rotor and stator windings are connected in parallel.
2. **Separately Excited motor:** The rotor and stator are each connected from a different power supply, this gives another degree of freedom for controlling the motor over the shunt.
3. **Series motor:** the stator and rotor windings are connected in series.
4. **Permanent Magnet (PMDC) motors:** The stator is a permanent magnet, so the motor is smaller in size
5. **Compounded motor:** the stator is connected to the rotor through a compound of shunt and series windings, if the shunt and series windings add up together, the motor is called cumulatively compounded.



AC Machines

- 1) **Induction Motor:** So called because voltage is induced in the rotor (thus no need for brushes), but for this to happen, the rotor must rotate at a lower speed than the magnetic field. Therefore, a new term is needed to describe the induction motor: the slip. motor: the slip.
- 2) **Synchronous Motor:** So called because rotor tries to line up with the rotating magnetic field in the stator. It has the stator of an induction motor, and the rotor of a dc motor

- **ELECTRIC MOTOR CONTROL**

Once the proper motor is selected, understanding the many various control devices available and their uses and limitations becomes an important part related to reliable operation and protection of the motor and the personnel using the motor.

- **Motor Control Topics**

There are four major motor control topics or categories to consider. Each of these has several subcategories and sometimes the subcategories overlap to some extent. Certain pieces of motor control equipment can accomplish multiple functions from each of the topics or categories.

- **The four categories include:**

- A. Starting the Motor**

- Disconnecting Means
 - Across the Line Starting
 - Reduced Voltage Starting

- B. Motor Protection**

- Overcurrent Protection
 - Overload Protection
 - Other Protection (voltage, phase, etc.)
 - Environment

- C. Stopping the Motor**

- Coasting
 - Electrical Braking
 - Mechanical Braking



D. Motor Operational Control

- Speed Control
- Reversing
- Jogging
- Sequence Control

An understanding of each of these areas is necessary to effectively apply motor control principles and equipment to effectively operate and protect a motor.

- **MOTOR STARTING**

All motors must have a control device to start and stop the motor called a “motor controller”.

- **Motor Controller**

A motor controller is the actual device that energizes and de-energizes the circuit to the motor so that it can start and stop.

Motor controllers may include some or all of the following motor control functions:

- starting, stopping, over-current protection, overload protection, reversing, speed changing, jogging, plugging, sequence control, and pilot light indication.
- Controllers range from simple to complex and can provide control for one motor, groups of motors, or auxiliary equipment such as brakes, clutches, solenoids, heaters, or other signals.

- **Motor Starter**

The starting mechanism that energizes the circuit to an induction motor is called the “starter” and must supply the motor with sufficient current to provide adequate starting torque under worst case line voltage and load conditions when the motor is energized.

There are several different types of equipment suitable for use as “motor starters” but only two types of starting methods for induction motors:

- cross the Line Starting
- Reduced Voltage Starting

- **Across the Line Starting of Motors**

Across the Line starting connects the motor windings/terminals directly to the circuit voltage “across the line” for a “full voltage start”.

- This is the simplest method of starting a
- motor. (And usually the least expensive). Motors connected across the line are capable of drawing full in-rush current and developing maximum starting torque to accelerate the load to speed in the shortest possible time.
- All NEMA induction motors up to 200 horsepower, and many larger ones, can withstand full voltage starts. (The electric distribution system or processing operation may not though, even if the motor will).

EEL EMD22	Version:01	Page No.58
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Fig 3.5. Across the Line Starting of Motors

- **Across the Line Starters**

There are two different types of common “across the line” starters including

- A. Manual Motor Starters
- B. Magnetic Motor Starters

- A. Manual Motor Starters**

A manual motor starter is package consisting of a horsepower rated switch with one set of contacts for each phase and corresponding thermal overload devices to provide motor overload protection.

- The main advantage of a manual motor starter is lower cost than a magnetic motor starter with equivalent motor protection but less motor control capability.
- Manual motor starters are often used for smaller motors - typically fractional horsepower motors but the National Electrical Code allows their use up to 10 Horsepower.
- Since the switch contacts remain closed if power is removed from the circuit without operating the switch, the motor restarts when power is reapplied which can be a safety concern.
- They do not allow the use of remote control or auxiliary control equipment like a magnetic starter does.

EEL EMD22	Version:01	Page No.59
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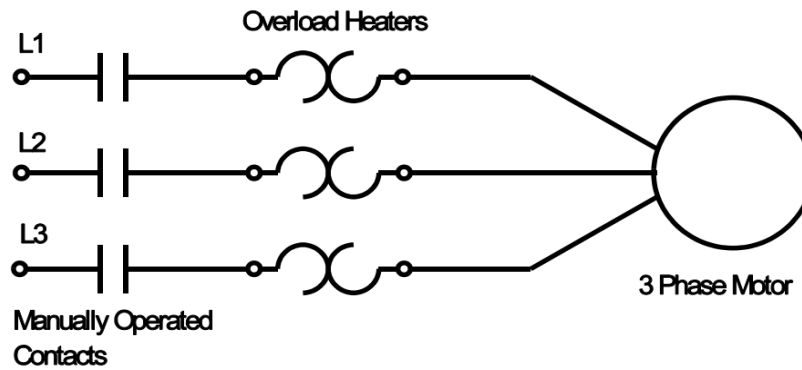


Fig 3.6. Manual Motor Starters

b. Magnetic Motor Starters

A magnetic motor starter is a package consisting of a contactor capable of opening and closing a set of contacts that energize and de-energize the circuit to the motor along with additional motor overload protection equipment.

Magnetic starters are used with larger motors (required above 10 horsepower) or where greater motor control is desired.

The main element of the magnetic motor starter is the contactor, a set of contacts operated by an electromagnetic coil.

- Energizing the coil causes the contacts (A) to close allowing large currents to be initiated and interrupted by a smaller voltage control signal.
- The control voltage need not be the same as the motor supply voltage and is often low voltage allowing start/stop controls to be located remotely from the power circuit.

EEL EMD22	Version:01	Page No.60
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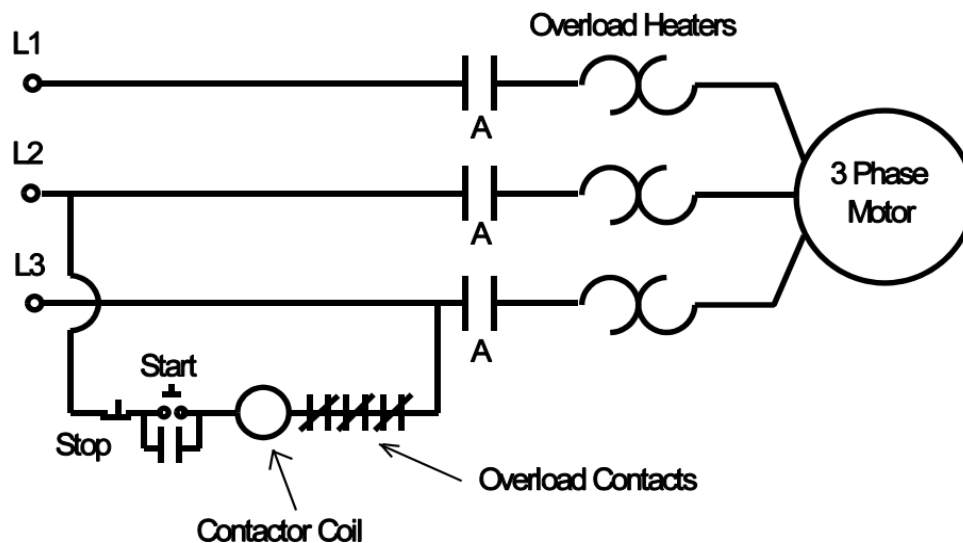


Fig 3.7. Magnetic Motor Starters

- Closing the Start button contact energizes the contactor coil. An auxiliary contact on the contactor is wired to seal in the coil circuit. The contactor de-energizes if the control circuit is interrupted, the Stop button is operated, or if power is lost.
- The overload contacts are arranged so an overload trip on any phase will cause the contactor to open and de-energize all phases.

Reduced Voltage Starting of Motors

Reduced Voltage Starting connects the motor windings/terminals at lower than normal line voltage during the initial starting period to reduce the inrush current when the motor starts.

- Reduced voltage starting may be required when
 - ✓ The current in-rush from the motor starting adversely affects the voltage drop on the electrical system.
 - ✓ needed to reduce the mechanical “starting shock” on drive-lines and equipment when the motor starts.
- Reducing the voltage reduces the current in-rush to the motor and also reduces the starting torque available when the motor starts.
- All NEMA induction motors can will accept reduced voltage starting however it may not provide enough starting torque in some situations to drive certain specific loads.

If the driven load or the power distribution system cannot accept a full voltage start, some type of reduced voltage or "soft" starting scheme must be used.

Typical reduced voltage starter types include:

A. Solid State (Electronic) Starters



- B. Primary Resistance Starters
- C. Autotransformer Starters
- D. Part Winding Starters
- E. Wye-Delta Starters

Reduced voltage starters can only be used where low starting torque is acceptable or a means exists to remove the load from the motor or application before it is stopped.

MOTOR PROTECTION

Motor protection safeguards the motor, the supply system and personnel from various operating conditions of the driven load, the supply system or the motor itself.

Motor protection categories include

- Overcurrent Protection
- Overload Protection
- Other Types of Protection.

The National Electrical Code requires that motors and their conductors be protected from both overcurrent and overload conditions.

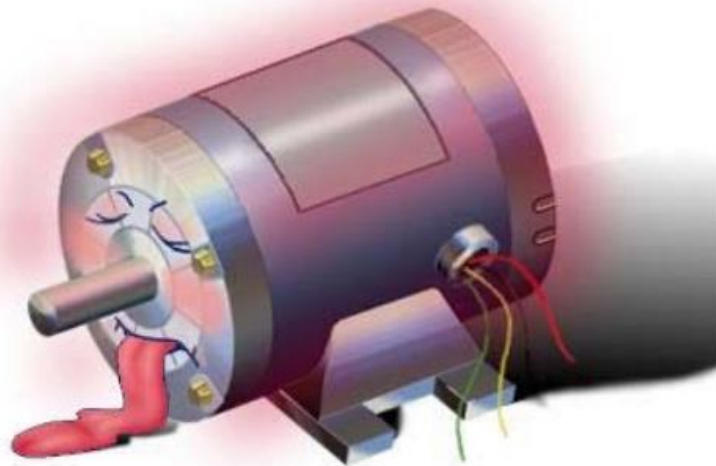


Fig 3.8. Motor protection

Overcurrent Protection

Overcurrent protection interrupts the electrical circuit to the motor upon excessive current demand on the supply system from either short circuits or ground faults.

EEL EMD22	Version:01	Page No.62
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- Overcurrent protection is required to protect personnel, the motor branch circuit conductors, control equipment, and motor from these high currents.
- Overcurrent protection is usually provided in the form of fuses or circuit breakers. These devices operate when a short circuit, ground fault or an extremely heavy overload occurs.
- Most overcurrent sources produce extremely large currents very quickly.

Overload Protection

Overload protection is installed in the motor circuit and/or motor to protect the motor from damage from mechanical overload conditions when it is operating/running.

The effect of an overload is an excessive rise in temperature in the motor windings due to current higher than full load current.

3. Types of Power Modulators

In the electric drive system, the power modulators can be any one of the following:

1. Controlled rectifiers (AC to DC converters)
2. Inverters (DC to AC converters)
3. AC voltage controllers (AC to AC converters)
4. DC choppers (DC to DC converters)
5. Cycloconverters (frequency conversion)

4. Electrical Sources

Very low power drives are generally fed from single-phase sources. Rest of the drives are powered from a three-phase source. Low and medium power motors are fed from a 400 V supply. For higher ratings, motors may be rated at 3.3 kV, 6.6 kV, and 11 kV. Some drives are powered from the battery.

5. Control Unit

Control unit for a power modulator is provided in the control unit. It matches the motor and power converter to meet the load requirements.

6. Sensing Unit

- A. **Speed sensing:** Speed can be sensed by using a tachometer. Wind speed can be sensed by anemometer similarly both speed and velocity can be measured by the speedometer.
- B. **Torque sensing:** Magneto elastic torque sensor is used in-vehicles applications on race cars, automobile, and aircraft.
- C. **Position sensing:** Motion can be sensed through GPS, vibrometer, and rotary encoder.
- D. **Current sensing and Voltage sensing from** lines or from motor terminals.
- E. **Temperature sensing:** Thermistor is a device which is used for temperature measurement.

EEL EMD22	Version:01	Page No.63
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CLASSIFICATION OF ELECTRICAL DRIVES

There are two types of electrical drives

- DC Drive: It is further classified into two types:
 - ✓ **Non-regenerative DC drives:** Non-regenerative DC drives are the most conventional type. In their most basic form, they are able to control motor speed and torque in one direction.
 - ✓ **Regenerative DC drives:** Regenerative adjustable speed drives, also known as four-quadrant drives, are capable of controlling not only the speed and direction of motor rotation but also the direction of motor torque.

APPLICATIONS OF ELECTRICAL DRIVES

Electric drives are used in boats,

1. traction systems,
2. lifts, cranes, electric car, etc.
3. They have flexible control characteristics. The steady state and dynamic characteristics of electric drives can be shaped to satisfy the load requirements.
4. They are available in wide range of torque, speed, and power.
5. They can be started instantly and can immediately be fully loaded.
6. They can operate in all the four quadrants of the speed-torque plane.
7. They are adaptable to almost any operating conditions such as explosive and radioactive environments.

