CHAPTER-01
Installation, Commissioning and Testing of Machine

INSPECTION ON ARRIVAL OF MACHINE

The main objective of inspection is to meet customer requirements, wants, and needs. The objective is to prevent defective product flowing down the successive operations and prevent loss to the company. Many characteristics cannot be inspected at the final stage of production.
Inspection machines use a range of technologies and configurations to assess whether or not products meet required specifications within given tolerances, as well as detecting any contamination or faults.
Depending on the product and industry, inspection covers colour, size, mass, the presence of foreign bodies in a product or package, pack integrity, missing labels or items, or incorrect data on labels, product or packaging.
Quality plays an important role in products and services for customer satisfaction and customer loyalty. Inspection is a function of quality discipline. An inspection is, most generally, an organized examination or formal evaluation activity.
Today, inspection falls into four main categories, namely:

1.Visual: appearance, surface characteristics, size, shape, color, etc., using the naked eye, microscope, magnifier, etc.

2.Physical or dimensional: measurements using micrometers, depth gages, etc.

3.Testing: mechanical properties (tensile strength, electrical characteristics—opens or shorts, parametric or functional, etc.)

4.Sensory (touch, smell, taste, etc.)

HANDLING OF ELECTRICAL MACHINES

Avoid contact with all energized electrical circuits. This may be an unwritten rule, but not following this rule just once could be fatal. A good way to avoid this is to assume all electrical devices and circuits are live. Never assume equipment is safe until you have confirmed it yourself, your life may depend on it.
Be sure to unplug the power source of all electrical equipment before working on it. Always pull from the plug, not the cord.
Always wear proper non conductive clothing – insulated gloves, non conductive protective apparel and shoes with insulated soles. Avoid loose clothing or ties.
Keep all water and liquids away from electrical equipment! If a spill does occur, immediately shut the power off at the circuit breaker or main power source and unplug the equipment.
If electrical equipment is producing a “tingle” or feels like it is overheating, immediately turn the power off. Repair if possible, if unrepairable dispose of the faulty equipment. Never take the risk of working with compromised equipment.
Enclose all electrical contacts and conductors to avoid accidental contact with them. Never leave exposed electrical contacts or conductors unattended.
When possible, work with only one hand, with your other hand at your side and away from all conductive material. This precaution will lessen the likelihood of an electrical current passing through the chest cavity.
Use only tools and equipment with non conductive handles

UNPACKING AND CHECKING OF THE MOTOR

Before adjusting the drive and putting it into service, make sure that the motor and all driven equipment are suitable for operation throughout the speed range provided by the drive.
The drive can be adjusted to operate the motor at speeds above and below the speed provided by connecting the motor directly to the power line.
Do not activate automatic fault reset functions if dangerous situations can occur. When activated, these functions will reset the drive and resume operation after a fault.
Never work on the drive, motor cable or motor when input power is applied. After disconnecting the input power, always wait for 5 minutes to let the intermediate circuit capacitors discharge before you start working on the drive, motor or motor cable.
Always ensure by measuring with a multimeter (impedance at least 1 Mohm) that

1. there is no voltage between the drive input phases U1, V1 and W1 and the ground

2. there is no voltage between terminals BRK+ and BRK- and the ground.

Do not work on the control cables when power is applied to the drive or to the external control circuits. Externally supplied control circuits may carry dangerous voltage even when the input power of the drive is switched off.
Do not make any insulation or voltage withstand tests on the drive.

STORAGE OF ELECTRICAL MOTORS

Always store motors indoors in a clean, dry, and vibration-free environment. Preferably in a cabinet or closed storage area that is free of insects and airborne debris.
Always remember to pack the bearing cavities with grease for added protection from moisture.
Don’t leave the motor surface exposed to the atmosphere even if it meets the specifications mentioned for storage. Apply a rust inhibitor to the exposed surface and reapply the inhibitor occasionally while in storage. Yes, the motor will require cleaning prior to use. However, compared to replacing the motor or being left without a backup, it’s a small price to pay.
Always store electric motors vertically, if this is not possible, rotate motors quarterly. This avoids creating a small dent in the bearing’s outer race due to the excess weight of the rotor and shaft assembly. This may not seem significant, but it will show up once the motor is placed in service as noise and appear in the vibration signature.
With your bearings packed in grease, you’re set to go, right? Well, no. Periodically turning over both sealed and shielded bearings prevent the grease from settling on one side, which will cause problems later if allowed to happen.
The insulation in the windings can degrade while in storage if the windings temperature falls below 10° F to 20° F above the ambient temperature. Portable heaters or humidifiers may be required.Take a baseline insulation resistance (IR) measurement prior to storage (followed by a second measurement before the motor is placed in service).
Another baseline measurement, the polarization index of the form coil windings prior to storage (annually, if motor is in storage for several years) also is suggested.
Carbon brushes in some electric motors may experience problems with chemical reaction during storage unless you do the following. Lift the brushes from the commutator and/or slip rings. You should also place the bushes in a relaxed position if possible to prevent against the springs from getting weak.

PROCEDURE FOR STORING A MACHINE AT SITE

Safe storage of materials and equipment is essential for many businesses, such as construction job sites, laboratories, and other locations that handle chemicals, flammable gases and other hazardous materials.
Storage methods and procedures are regulated for many such items; when in doubt it is always best to be cautious to prevent accidents. Locking storage cabinets and restricting access to storage areas will prevent unauthorized handling of stored items and minimize the possibility of theft.
These can be stored only in a specially constructed room that is able to contain a fire for one to two hours. Keep flammable materials 50 feet away from sources of heat or flame.
If there is a chance of oil, hydraulic fluid or other liquids leaking from the vehicle while it is stored, use a drip pan underneath it to catch any spills. Check the area frequently for such leaks and clean them up immediately if any are found, as these represent significant fall hazards for employees.
As far as storing goes, if a piece of equipment is not going to be used for a few months, store it with the gas shut off from the tank to the carburetor. Some manufacturers recommend draining fuel before storing equipment, which ensures the gas doesn't become stale and turn to a varnish, which can clog the carburetor ports, making the unit difficult to start.

PROCEDURE FOR INSPECTION OF AN MOTOR BEFORE INSTALLATION

Safety should always come first. Check to make sure all guards and covers are in place, as well as warning labels.
Check gas and oil levels and add accordingly.
Ensure the air filter is clean and placed correctly so air can move freely through the filter and debris doesn't get into the engine. It's a good idea to mark on the filter cover the date in which oil was changed and the new filter installed.
Grease the grease zerks, which are usually around bearings and moving parts that otherwise seize if not lubricated during operation.
Start the equipment to ensure it starts correctly. If it's an electric-start system, be sure the battery connections are in good working order. For manual start equipment, check the pull cord for wear.
Inspect the belts for wear spots.
Check aerator tines for wear and to ensure they will produce an adequate core depth.
Be sure the blades on lawn rakes and overseeders are also in good condition and not so worn they can't be set to the appropriate depth.
It's also a good idea to check the cutting blades on sod cutters, lawn mowers and brush cutters for sharpness and condition, and tighten any loose blade bolts.
Check trailer and equipment tires for proper air inflation.

DRYING OUT OF AN ELECTRIC ROTATING MACHINE

Completely dismantle all parts.
To remove silt or dirt, wash all parts of the machine,except ball or roller bearings, but including windings with clean, fresh water or stem clean them. Follow this with a thorough cleaning, using a suitable grease solvent. Many such cleaners are toxic, and the necessary safety precautions should be taken.
Thoroughly clean all bearings and housings, paying particular attention to oil grooves and oil reservoirs, which may collect silt and dirt. Disconnect and swab any oil lines, or stem clean and dry them.
Dismantle brush rigging and clean insulators. Some insulators will retain water, and must be dried thoroughly.
Do not apply any voltage to a winding until an insulation resistance reading of at least 100,000 ohms is obtained for several hours, and then only a very low voltage should be used. If windings are very wet, even the low voltage of hand-cranked ohmmeters can puncture the insulation. To avoid this, the crank should be turned at low speeds until some knowledge of insulation resistance value is obtained. Modern microelectronic testers have voltage regulation that

eliminates this problem. As mentioned above, models with kilohm ranges at low voltage (BMM Series and MIT320 & 330) are ideal.
The motor can first be checked at low voltage to be assured that it meets the 100-kohm requirement, and then the effectiveness of the drying process can be monitored until resistance has increased into the megohm range.
Commutators can be difficult to dry out. It may be necessary to loosen or even remove some of the V-ring bolts or clamping nuts in order to let the water out from the inside of the commutator. On large commutators it may be necessary to increase the drying temperature to as high as 266oF (130oC) if lower temperatures do not produce satisfactory results after a reasonable period

Bands on armatures or rotors should be checked carefully for tightness. For some applications, they will have to be replaced because of looseness resulting from drying out of insulation underneath.
Some slot wedge materials will be affected by moisture. All wedges should be carefully examined and new wedges installed where necessary.
DC motor or generator field coils and field coils from synchronous machines sometimes present problems. It may be necessary to remove these coils from the machines for proper treatment if it is found that it is impossible to bring up the insulation resistance otherwise. After a thorough drying in a suitable oven, they should be immersed completely in insulating varnish while hot, and allowed to cool while still immersed.
This will tend to draw the varnish into the inside layers. When cooled, the coils should be checked for short circuits by making a comparative test of their resistance.
A Megger DLRO10 digital low resistance ohmmeter will indicate open coils, and can also be used to determine shorted turns by the reduction in resistance that turn-to-turn shorts produce.
After a thorough cleaning and drying, most windings should be treated with insulating varnish, particularly if cleaning solvents have removed any of the varnish coatings. Dipping and baking-type varnish, followed by a suitable baking period, is preferable, but air-drying varnish may be used to expedite the return of equipment to service; this latter type is only recommended if the original varnish is in reasonably good condition.

METHODS OF HEAT APPLICATION

Heat transfer, which is of equal importance as the electromagnetic design, yet a far more difficult and complicated issue. The temperature rise determines the maximum output power and allowed constant load of the machine.
To analyze heat transfer, empirical knowledge can be utilized; however, for the modelling of a new construction, prototyping and measurements are required. Heat removal by conduction, radiation, and convection is discussed. Guidelines how to create a thermal equivalent circuit of an electrical machine based on the analogy between the electrical and thermal quantities are given.
Modelling of the coolant flow is shown, including a method of analysis and rules for writing the temperature source equations. An example of a thermal network for totally enclosed fan-cooled induction motor, with outer and inner coolant cycles, is given to clarify the theory.
Electric machines have broadly been used in many industries including the transportation industry. With the evolving trend of electrification in transportation, electric machines with higher power density and higher efficiency are demanded and, thus, more stringent thermal management requirements are needed for electrified vehicle applications.

