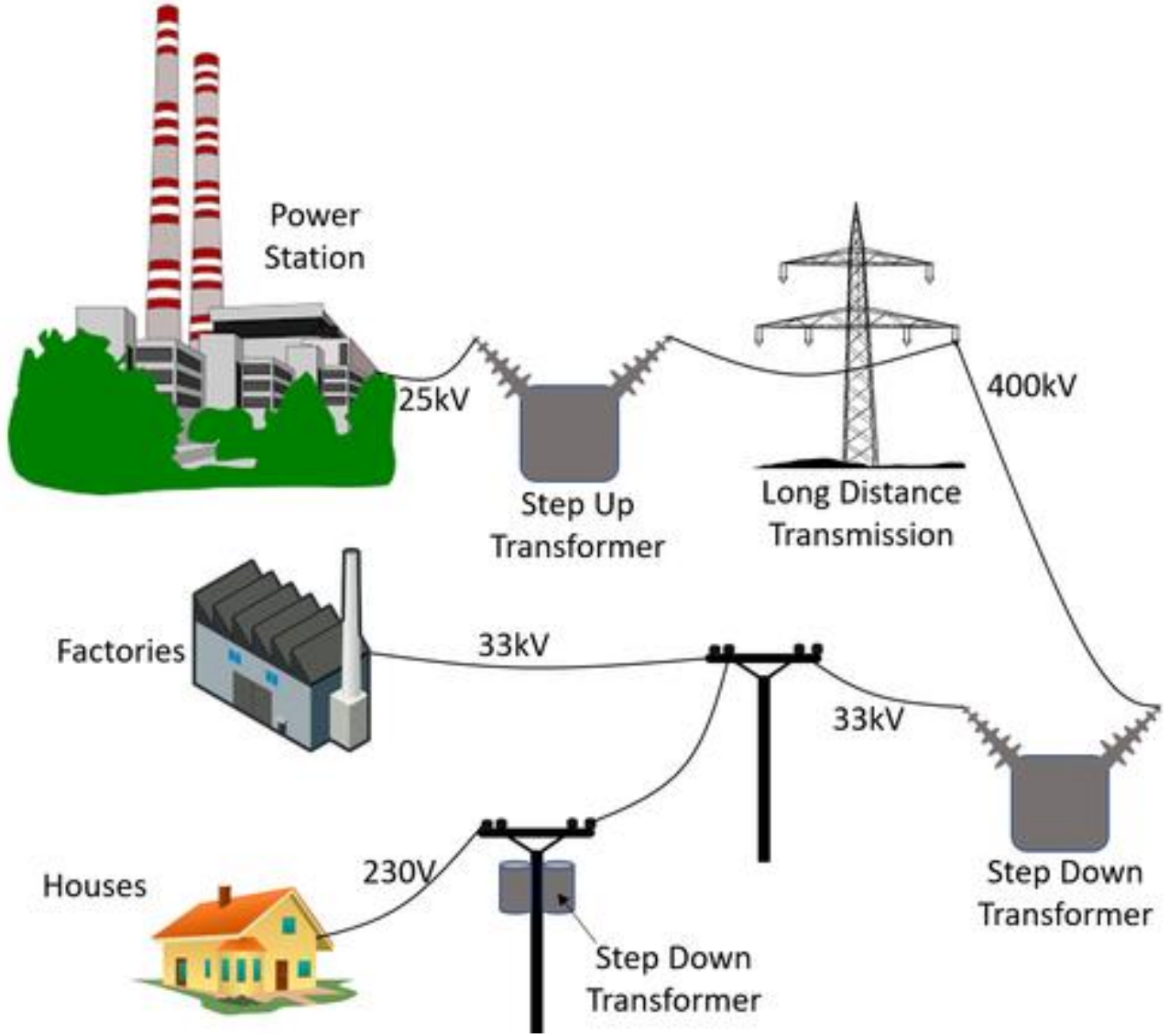
Home Electrical Technology

Grade 12 – Prepared by Eng. Susantha Jayasinghe


Power
Station
25kV
Step Up
Transformer
Long Distance
Transmission
400kV
Factories
33kV
33kV
Step Down
Transformer
Houses
230V
Step Down
Transformer

In countries such as Sri Lanka, India, Nigeria and many others have **230v** basic electricity power supply to consumers from the national electricity grid which is an **alternating current** (AC) with a **50Hz frequency**. However, the Voltage and Frequency can be different for other countries, for example United States has 120v electric power supply with a 60Hz frequency.

The electricity supply is given by a service cable consisting two wires known as **Live wire (L)** and **Neutral wire (N)** according to the Voltage & Frequency regulations of your country. Now let's focus on a few **electrical parts** often you can see in your home.

National Grid

- National Grid is a network of power stations , transmission lines and transformers , which generation , transmission and distribution of Electricity across the Sri Lanka.

About The National Grid

The National Grid consists of several stages:

1. Power Stations - Electricity is generated with a potential difference of around 25kV.

2. Step Up Transformer - The potential difference of the electricity is increased to around 400kV for long distance transmission. This is because the higher potential difference means a lower current so less energy will be dissipated through heating the transmission lines.

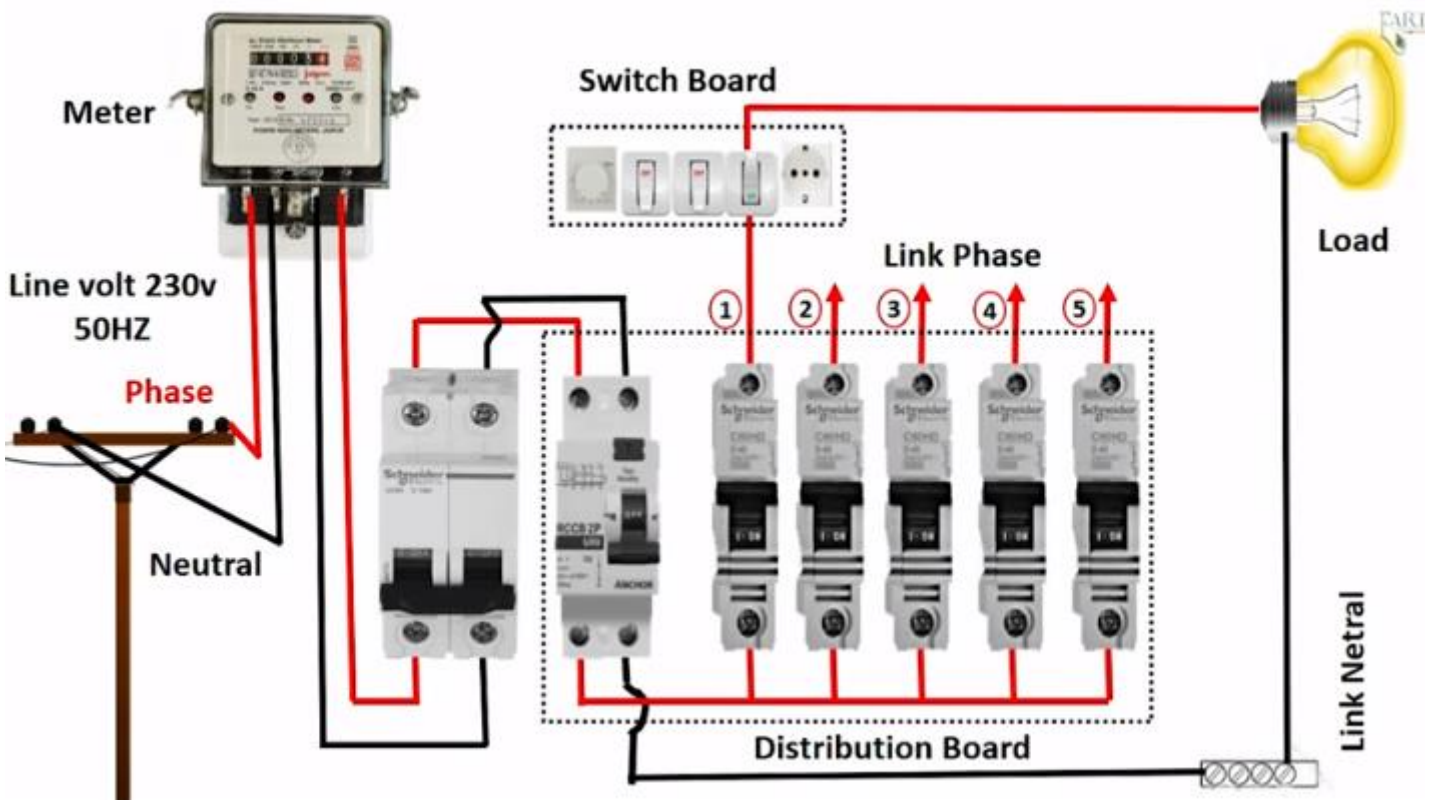
3. Long Distance Transmission Lines - Electricity is transmitted at very high potential difference (400kV) so it is kept on very high transmission lines.

