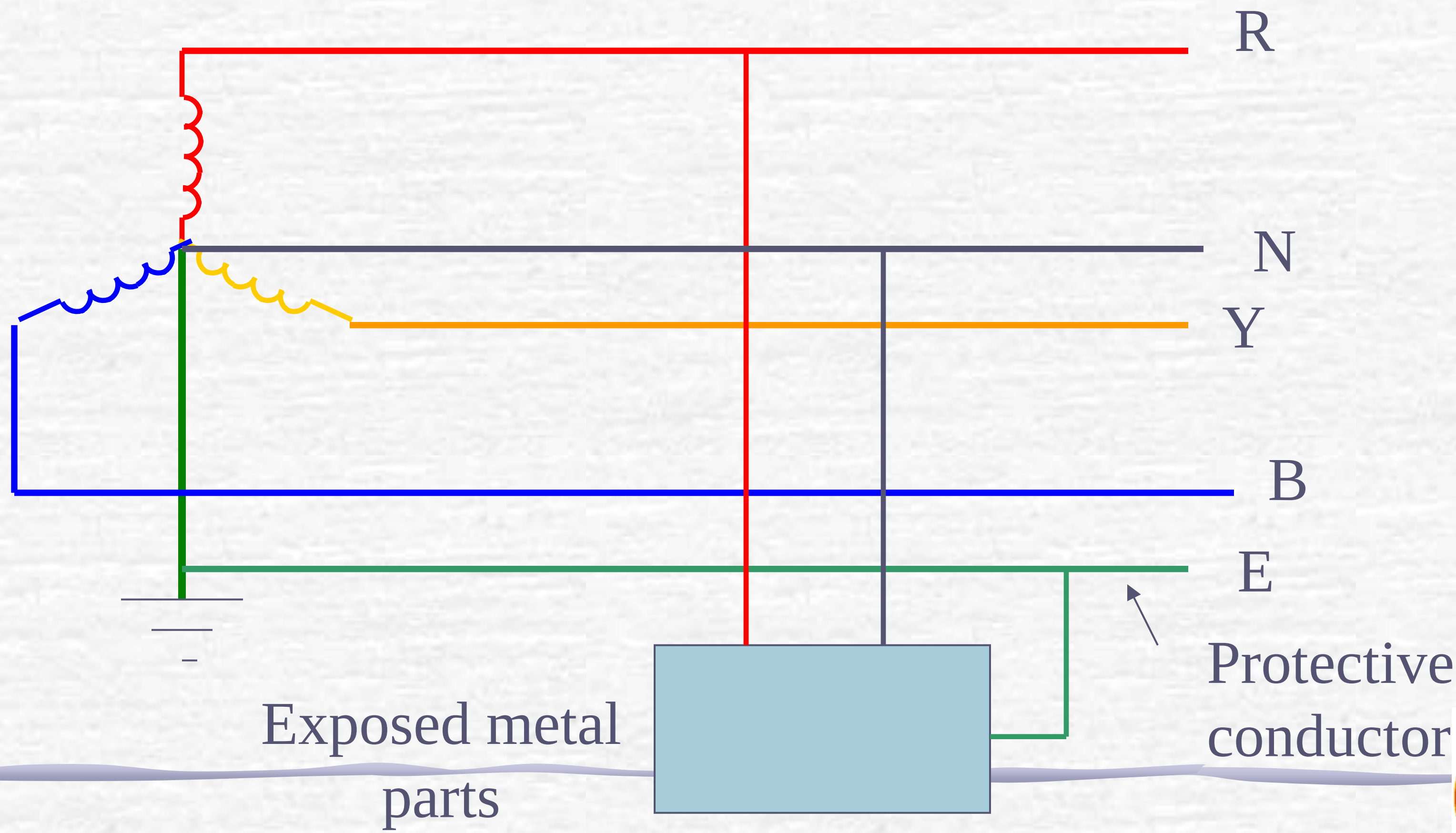
IET WIRING REGULATIONS

Electrical installations:
TN – S System