Advantages of Electric Drives

- Cost is too low as compared to another system of the drive.
- The system is more simple and clean.
- The control is very easy and smooth.
- Flexible in the layout.
- Facility for remote control.
- Transmission of power from one place to other can be done with the help of cables instead of long shafts, etc.
- Its maintenance cost is quite low.
- It can be started at any time without delay.

Electrical devices

There are two types of electrical device

1. **Analogue devices** (Actuators, Servo and stepper motors, Frequency drives, Transducer, Transmitters & Buzzer)
2. **Digital device** (indicating lamps, Limit switch, Photo sensors, proximity sensors, Directional solenoid valves & Pneumatics / electro-pneumatics)

Analogue devices (Actuators, Servo and stepper motors, Frequency drives, Transducer, Transmitters & Buzzer)

EEL EMD22	Version:01	Page No.64
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Industrial servomotor

A servomotor is a rotary actuator or linear actuator that allows for precise control of angular or linear position, velocity and acceleration. It consists of a suitable motor coupled to a sensor for position feedback. It also requires a relatively sophisticated controller, often a dedicated module designed specifically for use with servomotors. Servo motors are not a specific class of motor although the term servomotor is often used to refer to a motor suitable for use in a closed-loop control system. Servomotors are used in applications such as robotics, CNC machinery or automated manufacturing.

Mechanism: - As the name suggests, a servomotor is a servomechanism. More specifically, it is a closed-loop servomechanism that uses position feedback to control its motion and final position. The input to its control is some signal, either analogue or digital, representing the position commanded for the output shaft.

The motor is paired with some type of encoder to provide position and speed feedback. In the simplest case, only the position is measured. The measured position of the output is compared to the command position, the external input to the controller. If the output position differs from that required, an error signal is generated which then causes the motor to rotate in either direction, as needed to bring the output shaft to the appropriate position. As the positions approach, the error signal reduces to zero and the motor stops.

The very simplest servomotors use position-only sensing via a potentiometer and bang-bang control of their motor; the motor always rotates at full speed (or is stopped). This type of servomotor is not widely used in industrial motion control, but it forms the basis of the simple and cheap servos used for radio-controlled models.

More sophisticated servomotors measure both the position and also the speed of the output shaft. They may also control the speed of their motor, rather than always running at full speed. Both of these enhancements, usually in combination with a PID control algorithm, allow the servomotor to be brought to its commanded position more quickly and more precisely, with less overshooting

TRANSDUCERS

Transducer is a device that converts one form of energy to another. Usually a transducer converts a signal in one form of energy to a signal in another. Transducers are often employed at the boundaries of automation, measurement, and control systems, where electrical signals are converted to and from other physical quantities (energy, force, torque, light, motion, position, etc.).

Types of Transducers

- Active Transducers
- Passive Transducers
- Sensors

EEL EMD22	Version:01	Page No.65
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- Actuators

Active Transducers: - Active transducers convert energy directly from one form to another. They require no external power source to operate. For example, a thermocouple converts a temperature differential directly into an (resistance which can be measured by the amount of electrical voltage which it passed thru) electrical voltage.

Passive Transducers: -Passive transducers produce a change in some passive electrical quantity, such as capacitance, resistance, or inductance, as a result of stimulation. These usually require additional electrical energy for excitation.

Sensors: - A sensor is a transducer whose purpose is to sense (i.e. detect) some characteristic of its environs; it is used to detect a parameter in one form of energy and report it in another, often an electrical signal. For example, a pressure sensor might detect pressure (a mechanical form of energy) and convert it to electrical signal for display at a remote gauge. Transducers are widely used in measuring instruments.

Photoelectric Sensor

Light sensors have been used for almost a century. Originally photocells were used for applications such as reading audio tracks on motion pictures. But modern optical sensors are much more sophisticated.

Optical sensors require both a light source (emitter) and detector. Emitters will produce light beams in the visible and invisible spectrums using LEDs and laser diodes. Detectors are typically built with photodiodes or phototransistors. The emitter and detector are positioned so that an object will block or reflect a beam when present. A basic optical sensor is shown in

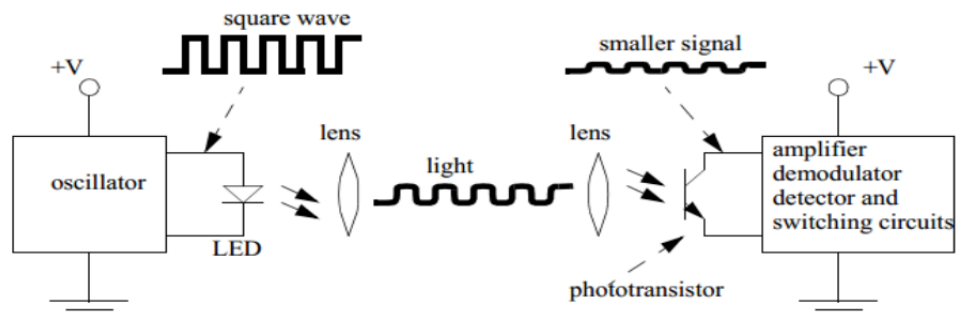


Fig 3.9. Photoelectric Sensor

Actuators: -An actuator is a type of motor that is responsible for moving or controlling a mechanism or system. It is operated by a source of energy, typically electric current, hydraulic fluid pressure, or pneumatic pressure, and converts that energy into motion. An actuator is the mechanism by which a control system acts upon an environment. The

control system can be simple (a fixed mechanical or electronic system), software-based (e.g. a printer driver, robot control system), a human, or any other input.

Transmitter

The transmitter itself generates a radio frequency alternating current, which is applied to the antenna. When excited by this alternating current, the antenna radiates radio waves. In addition to their use in broadcasting, transmitters are necessary component parts of many electronic devices that communicate by radio, such as cell phones, wireless computer networks, Bluetooth enabled devices, garage door openers, two-way radios in aircraft, ships, spacecraft, radar sets and navigational beacons. The term transmitter is usually limited to equipment that generates radio waves for communication purposes; or radiolocation, such as radar and navigational transmitters. Generators of radio waves for heating or industrial purposes, such as microwave ovens or diathermy equipment, are not usually called transmitters even though they often have similar circuits. An unrelated use of the term is in industrial process control, where a "transmitter" is a telemetry device which converts measurements from a sensor into a signal, and sends it, usually via wires, to be received by some display or control device located a distance away.

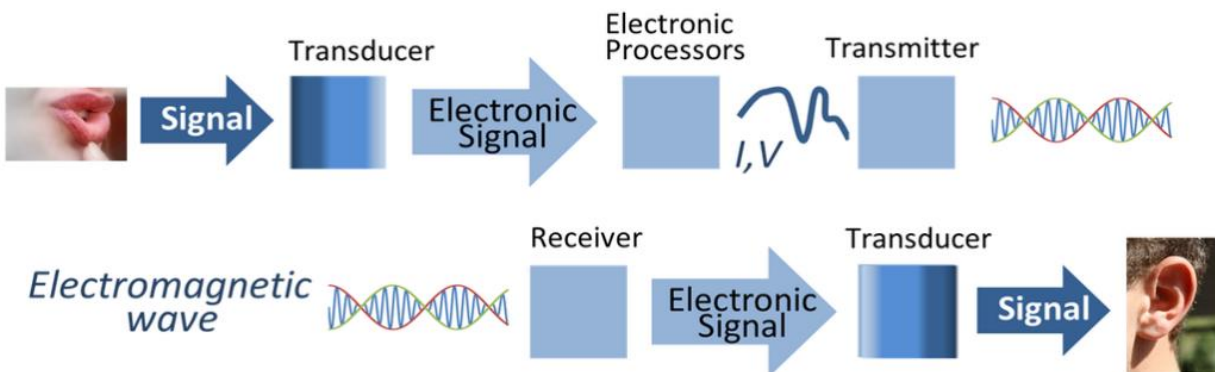


Fig 3.10. Transmitter

Buzzer: - A buzzer is a mechanical, electromechanical, magnetic, electromagnetic, electro-acoustic or piezoelectric audio signaling device. A piezo electric buzzer can be driven by an oscillating electronic circuit or other audio signal source. A click, beep or ring can indicate that a button has been pressed. Types of Buzzers There are several different kinds of buzzers. At Future Electronics we stock many of the most common types categorized by Type, Sound Level, Frequency, Rated Voltage, Dimension and Packaging Type. The parametric filters on our website can help refine your search results depending on the required specifications. Buzzers from Future Electronics Future Electronics has a complete selection of buzzers from several manufacturers that can be used as an electromagnetic buzzer, piezo buzzer, electro-acoustic transducer, piezo electric transducers or magnetic buzzer for any electric circuit applications. Simply choose from the buzzer technical attributes below and your search results will quickly



be narrowed in order to match your specific buzzer application needs. Applications for Buzzers/Typical uses of buzzers include:-

- Alarm devices
- Timers
- Confirmation of user input (ex: mouse click or keystroke)
- Electronic metronomes
- Annunciator panels
- Game shows
- Sporting events
- Household appliances

Analog actuators

Functioning and design of analog actuators AG01 and AG02 positioning drives in detail

With the Drive Line AG01 and AG02 analog actuator / spindle drive, potentiometer sensors are used as sensors for recording angle change or rotation direction and in conjunction with mechanical units such as spindles, synchronous belts or gear racks for recording linear movements. Areas of application of analog actuators. In an industrial environment, Drive Line drives/ actuators with an analog output are often used for automated format adjustment, stops, tools and valves or fittings as well as for many other comparable positioning tasks, in general and special machine construction, in assembly technology, handling technology, robot technology and on or in trade fair equipment and testing equipment as well as in process automation.

2. **Digital device** (indicating lamps, Limit switch, Photo sensors, proximity sensors, Directional solenoid valves & Pneumatics / electro-pneumatics)

Indicating lamps: - Digital Light Processing (DLP) is a display device based on optical micro-electro-mechanical technology that uses a digital micro mirror device. DLP is used in a variety of display applications from traditional static displays to interactive displays and also non-traditional embedded applications including medical, security, and industrial uses.

LED Indicator Lamps RS Components guarantees that when our business customers order online with us, they are purchasing products of the highest quality, and of safety-approved standards. Our customer service is something we've built our reputation on. Our entire range of LED Indicator Lamps spares and other LED Lamps and Lighting items are the best-stocked in the business, and with a delivery service that is highly efficient we can guarantee that your LED Indicator Lamps products get to you when you need them. Aside from LED Indicator Lamps, you can order further products from our Electrical, Automation & Cables range. RS Components' range of Electrical, Automation & Cables products includes Cables & Wires and Control Gear, all available for quick and efficient delivery. Finally, for any queries or concerns about your product there is support offered from a technical team available to you online and on the phone.

EEL EMD22	Version:01	Page No.68
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Limit Switches: - Limit Switch are basic switches that have been encased to protect them from external forces, water, oil, and dirt. Many models are available, such as those resistant to heat, cold, or corrosion, as well as high-precision models. Limit switch is a switch operated by the motion of a machine part or presence of an object. They are used for controlling machinery as part of a control system, as a safety interlocks, or to count objects passing a point. A limit switch is an electromechanical device that consists of an actuator mechanically linked to a set of contacts. When an object comes into contact with the actuator, the device operates the contacts to make or break an electrical connection. Limit switches are used in a variety of applications and environments because of their ruggedness, ease of installation, and reliability of operation. They can determine the presence or absence, passing, positioning, and end of travel of an object. They were first used to define the limit of travel of an object; hence the name "Limit Switch".



Fig 3.11. Limit Switches

Magnetic Contactor/Switches

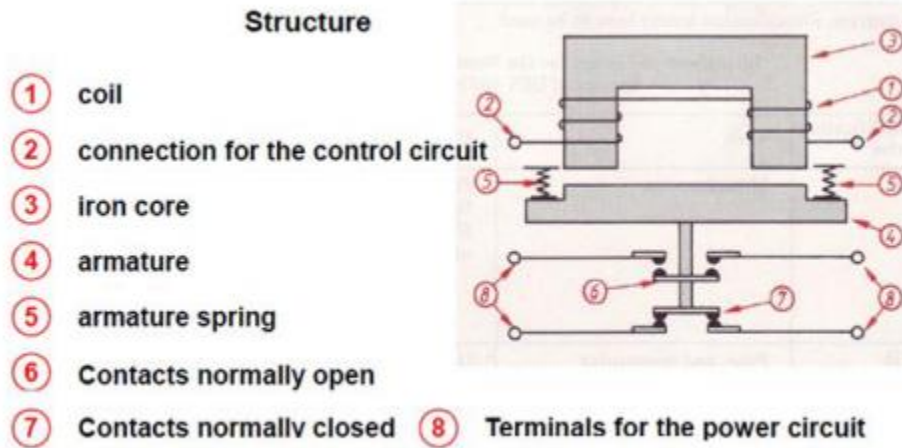
Configuration: - Composite magnetic switch (abbreviated as MS) is comprised of a contractor for switching on and off current and a thermal overload relay for protecting the load.

Functions

- A. Switching the control system for electric power transmission and distribution.
- B. Operation of the start and stop of motors.
- C. Electric power control for all kinds of industrial machinery, machine tools, injection molding machines.

EEL EMD22	Version:01	Page No.69
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Contactors may have different arrangements of contacts. One has to differentiate between primary contacts (main contacts) and secondary contacts (auxiliary / control contacts).as shown in the fig.2.1.



If the coil ① is energized via the terminals ② of the control circuit , a magnetic field is generated in the core ③ . The armature ④ kept back by springs ⑤ will be attracted by the core ③ . The attraction of the armature operates the set of contacts ⑥ ⑦ (open or close). By operation of the contacts the operated circuit ⑧ will be opened or closed.