4. Step Down Transformer - The potential difference of the electricity is lowered to be sent to factories and neighbourhoods at 33kV.

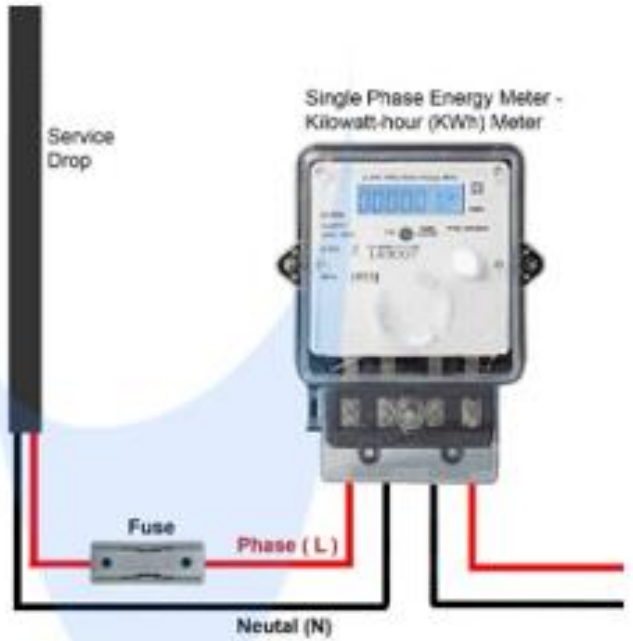
5. Short Distance Transmission Lines - Electricity is transmitted at 33kV over a short distance.

6. Neighbourhood Step Down Transformer - The potential difference is lowered to 230V for use in houses.

Domestic Electrical Circuit



Drop wire to Energy Meter



The Phase and Neutral supply lines (230V AC 50Hz/60Hz) are fed to the DB through the service drop running from the utility pole. It is then connected to the energy meter through a fuse.

First in the list of common electrical parts you see everyday is the Electric meter. It is used by the national electricity grid to measure the units of electrical energy used in your household circuits. Yeah, that's how they find the amount you need to pay for your electricity bill per month.

Suppose you have a 1000W electrical appliance in your house and you have to use this appliance for one hour everyday. Then the electrical energy consumed is one kilowatt-hour per day. Electric Meter calculate this consumed electric energy through the circular disc fixed in it.

When you use electricity, this circular disc starts to rotate which records the number of electrical energy units used by you. If you look closer inside the meter, you can see there are digits moving at the same time when the circular disc rotates.

Electricity grid company uses that meter readings to create your monthly electricity bill every 30 days or so.

1 kWh = Amount of Watt x Number of hours used / 1000
1 Unit = 1kWh

Circuit Breaker / Isolator/Service Breaker

When electrical current flows through the circuit exceeding the rated ampere value of the fuse, the thin wire melts down (fuses) thanks to heating effect of electric current and in return makes the closed-circuit an open-circuit. As you already guessed, open-circuits never flow electrical current, hence the current flow is cut down suddenly while protecting the appliance and other electrical parts & components.

When a fuse goes down, it's gone forever. Since replacing fuses *seem* annoying, a new electrical part was created to avoid such complications.

This component is a **miniature circuit breaker** and it looks like a switch consisting various ampere values. Circuit breakers function similar to fuses. In the event of an exceeding current flow than the rated ampere value, the switch opens and stops the current, instead of melting anything or dying forever. The circuit can be connected again by closing the switch.

Circuit Breaker / Isolator/Service Breaker

Main Isolator

L-Live

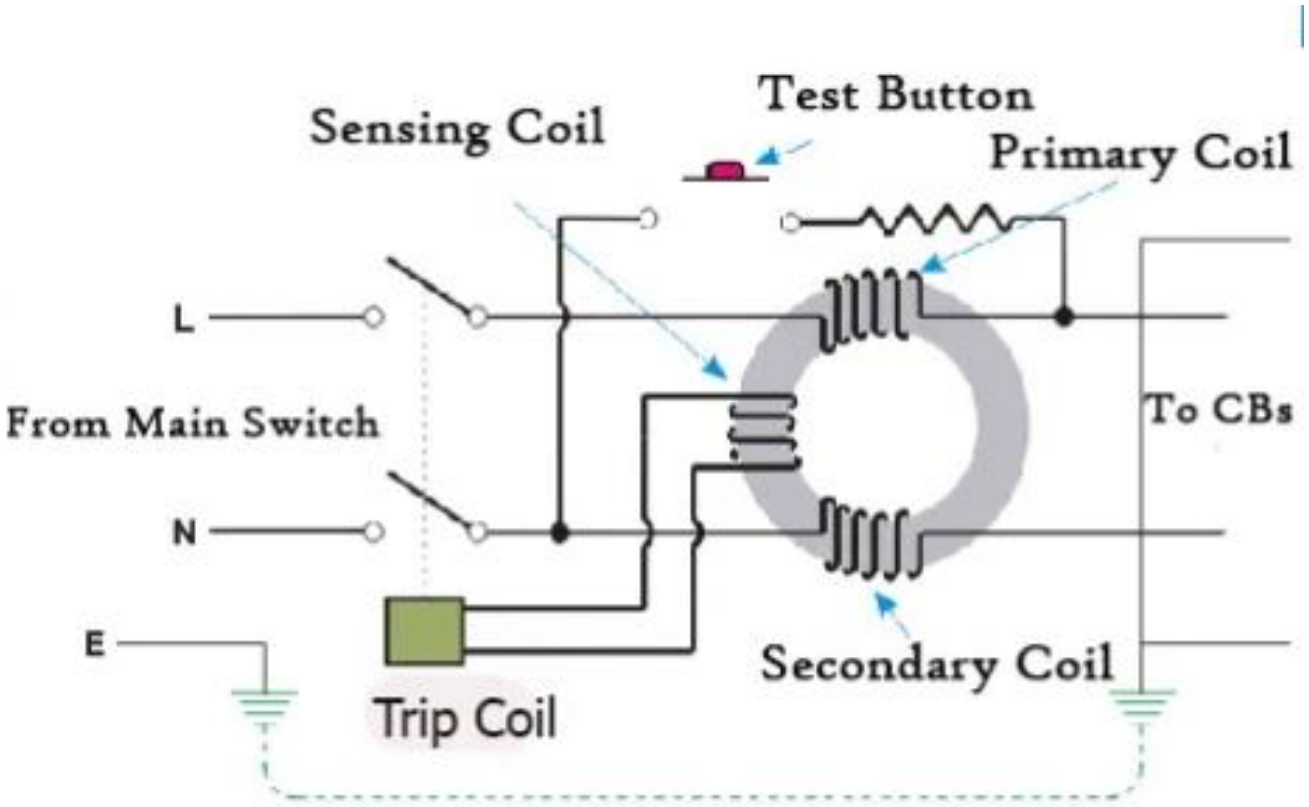
N-Neutral

Main Isolator

The phase and neutral lines from the energy meter are connected to the main isolator. The isolator is used to OPEN and CLOSE the lines manually, which is the main switch of the electrical system.

There are 2 wires inside the cable coming from the electric meter namely **Live Wire** and **Neutral Wire**. These 2 wires are then connected to the Main Switch. While the main switch is OFF the electric supply is stopped by disconnecting the two wires.

Trip Switch – Residual Current Circuit Breaker



The phase and neutral lines from the isolator are then connected to the RCCB. The RCCB is a device used to protect from current leakage. It isolates the circuit during fault conditions due to current leakage as well as during earthing, electric shock; when somebody comes to contact with phase and earth.

Remember the fuse I explained earlier? Just like a fuse, protecting people and electrical appliances is the primary goal of the Trip Switch, an electric switch designed to interrupt a circuit suddenly & automatically.

However, it's not a fuse, but a type of circuit breaker. This electrical part's common name is Trip Switch while the technical term is RCCB – Residual Current Circuit Breaker. Trip Switch is there to help you multiple times compared to a fuse.

If there is a fault in any of the circuits in the house this switch opens **(Trip)** automatically and disconnects the power supply. For example, when someone gets electrocuted or when your house become a target of a lightning attack. Since the Trip Switch is so useful, it comes with a Test Button letting you check if it works as expected.

Working Principle of RCCB

RCCB works on the principle of Kirchhoff's law, which states that the incoming current must be equal to the outgoing current in a circuit. RCCB thus compares the difference in current values between live and neutral wires. Ideally, the current flowing to the circuit from the live wire should be the same as that flowing through the neutral wire. In case of a fault, the current from the neutral wire is reduced, the differential between the two known as Residual Current. On spotting a Residual Current, the RCCB is triggered to trip off the circuit.