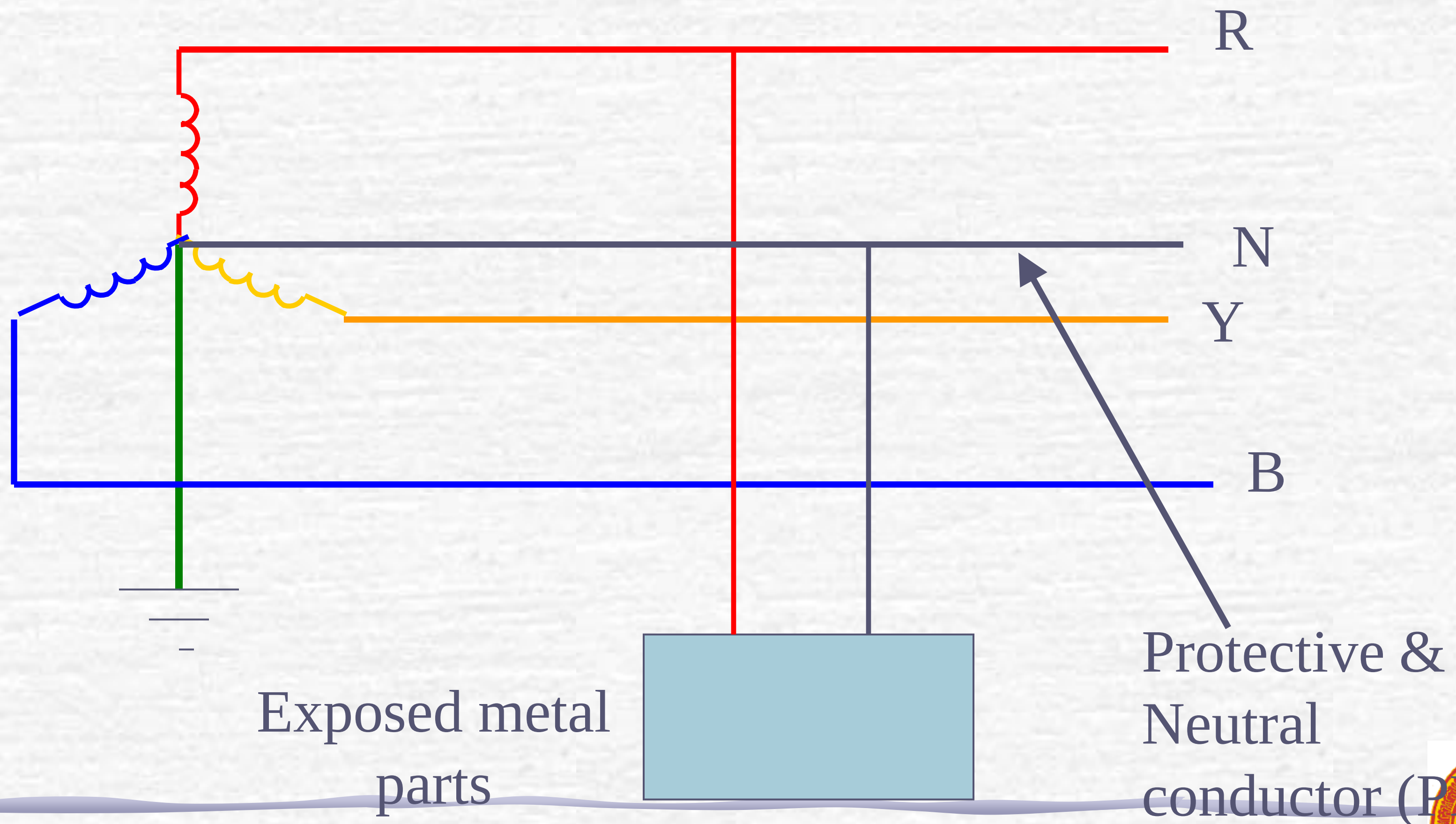
- Separate neutral and protective conductor throughout the system



Electrical installations:

