

Welcome



Lighting Controls Pte Ltd

Basic Electrical Course

Date: 24th - 25th Feb 2009

Introduction

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Basic Electricity

**Safety should always be the
first concern**

whenever the task involves
electricity.

[http://www.hse.gov.uk/electricity/
precautions.htm](http://www.hse.gov.uk/electricity/precautions.htm)

All Local Safety Codes CP5 should be followed when performing any procedures outlined in this or any of our training modules.

Safety Precautions

**NEVER ATTEMPT TO WORK ON
ANY
ELECTRICAL EQUIPMENT WITHOUT
PROPER TRAINING.**

Safety Precautions

Never test a system without first testing for improper shorts or grounds.

“Electricity is your friend if you respect it and a killer if we do not follow its rules.”

Anyone got shocked before??

Introduction to Electricity

Any metal will conduct electricity.
Gold, aluminum, mercury and copper
are the most efficient conductors of
electricity.

Introduction to Electricity

Gold is very expensive.

Aluminum is inexpensive, but has a corrosive nature.

Mercury is difficult to contain.

Copper is relatively inexpensive and only mildly corrosive.

Introduction to Electricity

Copper is the most commonly used material to carry electricity. Copper is also flexible which adds to its appeal.

Introduction to Electricity

Insulation is material that does not conduct electricity. Insulation is used to contain the electricity while it is in route to the device using the electricity.

Introduction to Electricity

Light bulbs, electric motors and electromagnetic coils (used to operate electric valves and automatic switches) are examples of devices that use electricity.

Introduction to Electricity

Copper wire wrapped with insulation is commonly used to provide these devices with electricity.

What is Electricity?

An electron will flow from one atom to another when the conductor (such as a copper wire) is passed through a magnetic field. Either the wire or the magnetic field must move to mechanically produce electricity.

Static Electricity

Another method of producing electricity is called "static electricity". Rubbing synthetic materials (such as latex and glass) can produce static electricity.

Voltage

Alessandro Volta, an Italian physicist, invented the battery; thus the term "Volt", meaning electrical potential.

Ohms Law

The scientific law that governs electricity is known as OHM's Law.

Formulae

Several mathematical formulas are used to determine the characteristics of electrical efforts.

Current

Amperage: current flow, intensity of flow of current. Common term (**amps**).
Symbol "**I**".

Voltage

Voltage: potential difference,
electrical pressure (volts).
Symbol "V".

Resistance

Resistance: restricting the flow of current, measured in (ohms).
Symbol "R".

Power

Power: the amount of current used.
Measured in (Watts).
Symbol "P".

Videos on Voltage and Current

Part 1

http://www.youtube.com/watch?v=bnzmVAa46xg&feature=channel_page

Part 2

http://www.youtube.com/watch?v=LOEiA9yAh6E&feature=channel_page

Videos on Resistance

Part 1

<http://www.youtube.com/watch?v=fDfrdcs65HY&feature=related>

Part 2

<http://www.youtube.com/watch?v=VXporsDPjdE&feature=related>

Videos on Calculating Power

http://www.youtube.com/watch?v=cfd-QOVa8pw&feature=channel_page

Ohms Law

Ohm's Law is very helpful to determine unknowns when diagnosing electrical problems.

Ohm Law Formulae

Ohm's Law

$$V=IR \quad \Omega$$

Ohm's Law

Voltage divided by amps is equal
to resistance
($V / I = R$)

Ohm's Law

Amperage multiplied by resistance
is equal to voltage
($I \times R = V$)

Ohm's Law

Voltage multiplied by amps is equal to
watts
($V \times I = P$)

Ohm's Law

Example:

If 12 volts is applied to 12 ohms of resistance, 1 amp of current will flow.

The amount of power used will be 12 watts.

$$V / R = I \text{ (1 amp)}$$

$$V \times I = P \text{ (12 watts)}$$

Video on Ohm's Law

Part 1

http://www.youtube.com/watch?v=JRp_iSaVRjE&feature=channel_page

Part 2

http://www.youtube.com/watch?v=FwEz9ygPHiM&feature=channel_page

Resistive Circuits

Note

These formulas work for "resistive" circuits only. Other, more complicated formulas, are available through Ohm's law for "inductive reactive" circuits.

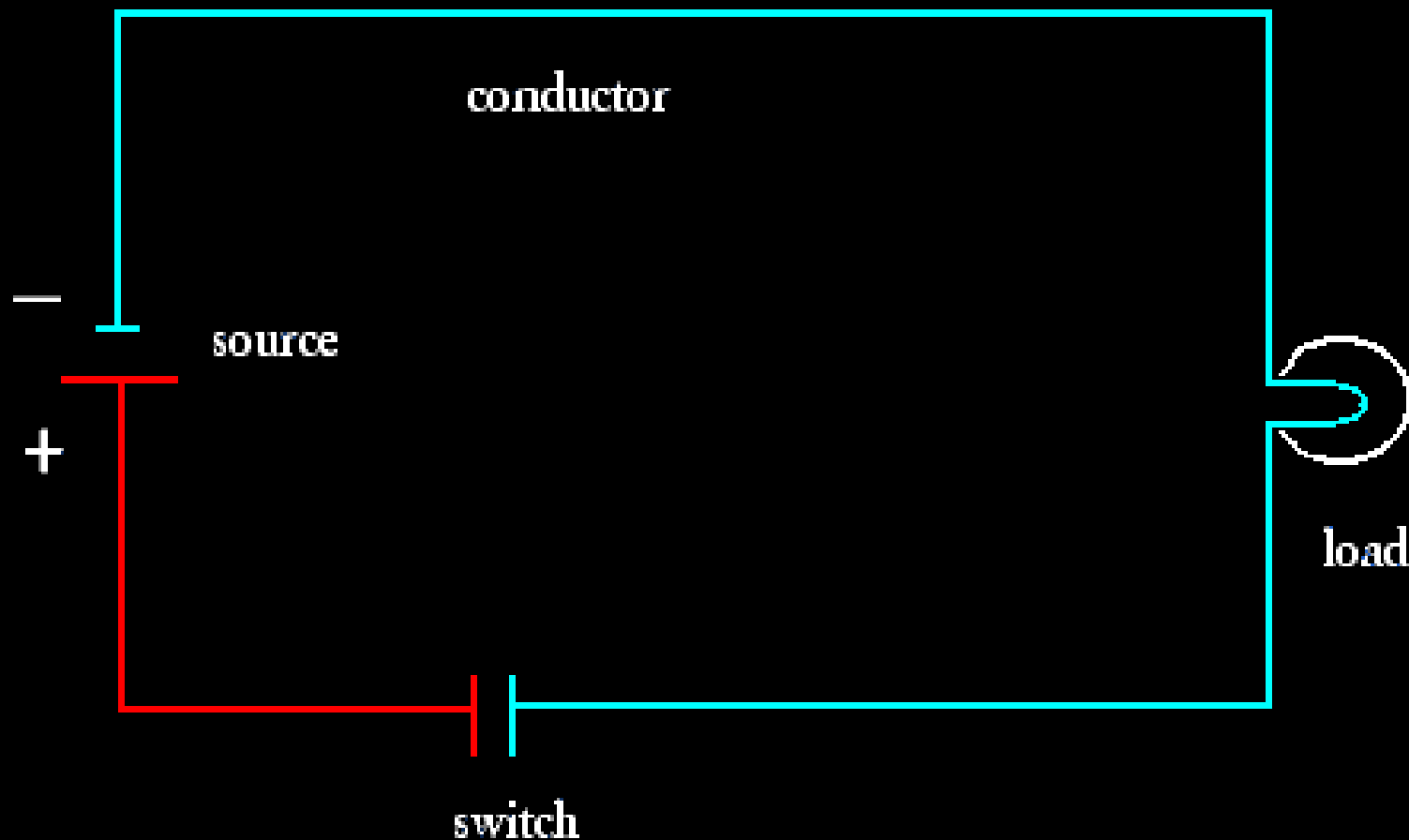
Inductive circuits

Inductive reactive circuits use magnetic fields to perform work. The resistance to the flow of current changes from their static values after current begins to flow.

Electrical Circuit

A simple electrical circuit consists of a source of power, a conductor, a switch, and a load.