A test circuit included with the Residual Current device ensures that the reliability of RCCB is tested. When the test button is pushed, the current starts to flow through the test circuit. As it creates an imbalance on the neutral coil of the device, the RCCB trips and supply is disconnected thereby checking RCCB's reliability.

Sensitivity of RCCB

A human being is able to sustain an electric shock to the extent of 30 mA. While upto 10 mA may just evoke a prickling sensation, 10 mA onwards may lead to muscular contraction, further leading to a respiratory paralysis at around 30mA. RCCBs are therefore designed to look for small changes in residual current. In cases where protection from fire is sought, RCCBs are also used to track higher changes in residual current of up to 300mA.

Classification of RCCB

RCCB are of two types; the 2 Pole RCCB and 4 Pole RCCB.

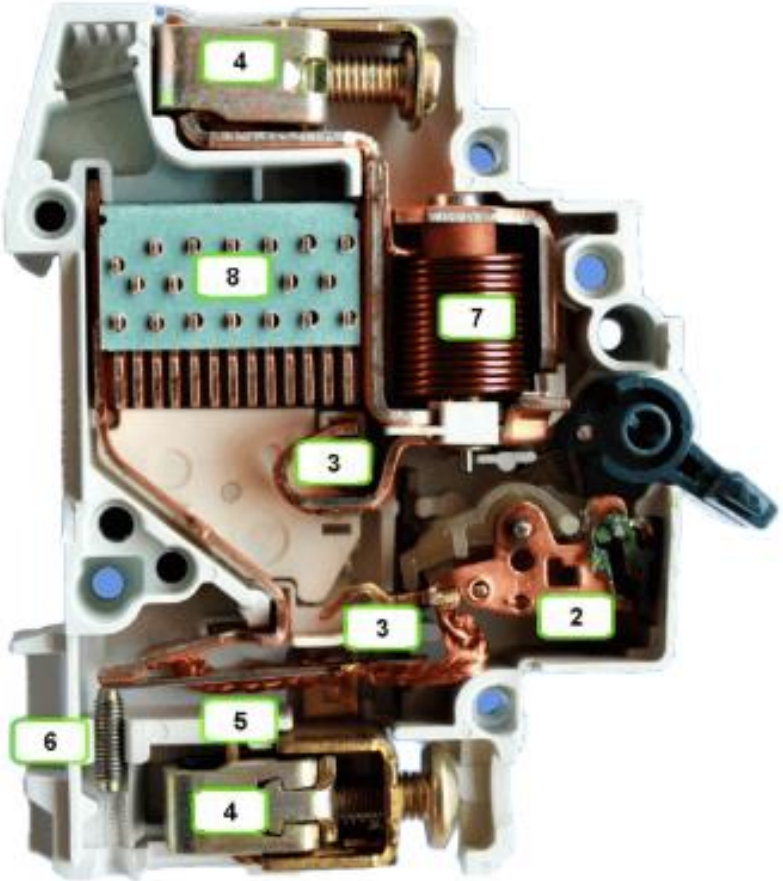
2 Pole RCCB: This is used in case of a single-phase supply connection that has only a live and a neutral wire.

4 Pole RCCB: This is used in case of a three-phase supply connection.

Rating from 10 Amp ….100 Amp

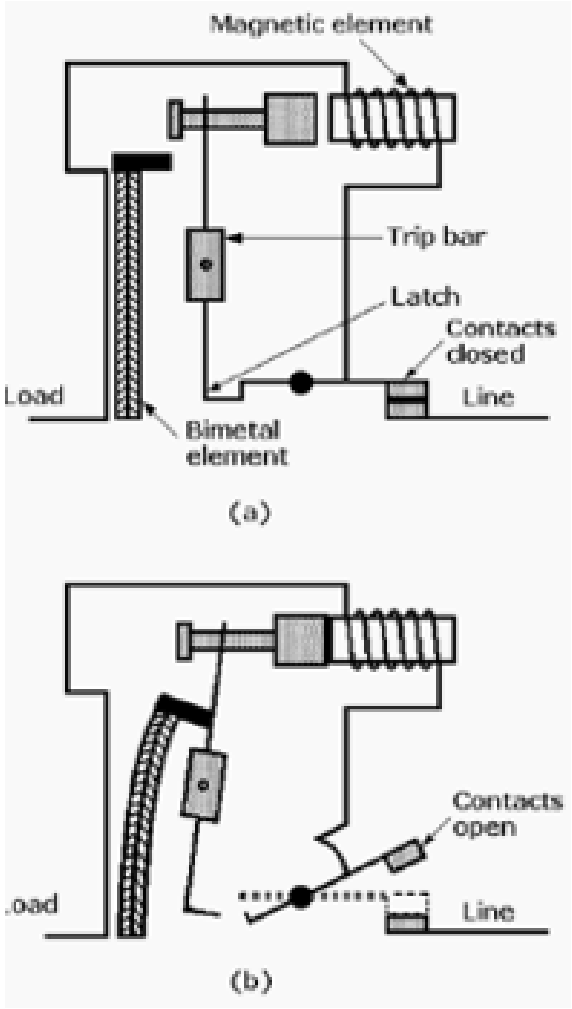
Sensitivity 30,100,300 m Amp

MCB – Miniature Circuit Breaker



MCB stands for Miniature Circuit Breaker. It automatically switches OFF electrical circuit during any abnormal condition in the electrical network such as overload & short circuitconditions. However, fuse may sense these conditions but it has to be replaced though MCB can be reset. The MCB is an electromechanical device which guards the electric wires &electrical load from overcurrent so as to avoid any kind of fire or electrical hazards. Handling MCB is quite safer and it quickly restores the supply.When it comes to house applications, MCB is the most preferred choice for overload and short circuit protection. MCB can be reset very fast & don't have any maintenance cost. MCB works on bi-metal respective principle which provides protection against overload current&solenoidshort circuit current.

Operation Principle of MCB

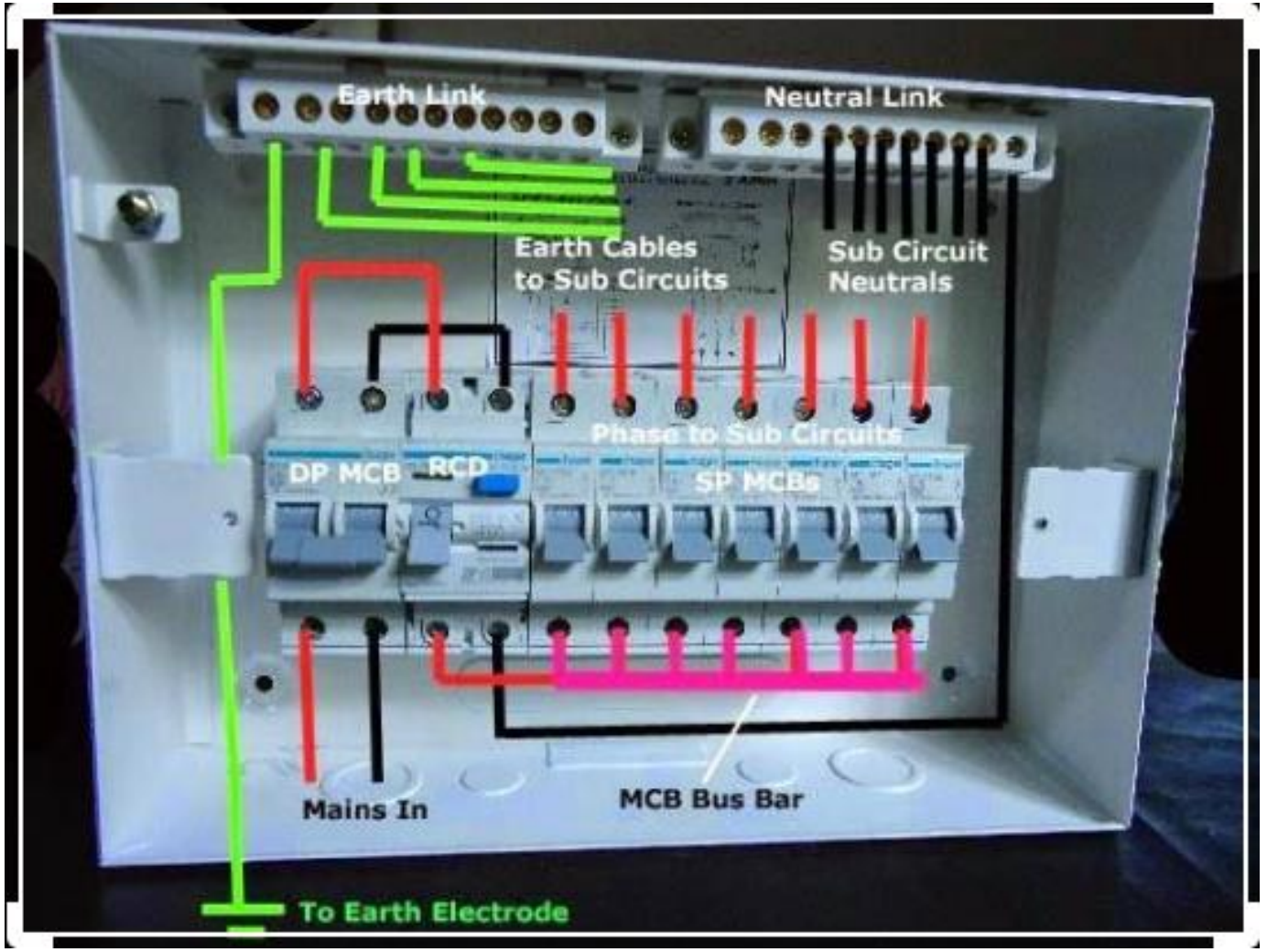


As the current flows through the bimetallic strip, it gets heated up and deflects by bending and releases the mechanical latch.

