

Energy Audit:

Energy audit is an inspection, survey and analysis of energy flow for energy conservation in a building, process or system. It is done with a view to reduce the amount of energy input into the system without negatively affecting the output(s).

An Energy Audit is a survey conducted by an Energy Auditor to determine how much energy a building uses and identify ways to reduce energy consumption. These are used to improve the energy efficiency of homes, businesses, and other buildings.

As per the Energy Conservation Act, 2001, an energy audit is defined as “the verification, monitoring and analysis of use of energy including submission of a technical report containing recommendations for improving energy efficiency with cost benefit analysis and an action plan to reduce energy consumption.”

Need for energy audit

The functions of the energy audit are,

- an energy audit can reduce energy consumption
- an energy audit can reduce the energy bill and save the money
- an energy audit can improve the comfort level
- an energy audit can reduce the carbon footprints
- an energy audit can reduce unnecessary waste and pollution

The energy audit is the great and most valuable step to save energy consumption and save money.

Types of Energy Audit

There are several types of energy audits: walk-through energy audits, target energy audits, and detailed energy audits.

Walk-through Energy Audits

The simplest and fastest type of energy audit is a walk-through energy audit. It is defined as the simple surveying audit in which the auditor only investigates the energy consumption of an organization and in this type of energy audit no major steps will be taken for consuming energy, it is also known as a preliminary audit. It is the first step of auditing and it is the simplest and quickest type of audit. And is focused on the major energy consumption area. The walk-through energy audit is completed in the lesser time of span. The auditor will find the energy consumption area and developed the full list of the energy-saving measures.

Target Energy Audits

A target energy audit is more comprehensive than a walk-through energy audit. The target energy audit starts with the finding of the walk-through energy audit. This type of audit provides a detailed analysis of a specific project. This energy audit approach differs depending upon the structure type whether it is a commercial structure, residential, or industrial structure, but in all the structures more detailed information and data are needed. The outcomes are the recommendations regarding the actions to be taken. A clear and brief energy report should be submitted including the action plan “how to improve energy efficiency”.

Detailed Energy Audits

A detailed energy audit is the most comprehensive type of energy audit. This audit is also known as an investment-grade or comprehensive energy audit. In the detailed energy, the audit may need a complete analysis of possible capital-intensive modifications, including modelling and simulation. The detailed energy audit may need the collection of data over a long period for high accuracy and provide detailed energy consumption reports and detailed saving reports so that it becomes easy for the contractors to understand what exactly the measures to install. The detailed energy audit has been carried out in three phases, i.e., pre-audit phase, audit phase, and post-audit phase.

Equipment Earthing:

Equipment earthing is a connection done through a metal link between the body of any electrical appliance, or neutral point, as the case may be, to the deeper ground soil. The metal link is normally of GI wire which should be penetrated into the ground earth grid. The potential of the earth is to be considered zero for all practical purposes. Earthing is to connect any electrical equipment to earth with a very low resistance wire, making it to attain earth's potential. This ensures safe discharge of electrical energy due to failure of the insulation line coming in contact with the equipment casing, etc. Earthing brings the potential of the body of the equipment to zero, thus protecting the operating personnel against electrical shock.

The earth resistance is affected by the following factors:

- (a) Material properties of the earth, wire and the electrode
- (b) Temperature and moisture content of the soil
- (c) Depth of the pit
- (d) Quantity of the charcoal used

Necessity of Earthing:

The requirement for provision of earthing can be listed as follows:

- (1) To protect the operating personnel from the danger of shock.
- (2) To maintain the line voltage constant, under unbalanced load condition.
- (3) To avoid risk of fire due to earth leakage current through unwanted path.
- (4) Protection of the equipment.
- (5) Protection of large buildings and all machines fed from overhead lines against lightning.

Fuse:

The electrical equipment are designed to carry a particular rated value of current under normal conditions. Under abnormal conditions such as short circuits, overload, or any fault; the current rises above this value, damaging the equipment and sometimes resulting in fire hazard. Fuses come into operation under fault conditions.