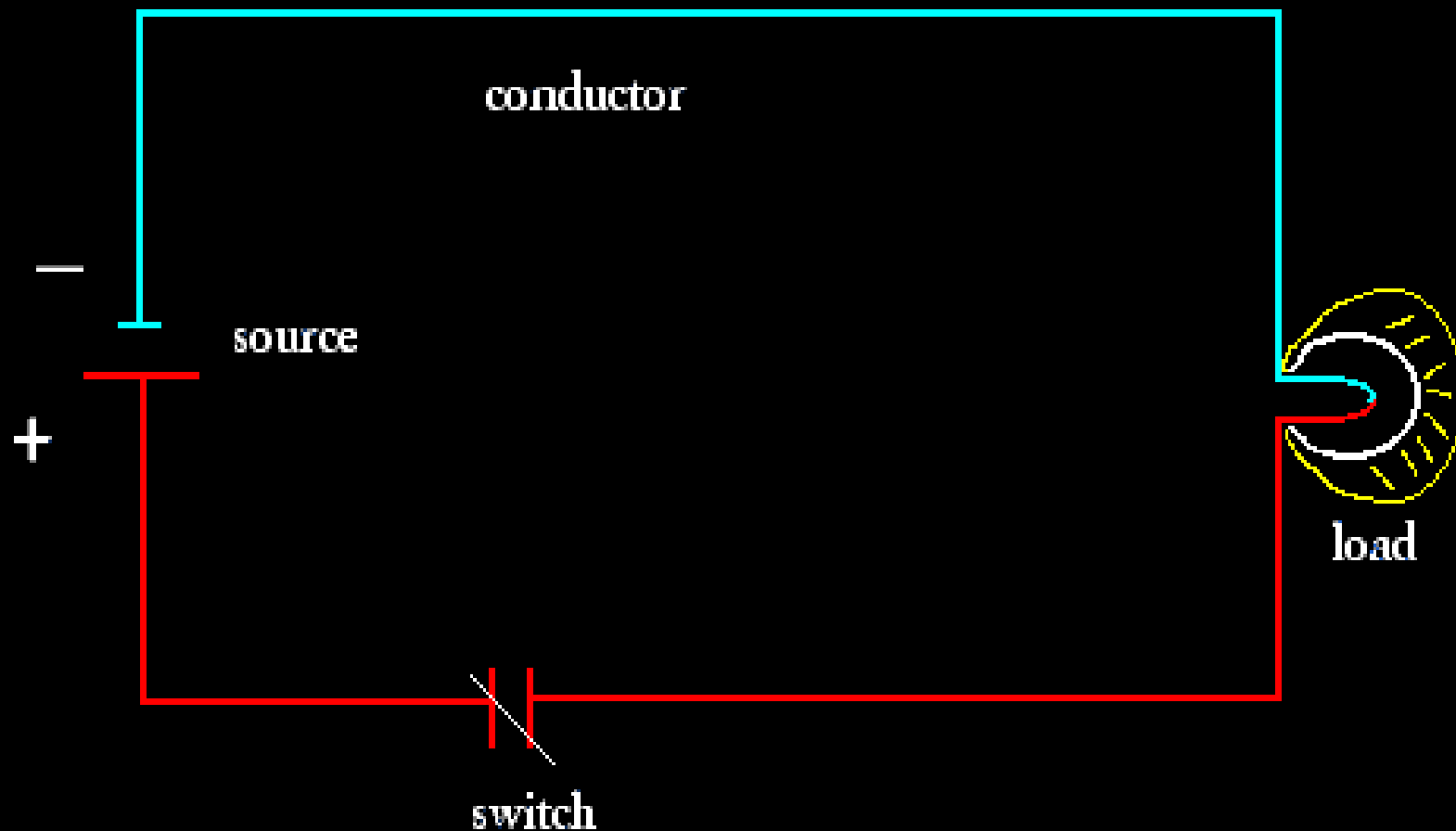
SIMPLE CIRCUIT



WITH SWITCH OPEN LIGHT DOES
NOT BURN

NOTICE THE CONDUCTOR FROM THE SWITCH
TO THE LOAD IS A NEGATIVE POTENTIAL

SIMPLE CIRCUIT



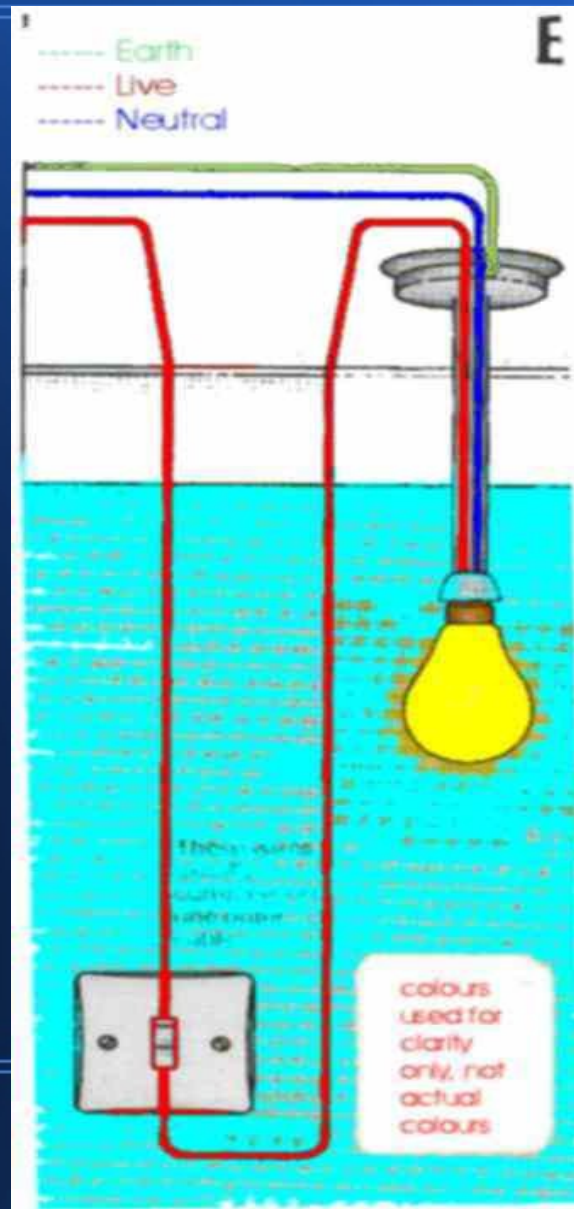
WITH THE SWITCH CLOSED THE LIGHT
WILL BURN

NOTICE THE CONDUCTOR FROM THE SWITCH TO
THE LOAD BECOMES A POSITIVE POTENTIAL

Switch in Circuit

Lamp Wiring

Socket wiring



Terms used

Terms used to describe the electrical effort are important to understand.

Common terms and their definitions are:

Terms used in Electrical terminology

- 1) Open Circuit**
- 2) Short Circuit**
- 3) Closed Circuit**

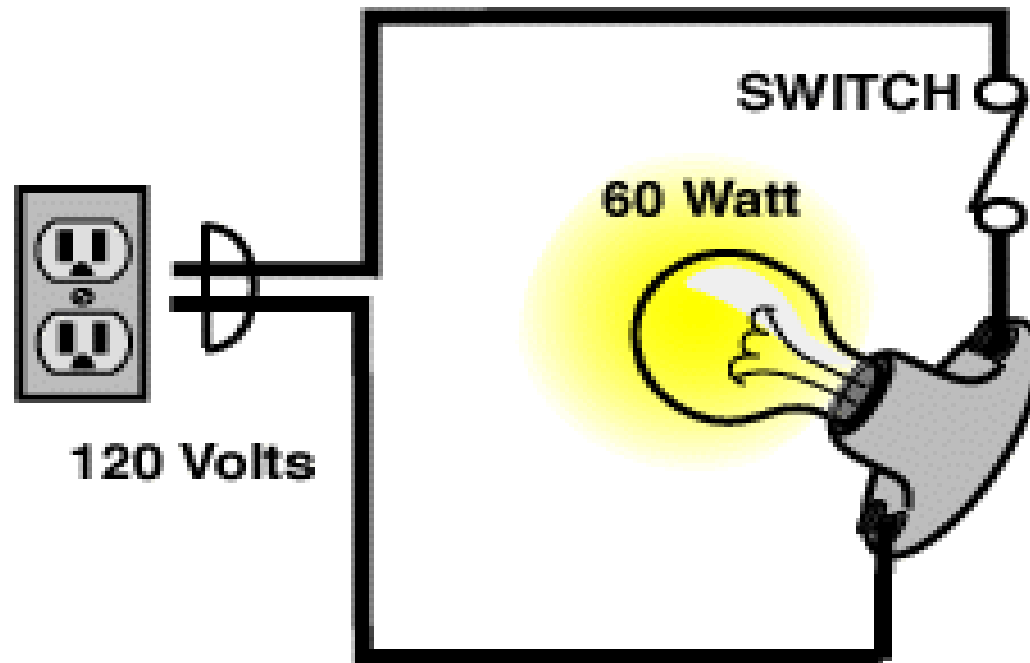
A flashlight is a good example of a simple electrical circuit.

A flashlight has a battery (**source**), wires connected to the battery (**conductor**), the (**switch**) activated by the thumb of the hand holding the flashlight, and the bulb in the head of the flashlight is the (**load**).