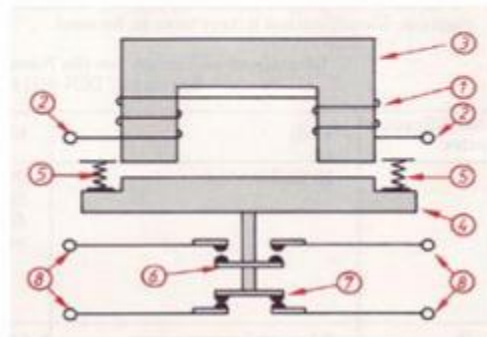


Fig 3.12. Magnetic Contactor/Switches

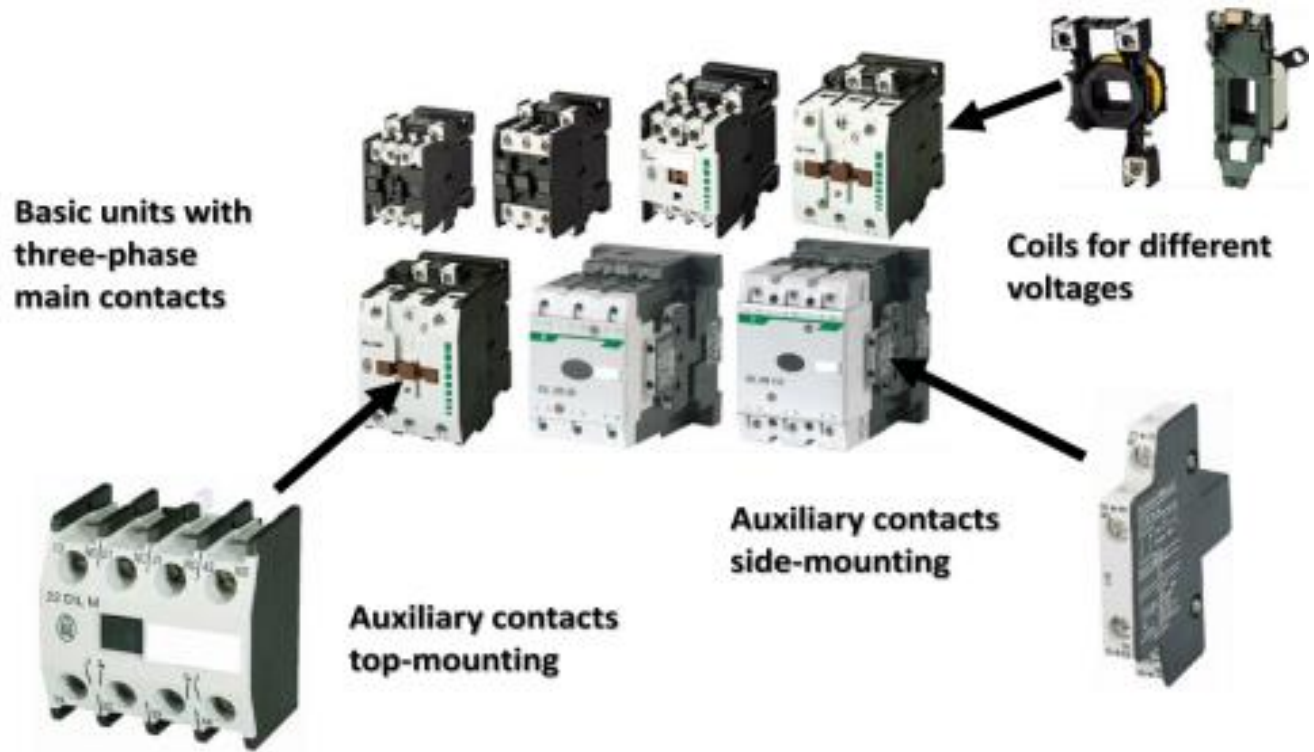


Fig 3.13. Magnetic Contactor/Switches

proximity sensor: - is a sensor able to detect the presence of nearby objects without any physical contact. A proximity sensor often emits an electromagnetic field or a beam of electromagnetic radiation (infrared, for instance), and looks for changes in the field or return signal. The object being sensed is often referred to as the proximity sensor's target. Different proximity sensor targets demand different sensors. For example, a capacitive or photoelectric sensor might be suitable for a plastic target; an inductive proximity sensor always requires a metal target. The maximum distance that this sensor can detect is defined "nominal range". Some sensors have adjustments of the nominal range or means to report a graduated detection distance. Proximity sensors can have a high reliability and long functional life because of the absence of mechanical parts and lack of physical contact between sensor and the sensed object.

The Actuator

The actuator is the business end of a pneumatics system. All of the parts listed above are to make the actuator move, and move with authority. Pneumatic execution components provide rectilinear or rotary movement. Examples of pneumatic execution components include cylinder pistons, pneumatic motors, etc. Rectilinear motion is produced by cylinder pistons, while pneumatic motors provide continuous rotations.

Single acting cylinder

EEL EMD22	Version:01	Page No.71
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Directional control valves ensure the flow of air between air ports by opening, closing and Switching their internal connections. It controls start, stop, and directional of air flow so that the cylinder's movement can be controlled. It also used to tart or stop, forward or reduce stroke, clockwise or anti-clockwise rotation of an air motor.

Their classification is determined by the number of ports, the number of switching positions, the normal position of the valve and its method of operation. Common types of directional control valves include 2/2, 3/2, 4/2, 5/2, etc. The first number represents the number of ports; the second number represents the number of positions. For example, look at the following representation:



3/2 valve

The number of ports/connections (3) the number of direction/position (2)

2/2 Directional control valve (shut-off valve)

The structure of a 2/2 directional control valve is very simple. It uses the thrust from the spring to open and close the valve, stopping compressed air from flowing towards working tube „A“ from air inlet „P“. When a force is applied to the control axis, the valve will be pushed open, connecting „P“ with „A“ (Fig. 3.16). The force applied to the control axis has to overcome both air pressure and the repulsive force of the spring. The control valve can be driven manually or mechanically, and restored to its original position by the spring.

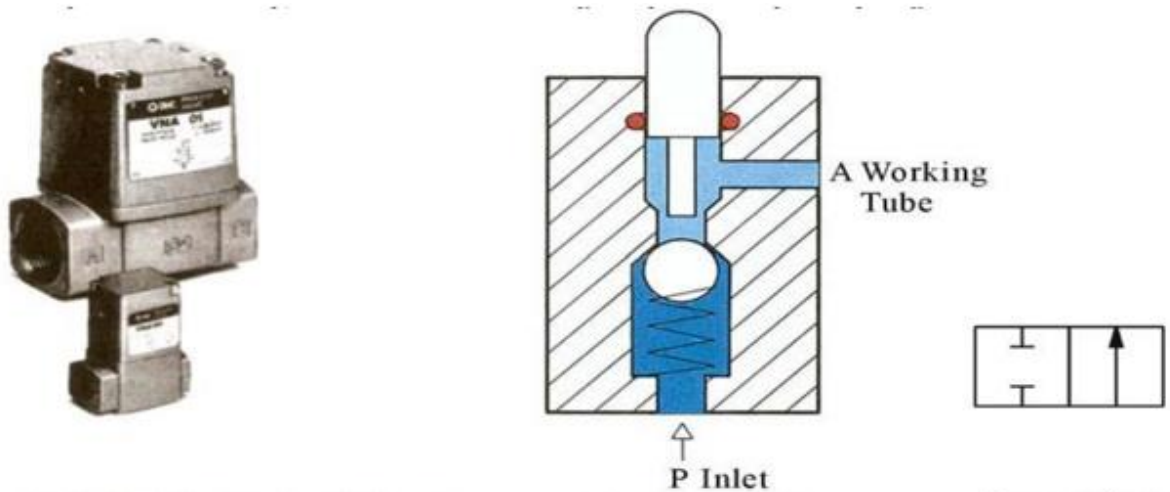


Fig 3. 16. 2/2 Directional control valve (shut-off valve)

3/2 Directional control valve

A 3/2 directional control valve can be used to control a single acting cylinder (Fig. 3.17). In idle position the 3/2-way directional control valve with normally open position opens from P to A and shuts off exhaust valve R. (Fig.3.17 a). When the push rod is pressed the sealing disc shuts off flow of air from P to A. The second sealing disc is pushed off its seat by the shoulders of the push rod. An exhaust to R. It is used for control of single acting clamping cylinders (NO -function).

The normally closed directional control valve is shown at Fig.3.17 b. The spring loaded ball shuts off the flow of compressed air from P to A. Working line A is connected with the atmosphere through port R in the pusher rod. When the pusher rod is actuated, the ball first shuts off the exhaust port and then it is lifted off its seat.

In the reverse direction the ball first shuts off the pressure line P before the exhaust port in the pusher rod is opened to allow ventilation from A to R, i.e. ventilation of the valve does not overlap.

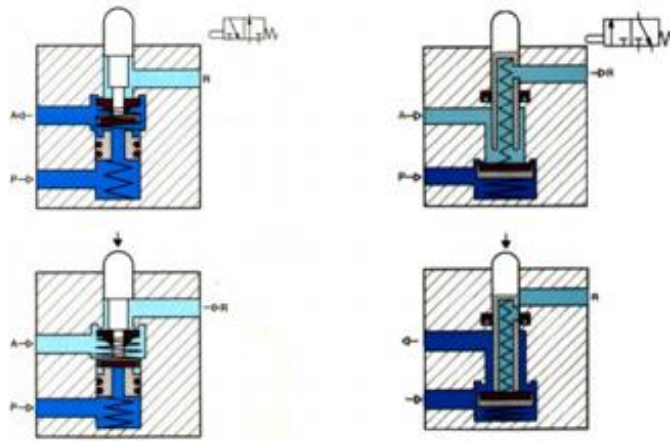


Fig 3.17. 3/2 Directional control valve

5/2 Directional control valve

When a pressure pulse is input into the pressure control port „P” (Fig.3.18), the spool will move to the left, connecting inlet „P” and work passage „B”. Work passage „A” will then make a release of air through „R1” and „R2”. The directional valves will remain in this operational position until signals of the contrary are received. Therefore, this type of directional control valves is said to have the function of „memory”.

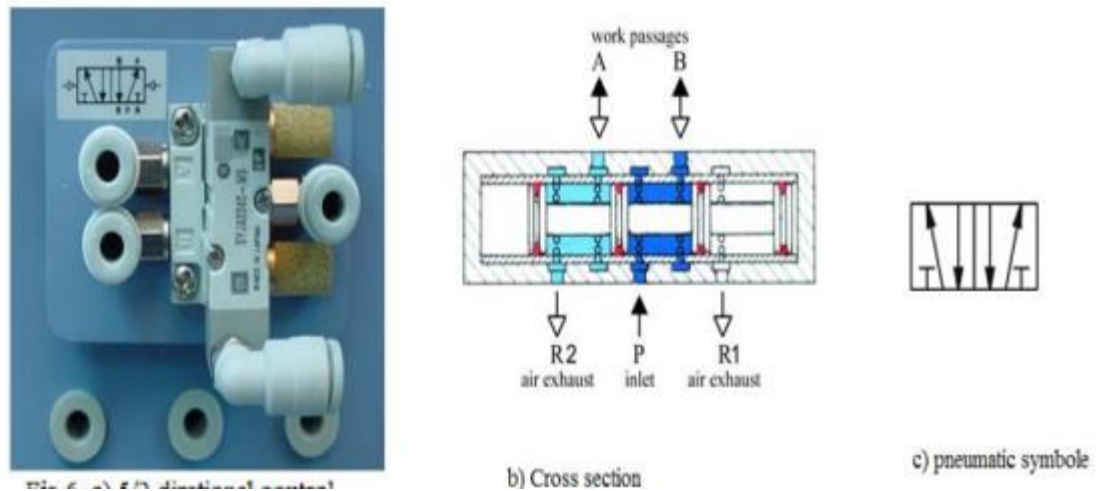


Fig 3.18. 5/2 Directional control valve

A. Control valve

A control valve is a valve that controls the flow of air. Examples include non-return valves, flow control valves, shuttle valves, etc.

Non-return (check, poppet) valve

A non-return valve allows air to flow in one direction only. When air flows in the opposite direction, the valve will close. Another name for non-return valve is poppet valve and also called check valve (Fig.3.19).

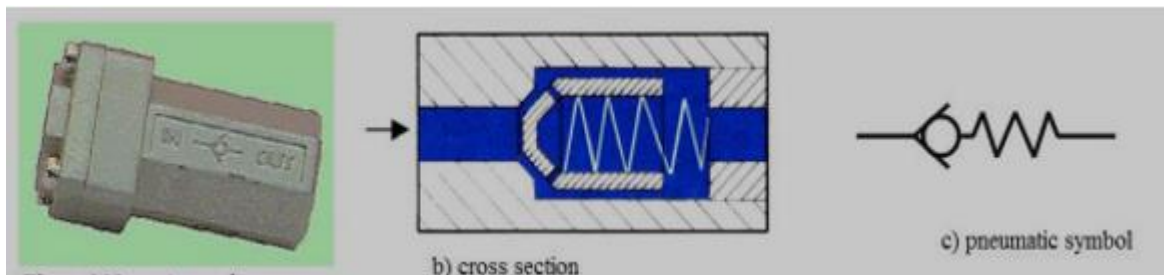


Fig 3.19. Non-return (check, poppet) valve

Flow control (throttle relief) valve

A flow control valve is formed by a non-return valve and a variable throttle (Fig. 3.20).