A fuse is short piece of metal, inserted in series with the circuit, which melts when excessive current flows through it and thus breaks the circuits. Under normal operating conditions it designed to carry the full load current. If the current increases beyond this designed value due to any of the reasons mentioned above, the fuse melts, isolating the power supply from the load.

Desirable characteristics of a Fuse Element:

The material used for fuse wires must have the following characteristics:

- i. Low melting point e.g., tin, lead.
- ii. High conductivity e.g., copper.
- iii. Free from deterioration due oxidation e.g., silver.

iv. Low cost e.g., tin, copper.

Materials used for Fuse:

Material used are tin lead or silver having low melting points. Use of copper or iron is dangerous, though tinned copper may be used.

Types of Fuses:

Fuses are classified into following types

- (i) Re-wireable or kit-Kat fuse and
- (ii) High rupturing capacity (H.R.C) cartridge fuse

Miniature Circuit Breaker (MCB):

Minimum circuit breakers are electromechanical devices which protect an electrical circuit from over currents. Over currents in an electrical circuit may results from short circuits overload, or faulty design. An MCB is better alternative than fuse, since it does not require replacement once an overload is detected. An MCB functions by interrupting the continuity of electrical flow through the circuits once a fault is detected.

In simple terms, MCB is a switch which automatically turns off when the current flowing through it passes the maximum allowable limit. Generally, MCB is designed to protect against over current and over temperature faults (over heating).

Working Principle:

There are two contact one is fixed and the other is moveable. When the current exceeds the predefined limit, the moveable contact open (i.e., disconnect from the fixed contact) and the MCB turns off, thereby stopping the current from flowing in the circuits.

The normal current ratings are available from 0.5-63 A with a symmetrical short circuit rupturing capacity of 3-10kA, at a voltage level of 230/440V. MCBs are generally designed to trip within 2.5 millisecond when an over current fault arises. In case of temperature rise or over heating it may take 2 seconds to 2 minutes for the MCB to trip.

Advantages:

- i. MCBs are replacing the fuse units for low power domestic and industrial applications.
- ii. The disadvantages of fuses, like low SC interrupting capacity (say 3kA), etc. are overcome with high SC breaking capacity of 10kA.
- iii. MCB is combination of all three functions in a wiring system like switching, overload and short circuits protection.

Earth Leakage Circuits Breaker (ELCB):

An Earth Leakage Circuits Breakers (ELCB) is a device used to directly detect currents leaking to earth from an installation and cut the power. An Earth-leakage circuit breaker (ELCB) is a safety device used in electrical installations (both residential and commercial) with high Earth impedance to prevent electric shocks. It detects small stray voltages on the metal enclosures of electrical equipment, and interrupts the circuit if a dangerous voltage is detected.

ELCBs help detect current leaks and insulation failures in the electrical circuits that would cause electrical shocks to anyone coming into contact with the circuit.

There are two types of ELCBs:

- (i) Voltage Earth Leakage Circuits Breaker (voltage -ELCB)
- (ii) Current Earth Leakage Circuits Breaker (Current -ELCB)

Advantages of Earth Leakage Circuit Breaker

The advantages of ELCB include the following.

- (i) The ELCB is not a sensitive device to faults.
- (ii) It is inexpensive as well as efficient.
- (iii) It guards humans & animals against electrical shock.
- (iv) In this procedure, once the installation of ELCB has two connections toward the ground, high current lightning which is nearby to the ground will strike to cause a voltage gradient within the soil, so the ELCB can sense the coil by sufficient voltage to cause it to safety trip.

Isolator:

Electrical isolator is a type of mechanical switch that is used in electric circuits to effectively isolate the power circuit. Electrical Isolator switches are used for opening an electrical circuit in the no-load condition. It is not proposed to be opened while current flows through the line. Generally, these are employed on circuit breaker both the ends thus the circuit breaker repair can be done easily without any risk.