The deflection of the bimetallic strip depends on the amount of current flowing through the strip. More the current, the faster the deflection of the bimetallic strip.

During the short circuits, the transient current flowing through the solenoid forces the plunger towards the latch. This action is rapid and releases the mechanical latch and opens the contacts immediately.

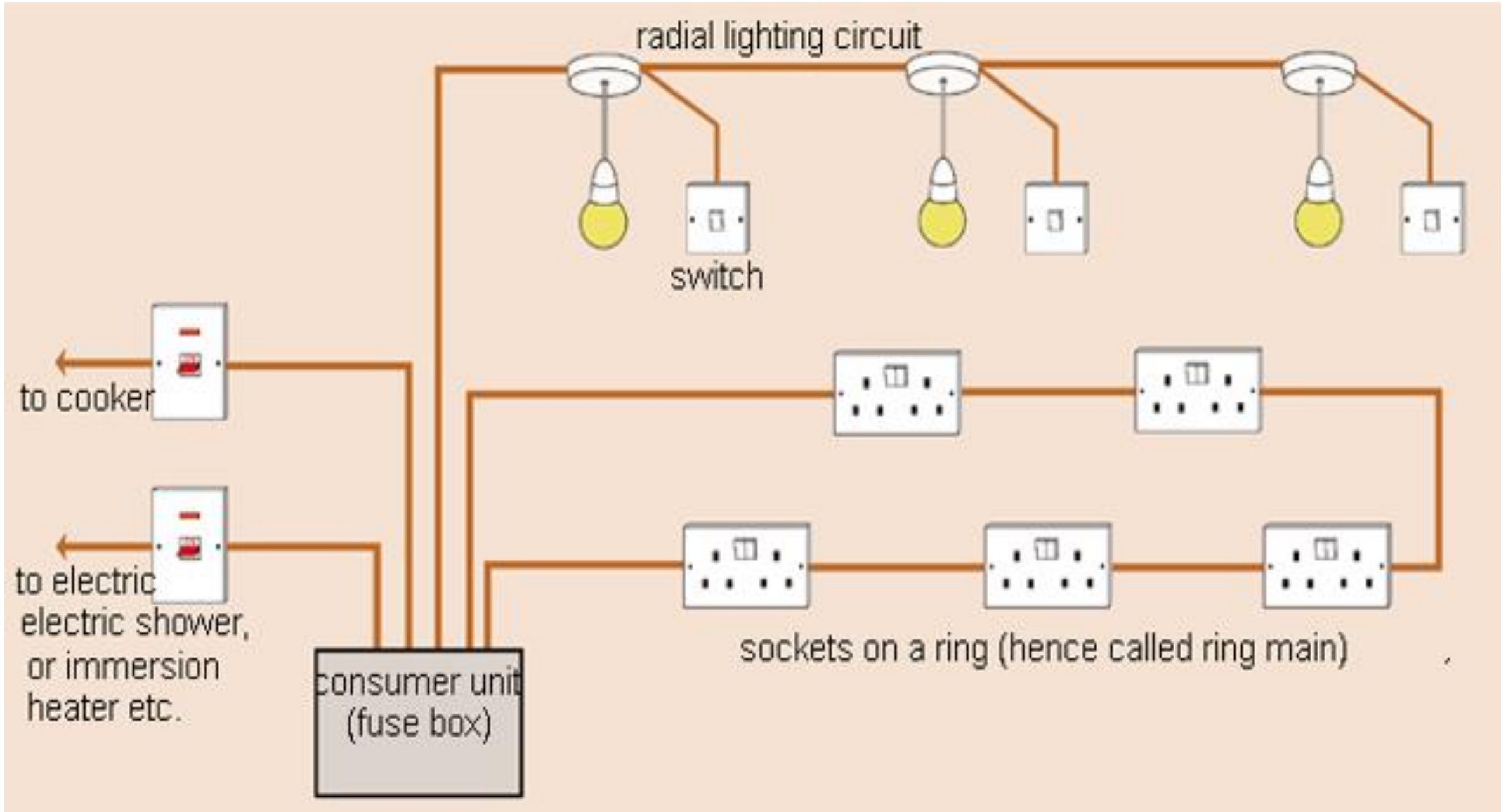
Distribution Box



Distribution Box

Electrical distribution board is a panel board that is an integral part of every electrical installation. Electrical distribution boards serve to evenly distribute the power supply through different circuits, supplying various consumption points in the residential or commercial buildings. The overall supply of electrical power coming from the electrical network comes to the building through one main feeding cable. Feeding cable that transports the electrical power from the network to the building is directly connected to an electrical distribution board.

Electrical distribution boards contain a special circuit breaker, which is the main part of these board panels. It has the main function which includes splitting the total amount of electrical power and distributing it to a certain number of mini circuit breakers. Each of the mini breakers are connected to a specific cable that leads to an individual power outlet, machine point or light circuit. These cables are also inserted in the distribution board, but they are located on the opposite side of the main feeding cable.


radial lighting circuit
switch
to cooker
to electric
electric shower,
or immersion
heater etc.
consumer unit
(fuse box)
sockets on a ring (hence called ring main)

Earth Electrode

During house wiring, we usually connect earthing wires from all the sockets to earth links on the distribution board (DB). From the DB, we connect them to the earth plate or electrode.

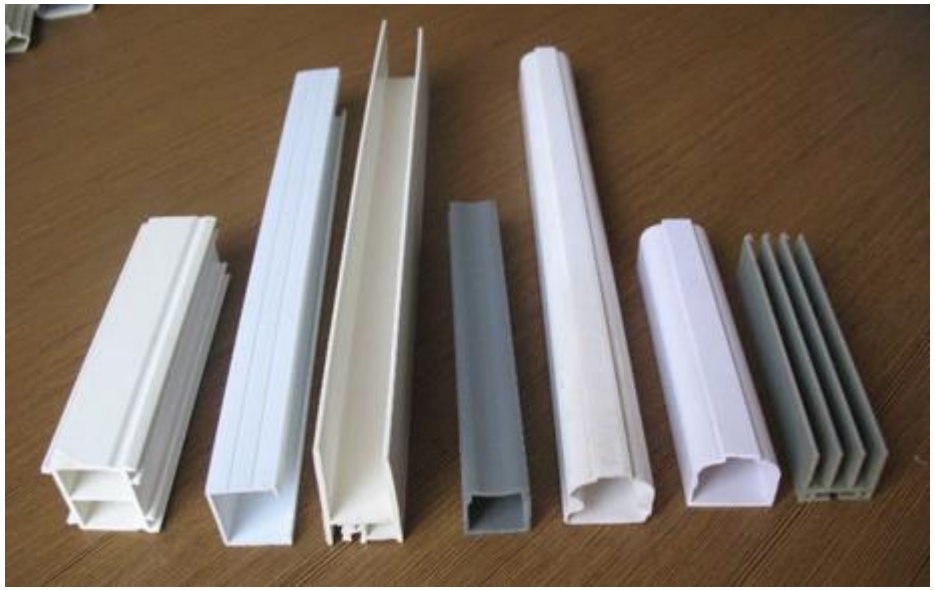
Whenever there is circuit overload or power surge, current flows through the earth rod to the ground. House earthing protects you from electric shock by providing a conductive plate which carries the faulty current to the ground.

Reasons we earth our houses

- Earthing prevents electric shock by providing a path (protective conductor) which carries the fault currents to the ground.

- To protect electrical appliances from damage arising from faulty currents.
- Prevent the risk of fire outbreaks that may arise from current leakage.
- To maintain a stable voltage in three-phase circuits of an electrical system, even when the load is unstable.