- Designed to control the flow of air in the system.
- air flow is throttled in one direction only
- check valve blocks the flow in one direction and the air can only pass through the restricted passage

- check valve allow the reversed air to bypass the restricted passage
- used for speed regulation

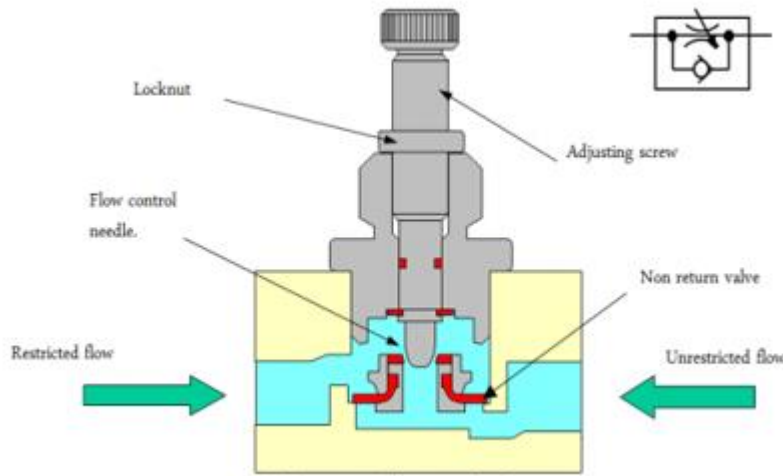


Fig 3.20. Flow control (throttle relief) valve

- Controlling the speed of actuators is achieved by controlling the flow of air to or from the actuators. NOT BY ADJUSTING THE PRESSURE

Shuttle valve

Shuttle valves are also known as double control or single control non-return valves. A shuttle valve has two air inlets „P1” and „P2” and one air outlet „A”. When compressed air enters through „P1”, the sphere will seal and block the other inlet „P2”. Air can then flow from „P1” to „A”. When the contrary happens, the sphere will block inlet „P1”, allowing air to flow from „P2” to „A” only (Fig.3.21).

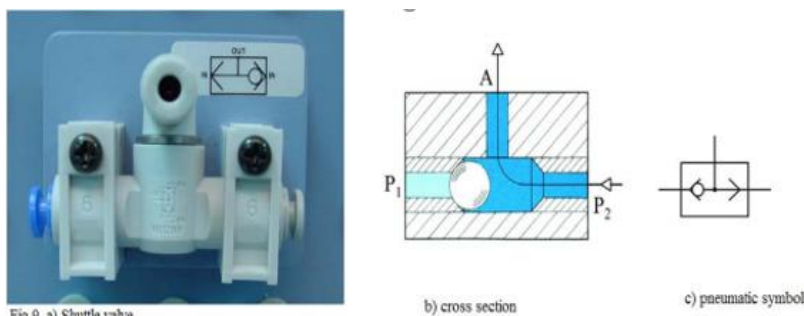


Fig 3.21. Shuttle valve

Digital Frequency Meter

Digital frequency meter is a general purpose instrument that displays the frequency of a periodic electrical signal to an accuracy of three decimal places. It counts the number events occurring within the oscillations during a given interval of time. As the preset period gets completed, the value in the counter display on the screen and the counter reset to zero.



Various types of instruments are available which operates at a fixed or variable frequency. But if we operate any frequency meter at different frequencies than the specified range, it could carry out abnormally. For measuring low frequencies, we usually use deflection type meters. The deflection of the pointer on the scale shows the change in frequency. The deflection type instruments are of two types: one is electrically resonant circuits, and other is ratio meter.

ACTUATOR

Electrically actuated systems are very widely used in control systems because they are easy to interface with the control systems which are also electric and because electricity is easily available unlike fluid power which require pumps and compressors.

The advantages of electric systems are

- Electricity is easily routed to the actuators; cables are simpler than pipe work.
- Electricity is easily controlled by electronic units
- Electricity is clean.
- Electrical faults are often easier to diagnose

The disadvantages of electric actuators are

Electrical equipment is more of a fire hazard than other systems unless made intrinsically safe, in which case it becomes expensive. Electric actuators have a poor torque –speed characteristic at low speed. Electric actuators are all basically rotary motion and complicated mechanisms are needed to convert rotation into other forms of motion. The power to weight ratio is inferior to hydraulic motors.

EEL EMD22	Version:01	Page No.77
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6. _____ Transducer is a device that converts one form of energy to another. Usually a _____ transducer converts a signal in one form of energy to a signal in another

A. Active Transducers B. Passive Transducers C. Transmitter D. Transducer

PART II

Matching column, **A** with column **B**

	A	B
	1. Shuttle valve 2. Control valve 3. Non-return valve 4. Flow control valve 5. Directional control valves	A. air to flow in one direction only. B. is formed by a non-return valve and a variable throttle C. the flow of air between air ports by opening, closing and switching their internal connections. D. valve that controls the flow of air E. displays the frequency of a periodic electrical F. double control or single control non-return valves G moving or controlling a mechanism or system



Note: Satisfactory rating - 3 points

Unsatisfactory - below 3 points

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

Information Sheet-4	Responding unplanned events or conditions
----------------------------	--

4.1. Introduction

In this section, the potential accidents, malfunctions, and unplanned events that could occur during any phase of the Project are described and assessed. The focus is specifically on credible accidents scenarios that have a reasonable possibility of occurrence, and for which the resulting environmental effects could be significant.

The general approach to assessing the potential environment effects of the selected accident, malfunction, or unplanned event scenarios involves:

- consideration of the potential event that could occur during the life of the Project;
- description of the Project planning and safeguards established to minimize the potential for such occurrences to happen;
- consideration of the contingency or emergency response procedures applicable to the event; and
- a determination of the significance of the potential residual environmental effects in the unlikely event that these accidents, malfunctions, or unplanned events do happen.

Example of unplanned event

A. Electrical Hazard: The live high voltage wires and cables over land pose a risk of injury or death to individuals or wildlife through electrocution, or damage to equipment if contacted directly or indirectly. With the currently proposed mitigation to protect the cables in the marine environment (i.e., insulated with a layer of cross-linked polyethylene), and the fact that the ocean setting would dissipate any electrical current if the cables were damaged, there is virtually no potential for electrocution within the marine environment.

B. Vehicle or Vessel Collision: A vehicle collision (e.g., vehicle-to-object collision, vehicle-to-electrical line, vehicle-to-vehicle collision, or vehicle-to-human or animal collision) associated with land-based Project activities also has the potential to result in injury or death, or equipment damage. A vessel collision (e.g., vessel grounding, vessel-to-vessel collision, or vessel-to-marine mammal collision) associated with Project activities in the marine environment has the potential to result in injury or death, or equipment damage.

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4.2. Electrical Hazard

The risk of an electrical hazard has the potential to interact with terrestrial environment and socioeconomic environment.

Live high voltage conductors pose the risk of injury or death to individuals or wildlife if contacted directly or indirectly. Mitigation measures to minimize the risk of electrical injuries to those in or proximate to a power transmission corridor are not generally a requirement for land-based transmission, given the height of conductors. Downed conductors can allow for the potential interaction of live electrical cables with personnel or wildlife in the area. Unauthorized access to secure locations can also put individuals at risk of electrocution. Avifauna can also interact with high voltage conductors by landing on and touching energized conductors and grounded hardware at the cable riser stations and can become electrocuted in certain circumstances.

4.2.2. Electrical Shock

Electric shock occurs when the body becomes part of an electrical circuit. Shocks can happen in three ways.

- A person may come in contact with both conductors in a circuit.
- A person may provide a path between an ungrounded conductor and the ground.
- A person may provide a path between the ground and a conducting material that is in contact with an ungrounded conductor.

The amount of the current depends on the potential difference and the resistance. The effects of low current on the human body range from a temporary mild tingling sensation to death. An electric shock can injure you in either or both of the following.

- A severe shock can stop the heart or the breathing muscles, or both.
- The heating effects of the current can cause severe burns, especially at points where the electricity enters and leaves the body.

4.2.2. Step Potential

During a ground fault, current flows through the grounding system to a ground rod or some type of system ground (steel structure, guy wire) seeking a return to its source. This current flow could possibly exist in, or along the surface of the ground for quite some distance around the point where the earth becomes energized.

The current will follow, as nearly as possible, the conductors supplying the fault current. Step potential is caused by the flow of fault current through the earth. The closer a person is to the ground rod or grounded device, the greater the concentration of current and the higher the voltage.

The current flow creates a voltage drop as it flows through the earth's surface and a person standing with their feet apart bridges a portion of this drop thus creating a parallel path for current flow as seen in these two illustrations in Figure 4.1.

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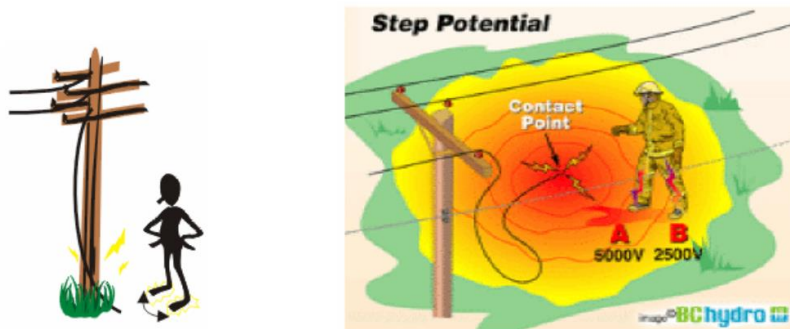


Fig 4.1 step potential

4.2.3. Touch Potential

Touch potential is a problem similar to step potential – see Figure 4.2 It involves a fault current flow in the earth establishing a potential difference between the earth contact point and some nearby conductive structure or hardware.

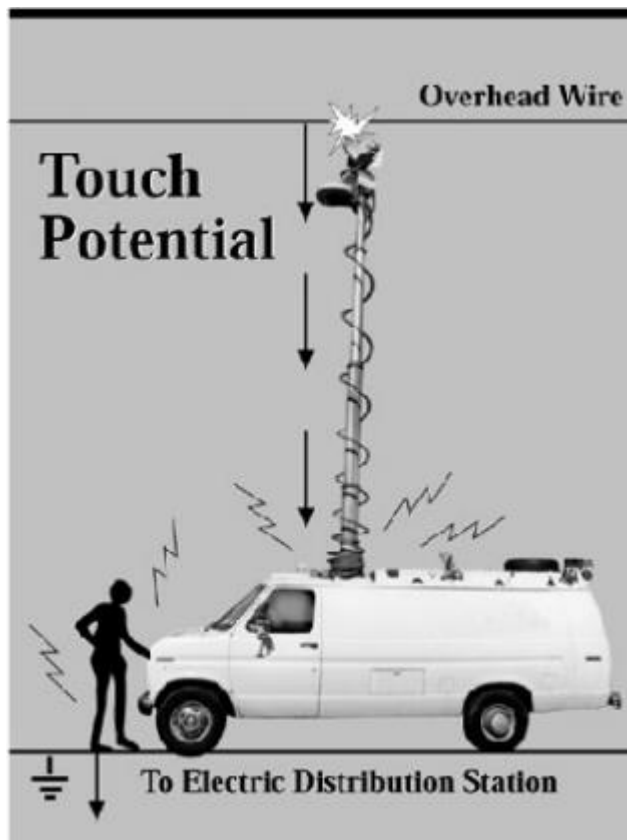


Fig 4.2. touch potential

Protection for step and touch potential is the use of switch operating platforms and ground grids. The worker must remain upon a local conductive mat as the highest voltage gradient has been moved to the mat's edges. Sub stations on Site have a ground grid located under the rocks, but if an individual is located outside this area and

while standing on the earth, touches a ground or a grounded object, a difference in potential may exist during a ground fault.

4.2.4. Heavy Equipment Operators

Contact with overhead power lines is a major cause of fatalities in the construction industry. As many as 100 workers are killed each year by inadvertent power line contacts, most of which occur through the use of high reaching material-handling equipment. A study of accidents involving power line contacts has indicated that the use of CRANE is the most common cause of fatalities as seen in Figure 4.3.

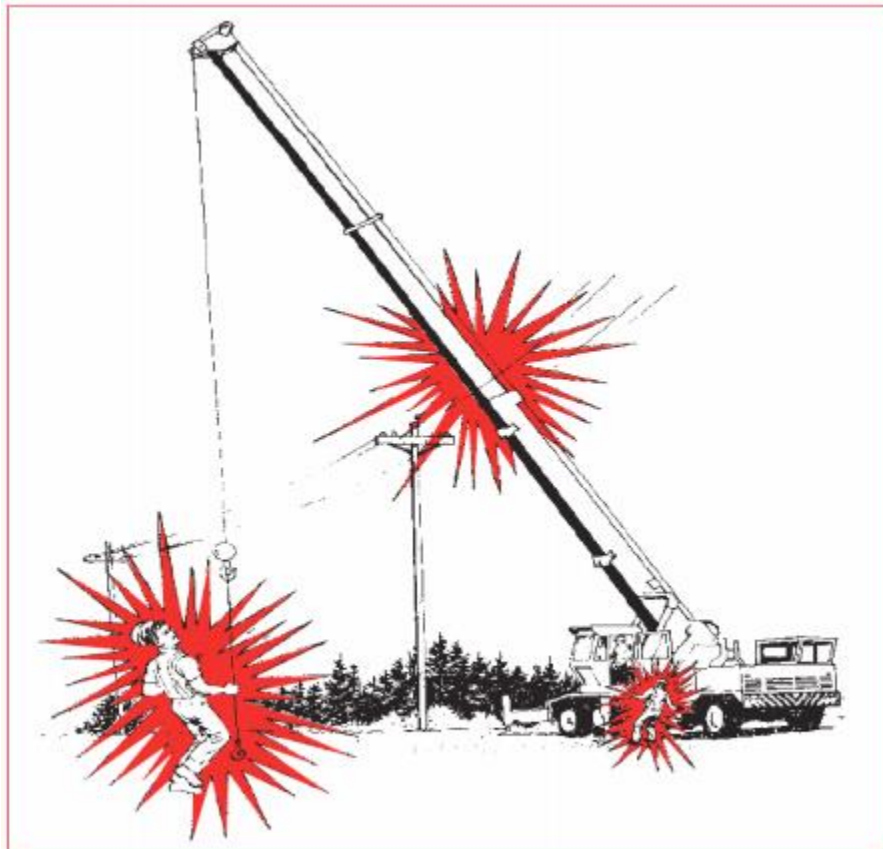


Fig 4.3. Heavy Equipment Operators

4.3. Risk Management and Mitigation

The following mitigation measures will be applied to reduce the probability of an electrical hazard and associated environmental effects.