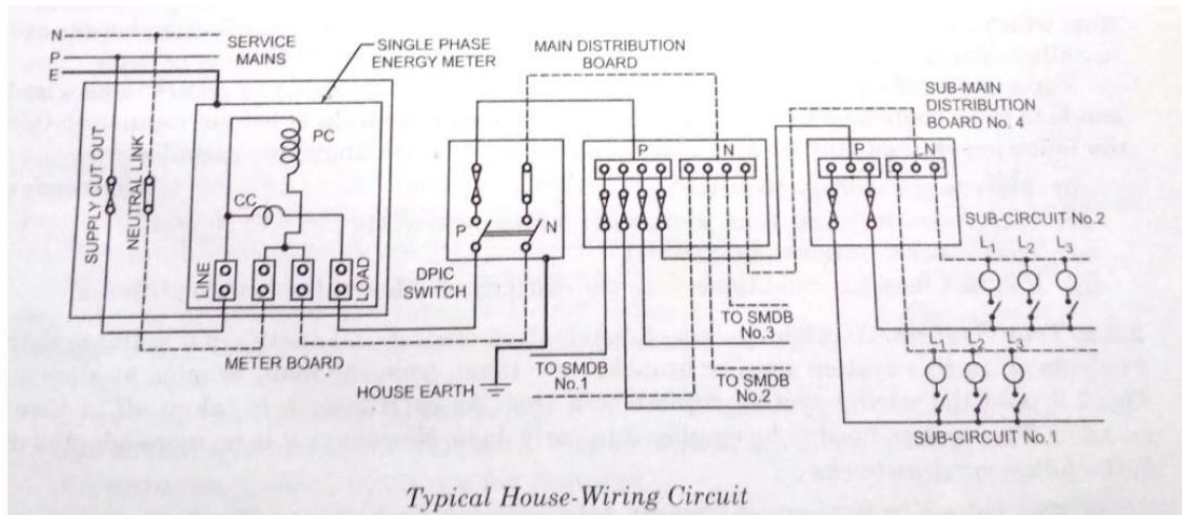
Isolators can be considered as the mechanical device utilized for the disconnection of any electrical equipment or the circuit from the main supply. Being an offload isolation device it only functions while the current passing through the system is zero. The presence of an isolator ensures maximum safety during maintenance. Furthermore, the isolator has a lesser breaking capacity.

Electrical House Wiring:

A network of wires connecting various accessories for distribution of electrical energy from the supplier meter board to the numerous electrical energy consuming devices such as lamps, fans and other domestic appliances through controlling and safety devices is known as a wiring system.

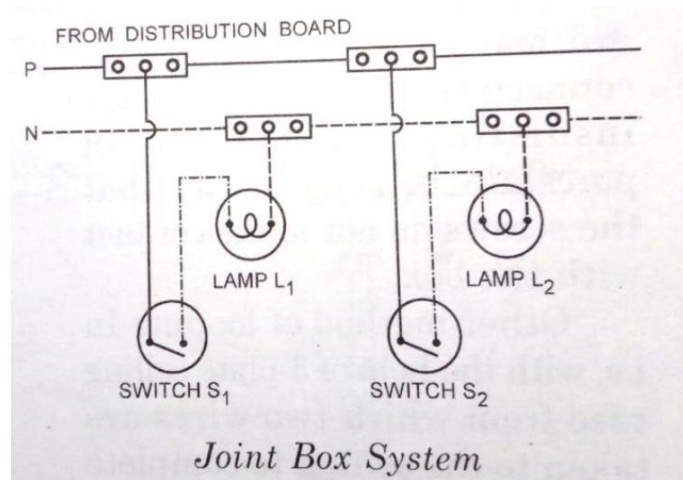
Systems of distribution of electrical energy: Since as per recommendation of Indian Standards the maximum number of points of lights, fans and 5A socket outlet that can be connected in one circuit is 10 and the maximum load that can be connected in such a circuit is 800 W, in case more load or points are required to be connected to the supply, then it is to be done by having more than one circuit.

Distribution Board System: In distribution board system, which is most commonly adopted for distribution of electrical in a building, the fuses of various circuits are grouped together on a distribution board, sometimes simply known as fuse board.