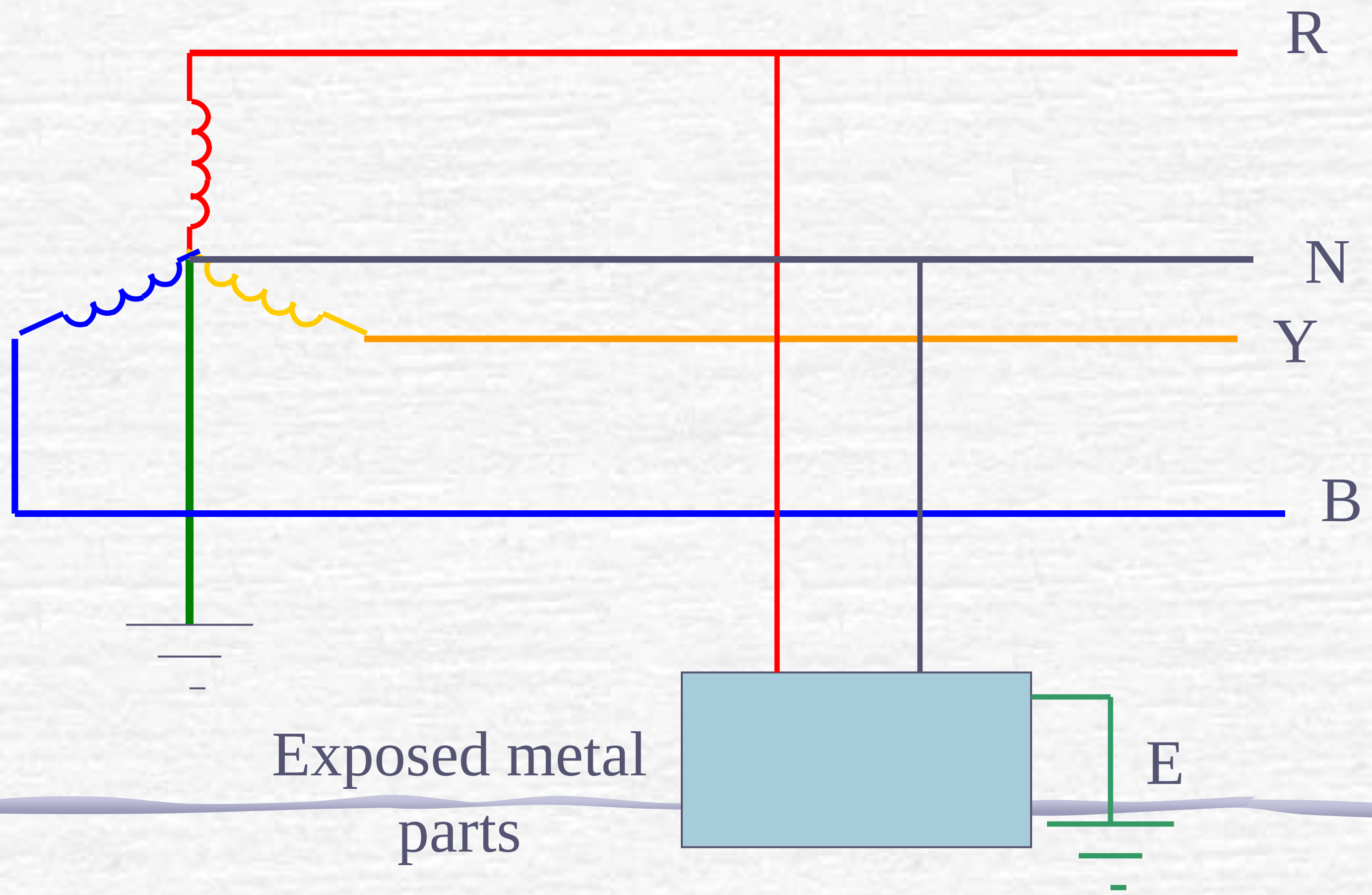
TN – C System

- Combined neutral and protective conductor

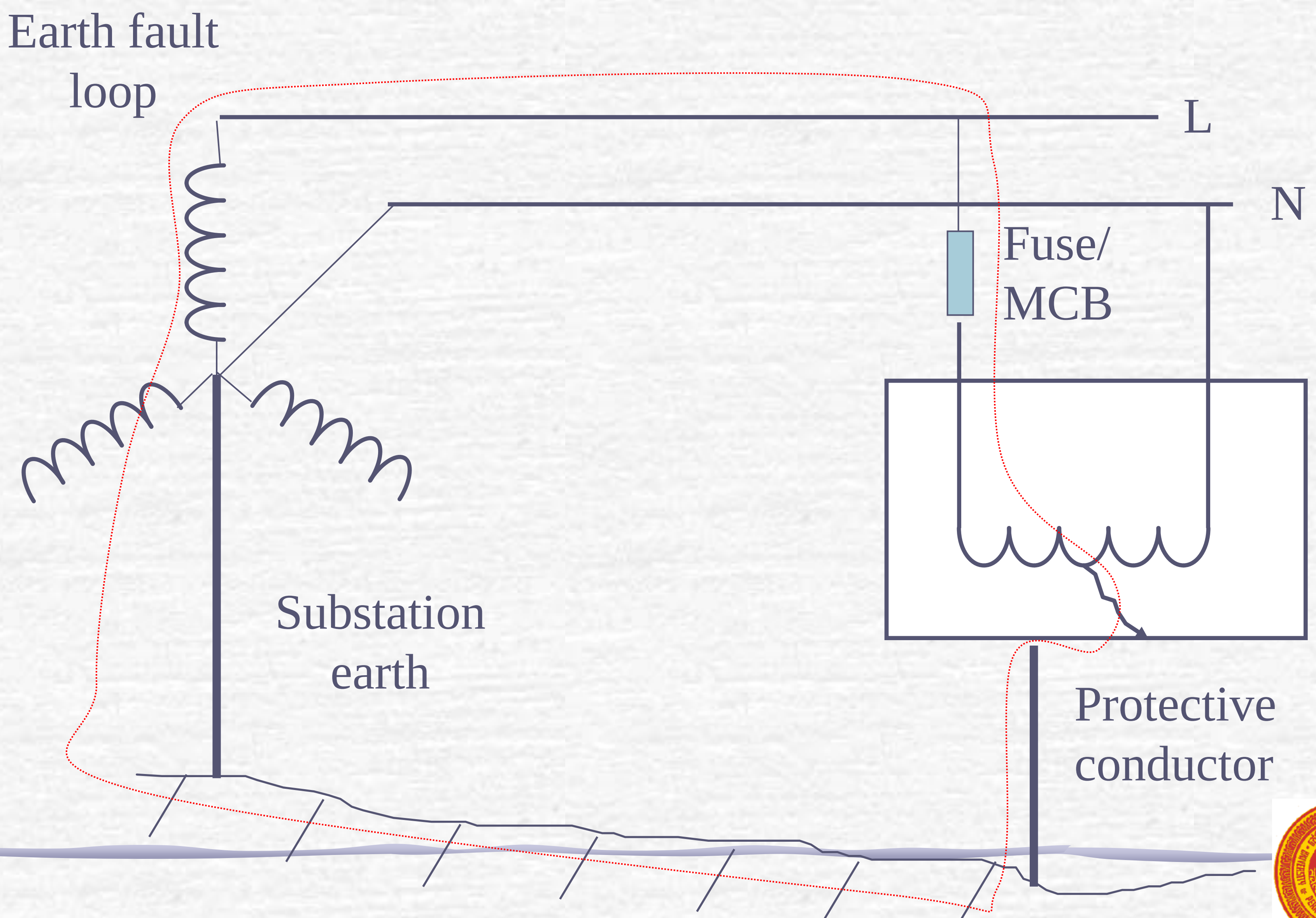


Electrical installations:
TT System

- Both source and installation have separate earth electrodes



AUTOMATIC DISCONNECTION



EARTH FAULT LOOP IMPEDANCE

- Phase conductor impedance
- T/F leakage impedance
- T/F earth resistance including protective conductor
- Resistance of the earth
- Resistance of the consumers earth electrode
- Protective conductor impedance
- Fault impedance

PROTECTION AGAINST FAULTS

- Fault current should be interrupted before a temperature rise cause damage to the insulation, joints etc.
- Devices that can be used:
  - Fuses
  - Miniature and moulded case circuit breakers (MCB and MCCB)

Over current protection

SELECTION CRITERIA OF THE PROTECTIVE DEVICE

- Protective device .. Nominal current (I_n)
- Operating current (I_2)
- $I_2 > I_n$
- Cable ... Current carrying capacity (For the smallest cable I_z)
- Designed current or load current (I_L)