This paper comprehensively presents various important aspects of thermal management in electric machines with the main focus on transportation applications.
Design considerations, challenges, and methods for enhanced thermal management are discussed. Fundamental thermal properties of common materials are presented and sources of losses in various parts of machines are explained.
Furthermore, typical cooling techniques and thermal analysis approaches for electric machines are reviewed in detail..

GENERALISED PROCEDURE FOR INSTALLATION OF MACHINES

All permanent materials (including fabricated and pre-fabricated supports), consumables, equipment to be installed and its accessories, construction area and resources shall be prepared and checked prior to installation works.

Ensure that working areas are safe and ready for installation in coordination with other discipline for the use of the area and scaffolding materials.

Work Transfer Sheet shall be duly signed and processed by other subcontractors or discipline for the preceding works to avoid confusion and discrepancies in the work responsibilities.

Study erection procedures of heavy electrical equipment and other sensitive equipment prior to installation.

Special tools shall bear a valid calibration certificates traceable to a national standard indicating calibration validity and periodically (at least six months) checked by a third party laboratory testing facility.

Electrical materials shall conform to all applicable requirements, standard, and specifications prior to release to be used as part of the work. Refer to Schedule “Q” Att. IV Para 7.1.

Review all references such as the latest approved for construction drawings, layout, and Technical Scope of Work.

All equipment related to substation works shall be checked after confirming the availability at company. Visual Inspection shall be conducted for possible factory or handling damage and recorded in appropriate QC Material Receiving Inspection Report form.

General requirement for Electric Installation according to Indian Electricity rules.

Electrical Wiring and its repairing should be done by licensed electrician.

ISI marked instrument should be used by electricians

Subcircuits should be placed in wiring and two distinct subcircuits should be made, one for light and fans and other for high power applications.

Lights and fans can be wired on a common subcircuit and should not have a total of more than 10 points of fans and lights and a 5A socket outlet. The load on this subcircuit should not exceed 800W.

Subcircuit used for power applications should not have more than two outlets and the load on this subcircuit must not exceed 3000W.

Separate subcircuit should be utilized for external lightning of steps, walkways, carpet, terrace etc.

The lights of bathroom should be fitted in ceiling and switches of light should be outside the bathroom. If inside switch is required then waterproof switches should be used.

All electric points fixed outside the house should be waterproof.

Energy meters shall be Install at a place where it is readily accessible to both the owner of the building and to the authorized person of the supply authority. It should be installed above a height of 1m provided with protective covering.

All home appliances and other plug-in devices should be earthen using a 3-pin socket outlet.

Fuse should be installed to interrupt any short circuit current.

Cables connected to the ring line should be insulated and of red, yellow or blue in colour and the neutral wire should be of black colour.

Switches should never be connected with neutral line.

Switches should be adjacent to the entrance of any area. switches should not be obstructed by doors or by window and should be installed at a height of 1.3m staircase.

Two way switches is recommended for halls and staircase.

The distance between the fan's blades and the floor should be minimum of 2.4m and maximum of 3m.

All metallic covering used in wiring should be earthen.

The fitting of the light should be minimum of 2.25m above the floor.

No fuse should be connected to the earth wire, it should only be connected in the live wire.

Medium(650V) and High(11000V) voltage machines, transformers should be double earthen.

Heavy machines should be properly marked with safety sign.

Before starting wire fitting, proper layout should be prepared.

According to IE 85, the distance between two poles of overhead lines should be not more than 67m.

Before supplying power to any new electric wire fitting, current leakage should be checked by an instrument known as Meggar. The current leakage should not be greater than 1/5000 part of total supply voltage.

EARTHING

An earthing system or grounding system connects specific parts of an electric power system with the ground, typically the Earth's conductive surface, for safety and functional purposes. The choice of earthing system can affect the safety and electromagnetic compatibility of the installation.

PURPOSE OF EARTHING

It keeps people safe by preventing electric shocks

It prevents damage to electrical appliances and devices by preventing excessive current from running through the circuit

It prevents the risk of fire that could otherwise be caused by current leakage

The electrical system is related to the potential of the general earth mass and cannot reach a different potential.

The potential of the earth is zero volts and is known as the neutral of the electricity supply. This helps in keeping the balance.

Another advantage is that metal can be used in electrical installations without having to worry about conductivity.

Though metal is a good conductor of electricity, proper earthing ensures that metal parts not meant to be used for current transfer can be included in the system. This is done by providing a separate path for this faulty current, enabling its immediate detection and stoppage.

In cases of surges in the voltage, high voltages can pass through the electricity circuit. These kinds of overload can lead to damaging of devices and danger to human life.

When earthing is installed with the electrical installations, the current is routed through a different path and does not affect the electrical system.

An electrical circuit has to be connected together with a lot of attention to the kind of reactions each transformer may have in response to any action on the part of any other transformer. The earth is an ever-present conductive surface and helps configure these relationships between different electrical sources and makes them easier to handle.

TYPES OF EARTHING

1.Pipe earthing

Pipe earthing is best form of earthing. It is cheap in system of earthing a GI pipe of 38mm diameter and 2 meters length is embedded vertically in ground to work as earth electrod, but depth depends on soil conditions.

Wire is embedded upto the wet soil.

The earth wire is fastened to the top sction of the pipe with nut and bolts.

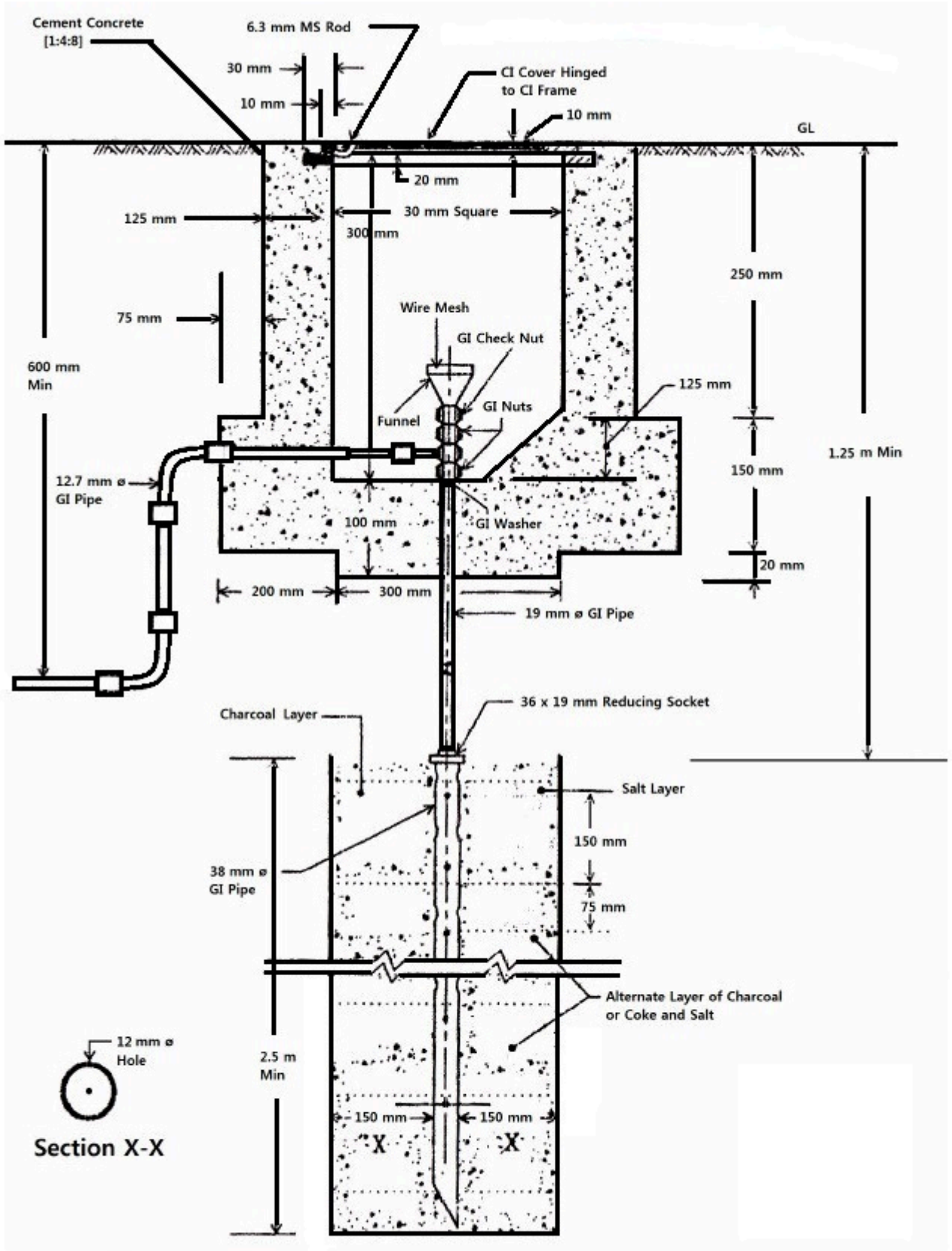
The pit area around the pipe is filled with salt and coal mixture for improving soil condition and efficiency of earthing systems.

It can take heavy leakage current for same electrode size in comparison to plate earthing.

The earth wire connection with GI pipes being above the ground level can be checked for carrying out continuity test as and when desired where it is difficult for plate earthing.

In summer season to have effective earthing 3 or 4 buckets of water is put through the funnel for better continuity of earthing.

Galvanised iron pipe of 38mm diameter, 2m length placed to depth of 4.75mtrs. The depth depends on conditions of moisture. The size of pipe depends on the current to be carried and type of soil. The powdered charcoal salt is put 15cm around the pipe. A funnel is connected at the top of pipe and water is poured at regular period of for maintaining resistance as low as possible.



Pipe Earthing

2.Plate earthing:

In this type of earthing plate either copper or G.I is buried into the ground at depth of not less than 3meter from the ground level.

The earth plate is embedded in alternative layer of Coke and salts for minimum thickness of about 15cm.

The earth wire(Copper wire for copper plate earthing and G.I. wire for G.I. plate earthing) is securely bolted to an earth plate with the help of bolt nut and washer made of copper, in case of copper plate earthing and of G.I. pins in case of G.I. plate earthing.

In this type of earthing the pipe earthing along with additional earth plate is provided at the bottom of the earth rod. If earth plate is made up of iron, size of earth plate is 60cm X60cm X6.3mm. If it is made of copper, size of earth plate is 60cm X60cm X3.15mm. The plate is placed at the depth of 3meter and then alternative layers of charcoal and salt is put below and top of earth plate.