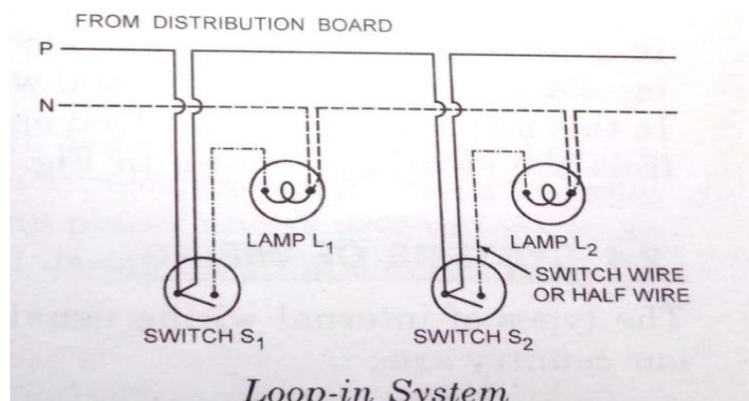


Methods of Wiring: There are two methods of wiring known as joint box system (or Tee system) and loop in system.

(i) **Joint Box or Tee System:** In joint box system the connections to the lamps are made through joints made in joint box by means of suitable connectors or joint cut outs. In this method though there is a saving in the quantity of wire or cable required but the same is offset by the extra cost of joint boxes. The other disadvantage is the number of 'T' connection made in wiring system results in weakness if not properly made. Now a days the use of this system is limited to temporary installations only as its cost is low.



(ii) **Loop-in System:** This system is universally used for connections of various lamps or other appliances in parallel. In this system when a connection is required at a light or switch, the feed conductor is looped in by bringing it direct to the terminal and then carrying it forward again to the next point to be fed as shown in below fig.



The switch and light feeds are carried round the circuit in a series of loops from one point to another until the last point on the circuit is reached. The phase or line conductors are looped either in switch board or box and neutrals are looped either in switch board or from light or fan. Line or phase should never be looped from light or fan.

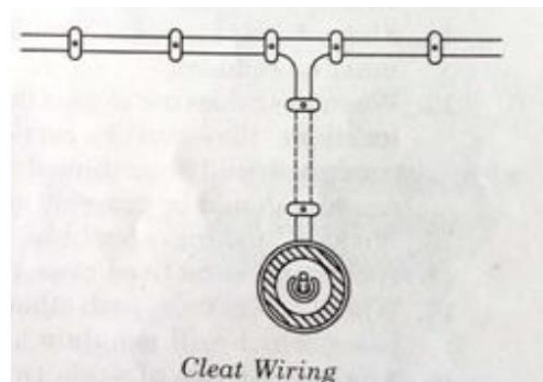
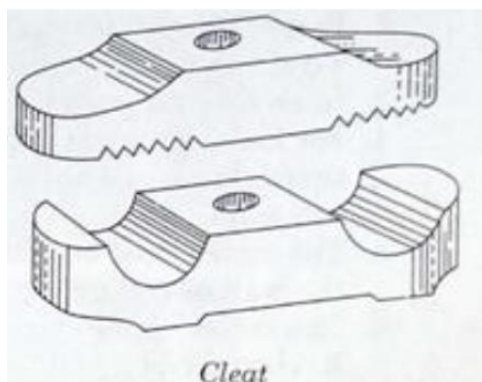
Selection or choice of wiring system depends on following parameters:

- (i) Safety
- (ii) Durability
- (iii) Appearance
- (iv) Mechanical protection
- (v) Accessibility
- (vi) Low initial cost
- (vii) Low maintenance cost

Types of Electrical wiring systems:

- (1) Cleat wiring system
 - (2) TRS wiring system
 - (3) Lead sheathed wiring system
 - (4) Wooden batten wiring system
 - (5) Plastic Casing-capping system
 - (6) Conduit wiring system
- (i) Conduit surface wiring
 - (ii) Concealed conduit wiring

1. Cleat wiring system: In this system of internal wiring the cables used are either vulcanized Indian Rubber (VIR) or Polyvinyl chloride (PVC) type. The cables are held by porcelain cleats about 6 mm above the walls or ceiling. The cleats are made in two halves, one base and the other cap. The base is grooved to accommodate the cables and the cap is put over it and the whole of it is then screwed on the wooden plugs (gutties) previously cemented into the wall and ceiling. The cleats used are of different sizes and different types in order to accommodate cables of various sizes and different number of cables respectively. The cleats are of three types; one groove, two grooves and three grooves to accommodate one, two and three cables respectively.