$$I_L < I_n < I_z$$

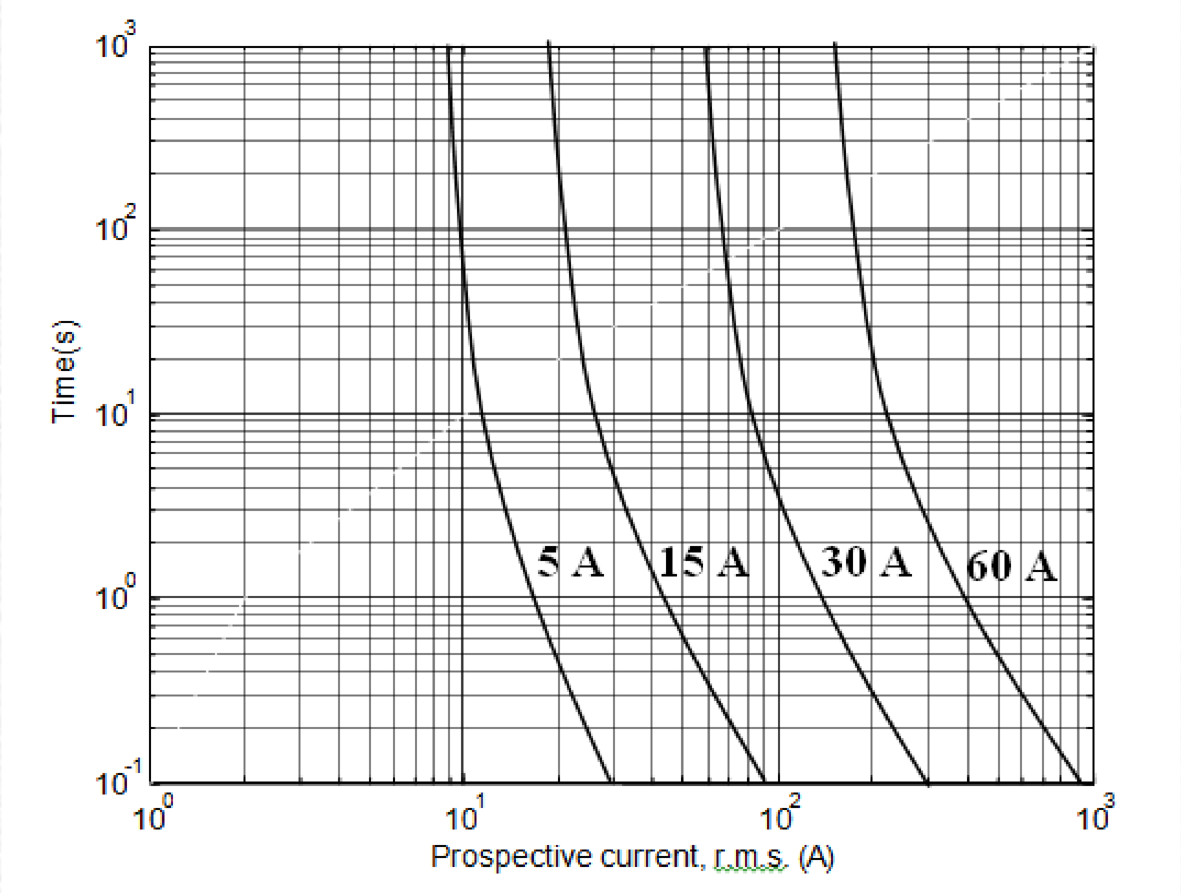
$$I_2 < 1.45 \times I_z$$

OPERATION CRITERIA FOR A FUSE

- Fusing current < Fault current
- Fusing current is based on operating time
  - 0.2 sec for final socket outlet circuits up to 63 A and 32 A fixed equipment circuits
  - within 1 sec final socket outlet circuits grater than 63 A and fixed equipment circuits greater than 32 A
- Fault current

  = Nominal voltage / Earth fault loop impedance

FUSING CHARACTERISTIC



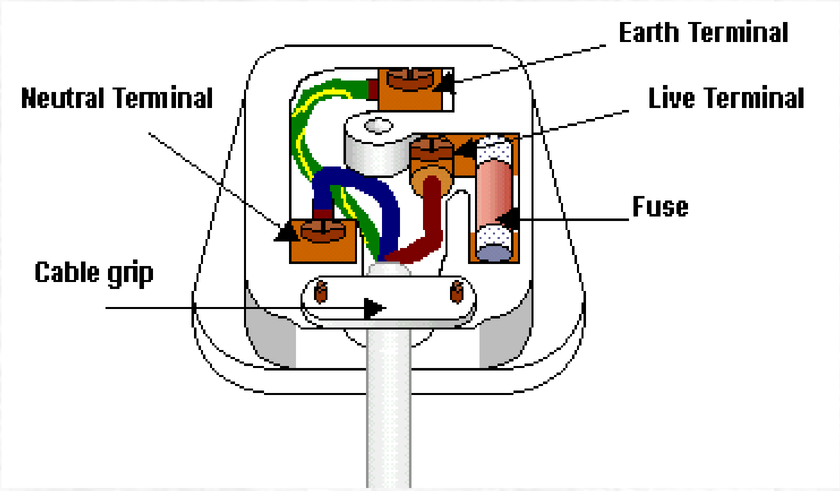
Example 1: What is the maximum allowable earth fault impedance to protect against an earth fault for equipment protected with a 15 A fuse?