- During the operation phase of the Project, Project components will be inspected periodically and repaired as required.
- Safe operating procedures will be established for all work activities, both during the construction and operation phases of the Project.
- NB Power's safety and environmental policies will be followed.

EEL EMD22	Version:01	Page No.83
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- Proper signage and public warning will be installed around project land-based components/facilities (e.g., “High Voltage”).
- Access to the work site during construction and energizing activities will be limited to NB Power and their consultants and required contractor crews.
- Physical safeguards such as security fences surrounding facilities will be implemented.
- Access to facilities will be restricted to authorized personnel only.
- The use of appropriate down lighting will be incorporated around Project components (e.g., cable riser stations) to discourage vandalism and loitering.

Self-check 4	Written test
---------------------	---------------------

Name: _____

Date: _____

Part I Directions: Answer all the questions listed below.

EEL EMD22	Version:01	Page No.84
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Choose the correct answer for each of the following questions.

1. _____ which of the following is not correct about electrical Shocks happen
 - A. a person may come in contact with both conductors in a circuit.
 - B. a person may provide a path between an ungrounded conductor and the ground.
 - C. a person may provide a path between the ground and a conducting material that is in contact with an ungrounded conductor
 - D. None of the above

2. _____ is a major cause of fatalities in the construction industry.
 - A. overhead power lines
 - B. Touch Potential
 - C. Electrical Shock
 - D. All of the above

Note: Satisfactory rating - 3 and 5 points
points

Unsatisfactory - below 3 and 5

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

Operation Sheet 1	Install electrical installation work
--------------------------	---

PURPOSE: - after performing this operation the trainees should be able to install electrical installation work

PROCEDURE;

1. Follow safety regulation

EEL EMD22	Version:01	Page No.85
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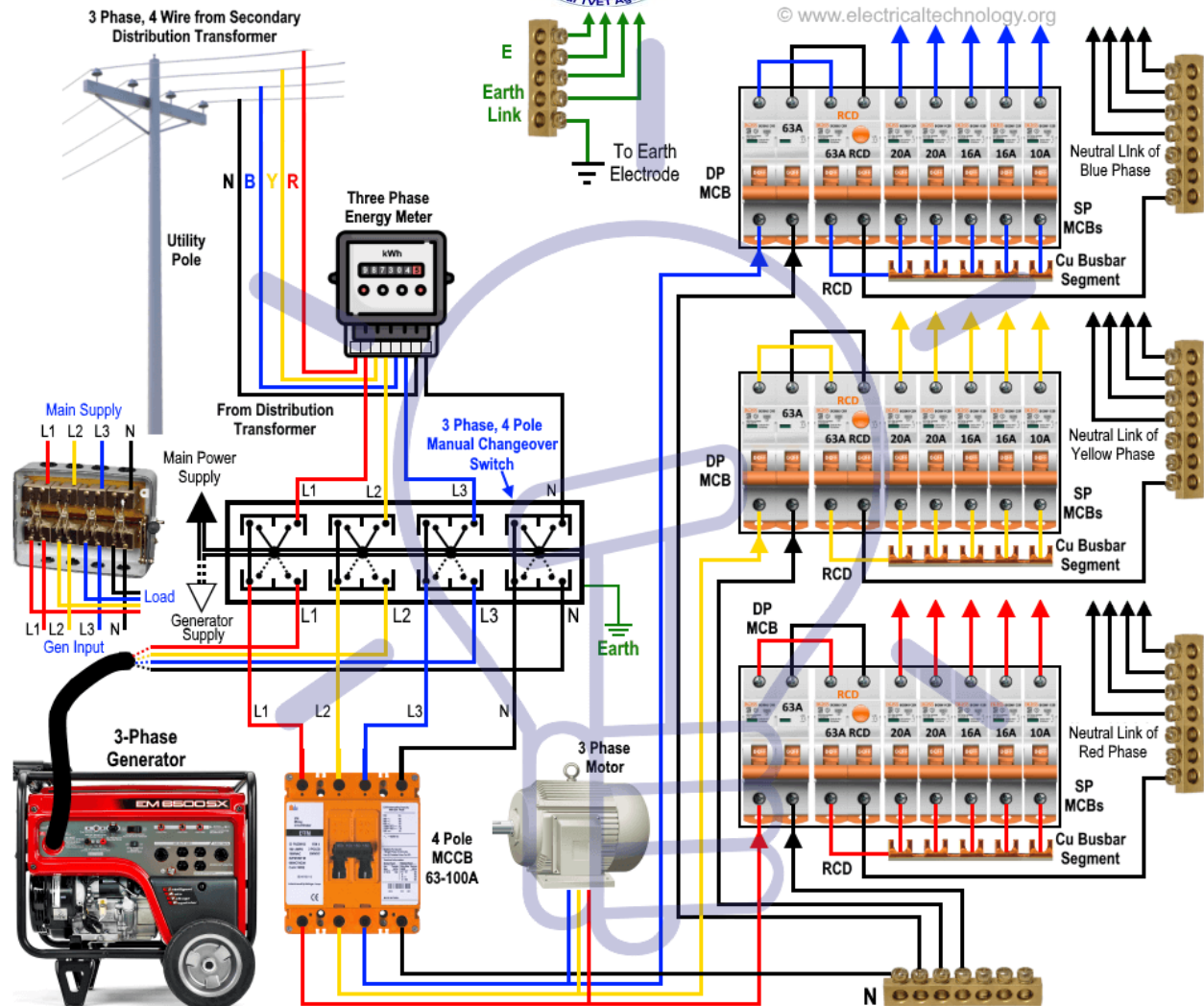


2. Use PPE
3. Read and interpret the wiring diagram
4. Select proper tool and instrument for the operation
5. Selection of material proper fuse ratings of all control circuits using drawings and schematic diagrams.
6. Check the functionality of materials also check burned-out fuses
7. Installing electrical installation work
8. Check all terminals for proper connections.
9. Check all enclosures for loose wires, tools and components.
10. Check all switches and push-buttons for completeness of movement, installation, adjustment, rating and labelling.
11. Check all wires terminated for being free of unintentional earth connections.
12. Check for proper sequence of connections as per schematic diagrams.
13. Check for proper earthing of enclosures and screen and drain wires in cables.
14. Check for proper sealing of conduit connections, cables.
15. Finally give the power to the system.

PRECAUTIONS: - Always use all the necessary safety equipment.

QUALITY CRITERIA: - the trainees should be able to perform Install electrical installation work

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How to Connect a 3-Phase Generator with Manual Changeover Switch to a Home

Operation Sheet 2	Install electrical machine and drive
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PURPOSE: - after performing this operation the trainees should be able Installing electrical wiring materials, equipment and accessories

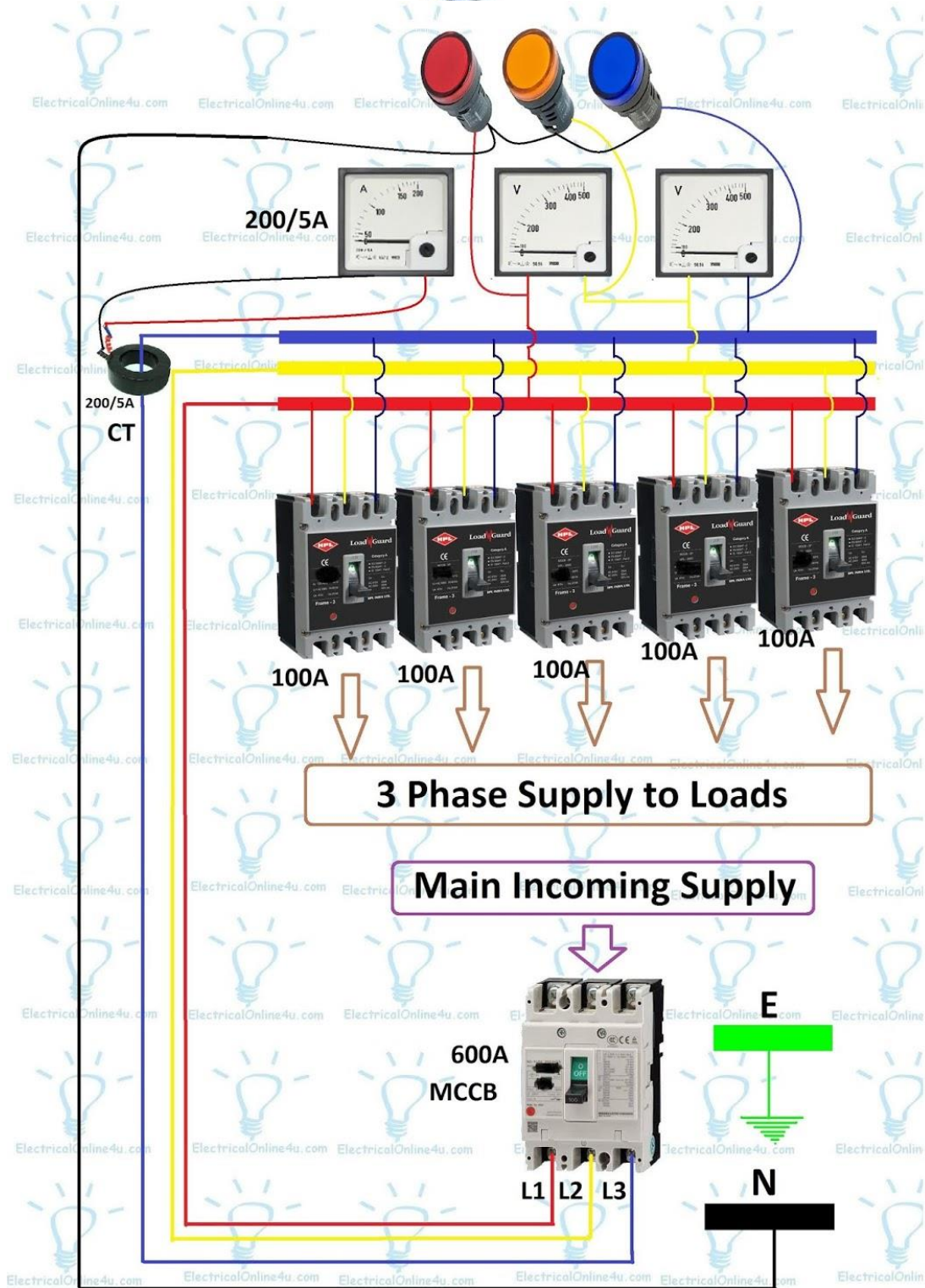
PROCEDURE;

1. Follow safety regulation
2. Use PPE
3. Read and interpret the wiring diagram
4. Select tools and instrument for this operation
5. Selection of material proper fuse ratings of all control circuits using drawings and schematic diagrams.
6. Check the functionality of materials also check burned-out fuses
7. Installing electrical installation work
8. Check all terminals for proper connections.
9. Check all enclosures for loose wires, tools and components.
10. Check all MCCB and the measuring instrument for completeness of movement, installation, adjustment, rating and labelling.
11. Check all wires terminated for being free of unintentional earth connections.
12. Check for proper sequence of connections as per schematic diagrams.
13. Check for proper earthing of enclosures and screen and drain wires in cables.
14. Check for proper sealing of conduit connections, cables.
15. Finally give the power to the system.

PRECAUTIONS: - A plays all the necessary safety equipment.

QUALITY CRITERIA: - the trainees should be able to perform Installing electrical wiring materials, equipment and accessories

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3 Phase Panel Board Wiring Diagram

Design By : Sikandar Haidar

Copyright : electricalonline4u.com



Operation Sheet 3

Install electrical machine and drive

PURPOSE: - after performing this operation the trainees should be able to work Installing electrical wiring materials, equipment and accessories

EQUIPMENT AND TOOLS: - Screw drivers, Pliers, wire strippers, multimeter.

MATERIALS: - wires, connector's. connector's, 3 pole MCCB, wooden board, 1 pole ckt, push button, timer, contactor, motor and overload relay.