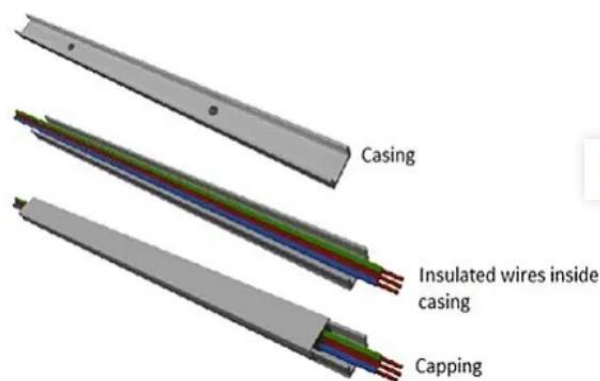
Advantages:

- (i) It is the cheapest system of internal wiring.
- (ii) Its installation and dismantlement is easy and quick.
- (iii) Material is recoverable after the dismantlement.
- (iv) Inspection, alterations and additions can be easily made.
- (v) Skilled labour required is little.

Disadvantages:

- (i) It is not good looking.
- (ii) The wires are exposed to mechanical injury.
- (iii) Oil and smoke are injurious to VIR insulation.

2. Casing-Capping wiring system: This is one of the simplest form of electrical wiring system. This is little bit old/conventional wiring system. Now a days, we often use this wiring system. PVC insulated cables are placed in plastic casing and covered with cap. The casing is of rectangular cross section. The colour of casing channel and cap are normally white or grey. The casing channel and cap are normally made of plastic. The casing channels and caps are available in market in standard sizes.



Casing and Capping wiring

Advantages:

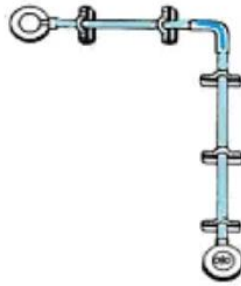
- (i) It is the cheapest wiring system as compared to concealed wiring system.
- (ii) It is strong and long lasting wiring system.
- (iii) Replacement and alteration of defective wire is easy.
- (iv) It provides protection against mechanical damage.
- (v) It is safe from oil, steam, smoke and rain.
- (vi) No risk of electric shock due to covered wires and cables in casing and capping.

Disadvantages:

- (i) Since it requires better workmanship, the labour cost is high.
- (ii) This type of wiring can be used only on surface and cannot be concealed in plaster.

(iii) Internal condensation of moisture may cause damage to the insulation.

3 Conduit wiring system: In this system of wiring steel tubes or PVC pipes known as conduits are installed on the surface of wall by means of saddles or buried under plaster and PVC cables are drawn afterwards by means of Galvanized Iron wire.



Surface mounting conduit system

Advantages:

- (i) It provides protection against mechanical damage.
- (ii) It provides complete protection fire due to short circuit.
- (iii) The whole system is waterproof.
- (iv) Replacement and alteration of defective wiring is easy.
- (v) Its life is long.
- (vi) It is shocked proof also if earthing is properly done.

Disadvantages:

- (i) It is very costly system of wiring.
- (ii) Its erection is not easy and required time.
- (iii) Experienced and highly skilled labour is required for carrying out the job.

Batten Wiring

TRS cables with single, double, and three cores are used in this type of wiring. These wires can withstand steam, chemicals, and water. In comparison to any other electrical wiring method in an electric circuit, it is inexpensive.



Batten Wiring System

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. It is used in wiring and cable making.

(b) Aluminium

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 colour and it has a soft texture. It is often used in wiring and making cable.

Insulating Materials

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