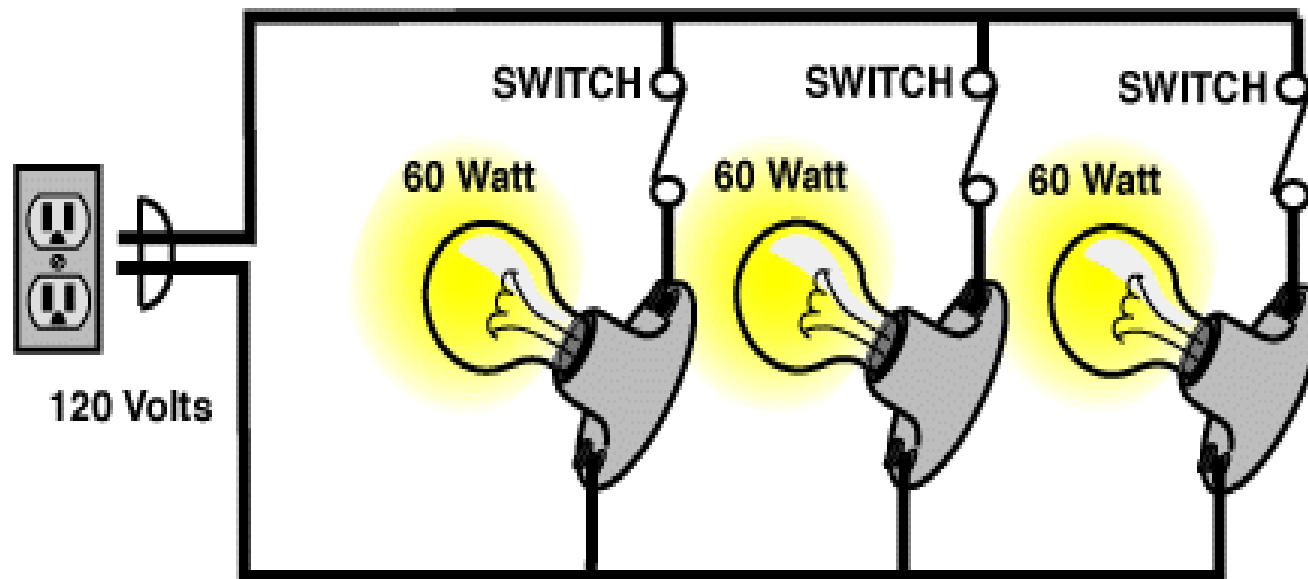
LOAD

A load, in order to perform its task, must have the proper voltage applied. The voltage is carried to the load with the conductor and the switch controls the flow of the current to the load.

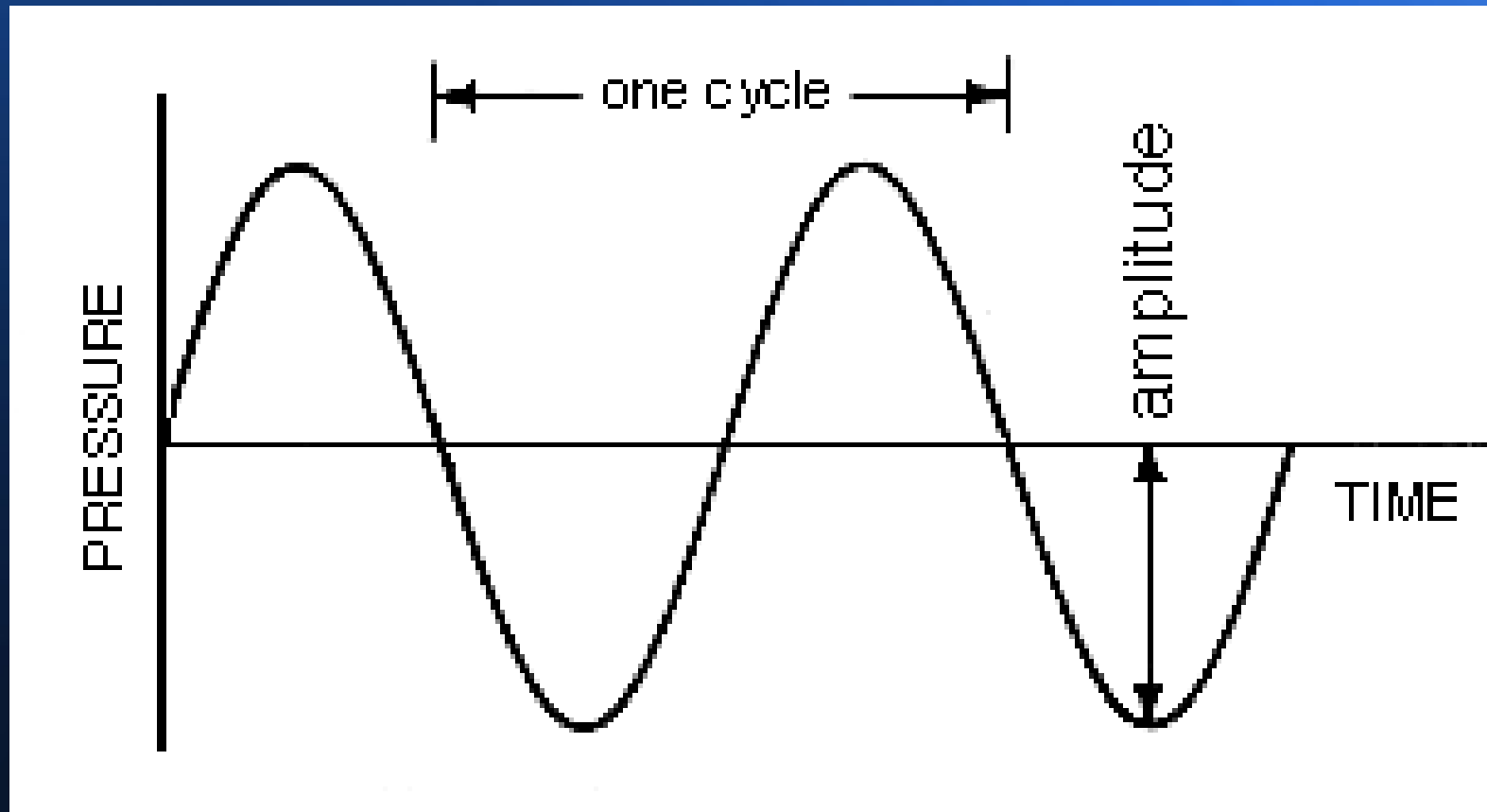
Series Connection



Parallel Connection



Sine wave



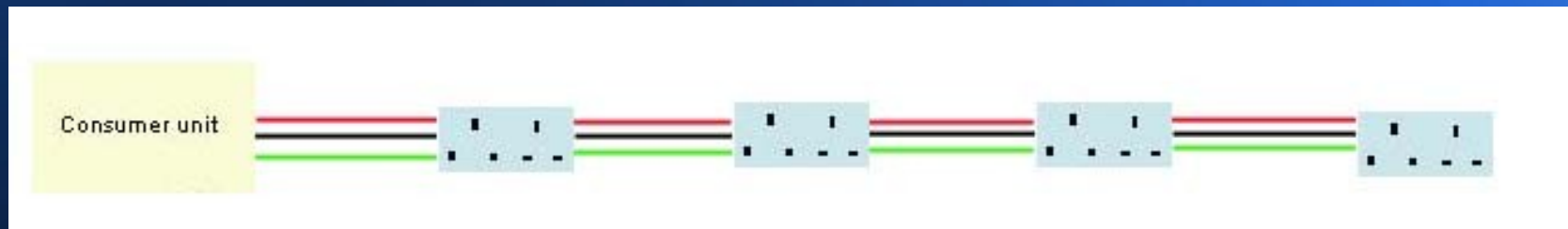
$$V_{rms} = V_p / \sqrt{2},$$

Where I_p represents the peak current and V_p represents the peak voltage. It bears repeating that these two solutions are for a sinusoidal wave only.

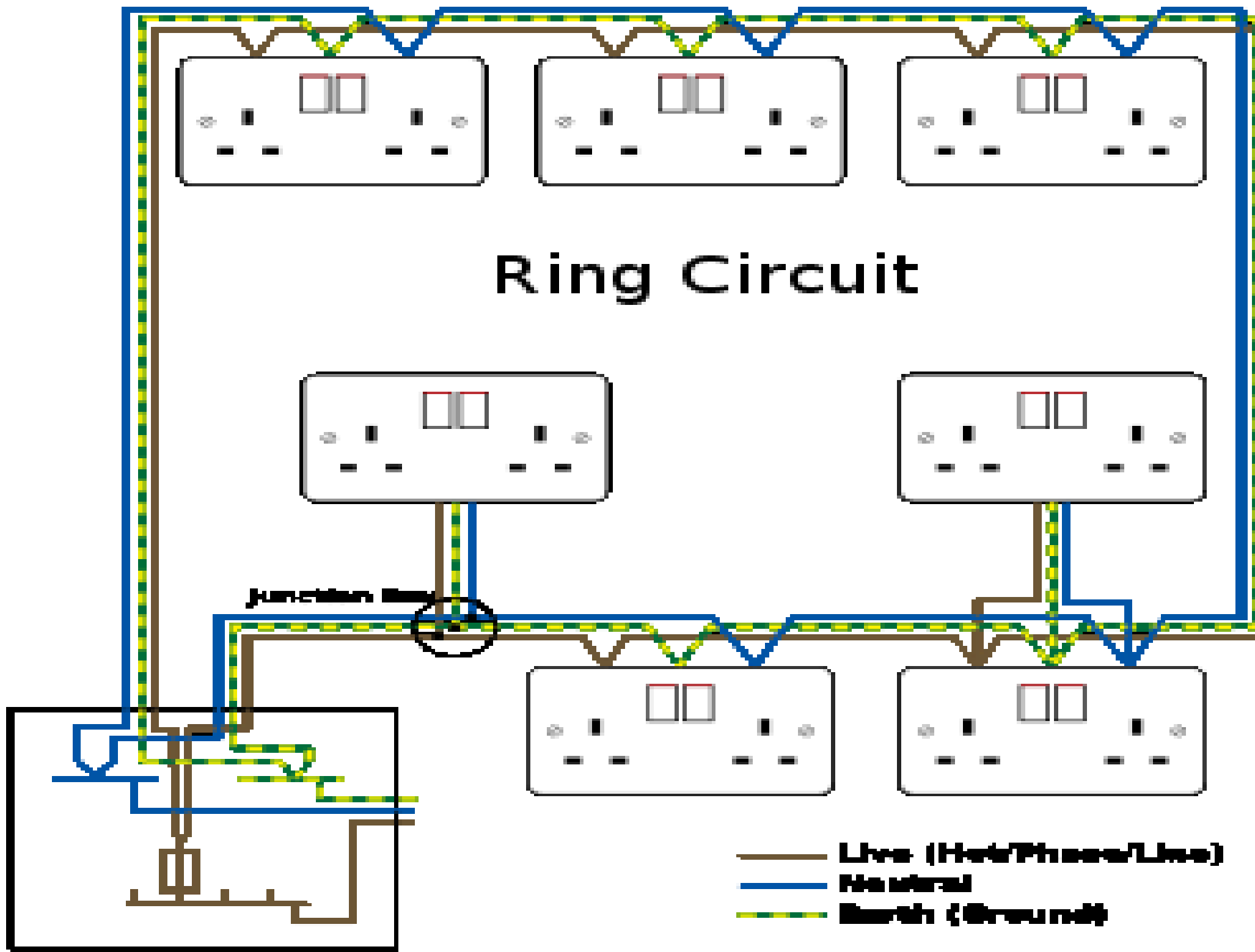
Because of their usefulness in carrying out power calculations, listed voltages for power outlets, e.g. 120 V (USA) or 230 V (Europe), are almost always quoted in RMS values, and not peak values. Peak values can be calculated from RMS values from the above formula, which implies $V_p = V_{RMS} \times \sqrt{2}$, assuming the source is a pure sine wave. Thus the peak value of the mains voltage in the USA is about $120 \times \sqrt{2}$, or about 170 volts. The peak-to-peak voltage, being twice this, is about 340 volts. A similar calculation indicates that the peak-to-peak mains voltage in Europe is about 650 volts.