Cable / Wire Feeders



Wires and Cables use in House wiring

එක්හර රැහැන්

දෙහර රැහැන්

තුන්හර රැහැන්

Wire code	Wire Size - Area of cross section (mm^2)	Rated maximum current (Amps)	Colour	Application
1/ 1.13	1.0	11	Red/black	For lamp circuits and for 5A plug base circuits
7/ 0.53	1.5	13	Red/black	For 15 A plug base circuits
7/ 0.85	4	24	Red/black	For CEB power supply to distribution box
7/ 1.04	6	31	Red/black	For CEB power supply to distribution box
7/ 0.67	2.5	-	Green	Earth wire

Electrical Switches

- Toggle switches
- Push Button switches

SPST

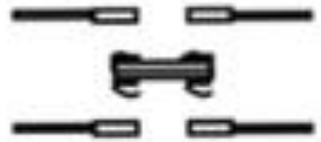
Single-Pole
Single-Throw
Single-Break

SPST

Single-Pole
Single-Throw
Double-Break

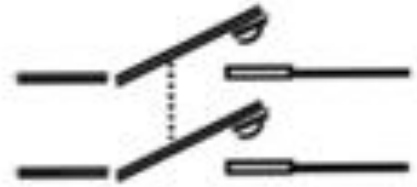
SPDT

Single-Pole
Double-Throw
Single-Break



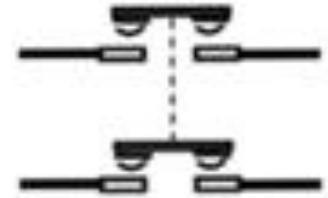
SPDT

Single-Pole
Double-Throw
Double-Break



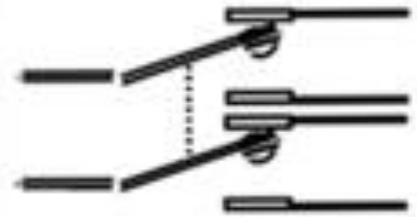
DPST

Double-Pole
Single-Throw
Single-Break



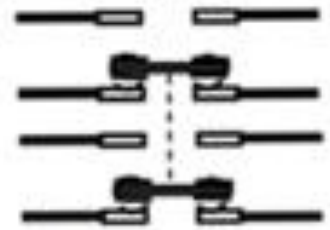
DPST

Double-Pole
Single-Throw
Double-Break



DPDT

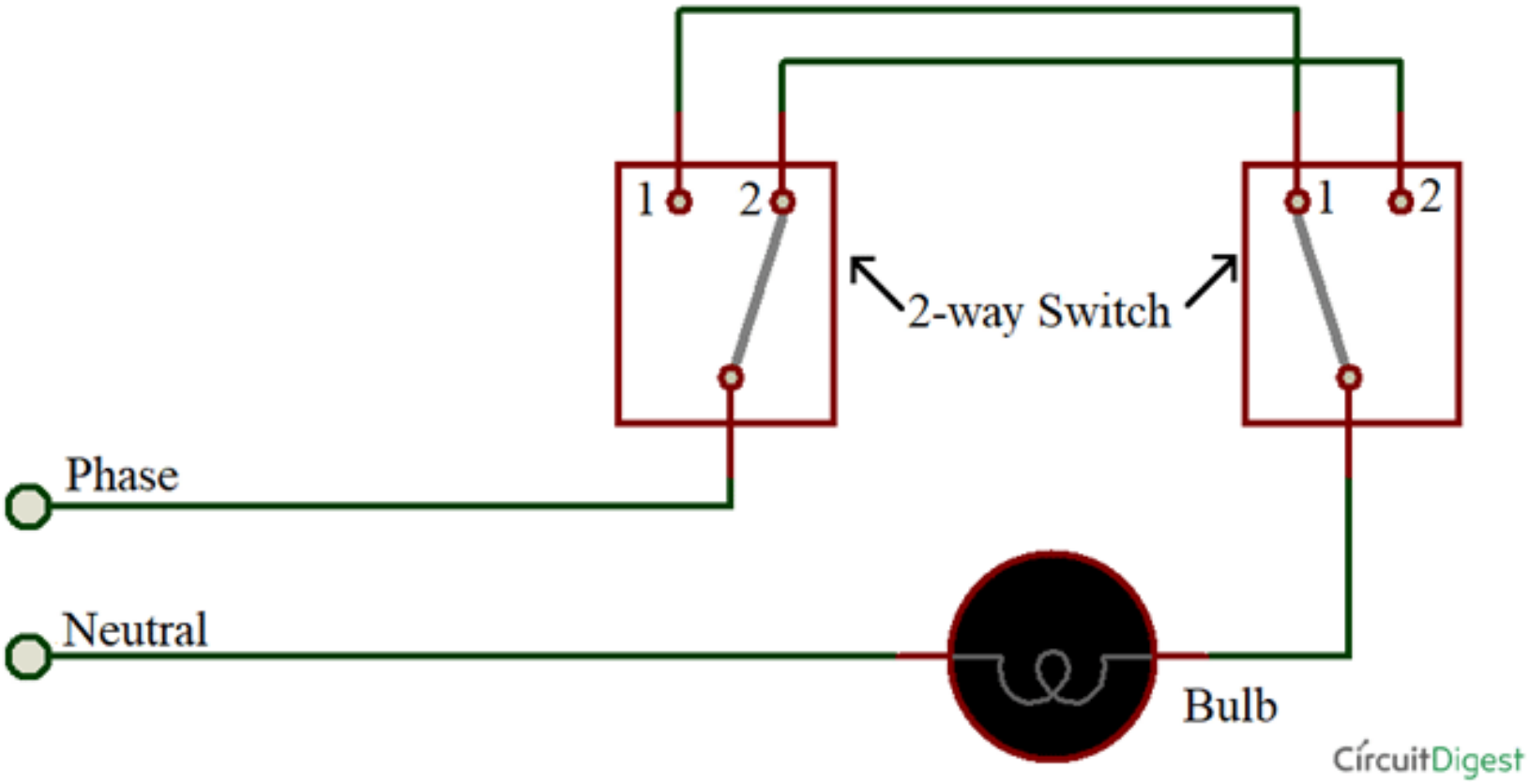
Double-Pole
Double-Throw
Single-Break

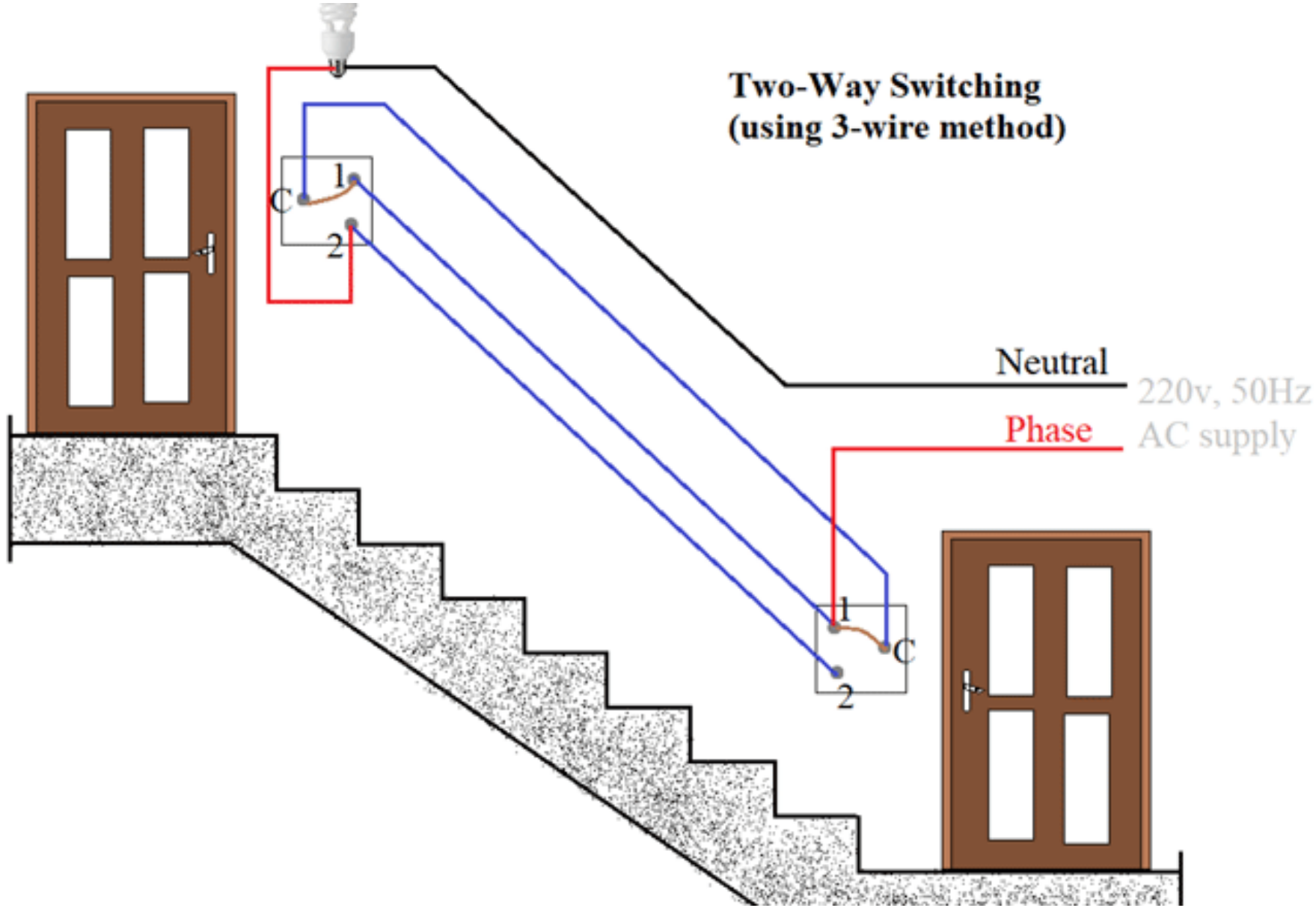


DPDT

Double-Pole
Double-Throw
Double-Break

Two Way Switch

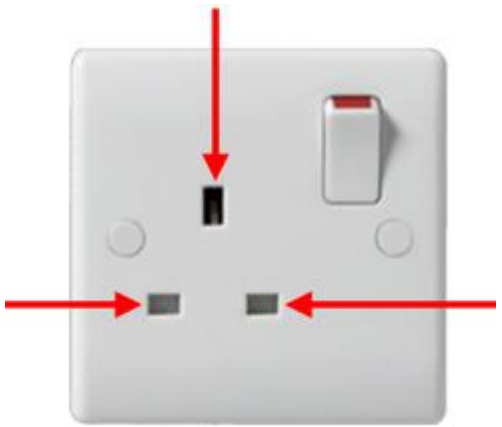



Two-Way Switching
(using 3-wire method)
C
1
2
Neutral
220v, 50Hz
AC supply
Phase
1
C
2

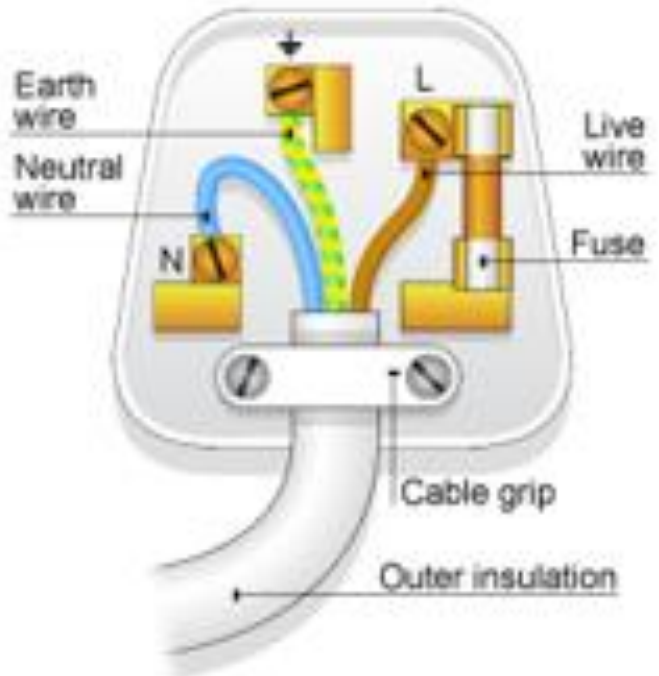
Socket Outlets

EARTH TERMINAL

NEUTRAL TERMINAL



LIVE TERMINAL



1. Why did Sri Lanka decide to use the 13 ampere plug and socket as the standard, and not anything else?

Ans: Among the many reasons are that (i) it is already widely used in Sri Lanka, (ii) it is the single standard in more than 29 countries in the world including UK, Ireland, UAE, Singapore and Malaysia, (iii) the rectangular pins make a firm connection with the socket, and (iv) there is a fuse in the plug top, to protect the appliances and wires.