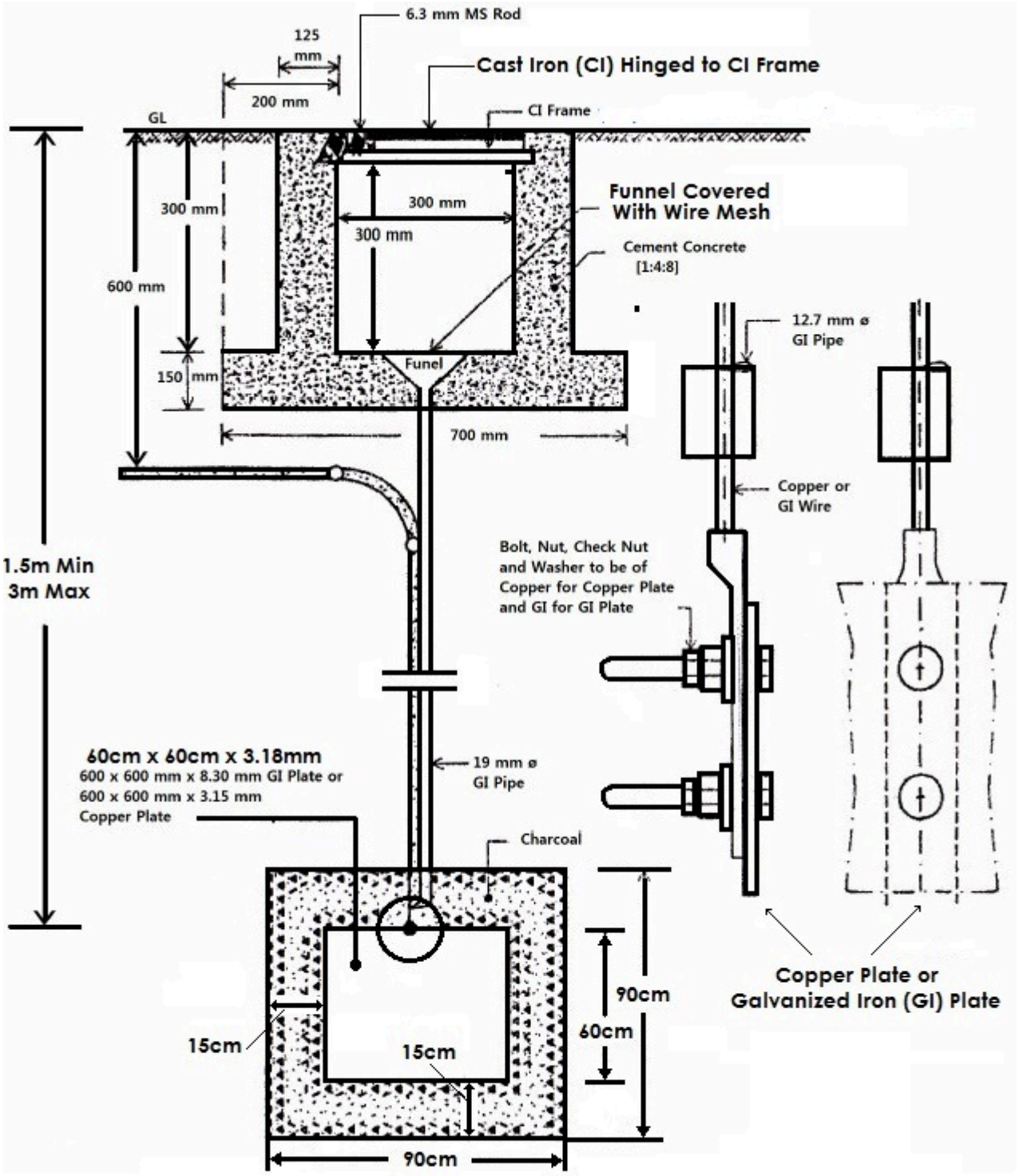


Plate Earthing

3.Strip earthing:

This type of earthing widely used in transmission.

In this system of earthing, strip electrod of cross section not less than 25mm into 1.6mm of copper or 25mmX4mm of G.I. or steel are buried in horizontal trenches of minimum depth of 0.5m.

If round conuctors are used, their cross section area shall not be smaller than three if copper is used and 6mm2 if G.I. or steel is used.

The length of buried conductor shall be sufficient to give the required earth resistance.(about 0.5ohm to 1.5Ohm)

The electrod shall be widely distributed as possible in single straight or circular trenches radiating from the point.

This type of earthing is used in rocky soil earth bed because at places at such places excavation work for plate earthing is difficult.

In this method, wires made of GI of size 25mmX4mm or wires made of copper of size 25mmX1.6mm are placed below the surface as shown in figure.

4.Rod earthing

1.This type of earthing is similar to pipe earthing, but a rod made of galvanized steel is used in this case. The rod used for this purpose is buried inside the earth at a certain depth.
2. As it is of low resistive material, the short circuit current will be diverted to the ground safely.

Different Terms used in Electrical Earthing

1.Earth

Earth is the proper connection among electrical installation systems through conductor toward the covered plate within the earth

2.Earthed

Once an electrical appliance is connected toward the earth using an earth electrode, then it is called an earthed device.

3.Solidly Earthed

Once an electric device is connected toward the earth without using a circuit breaker, fuse or Impedance/ resistance is called solidly earthed.

4.Earth Electrode

Once a conductor is covered within the earth used for the electrical earthing system is called as Earth Electrode. These are available in various shapes such as conductive rod, conductive plate, metal water pipe otherwise any other conductor through less resistance.

5.Earthing Lead

When the conductive strip is connected among the Electrical installation system & Earth electrode then it is known as Earthing lead.

6.Earth Continuity Conductor

When the conductor wire is connected among different electrical devices is known as an earth continuity conductor. The shape of this conductor is like a metal pipe or flexible wire or cable metallic sheath.

7.Sub Main Earthing Conductor

A wire is connected among the distribution board & switchboard, then the conductor is associated to sub-main circuits.

8.Earth Resistance

The whole resistance among earth electrodes as well as earth in ohms is known as earth resistance. This resistance is the sum of the resistances of earthing lead, earth continuity conductor, earth & earth electrode.

9.Codes in Earthing System

Earthing systems are available in different types which are represented through codes for different purposes.

The system properties are mainly used for electrical installation.

In the code, the initial letter denotes the main connection of the distribution system toward the ground either I or T.

The next letter in the code denotes the main relationship of the fixed exposed-conductive parts toward earth.

The 'T' specifies that the exposed-conductive elements are earthed directly & independently at any end of the power system.

Here, 'N' means that a conductor with low impedance can be detached from the connection of earth at the source, after that it is connected to the exposed conductive parts. Further, 'N' is sub-divided into two letters like C & S.

Electricity Rules for Earthing

The electricity rule for earthing mainly includes the following.

In house wiring system, the earthing should be continuous through a single solid conductor. The main switch, electrical equipment, distribution box, ceiling fans with the walls socket's earth must be earthed.

The earth continuity conductor's resistance should not be above 1 ohm during the system.

All the machine metallic covers including average voltage must be earthed through two separate earth connections.

The electrodes earth resistance should not go beyond three ohms for normal earth. The resistance of the earth for the electrode should not go beyond eight ohms for rocky soil.

Function of Earth Wire in Electrical Instruments

The electric appliance's metallic body can be connected toward the earth with the help of earth wire so that electric current any leakage can be transmitted toward the ground. This avoids electric shock for the human being.

Here, the connection of the metallic body can be done with the earth wire that gives a less resistant conducting lane for the current. Therefore, it guarantees that any current leakage

toward the metallic body of the appliances will keep its possible to the earth, so the user may not get an electric shock.

Grounding wires provide an alternate path for the current supply to flow back to the source instead of supply throughout anyone handling a hazardous appliance otherwise electrical box.

Some appliances like electric drills and vacuum cleaners do not include an earth wire. The earth is in an attractive position for electric supply as it is charged positively.

How Earthing Reduces Electricity Bill?

Actually, Earthing is one kind of method where some additional voltage is not necessary through the appliance and this voltage can be transmitted toward the Earth through a wire.

So this will help in decreasing chances for overloading & conserves extra current. So it really decreases your electricity bills.

Affecting Factors while Earthing Installation

There are different factors that affect while earthing installation are discussed below.

While earthing installation, several factors play a key role which must be taken into consideration for any type of calculation regarding the kind of earth, the type of circuits necessary, etc

The effectiveness of earthing can be decided based on the type of soil like resistance, level of moisture, salts within the soil.

Another factor that needs to take into consideration is soil composition. For instance, as compared to wet soil, rocky soil has to be treated very differently.

The final factor is the earth pit's location so that we can decide how the earthing installation must be done. If there are obstacles in the underground in the rock beds form, then this will be another factor that will affect the earthing installations.

Advantages

The advantages of Earthing system include the following.

It provides safety for electrical devices and appliances from the extreme electric current.
It helps in avoiding the risk of fire in electrical installation systems.
It helps in the electric current supply directly in the ground.
It prevents the death caused by electric current.
Electric appliances can be protected from the damage
Earthing provides protection from overvoltage and voltage stabilization.
It protects from fire occurred because of the electric short circuit so that goods can be protected from fire.
From the lighting, it defends building breakdown.
It provides a simple path even after the insulation failure to the short circuit current supply
It provides surge protection and protects from electric shock
It gives protection to the apparatus from lightning discharge and high voltage surges
The Earthing assists in detecting any fault in phase & neutral conductors.
Earthing assists to get rid of the fire risk otherwise detonation throughout insulation fault.

Disadvantages

The disadvantages of Earthing system include the following.

Hard to place line-to-ground fault
Doesn't control transient overvoltages
Maintenance cost is high because of the labor involved in placing ground faults.

If the earthing system is not implemented then there are some drawbacks
If earthing is not used for houses, there is a chance to get an electric shock.
The switches used for protection will not work properly. Thus, any error can cause damage to appliances.
Appliances may get damage during fault or short circuit or lightning conditions. So this can reduce the working condition of home appliances or equipment.

Applications

The applications of electrical earthing include the following.

Earthing protects from an electric shock by providing a lane for a fault current to supply toward the earth.
Earthing causes the protecting device to disable the flow of current toward the fault circuit
The earth wire function is to perform the leaking current from the device to the earth and is connected to the appliance's external metallic body.
It is essential for earth metallic appliances because it guards the operator against electric shocks by supplying the current supply toward the ground.
Once the insulation fails or a short circuit occurs then it protects the devices as well as the operators
It functions as a circuit breaker once the wire strikes the earth wire then huge current supplies throughout it.
Lightning conductor utilizes Earthing while the lightning metal rod is attached to the metal plate to defend the people & building

FUSES

In electronics and electrical engineering, a fuse is an electrical safety device that operates to provide overcurrent protection of an electrical circuit. Its essential component is a metal wire or strip that melts when too much current flows through it, thereby stopping or interrupting the current.

HOW DOES A FUSE WORK?