Radial Circuit

Radial Circuit



Ring Circuit



- Live (Hot/Phase/Line)
- Neutral
- Earth (Ground)

Ring Circuit

This design enables the use of smaller-diameter wire than would be used in a radial circuit of equivalent total current. Ideally, the ring acts like two radial circuits proceeding in opposite directions around the ring, the dividing point between them dependent on the distribution of load in the ring. If the load is evenly split across the two directions, the current in each direction is half of the total, allowing the use of wire with half the current-carrying capacity. In practice, the load does not always split evenly, so thicker wire is used.

What is..

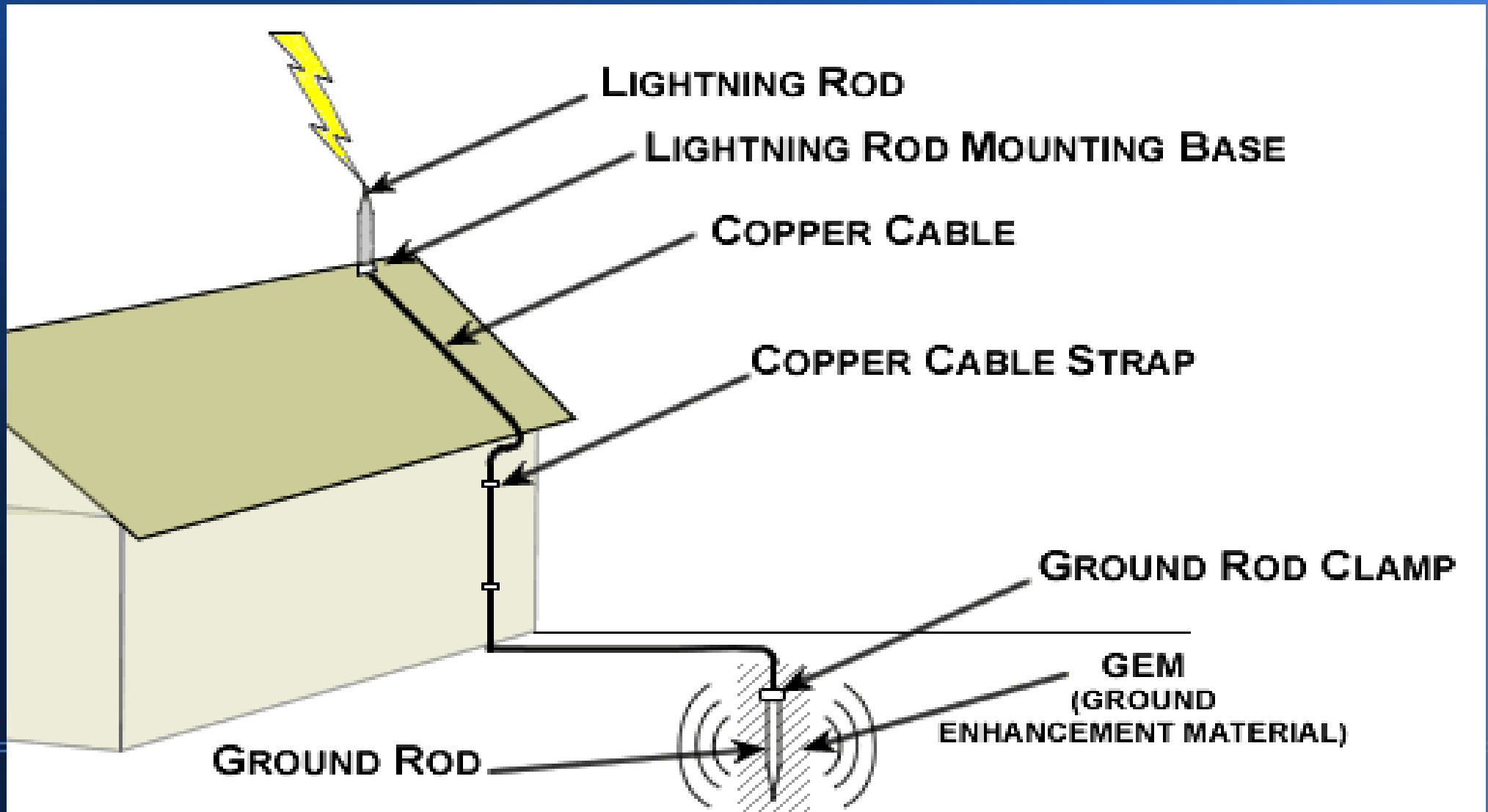
Transformer

- High voltage underground cables
- Copper sizes due to high voltage

Lightning

Lightning is a natural method of producing electricity. Benjamin Franklin was the first to capture the electrical current from a lightning storm using a wire as a kite tether. He invented the lightning rod.

Residential Lightning Rods



MCB AND RCCD

MCB AND RCCD

Miniature Circuit Breaker

What is Miniature Circuit Breaker?

Useful Links

<http://www.hager.com.sg/menu/product/protection-connection/mcb-s-80-125a-range/800>

Types of MCB



Circuit Breakers ensure the safety and reliability of your electrical installation from damage caused by overload or short circuit, for all residential, commercial and industrial needs.

MCB 2 Pole

RCCB/RCCD/ELCB

Residual Current Circuit Breakers (RCCB)



The Residual Current Circuit Breakers (RCCB's) range is commonly used to open a circuit automatically in the case of an earth leakage fault between phase/ neutral and earth, greater or equal to 10, 30, 100, 300 or 500mA