2. Do we need to replace the wall sockets at our houses with the introduction of the new standard?

Ans: Not necessarily. The 5 ampere (round pin) socket outlets, which are currently in use will not be banned but are allowed to be used until they are worn out or until August 2038, whichever is earlier. However, to fix a new appliance to an existing 5 ampere wall socket, a converter is required, because new appliances bought will come with a 13 ampere plug top.

3. Do we need to replace the wiring system, with the introduction of the new standard?

Ans: No. However, it is advisable that the existing wiring arrangement is assessed by a qualified electrician, to ensure that each circuit is protected with a correctly rated miniature circuit breaker (MCB) or a fuse. This has to be a regular practice.

4. Do we need to replace the plugs of existing electrical equipment with the introduction of the new standard?

Ans: No. However, a converter will be required to connect an existing 5 ampere plug (round pin) to a 13 ampere socket.

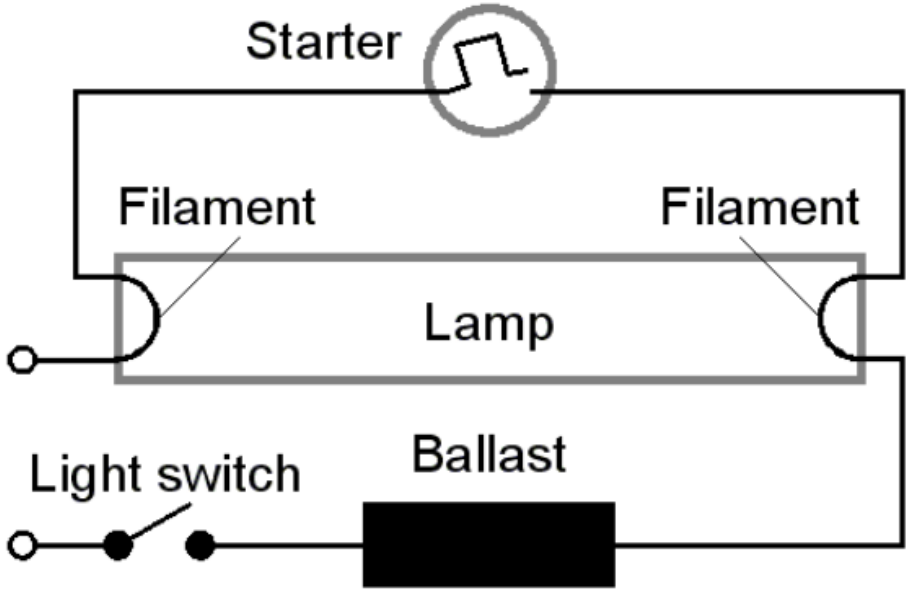
5. With the introduction of the new standard, what should I look for, when purchasing new electrical equipment?

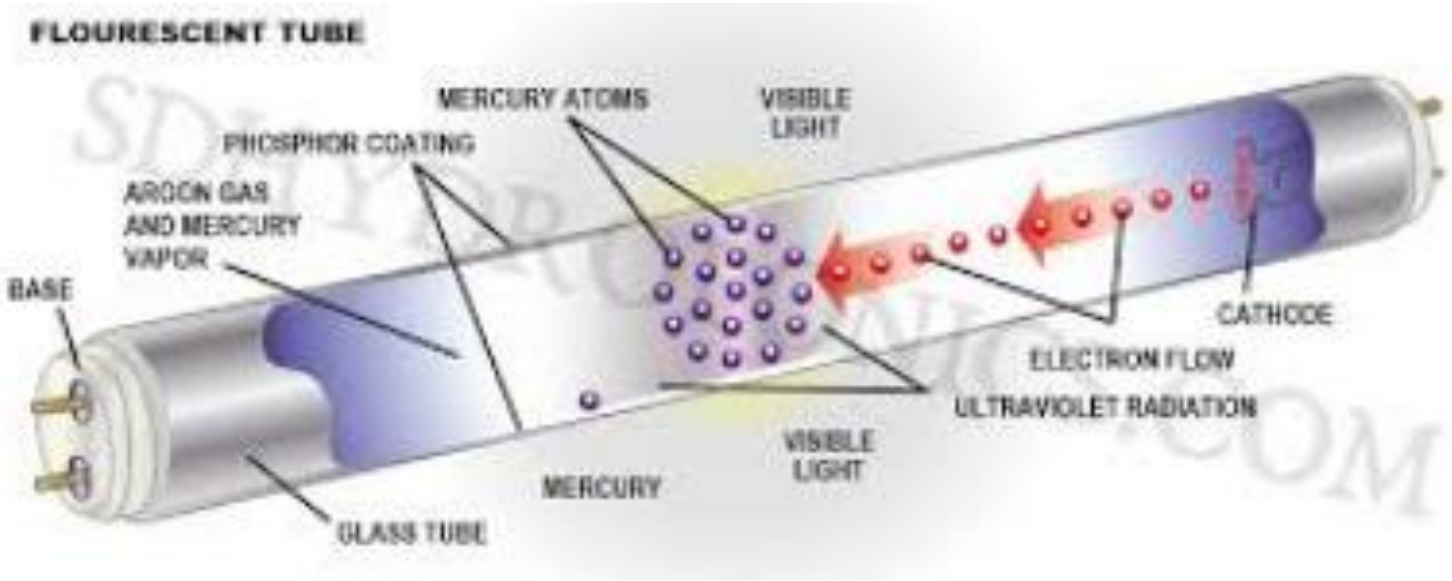
Ans: When it comes to purchasing small electrical equipment such as mobile phone chargers, table fans, pedestal fans, electric irons, etc, no special consideration would generally be required after 16 August 2018, because they would come with mandatory factory-fitted 13 ampere plugs. However, if your premises has wiring other than for Type G, then a one-to-one converter would be required. Further, as even at present, if you require to use an equipment which consumes more than 13 ampere, such as a large air conditioner or an electric cooker, then a dedicated electrical circuit is required.