The simplest kind of fuse consists of a resistive element, selected carefully for its melting point.
When a current passes through this element, a small voltage drop (small enough so the circuit downstream won't be affected) is created across the element, and some power is dissipated as heat.
The temperature of the element thus increases. For normal currents, this temperature increase is not enough to melt the filament.
However, if the current draw exceeds the rated current of the fuse, the melting point is quickly reached. The resistive element melts and the circuit is interrupted.
The thickness and length of the resistive element determine the rated current.

Characteristics of a Fuse

Different types of fuses can be categories on the following characteristics.

Current Rating & Current Carrying Capacity of Fuse

Voltage Rating of Fuse

Breaking Capacity of a Fuse

I2t Value of Fuse

Response Characteristic

Rated voltage of Fuse

Packaging Size

Why Do We Require Fuse?

These are used to prevent the home appliances from the high current or overload damage. If we use a fuse in the homes, the electrical faults cannot happen in the wiring and it doesn't damage the appliances from the fire of wire burning.

When the fuse gets break or damage, then an abrupt sparkle happens which may direct damage your home appliances.

That is the major reason we require different types of fuses to guard our home-appliances against damage.

There are many types of fuses used for circuit protection.Fuses are generally rated in Amperes.

Even though their functionality is based on the self-production of the heat in the scenarios of additional current through their own developed electrical resistance.

This can be generally achieved by making the fuse wire length to be as short as possible.

As the wire length is not dependent on current rating values, the minimal length of wire imposes the minimal value of resistance.

TYPES OF FUSES

1.Kitkat or Rewirable Types of Fuses

Rewirable fuses come under the classification of LV fuses, and those are almost used in small applications such as wiring in the house, small-scale industries, and other tiny current applications.

These types of fuses include two essential parts where those are a fuse base, which has two terminals like in and out. In general, this element is fabricated with Porcelain.

Another part of this fuse is a fuse carrier, which grips the fuse element.This element is fabricated with aluminum, tinned copper, and lead.

The main advantage of a fuse carrier is that we can simply plug and remove from the base of the fuse without the risk of shock.

As the fuse is damaged due to heavy current, then we can simply eliminate the Fuse Carrier as well as put back the fuse wire.



Rewirable or Kit – Kat Type Fuses are a type of Low Voltage (LV) Fuses. They are most commonly used in house wiring, small industries and other small current applications.

Rewirable Fuses consists of two main parts: a Fuse Base, which contains the in and out terminal, and a Fuse Carrier, which holds the Fuse Element. The Fuse Base is generally made up of Porcelain and the Fuse Element is made up of Tinned Copper, Aluminium, Lead, etc.

The Fuse Carrier can be easily plugged in or removed from the Fuse Base without the risk of any electric shock. When the fuse is blown due to over current, we can easily remove the Fuse Carrier and replace the fuse wire. This is the main advantage of Rewirable Fuses.

2.Cartridge Type Fuses or Totally Enclosed Type Fuses

As the name indicates, Cartridge or Totally Enclosed Fuses have a completely closed structure with the Fuse Links enclosed in the container. This type of design and construction will help in keeping the arc with in the container at the event of blown fuse.

Cartridge Type Fuses are a very important category of fuses that are used in almost all types of applications like Low Voltage (LV), High Voltage (HV) and miniature fuses.

Cartridge Type Fuses are again further divided in to D Type Cartridge Fuses and Link Type Cartridge Fuses.

D – Type Cartridge Fuse--This type of fuses consists of a Cartridge, fuse base, cap and adapter ring. The cartridge with the fuse element in it is fitted with the fuse cap and is inserted in to the fuse base through the adapter ring and the connection is complete only when the tip of the cartridge touch the conductor.

The cartridge type of fuses has entirely closed containers and metal contact as well. The applications of this fuse mainly include low voltage (LV), high voltage (HV), and small fuses. Again, these types of fuses are classified into two types, they are D-type and Link-type fuses.

D-type Cartridge Fuse

This type of fuse is composed of the cartridge, base of the fuse, adapter ring, and cap. The base of the fuse consists of a fuse cap, which is packed with the fuse ingredient by cartridge using an adapter ring.

It is composed of the cartridge, fuse base, cap & adapter ring. The fuse base has the fuse cap, which is fitted with the fuse element with a cartridge through the adapter ring. The connection of the circuit is finished when the tilt of the cartridge builds contact through the conductor.

Link Type Fuse or HRC fuse

The link type fuse is also known as high rupturing capacity (HRC) or BS type fuse. In this sort of fuse, the current flow with the fuse element is specified under standard conditions.

In this BS type fuse, the flow of current by fuse element is given under normal condition. The arc which is generated by the fuse blown is controlled is fabricated with porcelain, ceramic, and silver.

The container of the fuse element is packed with silica sand. This type of fuse is again categorized into two parts includes a blade type and bolted type.

High Rupturing Time or HRC Fuses are a type of Cartridge Fuses. In HRC Fuses, the current flows through the fuse element under normal conditions.

In case of a fault, the high current due to short circuit (or any other fault) will be allowed to flow through the fuse for a short but known period of time. If the fault is cleared in this time, the fuse will not blow or the fuse element doesn't melt.

If the fault continues even after some time i.e. short circuit current for longer duration than allowed, the fuse blows by melting the fuse element.

Since HRC Fuses are designed for high current rupturing, a special method must be used to control the arc produced in the event of blown fuse. Usually, the body of the fuse is made up of Porcelain or Ceramic and the fuse element chamber is filled with Silica Sand.

There are two types of HRC Fuses: Blade Type and Bolted Type. Blade Type Fuses are also known as Plug – in Type Fuses.

The body of the Blade Type Fuse is generally made up of plastic and the two conducting Blade Type Plates are fixed to the fuse element. Blade Type Fuses are generally used in Automobiles.

Advantages and Disadvantages of Electric Fuse

Few of the advantages and disadvantages of electric fuse are mentioned as follows:

Advantages

The advantages of electric fuse are

It is non-expensive and it does not any kind of additional care and maintenance

The devices are completely automotive fuses and need minimal time when compared to that of circuit breakers

As fuses are available in less size, they induce current restricting impact in abnormal conditions

The features of reversible time-current permit the device to be employed for overload safeguarding

Disadvantages

The disadvantages of electric fuse are:

It requires some time at the time of fuse replacement

The time-current feature will not be every time-synchronized with that of the safeguarding element

Applications of Different Types of Fuses

The different types of fuses and their uses have discussed are essential components in all the electrical circuits. Some of the main applications of fuses in the Electrical and Electronics field include the following.

Power Transformers

Electrical Appliances, like ACs (Air Conditioners), TV, Washing Machines, Music Systems, and many more.

Electrical Cabling in Home

Mobile Phones

Motor starters

Laptops

Power Chargers
Cameras, Scanners, Printers, and Photocopiers
Automobiles, electronic devices and Gaming's

DC MOTOR STARTERS

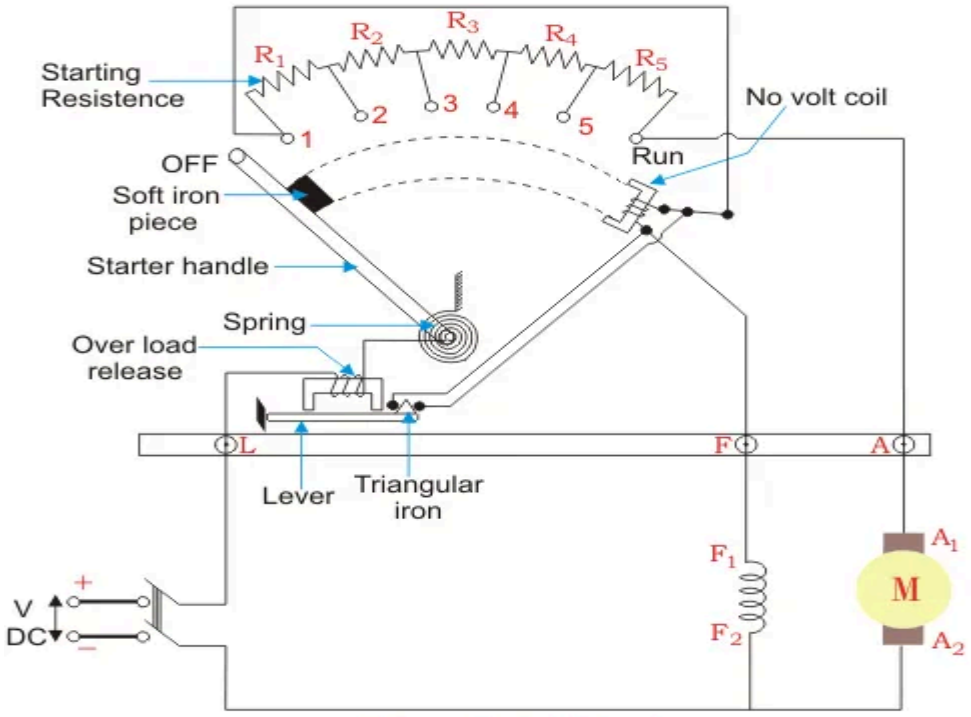
To avoid the above dangers while starting a DC motor, it is necessary to limit the starting current. So, a DC motor is started by using a starter.

There are various types of dc motor starters, such as 3 point starter, 4 point starter, no-load release coil starter, thyristor controller starter etc.

The basic concept behind every DC motor starter is adding external resistance to the armature winding during starting.

From the followings, 3 point starters and 4 point starters are used for starting shunt wound motors and compound wound motors.

3 POINT STARTER



Three Point Starter

When the connected dc motor is to be started, the lever is turned gradually to the right. When the lever touches point 1, the field winding gets directly connected across the supply, and the armature winding gets connected with resistances R1 to R5 in series.

During starting, full resistance is added in series with the armature winding. Then, as the lever is moved further, the resistance is gradually is cut out from the armature circuit.

Now, as the lever reaches to position 6, all the resistance is cut out from the armature circuit and armature gets directly connected across the supply.

The electromagnet 'E' (no voltage coil) holds the lever at this position. This electromagnet releases the lever when there is no (or low) supply voltage.

It can be seen that, when the arm is moved from the position 1 to the last position, the starter resistance gets added in series with the field winding. But, as the value of starter resistance is very small as compared to the shunt resistance, the decrease in shunt field current may be negligible.

However, to overcome this drawback a brass or copper arc may be employed within a 3 point starter which makes a connection between the moving arm and the field winding, as shown in the figure of 4 point starter.

When the motor is overloaded beyond a predefined value, 'overcurrent release electromagnet' D gets activated, which short-circuits electromagnet E and, hence, releases the lever and the motor is turned off.

4 POINT STARTER

A 4 point starter protects the armature of a DC shunt motor or compound wound DC motor against the initially high starting current of the DC motor.

The 4 point starter has a lot of constructional and functional similarity to a 3 point starter, but this special device has an additional point and coil in its construction (as the name suggests).

This brings about some difference in its functionality, though the basic operational characteristic remains the same.