RCCB

The RCCD should be tested every month or quarterly

Types of MCB

Large Circuit Breaker

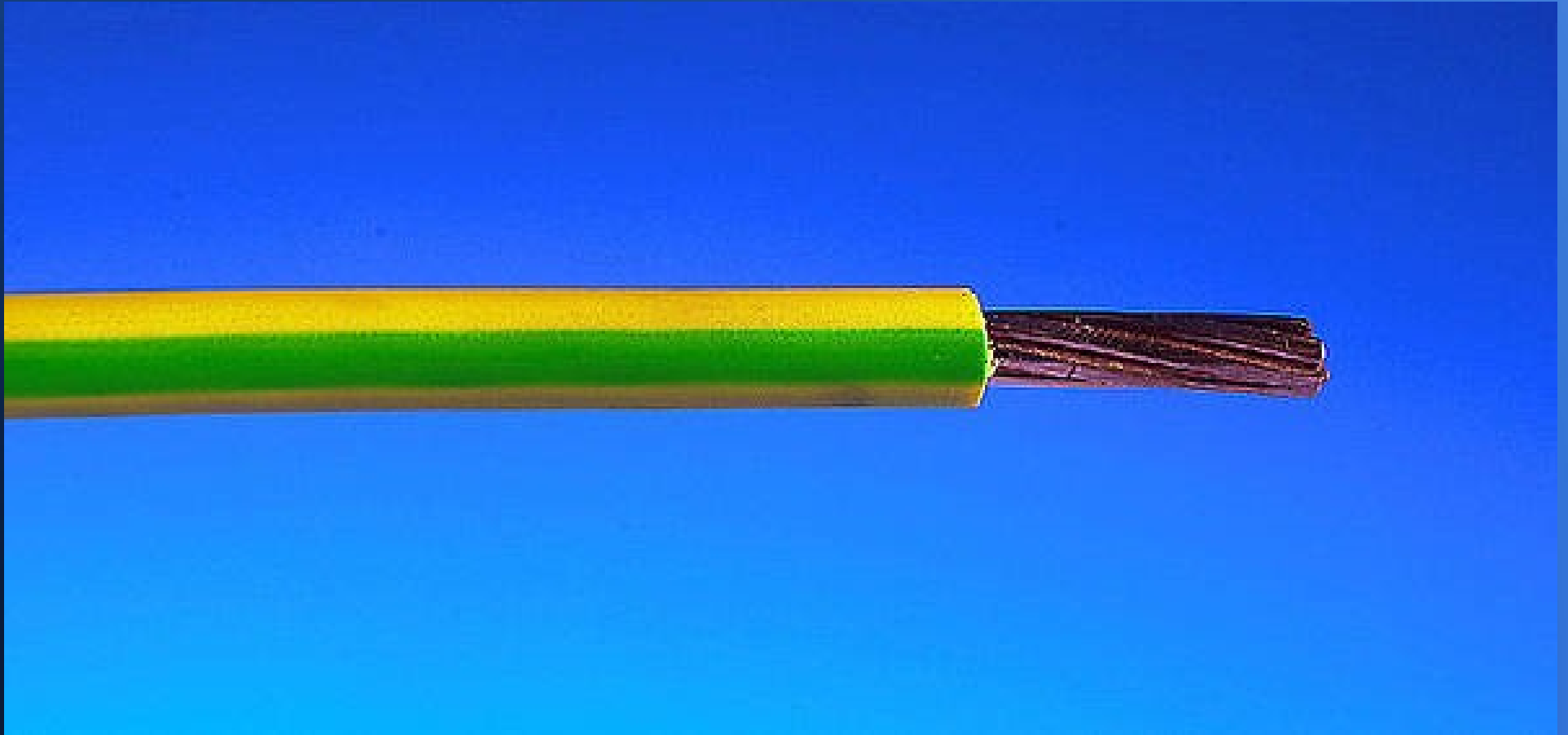


Useful Links

Here is a useful links on RCCB

<http://www.hager.com.sg/menu/product/protection-connection/residual-curr>

What is CPC



Do you know..

**Armored cables are used in sites
work and for garden lighting.**

Video on Electrical Wires

Click on this link

http://www.youtube.com/watch?v=_AApboO3aj0&feature=channel_page

Wire Gauges

1) 1.5mm^2

4) 10mm^2

2) 2.5mm^2

5) 16mm^2

3) 4mm^2

6) 35mm^2

Cable size in Residential

2.5mm sq for 13A SSO

1.5mm sq for Lighting (not true for Theatre and other venues)

4mm – 6mm for heater/ cooker (separate Final ccts)

What is..

- 1) **Battery Short Circuit**
- 2) **30mA for Cardiac Arrest**

What is..

1)Multimeter

2)Current Clamp

3)Insulation Tester

4)Bulb Tester

5)Light Meter

What is..

Difference between a **Switch** and
Isolator?

Air-con, locking isolator?

Switch



Isolator

Isolator not a switch



Video on Electrical Switches

Click on this link

http://www.youtube.com/watch?v=PaAqklrFKgM&feature=channel_page

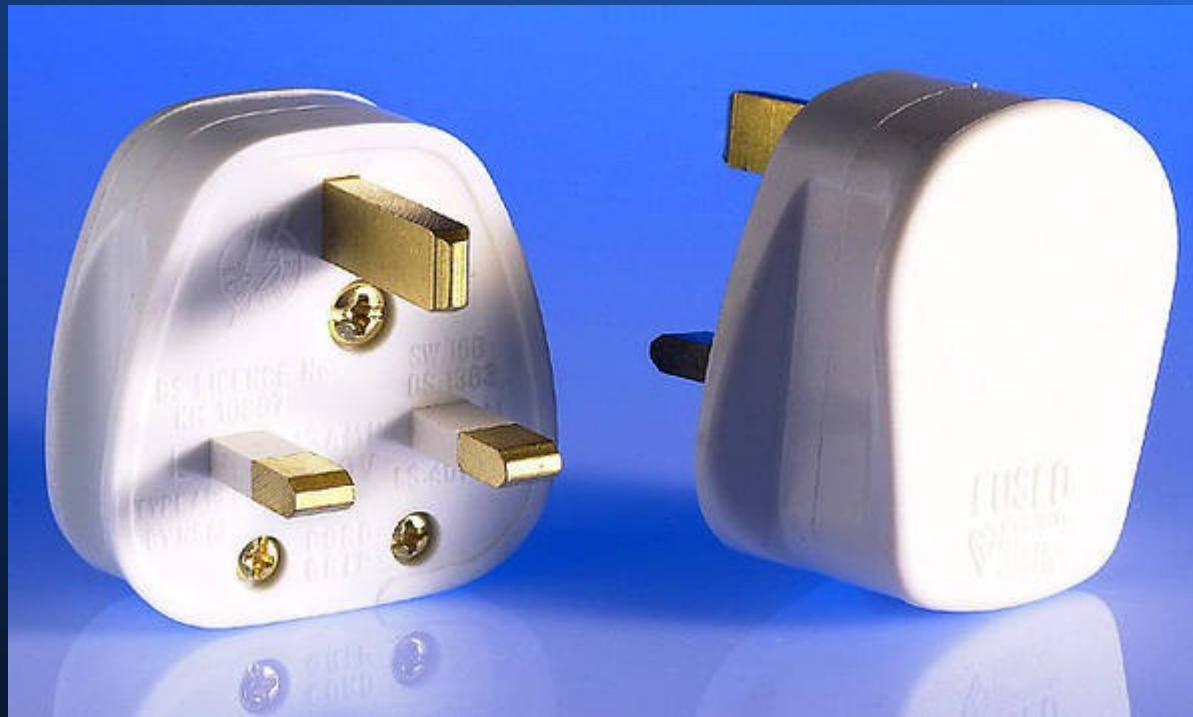
Types of Plugs



Note : There is no fuse

15A Plug

Types of Plugs



13A Plug

Switch Socket Adapter

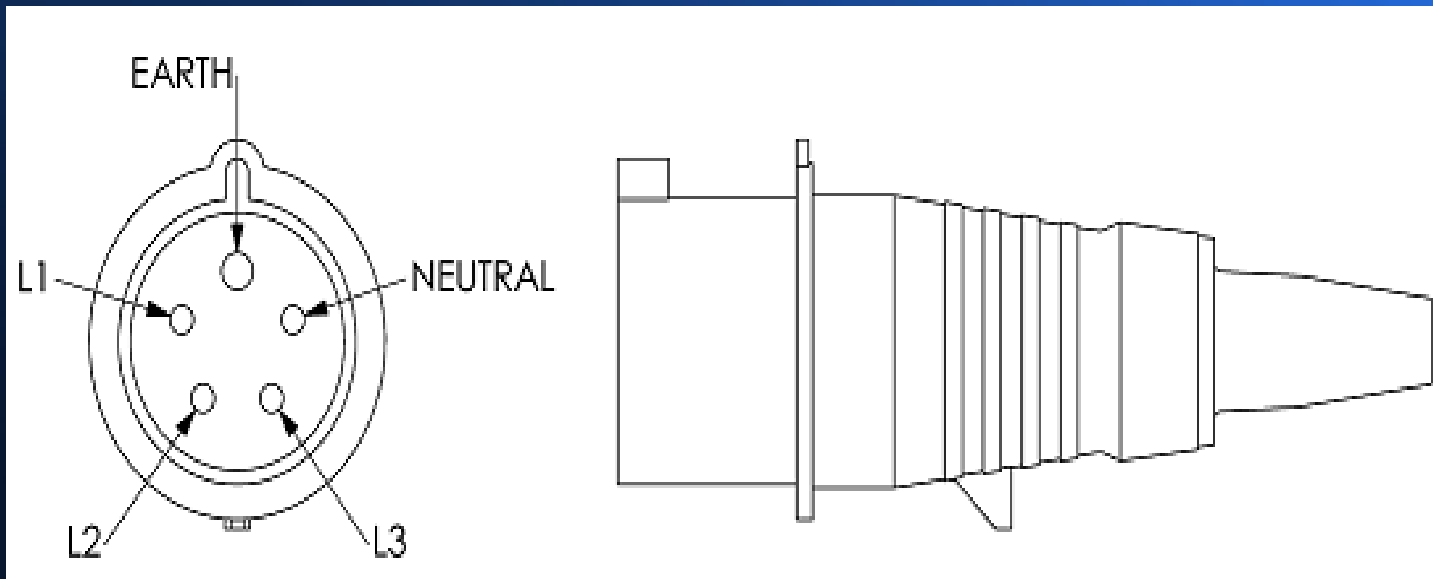


13A SSO

What is..

Difference between a Transformer
and a Ballast?

Types of Plugs



CEE Plug

What is..

**Fuses, slow
blow, Fast
blow , Fast Fast
Blow**



Switch Wiring



What is..