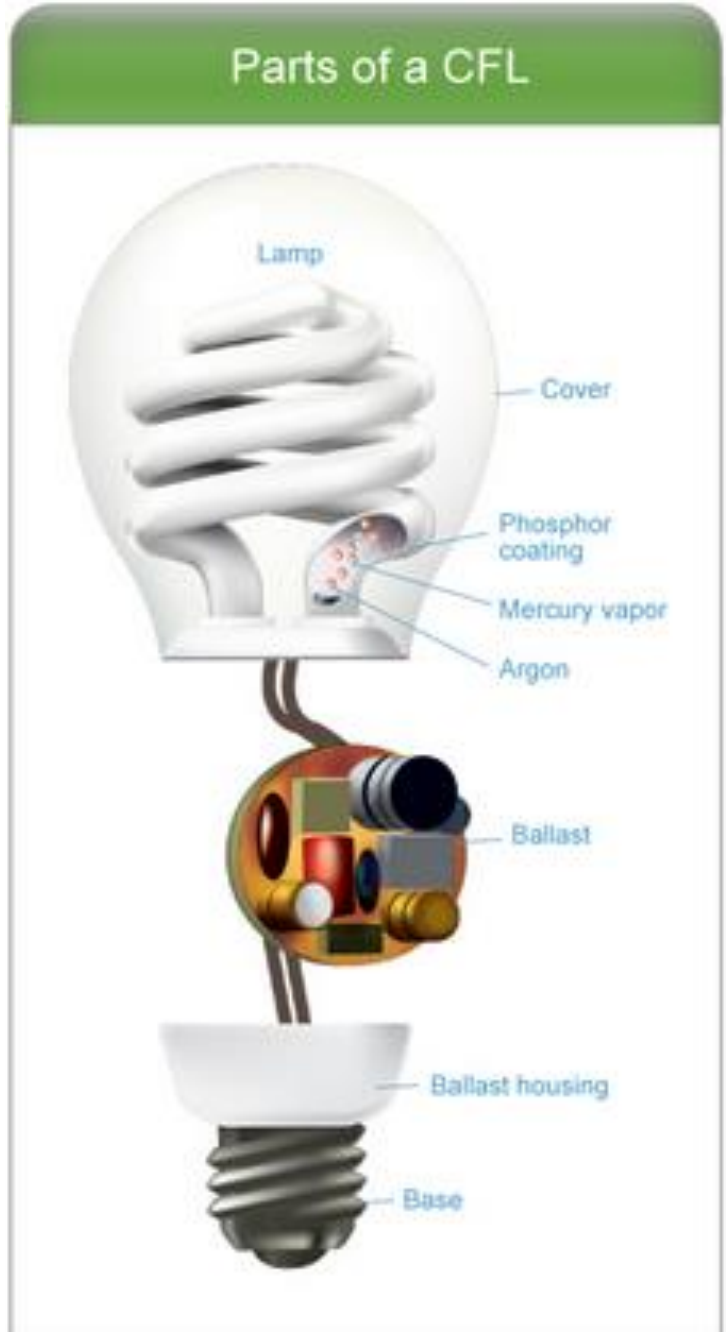
Comparison of incandescent , florescent , CFL and LED bulbs.