The basic difference in the circuit of a 4 point starter as compared to 3 point starter is that the holding coil is removed from the shunt field current and is connected directly across the line with current limiting resistance in series.

A 4 point starter as the name suggests has 4 main operational points, namely

‘L’ Line terminal (Connected to positive of supply.)

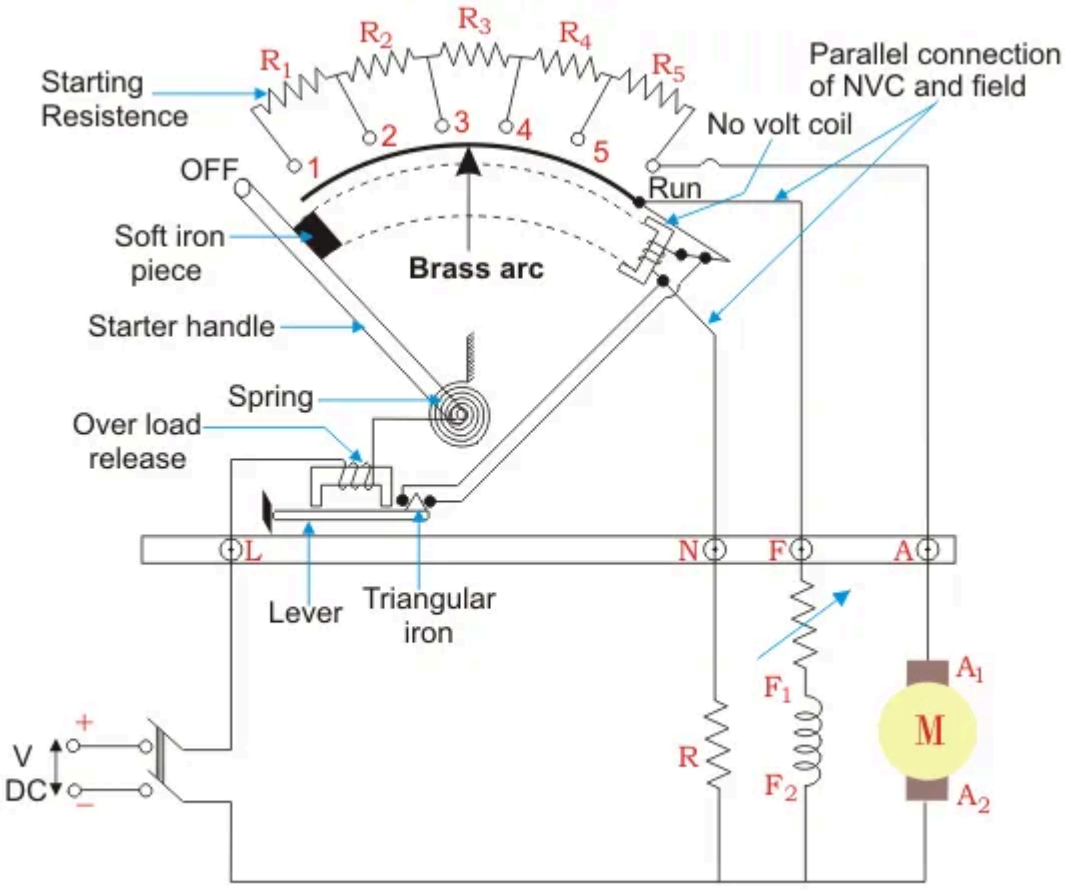
‘A’ Armature terminal (Connected to the armature winding.)

‘F’ Field terminal. (Connected to the field winding.)

Like in the case of the 3 point starter, and in addition to it there is,

A 4th point N (Connected to the No Voltage Coil NVC)

The remarkable difference in case of a 4 point starter is that the No Voltage Coil is connected independently across the supply through the fourth terminal called ‘N’ in addition to the ‘L’, ‘F’ and ‘A’. As a direct consequence of that, any change in the field supply current does not bring about any difference in the performance of the NVC. Thus it must be ensured that no voltage coil always produce a force which is strong enough to hold the handle in its ‘RUN’ position, against the force of the spring, under all the operational conditions. Such a current is adjusted through No Voltage Coil with the help of fixed resistance R connected in series with the NVC using fourth point ‘N’ as shown in the figure



Four Point Starter

Apart from this above mentioned fact, the 4 point and 3 point starters are similar in all other ways like possessing is a variable resistance, integrated into number of sections as shown in the figure above. The contact points of these sections are called studs and are shown separately as OFF, 1, 2, 3, 4, 5, RUN, over which the handle is free to be maneuvered manually to regulate the starting current with gathering speed.

Now to understand its way of operating let's have a closer look at the diagram given above. Considering that supply is given and the handle is taken stud No.1, then the circuit is complete and the line current that starts flowing through the starter. In this situation we can see that the current will be divided into 3 parts, flowing through 3 different points.

1 part flows through the starting resistance ($R_1 + R_2 + R_3$…..) and then to the armature.

A 2nd part flowing through the field winding F.

And a 3rd part flowing through the no voltage coil in series with the protective resistance R.

So the point to be noted here is that with this particular arrangement any change in the shunt field circuit does not bring about any change in the no voltage coil as the two circuits are independent of each other.

This essentially means that the electromagnet pull subjected upon the soft iron bar of the handle by the no voltage coil at all points of time should be high enough to keep the handle at its RUN position, or rather prevent the spring force from restoring the handle at its original OFF position, irrespective of how the field rheostat is adjusted.

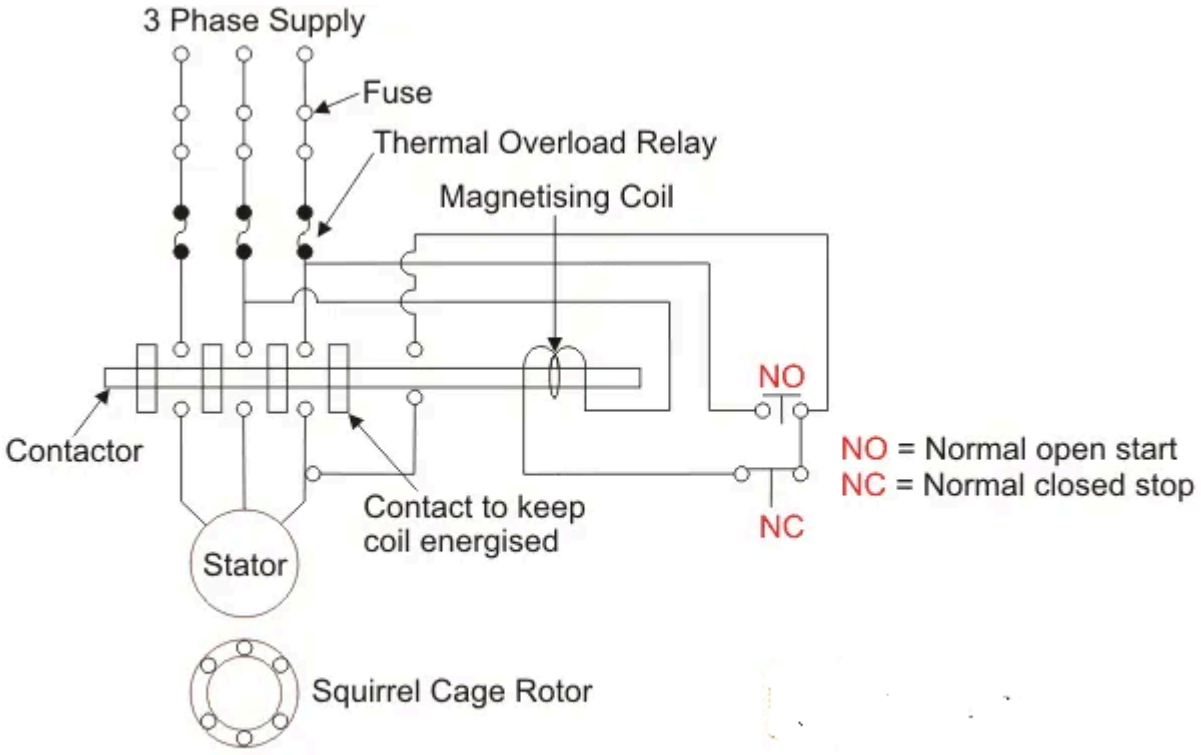
AC MOTOR STARTERS

DOL Starter (Direct On Line Starter)

A **DOL starter** (also known as a **direct on line starter** or **across the line starter**) is a method of starting a 3 phase induction motor.

In a DOL Starter, an induction motor is connected directly across its 3-phase supply, and the DOL starter applies the full line voltage to the motor terminals.

Despite this direct connection, no harm is done to the motor. A DOL motor starter contains protection devices, and in some cases, condition monitoring. A wiring diagram of a DOL starter is shown below:



Since the DOL starter connects the motor directly to the main supply line, the motor draws a very high inrush current compared to the full load current of the motor (up to 5-8 times higher). The value of this large current decreases as the motor reaches its rated speed.

A direct on line starter can only be used in circumstances when the high inrush current of the motor does not cause an excessive voltage drop in the supply circuit. If a high voltage drop

needs to be avoided, a star delta starter should be used instead. Direct on line starters are commonly used to start small motors, especially 3 phase squirrel cage induction motors.

As we know, the equation for armature current in the motor.

The value of back emf (E) depends upon speed (N), i.e. E is directly proportional to N.

At starting, the value of E is zero. So starting current is very high. In a small rating motor, the rotor has a more considerable axial length and small diameter. So it gets accelerated fastly.

Hence, speed increases and thus the value of armature current decreases rapidly. Therefore, small rating motors smoothly run when it is connected directly to a 3-phase supply.

If we connect a large motor directly across 3-phase line, it would not run smoothly and will be damaged, because it does not get accelerated as fast as a smaller motor since it has short axial length and larger diameter more massive rotor. However, for large-rated motors, we can use an oil-immersed DOL starter.