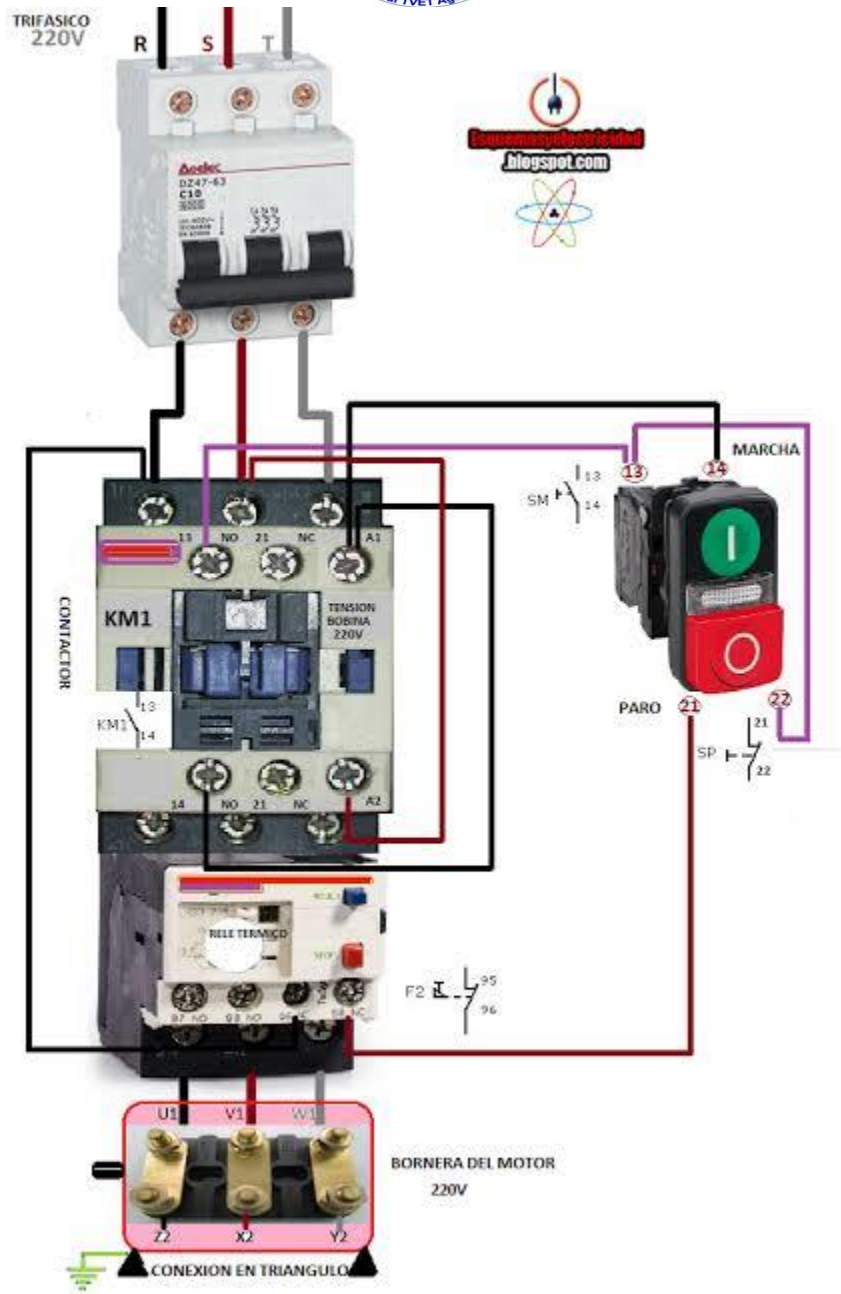
PROCEDURE;

1. Follow safety regulation
2. Use PPE
3. Read and interpret the wiring diagram
4. Selection of material proper fuse ratings of all control circuits using drawings and schematic diagrams.
5. Check the functionality of materials also check burned-out fuses
6. Installing electrical installation work
7. Check all terminals for proper connections.
8. Check all enclosures for loose wires, tools and components.
9. Check all MCCB and the remaining completeness of movement, installation, adjustment, rating and functionality
10. Check all wires terminated for being free of unintentional earth connections.
11. Check for proper sequence of connections as per schematic diagrams.
12. Check for proper earthing of enclosures and screen and drain wires in cables.
13. Check for proper sealing of conduit connections, cables.
14. Finally give the power to the system.

PRECAUTIONS: - A plays all the necessary safety equipment.

QUALITY CRITERIA: - the trainees should be able to perform Install electrical machine and drive

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LAP Test 1	Practical Demonstration
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Name: _____ Date: _____

EEL EMD22	Version:01	Page No.91
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Time started: _____ **Time finished:** _____

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within 8-12 hours.

Task 1: Install electrical installation work

Task 2: Install electrical installation work

Task 3: Install electrical machine and drive

Reference

- 1.“Safety and Employment protection” Department of Commerce – Annual Report 2009-2010
- 2.“Safety priorities for working with electricity”: Department of Commerce, WorkSafe
- 3.“Electrical appliances and equipment – Importing, selling or hiring”: Energy Safety

EEL EMD22	Version:01	Page No.92
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4. "Safety Guidelines for Electrical Workers": Energy Safety 2009.
5. "Electrical measuring and test instruments"
6. "costing and estimation of electrical installation"
7. "electrical machine and drive "

Acknowledgement

The **FEDERAL TVET AGENCY** wishes to extend thanks and appreciation to the many representatives of business, industry, academe and government agencies who donated their time and expertise to the development of this Model Curriculum for the TVET Program **Industrial Electrical Machines and Drives**

EEL EMD22	Version:01	Page No.93
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10	SERKABEBA ABERA	MSC	DEBUB	

We would like also to express our appreciation to the following Officials and Staff of Ministry of Education who made the development of this curriculum possible –

This **TTLM** was developed on the **September, 0919 G.C**

Industrial Electrical Machines and Drives Servicing Level-II

EEL EMD22	Version:01	Page No.94
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Learning Guide-28

Unit of Competence:	Perform Installation Works
Module Title:	Performing Installation Works
LG Code:	EEL EMD2 M06LO3-LG-28
TTLM Code:	EEL EMD2 M06TTLM 1019v1

LO3: Test installed electrical machines and drives

Instruction Sheet 3

Learning Guide #-28

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

- Test according to manufacturer`s instructions
- Perform inspection
- Preparing report on procedures installation and test equipment

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

- Teste Electrical machines and drives accordance with in manufacturer`s instruction

EEL EMD22	Version:01	Page No.95
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- Install and inspect electrical Machines and drives undertake to manufacturer's instruction.
- prepared Report on installation and testing of equipment according to Company's Procedures/policies.

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below
3. Read the information written in the information Sheet
4. Accomplish the "Self-checks, in each information sheets.
5. Ask from your teacher the key to correction (key answers) or you can request your teacher to correct your work. (You are to get the key answer only after you finished answering the Self-checks).
6. If you earned a satisfactory evaluation proceed to "Operation sheets and LAP Tests if any". However, if your rating is unsatisfactory, ask your teacher for further instructions or go back to Learning Activity.

Information Sheet- 1	Test installed electrical machines and drives
-----------------------------	--

Verify that the following test control activities are conducted and documented in accordance with the applicant's approved QA Plan:

Test Planning.

Verify that test planning includes the following:

1. Identification of documents to be developed to control and perform tests;
2. Identification of items to be tested, test requirements, and acceptance limits, including required levels of precision and accuracy;
3. Identification of test methods to be employed and instructions for performing the test;

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4. Identification of test prerequisites addressing, calibration for instrumentation, adequacy of test equipment and instrumentation, qualifications of personnel, condition of test equipment and the item to be tested, suitably controlled environmental conditions, and provisions for data acquisition;
5. Identification of mandatory hold points and methods to record data and results; and
6. Selection and identification of the M&TE to be used to perform the test to ensure that the equipment is of the proper type, range, accuracy, and tolerance to accomplish the intended function.

A. Performing Tests.

Verify that tests are performed in accordance with the applicant's QA procedures, and, as applicable, include the following:

1. Provisions for determining when a test is required, describing how tests are performed, and ensuring that testing is conducted by trained and appropriately qualified personnel.
2. Test objectives and provisions for ensuring that prerequisites for the given test have been met, adequate calibrated instrumentation is available and used, necessary monitoring is performed, and suitable environmental conditions are maintained.
3. Test requirements and acceptance criteria provided or approved by the organization responsible for the design of the item to be tested, unless otherwise designated.
4. Test requirements and acceptance criteria based on specified requirements contained in applicable design or other pertinent technical documents.
5. Potential sources of uncertainty and error.

B. Use of Other Testing Documents.

Other testing documents (e.g., American Society for Testing and Materials specifications, vendor manuals, or other related documents containing acceptance criteria) may be used instead of preparing special test procedures. If the applicant uses other documents, then verify that the information is

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incorporated directly into the approved test procedure, or incorporated by reference in the approved test procedure.

C. Tests Results.

Verify that test results are documented and their conformance with acceptance criteria evaluated by a qualified individual within the responsible organization, to ensure that the test requirements have been satisfied.

D. Test Documentation.

Verify that test documentation includes the following:

1. Item or work product tested, date of test, names of tester and data recorders, type of observation, and method of testing
2. Test criteria or reference documents used to determine acceptance;
3. Results and acceptability of the test;
4. Actions taken in connection with any nonconformance's noted;
5. The individual evaluating the test results; and M&TE used during the test, including the identification number and the most recent calibration date.

E. Qualification of Test Personnel.

Verify that the individual who directs a test to verify conformance of an item to specified acceptance criteria is qualified in accordance with the applicant's approved QA Plan. Verify that tests are directed by personnel other than those who performed or directly supervised the work being tested. Verify that test directors do not report directly to the immediate supervisor

responsible for the work being tested

A. Mechanical test

B. Electrical test

A. Mechanical test

- Cooling and ventilation.

The fan is located at the NDE of the motor, fitted to the shaft and a fan cowl guides the external air to the cooling fins of the motor surface. The fan is designed for bidirectional use. A person should have enough room to carry out cleaning services. On motors cooled with ambient air, cowls must be cleaned at regular intervals to ensure free air circulation.

EEL EMD22	Version:01	Page No.98
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- Degree of protection

To maintain the degree of protection of the motor unused holes and cable glands in the terminal box must be properly sealed.

Cable glands and blanking plugs with an equal or higher degree of protection as indicated on the nameplate must be used.

- Bearings

As standard the drive end (DE) bearing is axially fixed.

The fixed bearing absorbs axial and radial forces transmitted from the driven machine.

The floating bearing is installed in the non-drive end (NDE) to allow thermal expansion of the shaft and to absorb radial forces.

The calculated operating life L₁₀ of the bearings are at least 20,000 hours when radial and axial forces are below the limits stated in the catalogue

- Coupling Elements

When coupling elements are being fitted to the shaft, percussion blows must be avoided since they could cause bearing damage. Before fitting the coupling, the shaft end should be lightly lubricated to improve mounting.

Ensure the motor and driven shafts are accurately aligned. Mounting bolts must be carefully tightened to avoid alignment changes and the alignment must be rechecked to ensure it is correct after the bolts are fully tightened.

- Rotating Parts

- All shaft fitments and safety guards must be fully retained before the motor is started.

B. Electrical connection test

- **Approved Test Instruments**

The test instruments and test leads used by the electrician for testing an electrical installation must meet all the requirements of the relevant regulations. The HSE has published Guidance Notes GS 38 for test equipment used by electricians. The IEE Regulations (BS 7671) also specify the test voltage or current required to carry out particular tests satisfactorily.

All test equipment must be chosen to comply with the relevant parts of BS EN 61557. All testing must, therefore, be carried out using an 'approved' test instrument if the test results are to be valid. The test instrument must also carry a calibration certificate, otherwise the recorded results may be void. Calibration certificates usually last for a year. Test instruments must, therefore, be tested and recalibrated each year by an approved supplier. This will maintain the accuracy of the instrument to an acceptable level, usually within 2% of the true value. Let us now look at the requirements of three often used test meters.

- **Continuity tester**

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To measure accurately the resistance of the conductors in an electrical installation we must use an instrument which is capable of producing an open circuit voltage of between 4 and 24V ac. or dc., and deliver a short-circuit current of not less than 200mA (Regulation 612.2.1). The functions of continuity testing and insulation resistance testing are usually combined in one test instrument.

- **Insulation resistance tester**

The test instrument must be capable of detecting insulation leakage between live conductors and between live conductors and earth. To do this and comply with Regulation 612.3 the test instrument must be capable of producing a test voltage of 250, 500 or 1000V and deliver an output current of not less than 1mA at its normal voltage.

- **Earth fault loop impedance tester**

The test instrument must be capable of delivering fault currents as high as 25A for up to 40 ms using the supply voltage. During the test, the instrument does an Ohm's law calculation and displays the test result as a resistance reading.

- **Inspection Requirements**

Verify that selected elements associated with the applicant's program for inspection, test control, and control of M&TE (as identified in an approved inspection plan) are in accordance with the applicant's approved QA Plan.

- **Frequency Converter (Inverter) Supply**

Operation by a VFD can cause current harmonics. The strength depends on converter type and design. you must follow the installation, operation and maintenance instructions of the VFD manufacturer.

- **Electromagnetic compatibility**

when the power and signal cables are installed following the valid norms and regulations.

Unbalanced loads: When torque levels are very unbalanced (pulsating) non-sinusoidal motor current will create harmonics. If this causes unacceptable disturbances on the power system extra measures have to be taken.

- **Terminal box**

- ✓ General: - Supply cables shall be selected according to rated current, ambient conditions and specific installation (e.g. ambient temperature, wiring method etc.).

- ✓ Design: - The terminal box is designed for supply cable access from different directions. The standard cable entry is from the right hand side when looking from the motor drive end shaft.

After removing the terminal box lid the four screws fixing the terminal box body can be removed and the terminal box body can be turned in four steps of 90°.

Please make sure that the motor internal wiring between winding and terminal board do not get neither damaged nor twisted.

EEL EMD22	Version:01	Page No.100
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Prior to reassembly the terminal box body and terminal box lid please insure all 'o'-rings and gaskets (between housing to terminal box body and terminal box body to terminal box lid) are properly seated.