1) 3 phase – color Code

2) Phase Voltage

3) Line Voltage

4) Phase to Phase short circuit

5) Labeling 3 \emptyset 400V, 63A

3 Phase Colour Codes

<http://www.lightingcontrols.com.sg/home/installation>

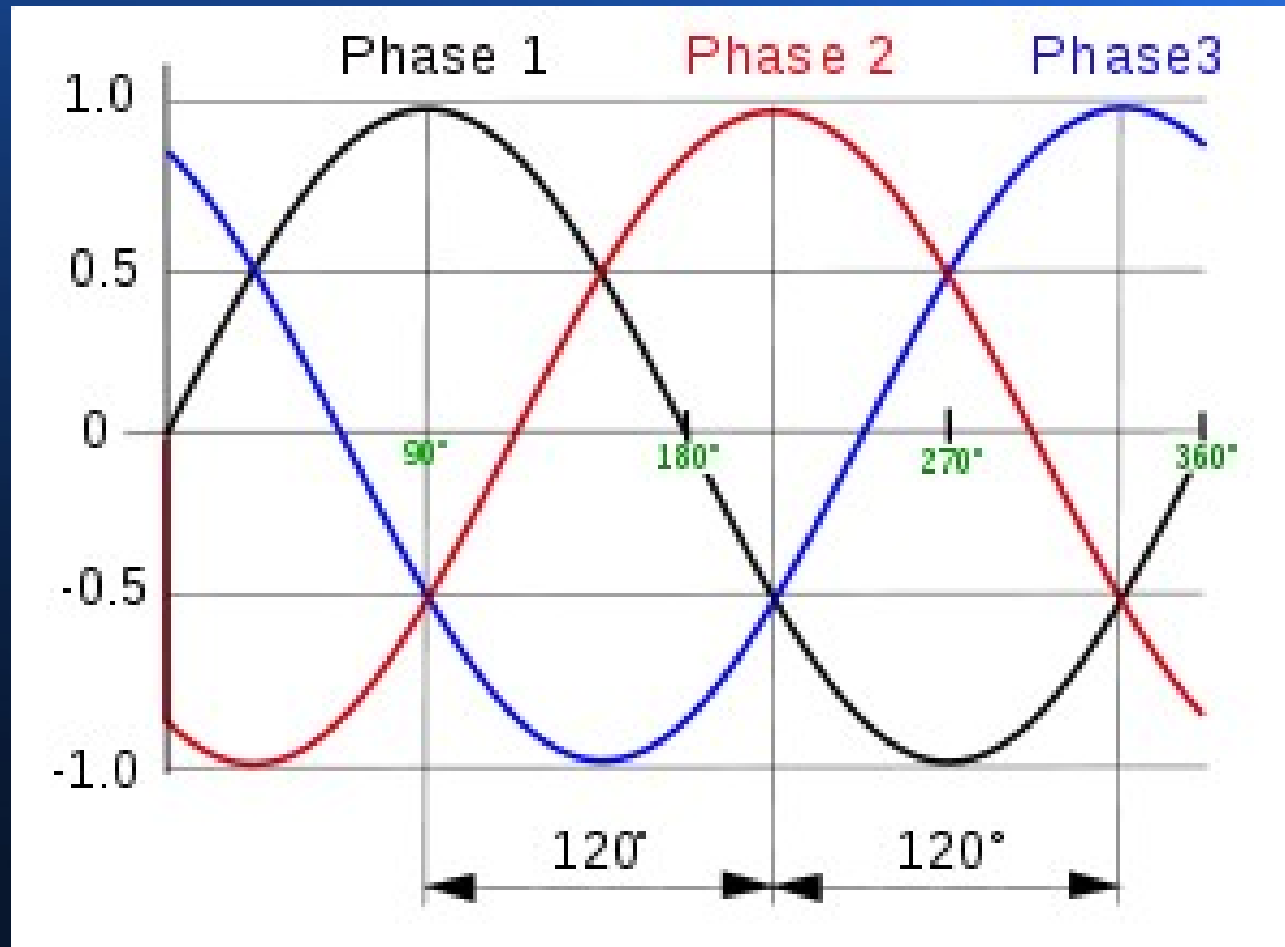
Neutral colour confusion?

3 Phase

Below is a link to a good site for a more clearer understanding of what is 3 Phase.

<http://www.3phasepower.org/>

3 Phase Wave



INGRESS PROTECTION

INGRESS PROTECTION

Ingress Protection

The IP Code (Ingress Protection Rating) consists of the letters IP followed by two digits and an optional letter. As defined in international standard IEC 60529, it classifies the degrees of protection provided against the intrusion of solid objects (including body parts like hands and fingers), dust, accidental contact, and water in electrical enclosures. The standard aims to provide users more detailed information than vague marketing terms such as "waterproof".

IP Rating

The digits ('characteristic numerals') indicate conformity with the conditions summarized in the tables below. Where there is no protection rating with regard to one of the criteria, the digit is replaced with the letter X.

IP Rating



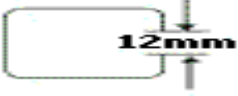
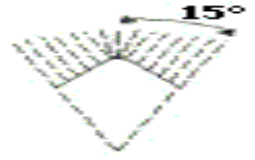
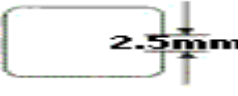
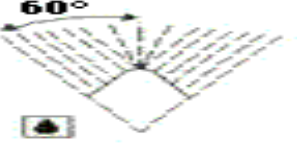

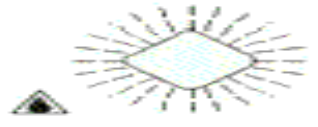



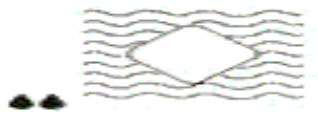
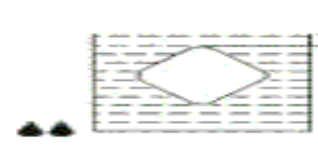

First digit

The first digit indicates the level of protection that the enclosure provides against access to hazardous parts (e.g., electrical conductors, moving parts) and the ingress of solid foreign objects.

IP Rating

Second digit

Protection of the equipment inside the enclosure against harmful ingress of water.

IP54 = IP Letter Code _____ IP		_____ 5 _____ 4	
1st Digit	Protection from solid objects	2nd Digit	Protection from moisture
0	Non protected	0	Non protected
1	 Protected against solid objects greater than 50mm	1	 Protected against dripping water
2	 Protected against solid objects greater than 12mm	2	 Protected against dripping water when tilted up to 15°
3	 Protected against solid objects greater than 2.5mmØ	3	 Protected against spraying water
4	 Protected against solid objects greater than 1.0mmØ	4	 Protected against splashing water
5	 Dust protected	5	 Protected against water jets
6	 Dust tight	6	 Protected against heavy seas
Note: EN 60529 does not specify sealing effectiveness against the following: mechanical damage of the equipment; the risk of explosions; certain types of moisture conditions, e.g. those that are produced by condensation; corrosive vapours; fungus; vermin		7	 Protected against immersion to a depth of 1.5m - 1m
		8	 Protected against submersion to a depth of 1m+ (see note)

IP Rating

For example,
an electrical socket rated IP22 is protected against insertion of fingers and will not be damaged or become unsafe during a specified test in which it is exposed to vertically or nearly vertically dripping water. IP22 or IP2X are typical minimum requirements for the design of electrical accessories for indoor use.

Name Plate



Typ SK 80 S/4		33112300	
3 ~ Mot.	Nr. NM 2407337190.00		
Th. Cl. 155 (F)	IP 55	S1	
EN 60034		(H)	
50 Hz	230/400	V Δ /Y	60 Hz 265/460 V Δ /Y
2,63/1,52 A	0,55 kW	2,60/1,50 A	0,63 kW
COS ϕ 0,73	1375 1/min	COS ϕ 0,73	1650 1/min
220-240/380-420	V Δ /Y	254-277/440-480	V Δ /Y
2,63- 2,67/ 1,52- 1,54 A	2,60- 2,63/ 1,50- 1,52 A		
MB=	Nm; AC	V~ , DC	V=

085-0457-0

Electric Transmission Lines



insulators



Messy Electrical Post



Voltage Ranges

IEC voltage range	AC	DC	defining risk
High voltage	> 1000 Vrms	> 1500 V	electrical arcing
Low voltage	50–1000 Vrms	120–1500 V	electrical shock
Extra-low voltage	< 50 Vrms	< 120 V	low risk

Extra Low Voltage

Swimming Pool lighting , 12V Transformers

Useful link for more understanding on the above..

http://en.wikipedia.org/wiki/Extra_low_voltage

Do you know..

Low voltage of 110V and isolation transformers are used in construction site.

SAFETY



Ladders , can we use another type of ladder



What actually caused it to happen?

This is the Links to the video on
Electrocution.

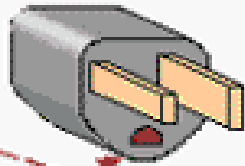
<http://www.youtube.com/watch?v=BtQtRGI0F2Q&feature=related>

Electrical Shock

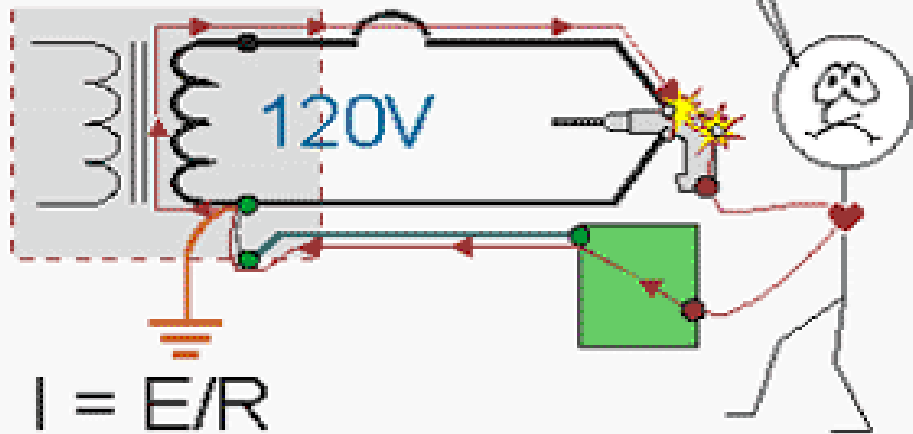
The body becomes part of an electrical path.