STAR DELTA STARTER

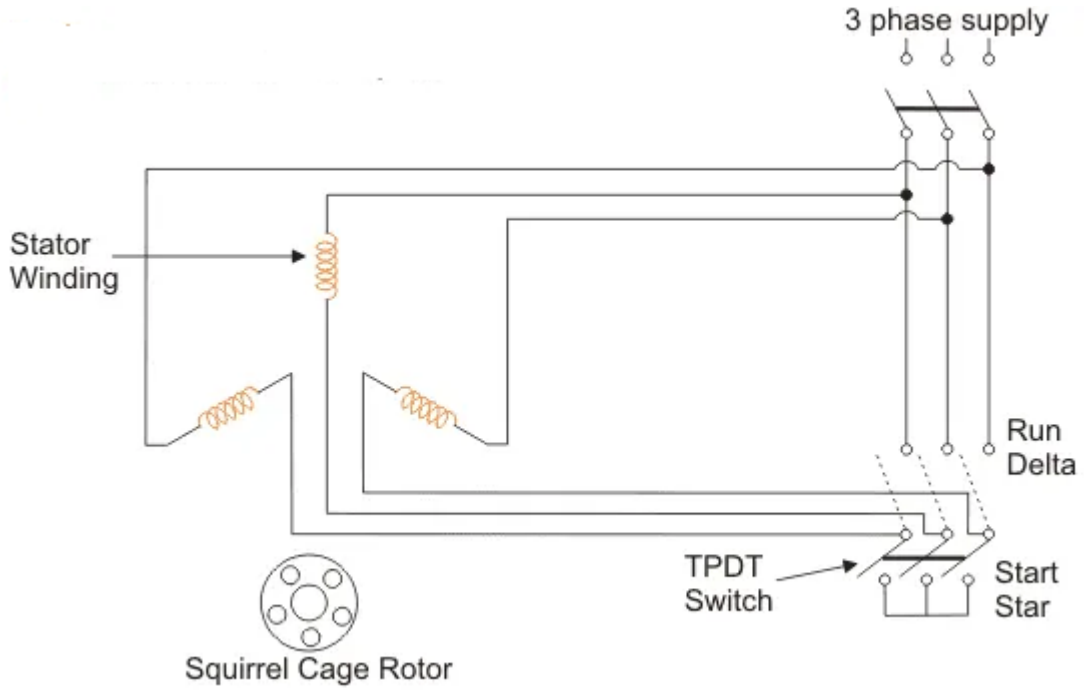
The stator winding is connected in star fashion so that voltage at each phase is

Where, V_L is line voltage. Therefore voltage is reduced at each phase at starting and hence current is reduced.

As soon as motor achieves certain speed, motor winding is connected in delta fashion such that line voltage is equal to phase voltage with the help of two way switch.

The star delta starter is used for starting of induction motor above 5 H.P.

A star delta starter will start a motor with a star connected stator winding. When motor reaches about 80% of its full load speed, it will begin to run in a delta connected stator winding.

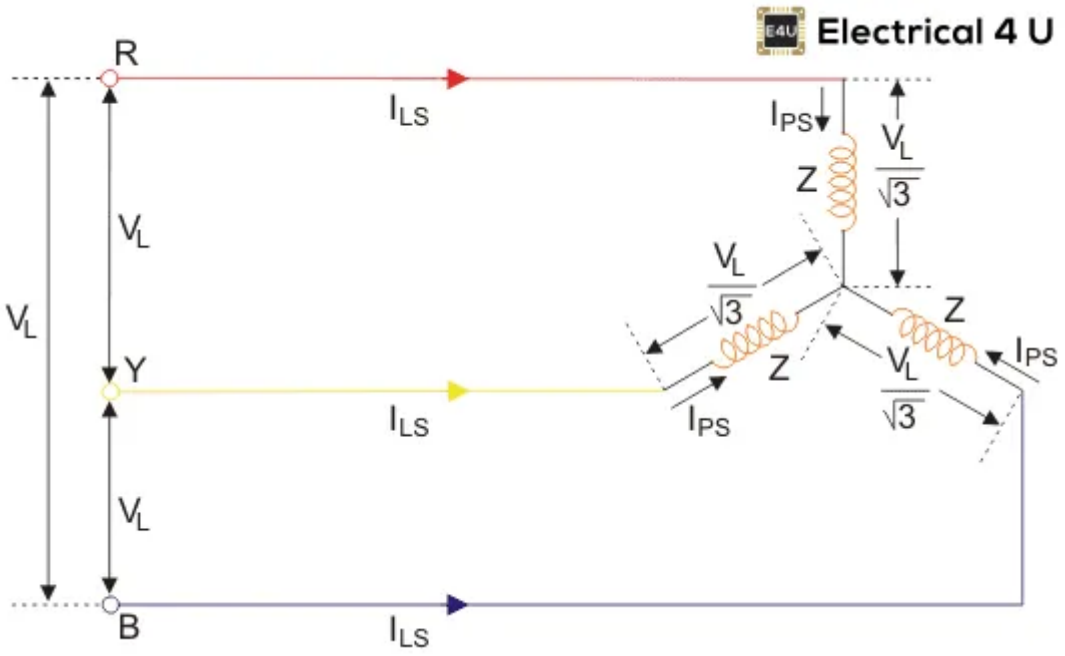


A star delta starter is a type of reduced voltage starter. We use it to reduce the starting current of the motor without using any external device or apparatus. This is a big advantage of a star delta starter, as it typically has around 1/3 of the inrush current compared to a DOL starter.

The starter mainly consists of a TPDP switch which stands for Tripple Pole Double Throw switch. This switch changes stator winding from star to delta. During starting condition stator winding is connected in the form of a star. Now we shall see how a star delta starter reduces the starting current of a three-phase induction motor.

For that let us consider,

VL = Supply Line Voltage, ILS = Supply Line Current and, IPS = Winding Current per Phase and Z = Impedance per phase winding at stand still condition.



As the winding is star connected, the winding current per phase (IPS) equals to supply line current (ILS).

As the winding is star connected, the voltage across each phase of the winding is

Hence, the winding current per phase is

Since here, the winding current per phase (IPS) equals to the supply line current (ILS), we can write,

Now, let us consider the situation where the motor gets started with delta connected stator winding from same three phase supply points,

HerILD = Supply Line Current and, IPD = Winding Current per Phase and Z = Impedance per phase winding at stand still condition.
As the winding is delta connected, supply line current (ILD) is root three times of the winding current per phase (IPD)

Now, by comparing supply line currents drawn by an induction motor with star and delta connected winding, we get

Thus we can say that the starting current from the mains in case of star delta is one-third of direct switching in the delta. Again, we know that the starting torque of an induction motor is proportional to the square of the voltage applied to the winding per phase.

The equation shows that **star delta starter** reduces the starting torque to one-third of that produced by DOL starter. The star-delta starter is equivalent to an autotransformer with a 57.7% tapping.

Advantages of Star Delta Starter

The advantages of star delta starters include:

- Inexpensive

No heat is produced, or tap changing device needs to be used, hence efficiency increases.

Starting current reduced to 1/3 of direct online starting current.

Produce high torque per ampere of line current.

Disadvantages of Star Delta Starter

The disadvantages of star delta starters include:

Starting torque is reduced to 1/3 of full load torque.

A particular set of motors required.

Application of Star Delta Starter

As discussed in the above advantages and disadvantages, a **s**tar delta starter is most suited to applications where the required starting current is low and where the line current draw must be at a minimum value.

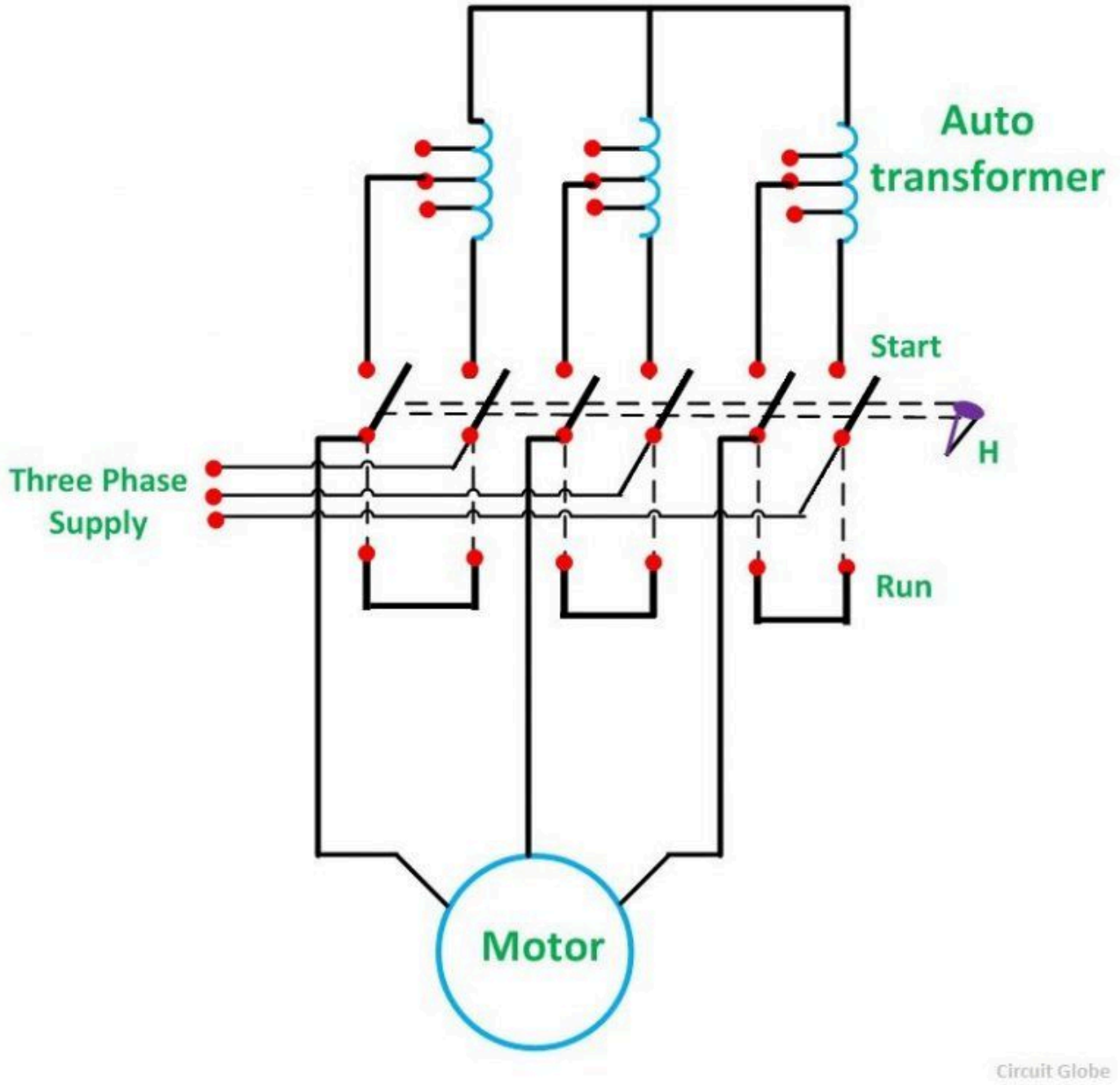
The star delta starter is not suitable for applications where high starting torque delivery is required. For these applications, a DOL starter should be used instead.

If the motor is too heavily loaded, there will not be enough torque to accelerate the motor upto speed before switching over to the delta position.

Example application for a star delta starter is a Centrifugal compressor.