- ✓ Cable glands: - As standard the cable entry holes are not equipped with cable glands! All cable entry holes are properly plugged with easy removable blanking plugs.
- ✓ Take care that the outer cable insulation is not damaged, the wire ends for connection is properly stripped, the wires have sufficient length, the wire insulation is not damaged and earthing and screen (if any) is connect accordingly,
- ✓ Terminal Block: - All motors are equipped with metric threaded terminal blocks with six studs and all necessary nuts, washers and jumpers to make the electrical connection (Y or Δ). The wire ends must be equipped with cable lugs suitable for fitting to the stud thread size. For mounting the cable lugs by solder or crimping use applicable tools and follow the recommendations of cable lug supplier.
- ✓ Earthing: - Earthing the equipment is an essential safety measure and must be accomplished according to the local rules and regulations. In some special cases (i.e. 500V) an unearthed main power supply may be used. In those cases, special safety devices are mandatory to protect human life.

Make sure that you have detailed knowledge about the power supply configuration and the applicable rules, norms and regulations for earthing of the individual application to protect human life.

The motors are equipped with two earthing points, one inside the terminal box and one on the motor frame close to terminal box. Both are indicated with the earthing.

For connecting the earthing wire make sure that

- The contact surface is unpainted, free of rust and protected against corrosion by using a suitable oil or grease (e.g. acid-free Vaseline)
- The cable lug or cable wire is fitted below the u-clamp or bracket
- The spring washer is located below the bolt head
- Connection
 - ✓ Terminal marking: - The power terminals are marked with U1, V1, W1 and U2, V2, W2. The accessory terminals are usually marked with:

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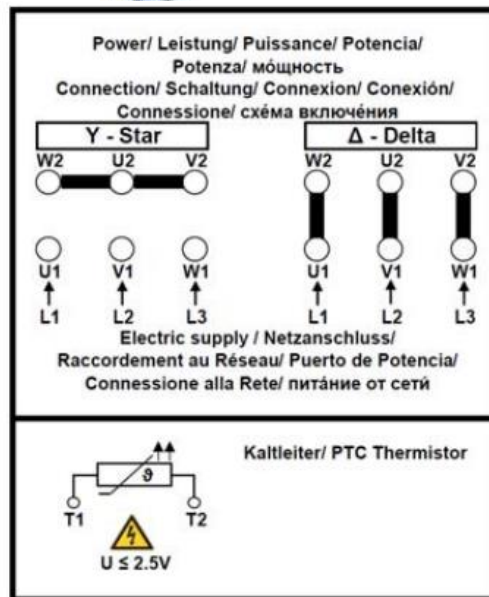


Fig 4.1. Stare-delta connection

- ✓ Direction of rotation: - All motors of standard design are for use in both directions of rotation. The standard connection as shown in connection diagram at 7.2.4.1 is for “clock wise” rotation when viewed from the drive end shaft. For “anti-clockwise” rotation the line wires L1 and L2 should be interchanged.
- ✓ Terminal board connections: - In case of flying leads the full responsibility for connection is the customer’s. Follow the local rules, norms and regulations for cable extensions and ensure a proper strain relieve and to stay below the winding limit temperature to avoid any winding damage.
- ✓ Connecting the temperature sensor (thermistors):- Make sure that the wiring of accessories is not in contact with the terminal studs or other metallic parts of the power connections and/or frame to avoid abrasion caused by vibration during operation.
- ✓ Connecting of accessories: - Make sure that the wiring of accessories is not in contact with the terminal studs or other metallic parts of the power connections and/or frame to avoid abrasion caused by vibration during operation.



Self-check 1	Written Test
---------------------	---------------------

Name: _____ Date: _____

Directions: Answer all the questions listed below.

Part I choose the correct answer for each of the following questions

- _____ Which one is not Mechanical Installation test?
A. Cooling and ventilation. B. Degree of protection
C. Bearings D. Frequency Converter (Inverter) Supply
- _____ when torque levels are very unbalanced (pulsating) non-sinusoidal motor current will create harmonics.
A. Electromagnetic compatibility B. Unbalanced loads C. Cable glands D. All
- _____ The equipment is an essential safety measure and must be accomplished according to the local rules and regulations
A. Earthing B. Cable glands C. Connection D. None
- _____ Which of the following is Electrical connection test?
A. Frequency Converter (Inverter) Supply
B. Electromagnetic compatibility
C. Terminal box
D. Connection
E. All

EEL EMD22	Version:01	Page No.103
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Note: Satisfactory rating - 3 points

Unsatisfactory - below 3 points

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

Information Sheet-2	Perform inspection
----------------------------	---------------------------

3.2 Perform inspection

Inspection and Testing Techniques

The testing of an installation implies the use of instruments to obtain readings. However, a test is unlikely to identify a cracked socket outlet, a chipped or loose switch plate, a missing conduit-box lid or saddle, so it is also necessary to make a visual inspection of the installation.

All new installations must be inspected and tested during erection and upon completion before being put into service. All existing installations should be periodically inspected and tested to ensure that they are safe and meet the regulations of the IEE (Regulations 610–634).

The method used to test an installation may inject a current into the system. This current must not cause danger to any person or equipment in contact with the installation, even if the circuit being tested is faulty. The test results must be compared with any relevant data, including the IEE Regulation tables, and the test procedures must be followed carefully and in the correct sequence, as indicated by Regulation 612.1. This ensures that the protective conductors are correctly connected and secure before the circuit is energized.

Visual Inspection

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The installation must be visually inspected before testing begins. The aim of the visual inspection is to confirm that all equipment and accessories are undamaged and comply with the relevant British and European Standards, and also that the installation has been securely and correctly erected Regulation 611.3 gives a checklist for the initial visual inspection of an installation, including:

- Connection of conductors;
- Identification of conductors;
- Routing of cables in safe zones;
- Selection of conductors for current carrying capacity and volt drop;
- Connection of single-pole devices for protection or switching in phase conductors only;
- Correct connection of socket outlets, lamp holders, accessories and equipment;
- Presence of fire barriers, suitable seals and protection against thermal effects;
- Methods of 'basic protection' against electric shock, including the insulation of live parts and placement of live parts out of reach by fitting appropriate barriers and enclosures;
- Methods of 'fault protection' against electric shock including the presence of earthing conductors for both protective bonding and supplementary bonding.
- Prevention of detrimental influences (e.g. Corrosion);
- Presence of appropriate devices for isolation and switching;
- Presence of under voltage protection devices;
- Choice and setting of protective devices;
- Labelling of circuits, fuses, switches and terminals;
- Selection of equipment and protective measures appropriate to external influences;
- Adequate access to switchgear and equipment;
- Presence of danger notices and other warning notices;
- Presence of diagrams, instructions and similar information;

Appropriate erection method.

Inspection Guidance

EEL EMD22	Version:01	Page No.105
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The inspector should refer to the applicant's approved QA Plan for specific requirements and commitments. Verify that the following inspection activities are documented and controlled by instructions, procedures, drawings, checklists, travelers, or other appropriate means:

A. Inspection Planning.

Verify that documented inspection planning includes the following:

1. Identification of each work operation where inspection is necessary to ensure quality;
2. Identification of documents that are used to perform the inspections;
3. Identification of the characteristics for inspection and the identification of when, during the work process, inspections are to be performed for those characteristics;
4. Identification of inspection or process-monitoring methods employed;
5. Sufficient information from the final inspection, to provide a conclusion regarding conformance of the item to specified requirements;
6. Identification of the functional-qualification level (category or class) of personnel performing inspections;
7. Identification of acceptance criteria;
8. Identification of sampling requirements;
9. Methods to record inspection results; and Selection and identification of the M&TE to be used to perform the inspection to ensure that the equipment is calibrated and is of the proper type, range, accuracy, and tolerance to accomplish the intended function.

B. Selecting Inspection Personnel to Perform Inspections.

1. Determine that the individual who performs an inspection to verify conformance of an item to specified acceptance criteria is qualified to the requirements specified in the applicant's approved QA Plan.
2. Verify that inspections are performed by personnel other than those who performed or directly supervised the work being inspected. Verify that

EEL EMD22	Version:01	Page No.106
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inspection personnel do not report directly to the immediate supervisor responsible for the work being inspected.

C. Inspection Hold Points.

1. If mandatory inspection hold points are used to control work, then verify that specific hold points are indicated in documents.
2. When applicable, verify that consent to waive hold points are documented and approved before continuing work beyond the designated hold point.

D. In-Process Inspections and Monitoring.

1. If inspection of processed items is not practicable, then verify that indirect control is provided by the monitoring of processing methods, equipment, and personnel.
2. Verify that both inspection and process monitoring are conducted, when control is inadequate with only one method.
3. Verify that controls are established and documented for the coordination and sequencing of the work at established inspection points during successive stages of the process.

E. Final Inspection.

1. Verify that finished items are inspected for completeness, markings, calibration, adjustments, protection from damage, or other characteristics, as required to verify the quality and conformance of the item to specified requirements.
2. Verify that final inspections include a review of the results and resolution of nonconformance's identified by earlier inspections. If modifications, repairs, or replacements of items are performed subsequent to the final inspection, then verify that appropriate re-tests or re-inspections are performed.

F. Accepting Items.

Verify that the acceptance of an item is documented and approved by qualified and authorized personnel.

EEL EMD22	Version:01	Page No.107
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G. Inspection Documentation.

Verify that inspection documentation includes the following:

1. The item inspected, date of inspection, the name of the inspector, or the inspector's unique identifier, who documented, evaluated, and determined acceptability;
2. The name of the data recorder, as applicable, and the type of observation or method of inspection;
3. The inspection criteria, sampling plan, or reference documents used to determine acceptance;
4. Results indicating acceptability of characteristics inspected;
5. M&TE used during the inspection, including the identification number and the most recent calibration date; and
6. Reference to information on actions taken in connection with nonconformance.

Verify that the following test control activities are conducted and documented in accordance with the applicant's approved QA Plan:

Final Check

Measures before start-up

Make sure that the equipment

- Data specified on the rating plate matches the operating conditions
- Is assembled and aligned correctly
- Screws and electrical connections are fastened according to the torques specified
- Earthing connections are wired and fastened according to the torques specified
- Is connected for the direction of rotation specified
- Rotor and driven machine can turn free without mechanical grinding (clearance values match limits)
- Contact protection devices for turning or energized parts are fitted
- Key is removed or properly fixed if nothing is mounted on the motor shaft
- Lifting eyes are properly tightened to avoid loosening by vibration
- Cooling air flow is clear and not obstructed
- Bearings are properly lubricated
- Resistance values are above the limits
- Monitoring equipment (if any) is connected correct and ready for operation

EEL EMD22	Version:01	Page No.108
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- Cannot exceed the speed limit specified (use speed control and/or monitoring device in case)
- Input and output signals (if any) have the correct settings
- Accessories (i.e. Brake, forced ventilation) are in effective operation

Make sure that the coupling

- is assembled and aligned correctly and has proper axial clearance

With a directly-coupled load ensure the motor and load shafts are accurately aligned and use a flexible coupling between them. Mounting bolts must be carefully tightened to avoid alignment changes and the alignment must be double checked to ensure it is correct even after the bolts are fully tightened.

Make sure that the pulley or sprocket

- is assembled and aligned correctly

In case of VFD (Inverter) operation ensure the limit values of drive match those of the equipment

- continuous minimum speed and related max. torque
- maximum speed and related max. torque
- reduced torque in case of field weakening operation
- supply voltage and connection (i.e. 87Hz operation).

Operation: -After equipment start it must accelerate continuously and smoothly to its nominal speed. If unusual noise, vibration or smells are detected the equipment must be switched off immediately and the whole drive system must be analyzed to detect where the problems or malfunction originates from.

The drive system must not be restarted until the malfunction is identified and corrected!

Once equipment is started and operates at its nominal speed motor temperature increase should be monitored at least every 15 minutes until stable. Use thermistors in the motor windings (if equipped) for temperature measurement.

Maintenance

- **Visual inspection**

Maintain and service the equipment at regular intervals according to its usage and insure the

- Equipment is clean, free of dust with clear air flow
- Equipment has no unusual vibration and/or noise
- Fixings and fasteners are not getting loose or corroded
- Electrical connections are tight and not corroded
- Earthing connections are functioning
- Shaft seals and terminal box gaskets are in position and not significantly frayed

EEL EMD22	Version:01	Page No.109
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- Paint finish is in good conditions, de-rust and repaint if necessary to avoid excessive corrosion
- Shaft couplings are firmly fixed and shaft alignment is correct
- There is no liquid or moisture inside the motor or terminal box caused by condensation

Lubrication

The grease must be replaced at regular intervals with the same quality and amount as indicated on the additional regreasing nameplates at the motor. The re-greasing intervals depend on the motor size and its usage.

Attention:

- For re-greasing use only the grease specified on the re-greasing nameplate
- Grease nipples must be clean to avoid dirt penetrating the bearings during re-greasing
- Grease relief openings must be open and have free access so that used grease can escape unhindered
- It is preferable to re-grease the bearings during operation for better grease distribution. Make sure that this work is done by trained personnel only and live and moving parts are safely covered.
- If this is impossible (i.e. danger from rotating parts) re-grease when stationary. In this case use only half of the grease amount specified on the re-greasing nameplate. Restart the equipment for at least one minute of operation. Shut down again and re-grease with the remaining half of the grease amount specified. Restart for operation
- Too excessive or too frequent lubrication may damage the motor!
- Once bearing failure or vibration is detected the alignment must be checked!