Line-to-ground fault energizes metal parts.

Broken Terminal



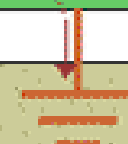
1000 Ohms



$$I = E/R$$

$$120V/1000\Omega = 120 \text{ mA}$$

Grounded Object or Surface



Video on Electric Shock

<http://www.youtube.com/watch?v=y1YcNT-v2ik>

How to..

Treat your test pen

- 1. Do not drop it/ abuse it**
- 2. DO not use it for any other purpose**
- 3. Do not trust another person's test pen**

What is..

Insulation Resistance Testing

What is..

1) Bonding

2) Trunking Bonding

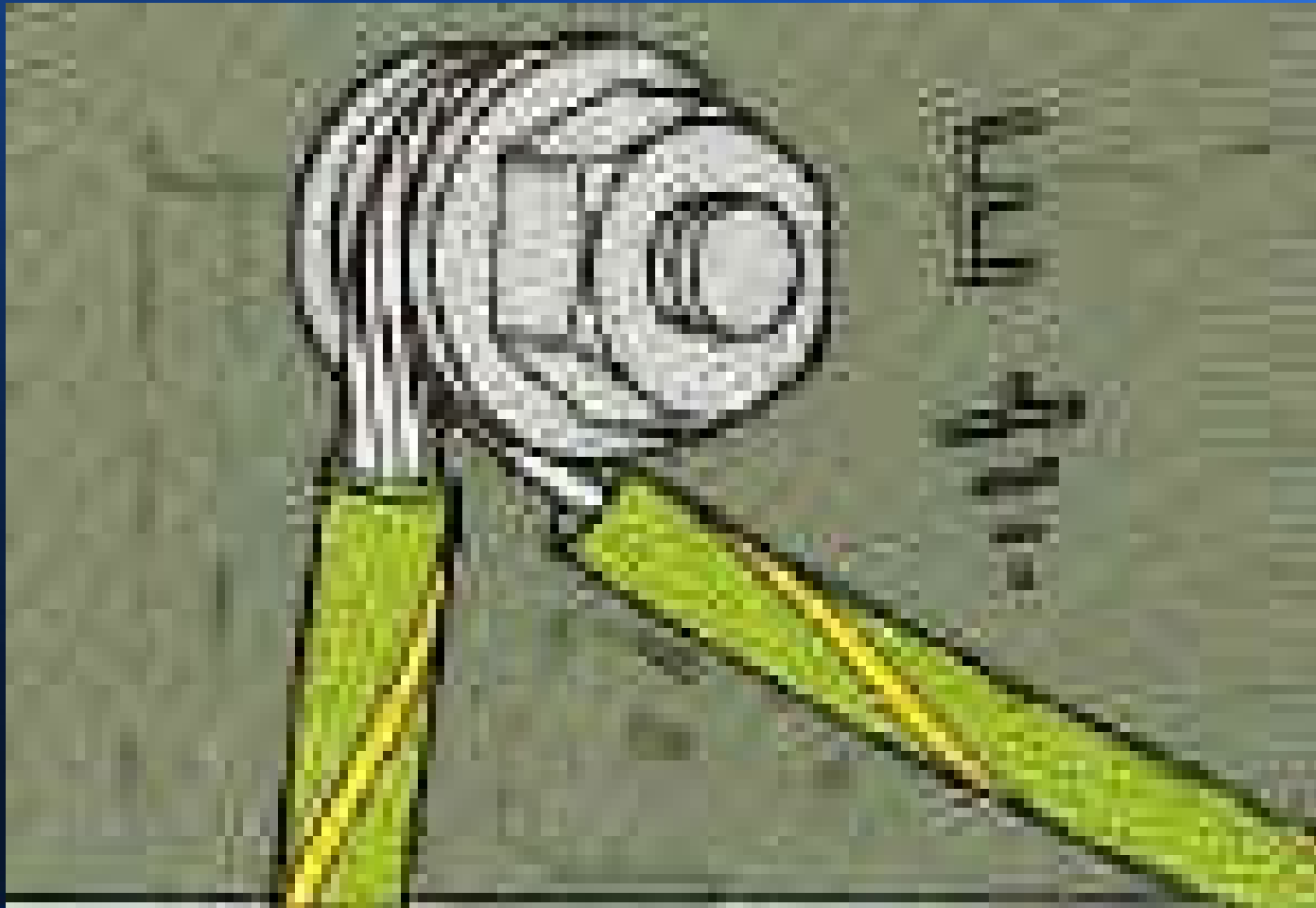
Safety Precautions

- False information
 - Neutral is Live
- 2 units wiring and 2 Dbs in one location
- Non- insulated pliers and screw drivers
 - Tester and Switch faulty
 - Poly on the job training
- Don't be a hero

Safety Precautions

- Lock the DB , Disconnect by Isolating the supply
 - Someone to stand at the DB box
- You might be in a different location and repair or dimmer another location
 - Test with the supply point again
 - Incorrect labeling

Bonding Bracket (Small)



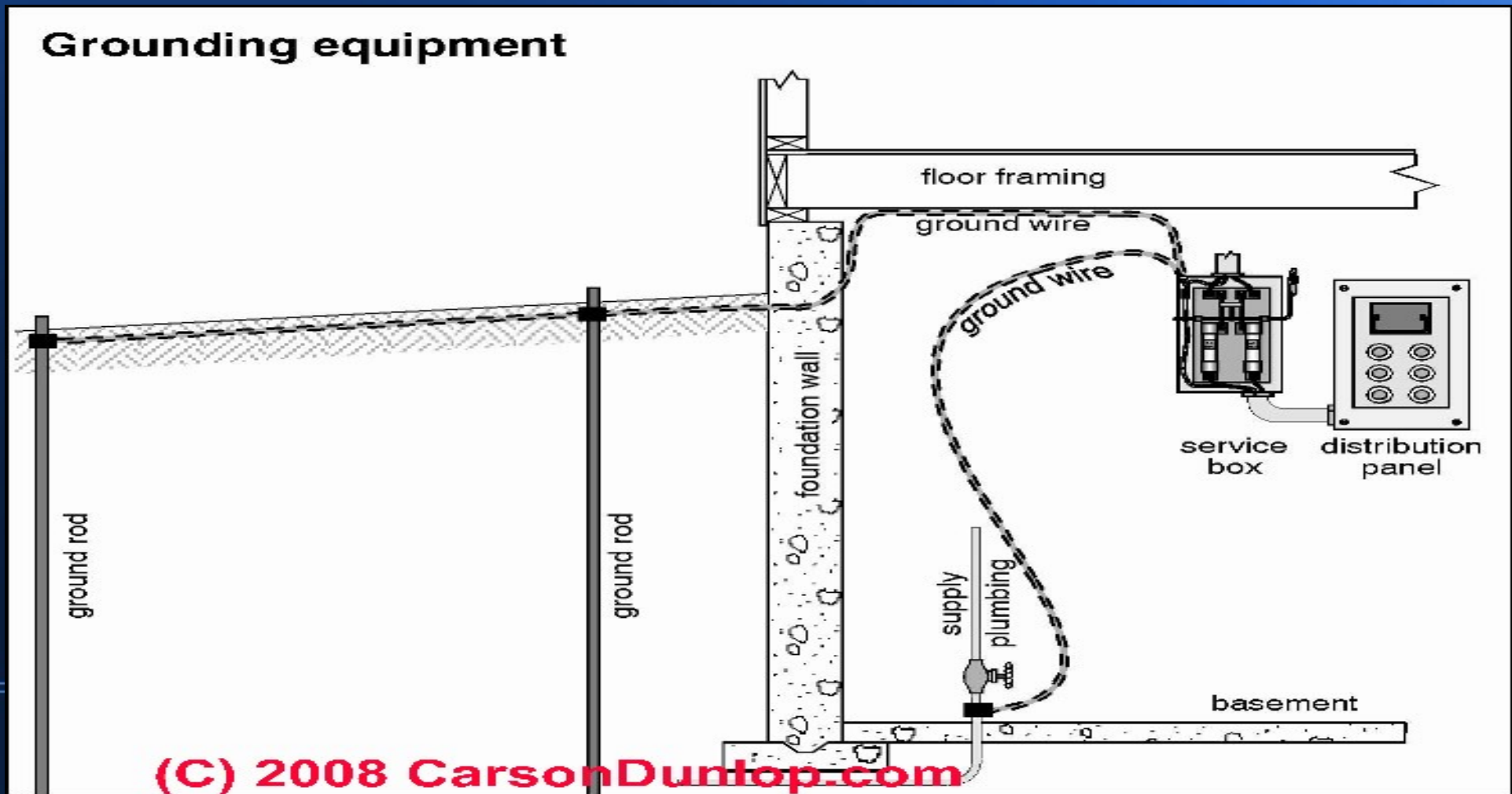
Do not disconnect Electrical Bonding – why some people do it?