AUTO TRANSFORMER STARTER

An Autotransformer Starter is suitable for both star and delta connected motors. In this method, the starting current is limited by using a three-phase autotransformer to reduce the initial stator applied voltage. The figure below shows the motor with the autotransformer starter:



It is provided with a number of tappings. The starter is connected to one particular tapping to obtain the most suitable starting voltage. A double-throw switch S is used to connect the autotransformer in the circuit for starting.

When the handle H of the switch S is in the START position, the primary of the autotransformer is connected to the supply line, and the motor is connected to the secondary of the autotransformer.

When the motor picks up the speed of about 80 percent of its rated value, the handle H is quickly moved to the RUN position. Thus, the autotransformer is disconnected from the circuit, and the motor is directly connected to the line and achieves its full rated voltage. The handle is held in the RUN position by the under voltage relay.

If the supply voltage fails or falls below a certain value, the handle is released and returns to the OFF position. Thermal overload relays provide overload protection whenever required.

RELAY

A relay is automatic device which senses an abnormal condition of electrical circuit and closes its contacts. These contacts in turns close and complete the circuit breaker trip coil circuit hence make the circuit breaker tripped for disconnecting the faulty portion of the electrical circuit from rest of the healthy circuit.

Reset Level:

The value of current or voltage below which a relay opens its contacts and comes in original position.

Operating Time of Relay:

Just after exceeding pickup level of actuating quantity the moving mechanism (for example rotating disc) of relay starts moving and it ultimately closes the relay contacts at the end of its journey. The time which elapses between the instant when actuating quantity exceeds the pickup value to the instant when the relay contacts close.

Reset Time of Relay:

The time which elapses between the instant when the actuating quantity becomes less than the reset value to the instant when the relay contacts return to its normal position.

Reach of Relay:

A distance relay operates whenever the distance seen by the relay is less than the pre-specified impedance. The actuating impedance in the relay is the function of distance in a distance protection relay. This impedance or corresponding distance is called the reach of relay.

Types of Relays

Types of protection relays are mainly based on their characteristic, logic, on actuating parameter and operation mechanism.

Based on operation mechanism protection relay can be categorized as electromagnetic relay, static relay and mechanical relay. Actually, a relay is nothing but a combination of one or more open or closed contacts. These all or some specific contacts the relay change their state when actuating parameters are applied to the relay. That means open contacts become closed and closed contacts become open. In an electromagnetic relay, these closing and opening of relay contacts are done by the electromagnetic action of a solenoid.

In the mechanical relay, these closing and opening of relay contacts are done by mechanical displacement of different gear level system.

overload relay

An overload relay is a device that protects an electric motor against overloads and phase failure.

It senses overloading of motor and interrupts the power flow to the motor, thus protecting it from overheating and winding damages. Apart from overloads, it can also protect the motor from phase loss/ failures and phase imbalance. They are very commonly known as OLR.

What is an overload?

An overload is a condition at which a motor draws a current above its rated value, for a prolonged period.

It is the most encountered fault and can result in temperature rise in the motor winding. Hence the rapid return to normal operation is important.

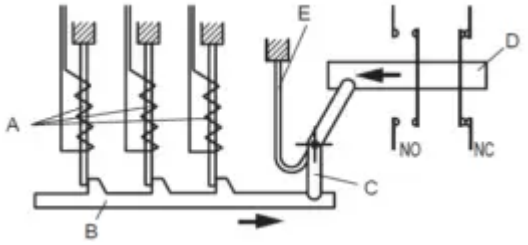
Principle of operation

A thermal overload relay works in the principle of electro-thermal properties in a bimetallic strip. It is placed in the motor circuit in such a way that the current to the motor flows through its poles.

The bimetallic strip gets heated up by the current directly or indirectly and when the current flow exceeds the set value, it bends.

They are always work in combination with contactors. When the bimetallic strips heat up, the trip contact is activated that in turn breaks the power supply to the contactor coil, de-energizing it and breaking the current flow to the motor.

This tripping time is always inversely proportional to the current flow through the OLR. Hence higher the current flow faster shall it trips. Therefore, thermal overload relays are referred to as current dependent and inversely time-delayed relay.



A = Indirectly heated bimetal strips
B = Trip slide
C = Trip lever
D = Contact lever
E = Compensation bimetal strip
Credit: Rockwell

Types of overload relays

Overload relays can be classified as follows:

1. Bimetallic thermal overload relays
2. Electronic overload relays

TIME DELAY RELAY

Some relays are constructed with a kind of “shock absorber” mechanism attached to the armature which prevents immediate, full motion when the coil is either energized or de-energized. This addition gives the relay the property of time-delay actuation.

Time-delay relays can be constructed to delay armature motion on coil energization, de-energization, or both.Time-delay relay contacts must be specified not only as either normally-open or normally-closed but whether the delay operates in the direction of closing or in the direction of opening.

Normally-Open, Timed-Closed Contact

First, we have the normally-open, timed-closed (NOTC) contact. This type of contact is normally open when the coil is unpowered (de-energized).
The contact is closed by the application of power to the relay coil, but only after the coil has been continuously powered for the specified amount of time.
In other words, the direction of the contact’s motion (either to close or to open) is identical to a regular NO contact, but there is a delay in closing direction. Because the delay occurs in the direction of coil energization, this type of contact is alternatively known as a normally-open, on-delay:

Normally-Open, Timed-Open Contact

Next, we have the normally-open, timed-open (NOTO) contact. Like the NOTC contact, this type of contact is normally open when the coil is unpowered (de-energized), and closed by the application of power to the relay coil.
However, unlike the NOTC contact, the timing action occurs upon de-energization of the coil rather than upon energization. Because the delay occurs in the direction of coil de-energization, this type of contact is alternatively known as a normally-open, off-delay:

Normally-Closed, Timed-Open Contact

Next, we have the normally-closed, timed-open (NCTO) contact. This type of contact is normally closed when the coil is unpowered (de-energized).
The contact is opened with the application of power to the relay coil, but only after the coil has been continuously powered for the specified amount of time.
In other words, the direction of the contact’s motion (either to close or to open) is identical to a regular NC contact, but there is a delay in the opening direction.
Because the delay occurs in the direction of coil energization, this type of contact is alternatively known as a normally-closed, on-delay:

Time delay relays are built in these four basic modes of contact operation:

1: Normally-open, timed-closed. Abbreviated “NOTC”, these relays open immediately upon coil de-energization and close only if the coil is continuously energized for the time duration period. Also called normally-open, on-delay relays.

2: Normally-open, timed-open. Abbreviated “NOTO”, these relays close immediately upon coil energization and open after the coil has been de-energized for the time duration period. Also called normally-open, off delay relays.

3: Normally-closed, timed-open. Abbreviated “NCTO”, these relays close immediately upon coil de-energization and open only if the coil is continuously energized for the time duration period. Also called normally-closed, on-delay relays.

4: Normally-closed, timed-closed. Abbreviated “NCTC”, these relays open immediately upon coil energization and close after the coil has been de-energized for the time duration period. Also called normally-closed, off delay relays.

One-shot timers provide a single contact pulse of specified duration for each coil energization (transition from coil off to coil on).

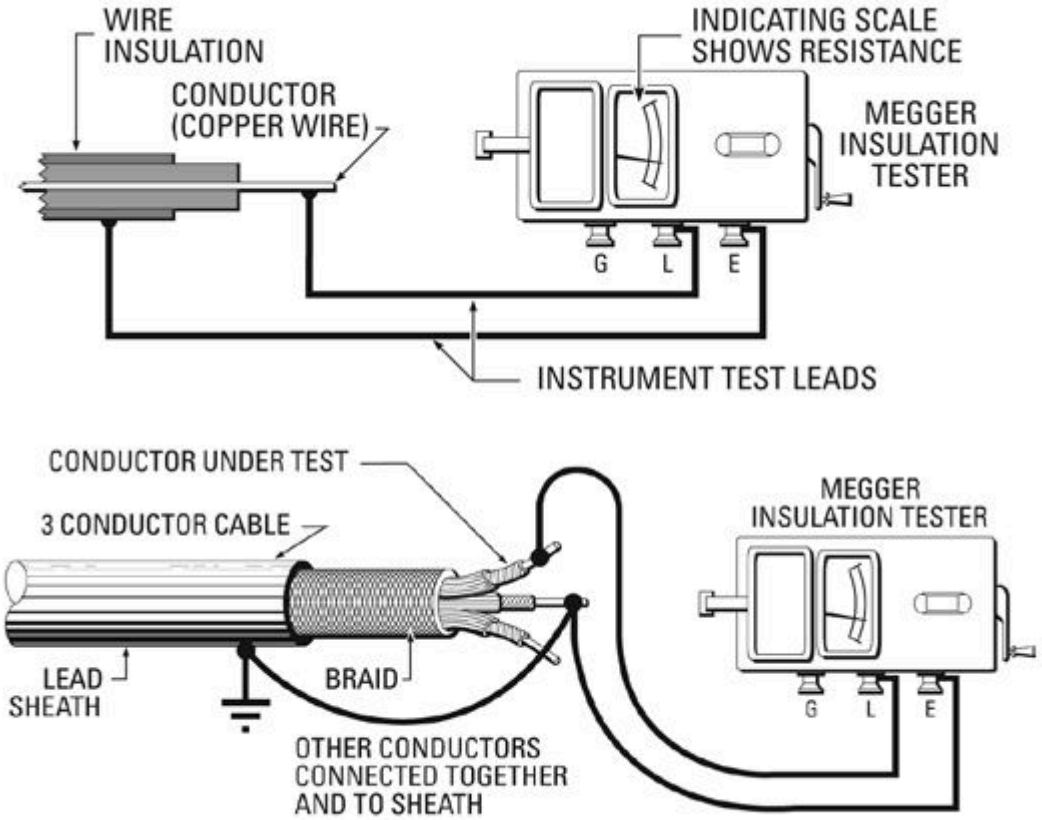
Recycle timers provide a repeating sequence of on-off contact pulses as long as the coil is maintained in an energized state.

Watchdog timers actuate their contacts only if the coil fails to be continuously sequenced on and off (energized and de-energized) at a minimum frequency.

At the completion of the electrical installation works, the entire installation shall be subject to the test before final placing in service under the full responsibility of the contractor. Unless Otherwise specifically called for all tests shall be carried out in conformity with IEE regulations. Contractor shall coordinate with the Client and the Supervising Engineer to get electricity from the local supply authority before starting of testing and commissioning.

Testing before giving supply and testing report.

At the completion of the electrical installation works, the entire installation shall be subject to the test before final placing in service under the full responsibility of the contractor. Unless Otherwise specifically called for all tests shall be carried out in conformity with IEE regulations. Contractor shall coordinate with the Client and the Supervising Engineer to get electricity from the local supply authority before starting of testing and commissioning.



For any reason, if there is any delay in getting the power supply contractor shall either make his own temporary arrangement to test all the equipment or to give undertaking to test and commission the equipments as and when supply available without any extra cost. The virtual completion of work can be accepted from the date of handing over after completing the successful testing and commissioning procedure.