Typical Motor Control Installation

EEL EMD22	Version:01	Page No.110
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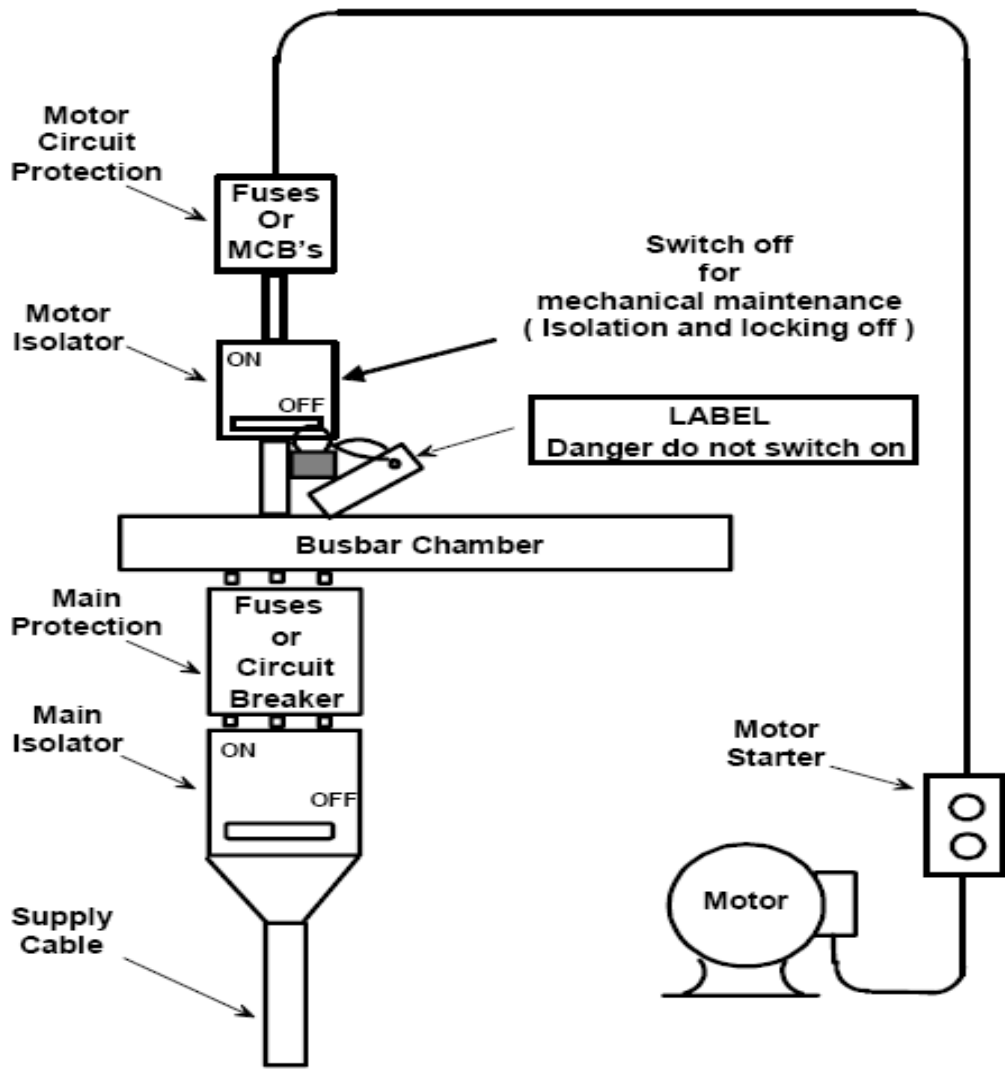


Fig. 10 Cable lag

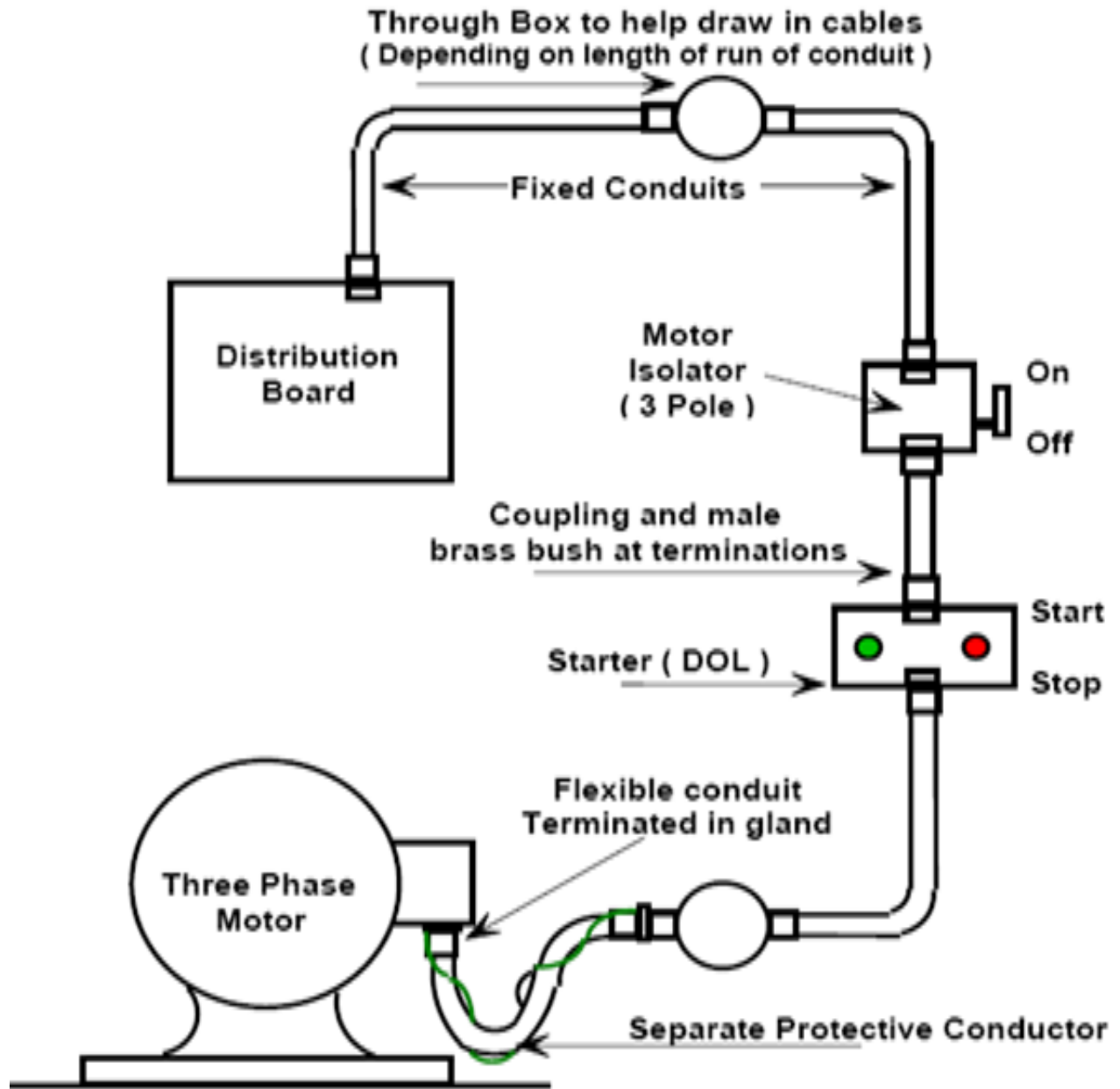


Fig 10 Cable lag

Self-check 2	Written Test
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Name: _____ **Date:** _____

Directions: Answer all the questions listed below.

Part I If the statement is correct write true if the statement is in correct write False

- 1_____ Rotor and driven machine can turn free without mechanical grinding (clearance values match limits)
- 2_____ monitoring equipment (if any) is connected correct and ready for operation
- 3_____ Too excessive or too frequent lubrication may the motor is not damage its good conditions
- 4._____ earthing connections are wired and fastened according to the torques specified
- 5_____ after equipment start it must accelerate continuously and smoothly to its nominal speed.

Note: Satisfactory rating – 15 points

Unsatisfactory - below 15 points

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

EEL EMD22	Version:01	Page No.113
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InformationSheet-3	Preparing report on procedures installation and test equipment
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3.3. Preparing report on procedures installation and test equipment

Safe working procedures when testing

Whether you are carrying out the test procedure

- I. As a part of a new installation
- II. Upon the completion of an extension to an existing installation
- III. Because you are trying to discover the cause of a fault on an installation or
- IV. Because you are carrying out a periodic test and inspection of a building, you must always be aware of your safety, the safety of others using the building and the possible damage which your testing might cause to other systems in the building.

For your own safety:

- Always use 'approved' test instruments and probes.
- Ensure that the test instrument carries a valid calibration certificate otherwise the results may be invalid.
- Secure all isolation devices in the 'off' position.
- Put up warning notices so that other workers will know what is happening.
- Notify everyone in the building that testing is about to start and for approximately how long it will continue.
- Obtain a 'permit-to-work' if this is relevant.
- Obtain approval to have systems shut down which might be damaged by your testing activities. For example, computer systems may 'crash' when supplies are switched off. Ventilation and fume extraction systems will stop working when you disconnect the supplies.

Requirements for safe working procedures

The following five safe working procedures must be applied before undertaking the fault diagnosis.

1. The circuits must be isolated using a 'safe isolation procedure',

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2. All test equipment must be 'approved' and connected to the test circuits by recommended test probes as described by the Health and Safety Executive (HSE) Guidance
3. Isolation devices must be 'secured' in the 'off' position as shown in
4. Warning notices must be posted.
5. All relevant safety and functional tests must be completed before restoring the supply.

Record-keeping

In order for an eye care unit to manage its equipment effectively, it needs good maintenance and repair records. It is very difficult to manage the unknown!

A central maintenance and repair record will help you to keep track of the maintenance and repair work done. Ideally, this system should correspond to the eye unit's equipment inventory (mentioned on page 34); this means that you will have maintenance and repair records for each of the items listed in the inventory.

Record-keeping for maintenance

The preventative maintenance schedule for users can be accompanied by a weekly or monthly 'tick sheet' near the item of equipment, with a space for each day so that users can date and sign it, thereby showing that they have carried out the required tasks. This may include a space for users to indicate what spare parts, such as bulbs, were used. On a regular basis, the list of spare parts used should be noted in the central maintenance and repair record so that more spare parts can be ordered.

The central maintenance and repair record can be used to keep track of all other maintenance, including maintenance done by the in-house team, by vendors, or by service agents. The information captured should include the date, the equipment reference number, what was done, who did the work, and when next maintenance is due.

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Self-check 3	Written Test
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Name: _____ **Date:** _____

Directions: Answer all the questions listed below.

Part I: If the statement is correct write true if the statement is in correct write false

- 1 _____ the preventative maintenance schedule for users can be accompanied by a weekly or monthly.
- 2 _____ A central maintenance and repair record will help you to keep track of the maintenance and repair work done.
- 3 _____ the central maintenance and repair record that more spare parts can be ordered.

This learning guide is developed to provide you the necessary information regarding the

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**Instruction Sheet-1****LG29: Clean-up**

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

- Cleaning and clearing work site all debris

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

- Work site is cleaned and cleared of all debris and left safe in accordance with the company requirement

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
3. Follow the instructions described below
7. Read the information written in the information Sheet
8. Accomplish the “Self-checks, in each information sheets.
9. Ask from your teacher the key to correction (key answers) or you can request your teacher to correct your work. (You are to get the key answer only after you finished answering the Self-checks).
10. If you earned a satisfactory evaluation proceed to “Operation sheets and LAP Tests if any”. However, if your rating is unsatisfactory, ask your teacher for further instructions or go back to Learning Activity.

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4.1. Cleaning and clearing work site all debris

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 can't 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 stowage place.

All divisions have incorporated a Tool Control Program as directed by the Aircraft Launch and Recovery Equipment Maintenance Program (ALREMP). 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.

Never use damaged tools. A battered 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

Cleaning work area

Work station is defined as an area, in an office, outfitted with equipment and furnishings for one or more workers. Normally leather goods are operated in a work shop therefore the work station for a leather goods worker would be the work shop. It is necessary for a worker to prepare his work station and the pieces to be done but before doing so a worker should be well aware of the safety rules and regulations.

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, and attention to such details as an orderly layout of the whole workplace, the marking of 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 see 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.

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

EEL EMD22	Version:01	Page No.119
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- 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:

- **Aisles:** 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:** Well distributed artificial light and effective use of available daylight.
- **Amenities:** Clean, up-to date 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.

Self-check 1	Written test
--------------	--------------

Name: _____ Date: _____

Part I: If the statement is correct write true if the statement is in correct write false

1. _____ where housekeeping is bad, fire is a constant hazard
2. _____ Keep your tools in good condition. Protect them from rust, nicks, burrs, and breakage.
3. _____ Good housekeeping is a vital factor in preventing accidents

EEL EMD22	Version:01	Page No.120
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Note: Satisfactory rating - 3 points

Unsatisfactory - below 3 points

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

Refinance

- 1. “Electrical appliances and equipment – Importing, selling or hiring”: Energy Safety
- 2. “Safety Guidelines for Electrical Workers”: Energy Safety 2009.
- 3. “Electrical measuring and test instruments”
- 4. “costing and estimation of electrical installation”
- “electrical machine and drive “
- 1 “Safety and Employment protection” Department of Commerce – Annual Report 2009-2010
- 2. “Safety priorities for working with electricity”: Department of Commerce, WorkSafe

EEL EMD22	Version:01	Page No.121
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- 3. “Electrical appliances and equipment – Importing, selling or hiring”: Energy Safety
- 4. “Safety Guidelines for Electrical Workers”: Energy Safety 2009.
- 5. “Electrical measuring and test instruments”
- 6. “costing and estimation of electrical installation”
- “electrical machine and drive “

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EEL EMD22	Version:01	Page No.122
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EEL EMD22	Version:01	Page No.123
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