Partition Boards / Gypsum Boards

Metal Conduit for concealed wiring

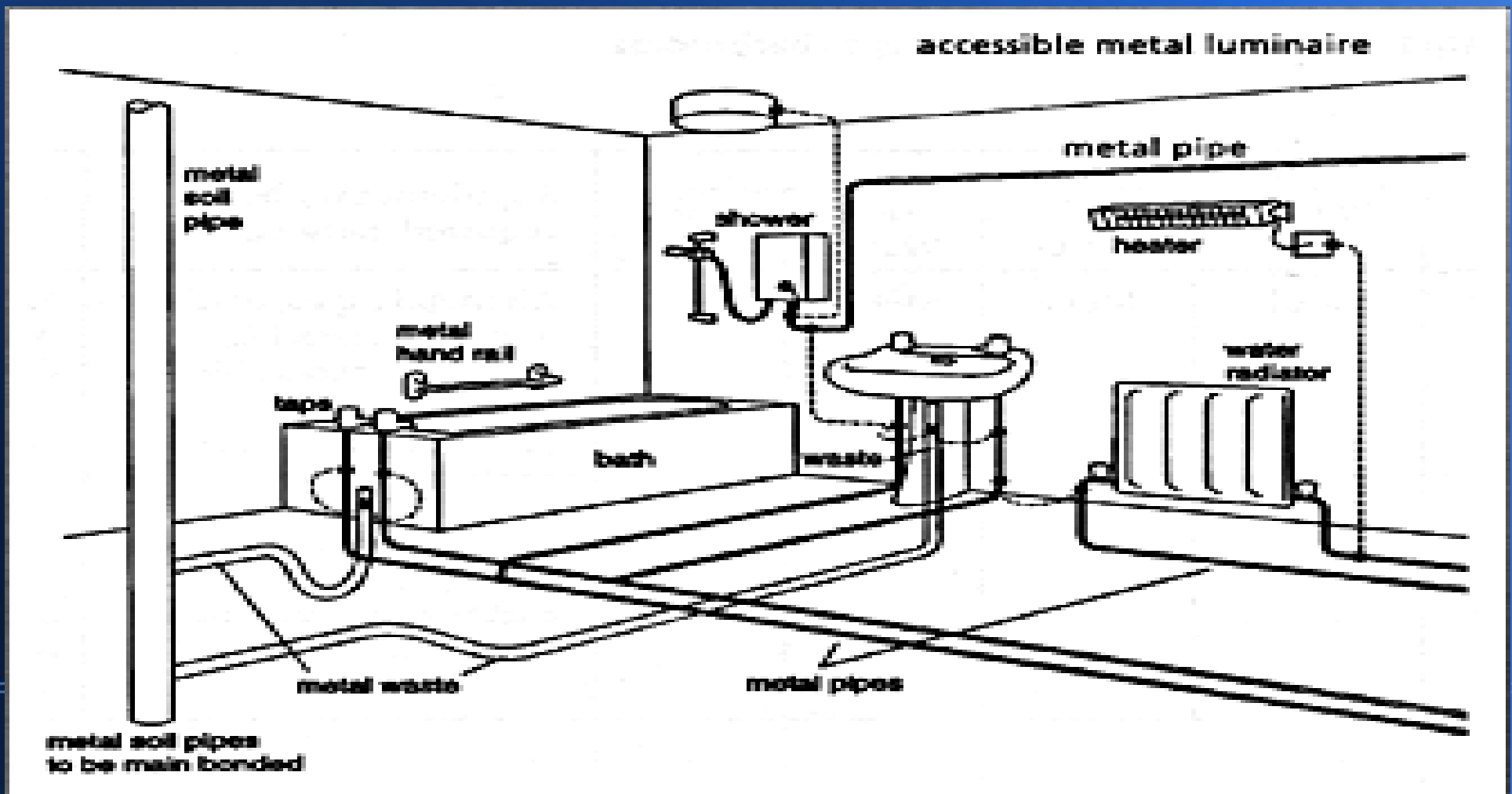
What is..

Ground Bonding



What is...

Equipotential Bonding



Other Interesting and “Shocking” Video

Loose power line

<http://www.youtube.com/watch?v=WdekH0UnWXk>

Electric Arc

http://www.youtube.com/watch?v=JTdc_pjZADI

Downed Electric Line

<http://www.youtube.com/watch?v=EochMYzYz20>

Large Electrical Explosion

<http://www.youtube.com/watch?v=eYUmdqQ94Ao>

Thank You



Lighting Controls Pte Ltd

Basic Electrical Course

Date: 24th - 25th Feb 2009

-End-

What is..

- 1) Leading Edge Dimmers**
- 2) Trailing Edge Dimmers**
- 3) Sine Wave Dimmers**

What is..

1) Analogue – 1-10v

2) DSI

3) Dali

4)DMX

What is..

CFL Lamps

Lightings

- 1) 2 pin PLC lamps – (Non – Dimmable)**
- 2) 4 pin PLC lamps - Dimmable**

Metal Halide

1) Ignitor

2) Metal Halide Lamp

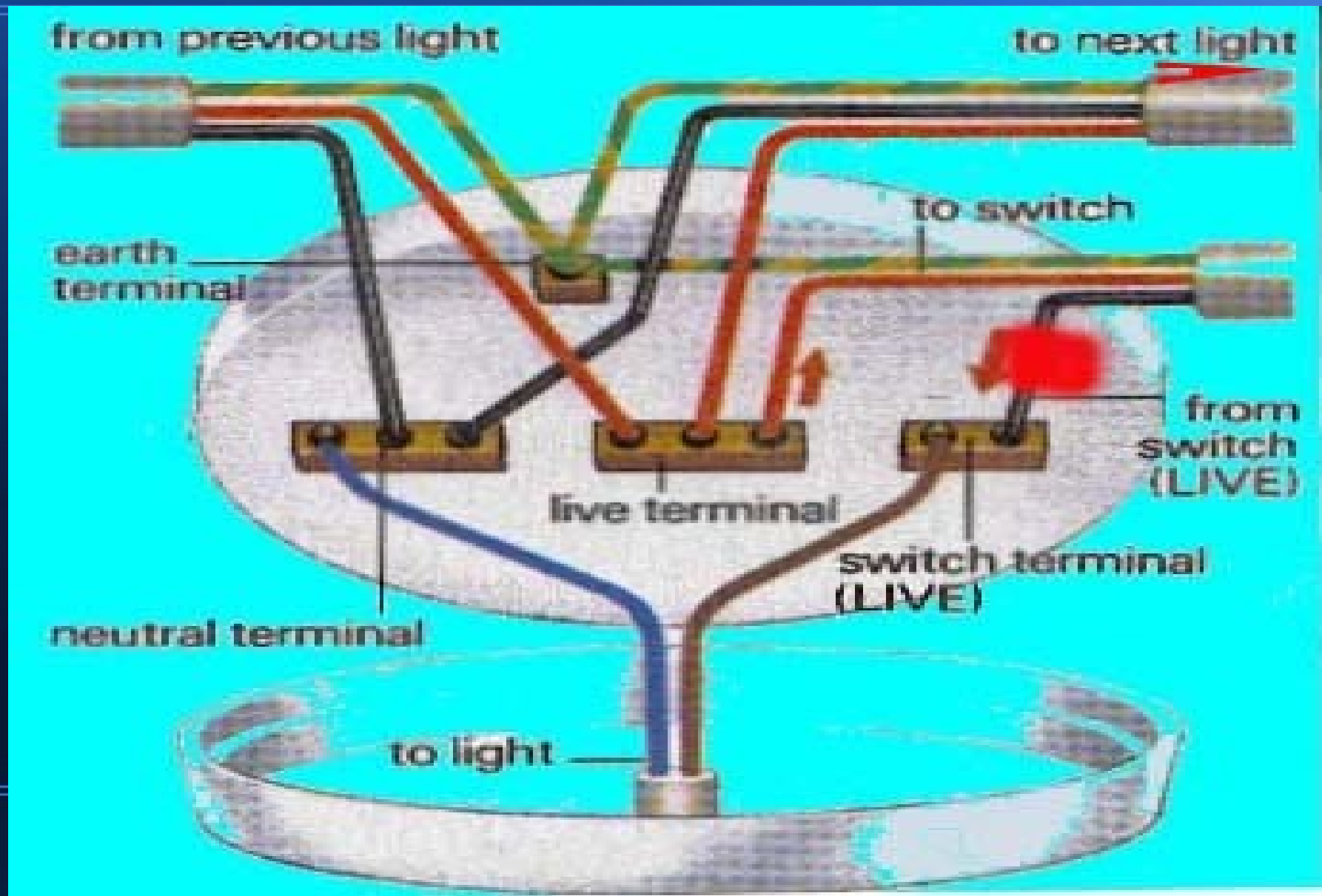
3) Ballast

4) Capacitor

Calculating

Lighting florescent x 1.8

Ceiling Lamp Diagram



Motor Section (Big)