Kinds of Electrical Installation Testing

Following tests shall be carried out: Wiring continuity test, Insulation resistance test, Earth continuity test, Earth resistivity test, Performance test, and any other tests as instructed by the Supervising Engineer.

1. Electrical Wiring Continuity Testing

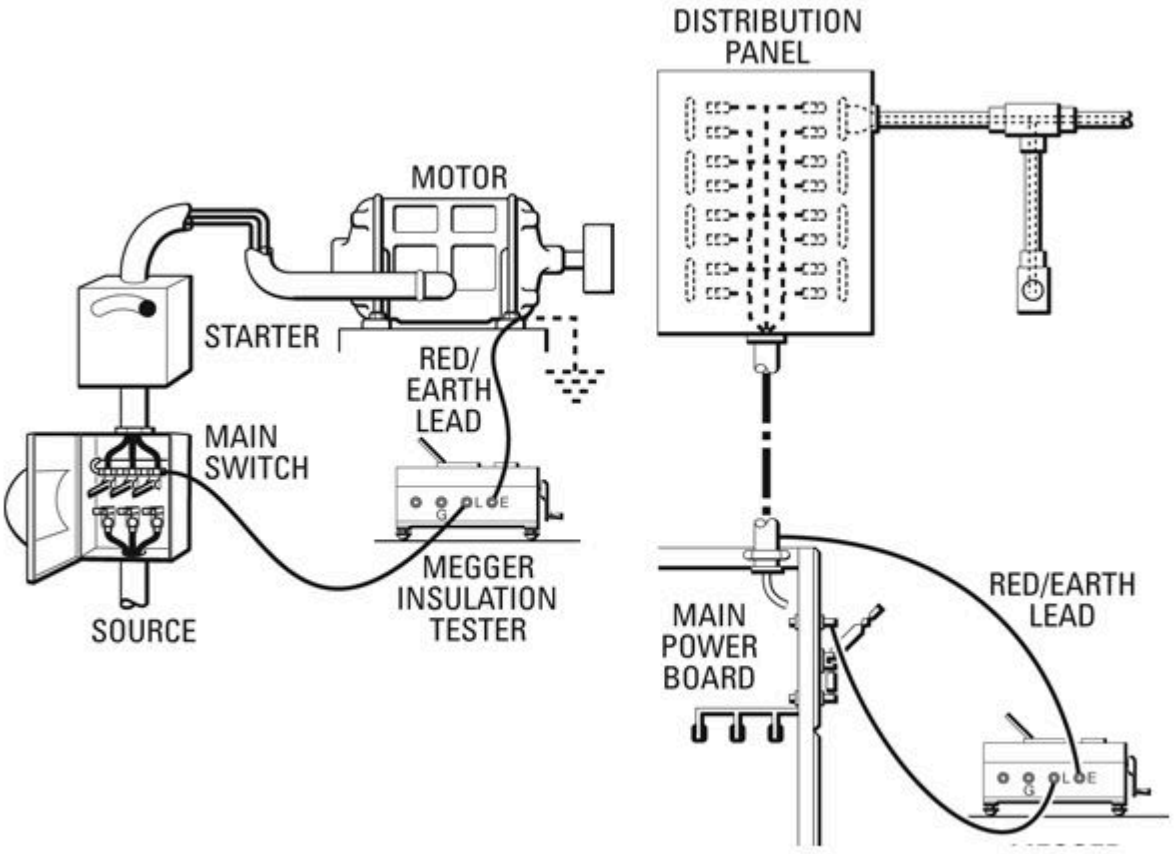
All wiring system shall be tested for continuity of circuits, short circuits and earthing after wiring is completed and before energizing.

2. Electrical Insulation Resistance Testing

The insulation resistance shall be measured across earth and the whole system of conductors, or any section thereof, with all fuses in place and all switches closed and except in concentric wiring all lamps in position of both poles of the installation otherwise electrically connected together.

A direct current pressure of not less than twice the working pressure provided that it does not exceed 660 V for medium voltage circuits. Where the supply is divided from AC three phase system, the neutral pole of which is connected to earth, either direct or through added resistance, pressure shall be deemed to be that which is maintained between the phase conductor and the neutral.

The insulation resistance measured as above shall not be less than 50 mega ohms divided by the number of points on the circuit provided that the whole installation, shall not be required to have an insulation resistance greater than one mega ohm.



The insulation resistance shall also be measured between all conductors connected to one phase conductor of the supply and all the conductors connected to the middle wire to the neutral or to the other phase conductors to the supply. Such a test shall be carried out after removing all metallic connections between the two poles of the installation and in these circumstances the insulation shall not be less than that specified above.

The insulation resistance between the case or frame work of housing and power appliances, and all live parts of each appliance shall not be less than that specified in the relevant British standard specification or where there is no such specification shall not be less than a mega ohm.

3. Electrical Earth Continuity Path Testing

The earth continuity conductor metallic envelops of cables, shall be tested for electric continuity and the electrical resistance of the same along with the earthing lead but excluding any added resistance or earth leakage circuit breaker measured from the connection with the earth electrode to any point in the earth continuity conductor in the completed installation shall not exceed one ohm.

4. Electrical Testing of Non-linked Single Pole Switches

In a two wire installation a test shall be made to verify that all non linked single pole switches have been fitted in the same conductor throughout, and such conductor shall be labeled or marked for connection, throughout, and such conductor shall be labeled or marked for connection to an outer or phase conductor or non earthed conductor a test shall be made three or four wire installation a test shall be made to verify that every non linked single pole switch is fitted in a

conductor to one of the outer or phase conductor of the supply. The entire electrical installation shall be subject to the final acceptance of the Supervising engineer as well as the local authorities.

5. Electrical Earth Resistivity Testing

Earth resistivity test shall be carried out in accordance with British Standard Code of Practice of Earthing. All tests shall be carried out in the presence of the Supervising Engineer.

6. Electrical Performance Testing

The complete electrical installation and equipment shall be subject to the final performance test as intended for each and every equipment shall be tested as per the manufacturers instructions.

TESTING REPORT

N0. _ _ _ _ _ _

WORK COMPLETION AND TEST REPORT

Sr. No
Name of the Applicant/Consumer _____
Address 1:_____
Address 2:_____
Address 3:_____
Address 4:_____

Date:-
Reference No._____
Account No._____
Tapping/Existing Meter No_____

We hereby certify that the electrical installation work at the the premises and for the party mentioned above has been carried out by us in full conformity with the Indian Electricity Rules 1956, and the conditions of supply. The particulars of the installation and insulation test results obtained by us are given below. (In case the form is filled up in respect of work of repairing and/ or testing of an existing installation, the above paragraph should specially be modified accordingly.)

Lighting
Between Phase____
Phase To Earth

Power
Megaohm_____ Megaohm _____
Megaohm Megaohm

Class of Premises
Residential_____ Industrial____
Commercial_____ Others

A) New Meter & Extension of Load

Load	Existing Load any			New Load Requirement			Total Wattage (1+2)
	No. of points	Wattage(1)	Voltage	No. of points	Wattage(1)	Voltage	
Lights							
Fans							
Call bell							
AC							
Refrigerator							
Heater/Geyser							
Iron							
Plug							
Water Pump							
Lift							
Others							
1							
2							
3							
4							
5							
Total							

Note: Please attach separate sheet, if necessary

B) Shifting of Meter/Reconnection
Area of the premise where Installation carried out _____ sq.m

Meter No.	Account No

Height of the Building is less/more than 15m. PWD Clearance certificate required/ not required.
It is certified that Electrical Contractors License and class-I license of the supervisor have been renewed up to date and are in force today.

Electrical Contractor
License No. _____
Name: _____
Address: _____
Signature _____

Class-1 Supervisor
License No. _____
Name: _____
Address: _____
Signature _____

Date:
Inspection Of installation_____between_____and_____L.E.C. advised on_____date:
Meter Size: Lighting

Power
Meter No._____

Clearance of arrears from recovery/vigilance department is required / received
to be removed

New Service [] Extn Of Load [] Tapping [] Subdivision of Load [] Shifting [] Temporary []

SAMPLE

TESTING AND MAINTENANCE OF ELECTRICAL MACHINE
Name of the Chapter:- Installation, Commissioning & Testing of Machine

ASSIGNMENT QUESTIONS

Group-A

Sl. No.	Gr.	Ch. No.	Q. No.	Question	
	A	1		What are instructions necessary before installation?	
	A	1		Why earthing is necessary?	
	A	1		Why starters are used in DC machine ?	2017-W
	A	1		Why no-volt coil is provided in the starter?	
	A	1		Inspection of electrical machine is necessary. Why?	

Group-B

Sl. No.	Gr.	Ch. No.	Q. No.	Question	
	B	1		Describe the principle of operation of thermal relay used for motor protection.	
	B	1		Explain 4-point starter briefly.	2017-W
	B	1		What are the test done on relays ?	2017-W
	B	1		Explain the Requirements of Civil Engineering works and foundation work for medium and large induction motors.	2017-S
	B	1		What do you mean by earthing ? Explain the PLATE earthing connection.	2017-S
	B	1		Explain different types of fuses.	

Group-C

Sl. No.	Gr.	Ch. No.	Q. No.	Question
	C	1		Explain the procedure for making foundation of electric machines.
	C	1		Explain the different methods of earthing?
	C	1		In the content of Indian electricity Rules, write short notes on the following: on the testing of common installations nst failure of supply.
	C	1		Write short notes on the following elay, of Relay.
	C	1		What are the different methods of starting and induction motor ?

TESTING AND MAINTENANCE OF ELECTRICAL MACHINE
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PRACTICE QUESTIONS

Group-A

Sl. No.	Gr.	Ch. No.	Q. No.	Question	
1	A	1		What is the purpose of earthing ?	2017-W
2	A	1		Define earth resistance.	2017-W
3	A	1		What are the functions of relay?	
4	A	1		What are the precaution to be taken while drying in a transformer ?	2017-S
5	A	1		Explain the various specifications and ratings of synchronous machine.	2017-S

Group-B

Sl. No.	Gr.	Ch. No.	Q. No.	Question	
	B	1		Write down the procedure for inspection of an electrical motor before instalation	
	B	1		Explain 3-point starter briefly.	2017-W
	B	1		What are the test done on relays ?	2017-W
	B	1		Write down the steps for drying out of motors	2017-S
	B	1		What are the precautions should be taken during drying out process	2017-S
	B	1			

Group-C

Sl. No.	Gr.	Ch. No.	Q. No.	Question
	C	1		Explain the different methodes of drying out of mototrs
	C	1		What do you mean by foundation?what are the objectives of foundation?
	C	1		What is vibration?explain about different types of vibrations
	C	1		Explain in detail about miniature cercuit breaker
	C	1		What are the different methods of starting and induction motor ?