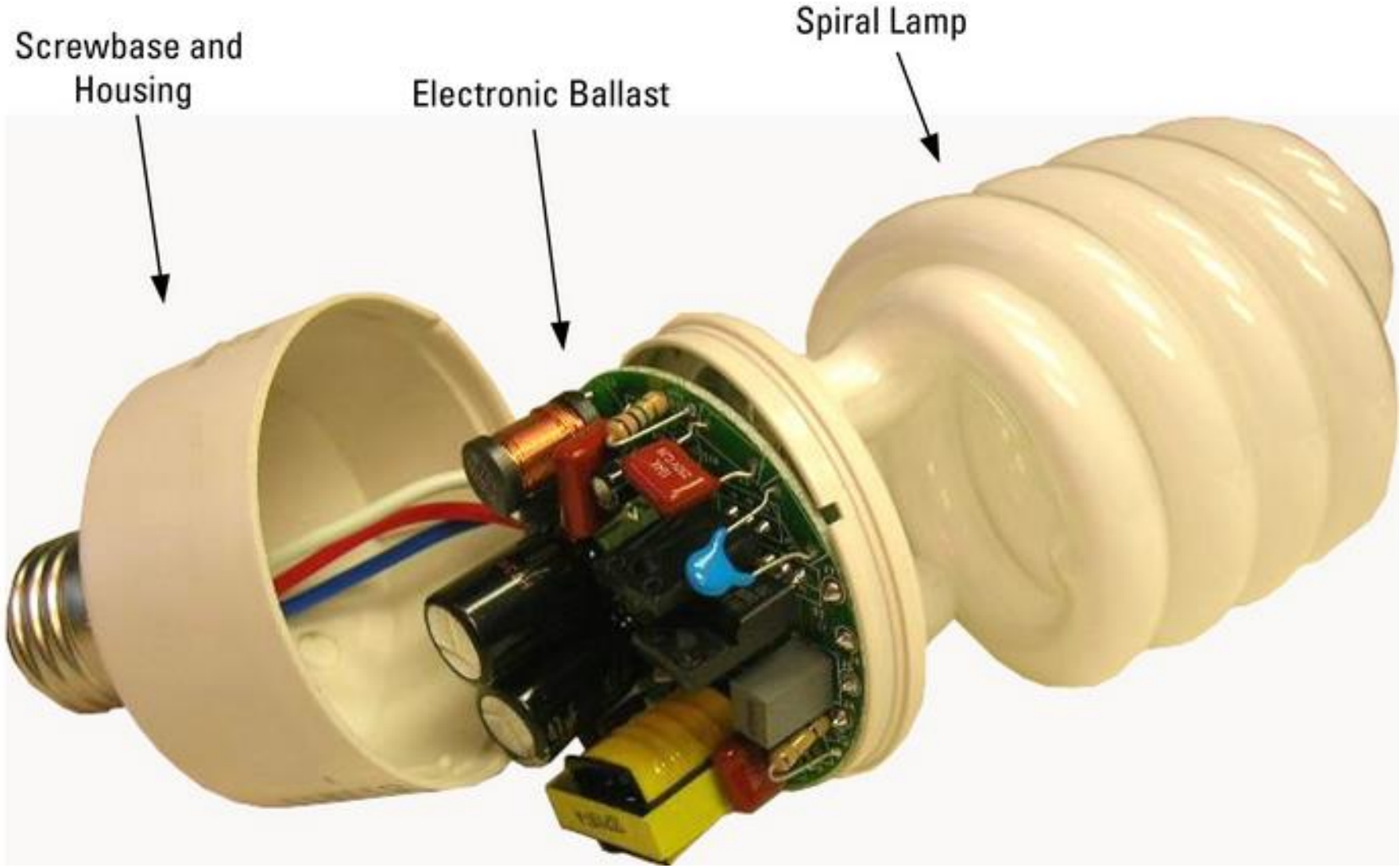
INCANDESCENT LAMP

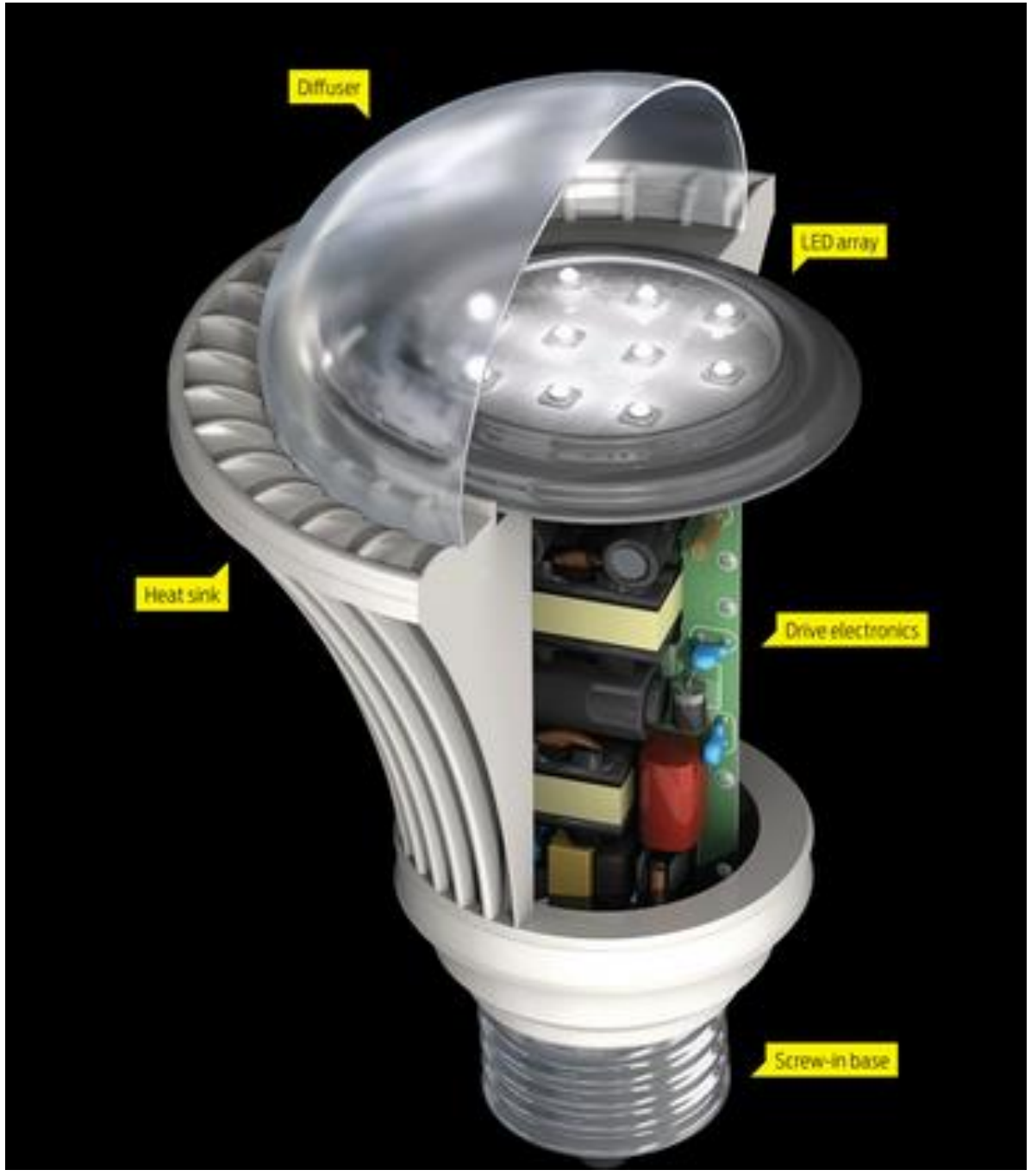
- HOT WIRE – FILAMENT SEALED IN A GLASS JAR (BULB)
- ELECTRIC CURRENT PASS THROUGH THE WIRE HEATS IT TO INCADESCENCE, AND THE WIRE EMITS LIGHT. USE STANDARD VOLTAGE CIRCUIT.

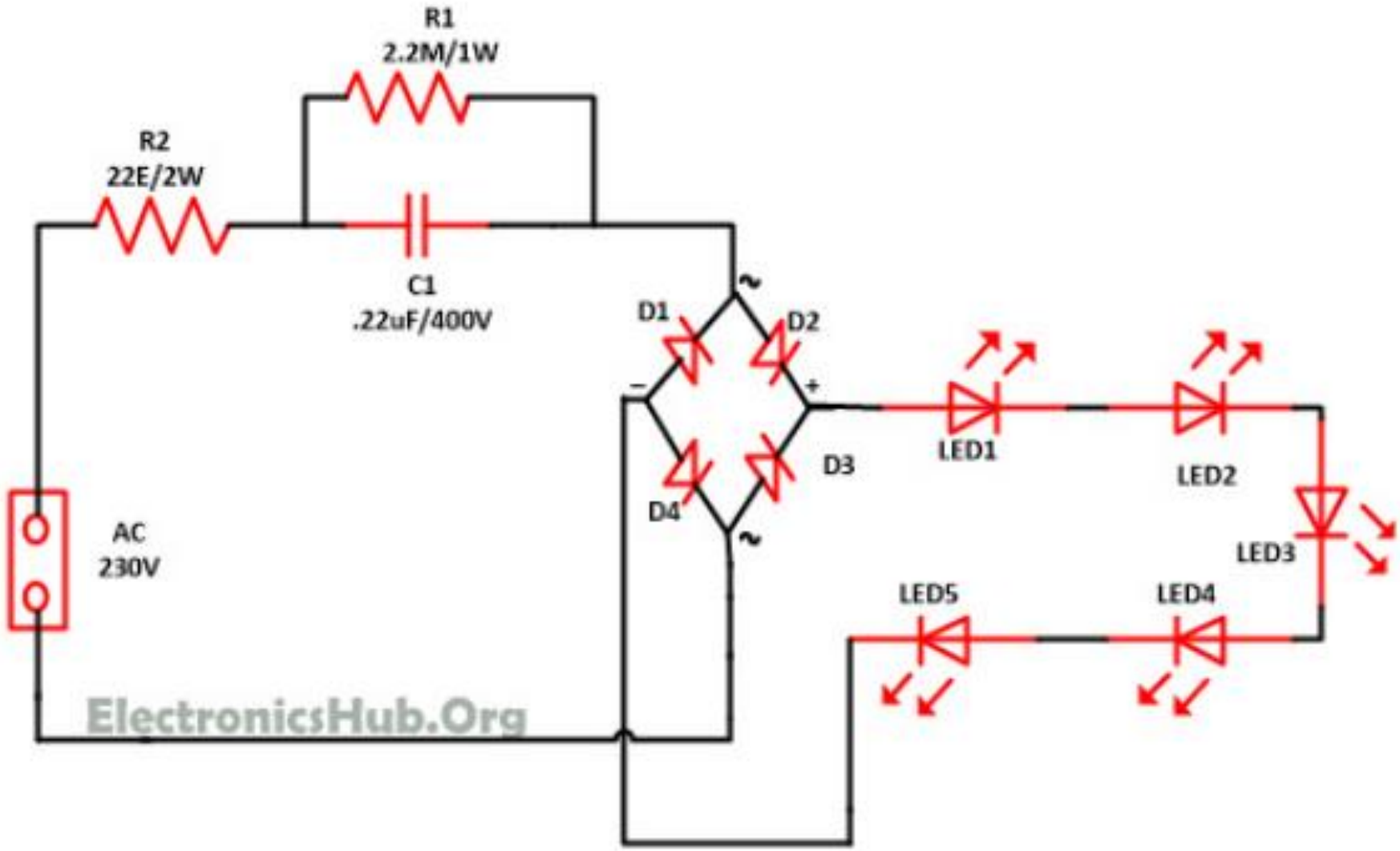



FLOURESCENT TUBE
MERCURY ATOMS
VISIBLE LIGHT
PHOSPHOR COATING
ARGON GAS AND MERCURY VAPOR
BASE
CATHODE
ELECTRON FLOW
ULTRAVIOLET RADIATION
VISIBLE LIGHT
MERCURY
GLASS TUBE


Parts of a CFL
Lamp
Cover
Phosphor coating
Mercury vapor
Argon
Ballast
Ballast housing
Base


Screwbase and
Housing
Electronic Ballast
Spiral Lamp


Diffuser
LED array
Heat sink
Drive electronics
Screw-in base


R1
2.2M/1W
R2
22E/2W
C1
.22uF/400V
D1
D2
D3
D4
AC
230V
LED1
LED2
LED3
LED4
LED5
ElectronicsHub.Org

Comparison among bulbs

Feature	LED light emitting diode	CFL compact fluorescent lamp	Incandescent bulb
lumen/watt	100	60	16
lifetime (in hours)	50,000	8000	1200