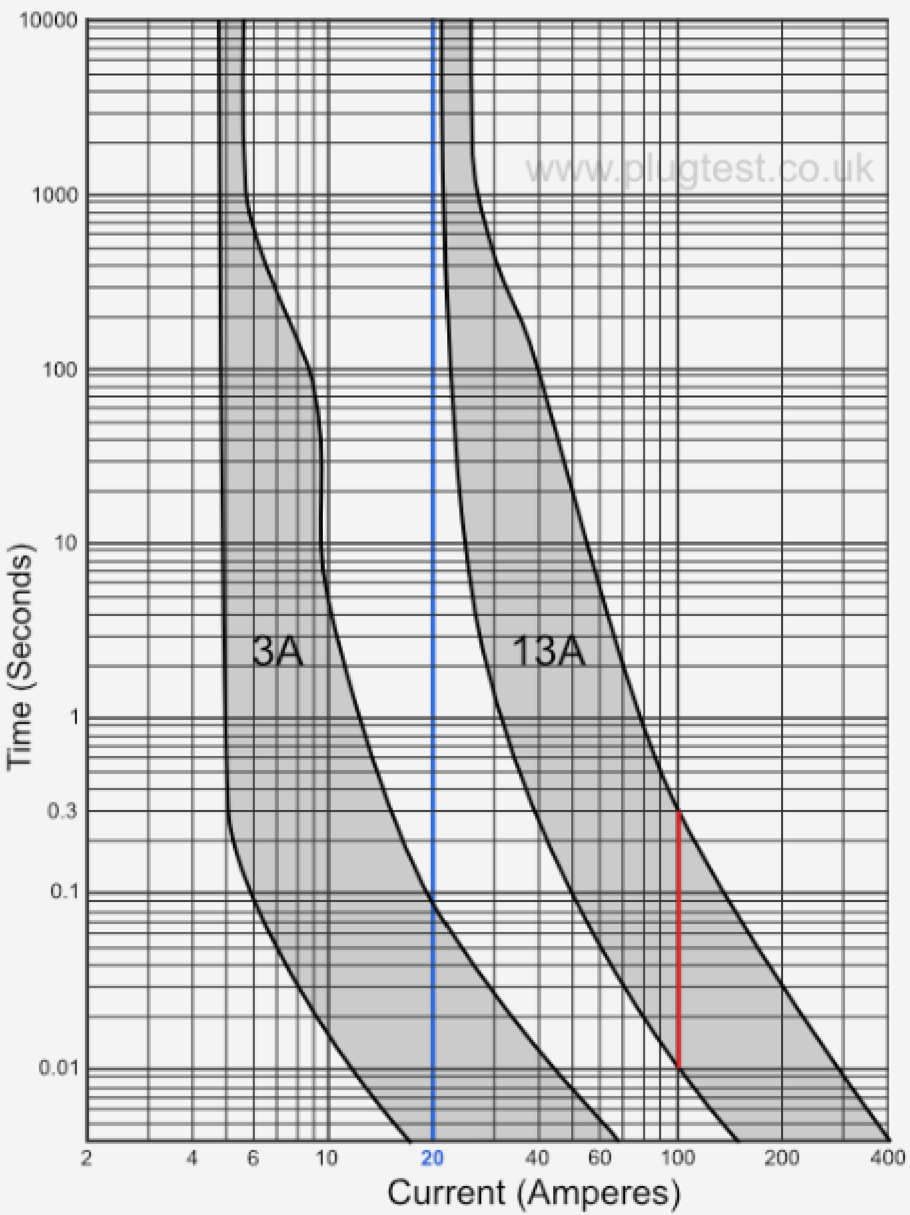
PROTECTION AGAINST SHORT CIRCUIT

- Fault current is very high
- Breaking capacity of the protective device > Fault current
- The fault current protection system must operate before there is damaging increase in conductor insulation temperature
- Time to damage a cable

$$t \propto \frac{A^2}{I^2}$$

Fuses

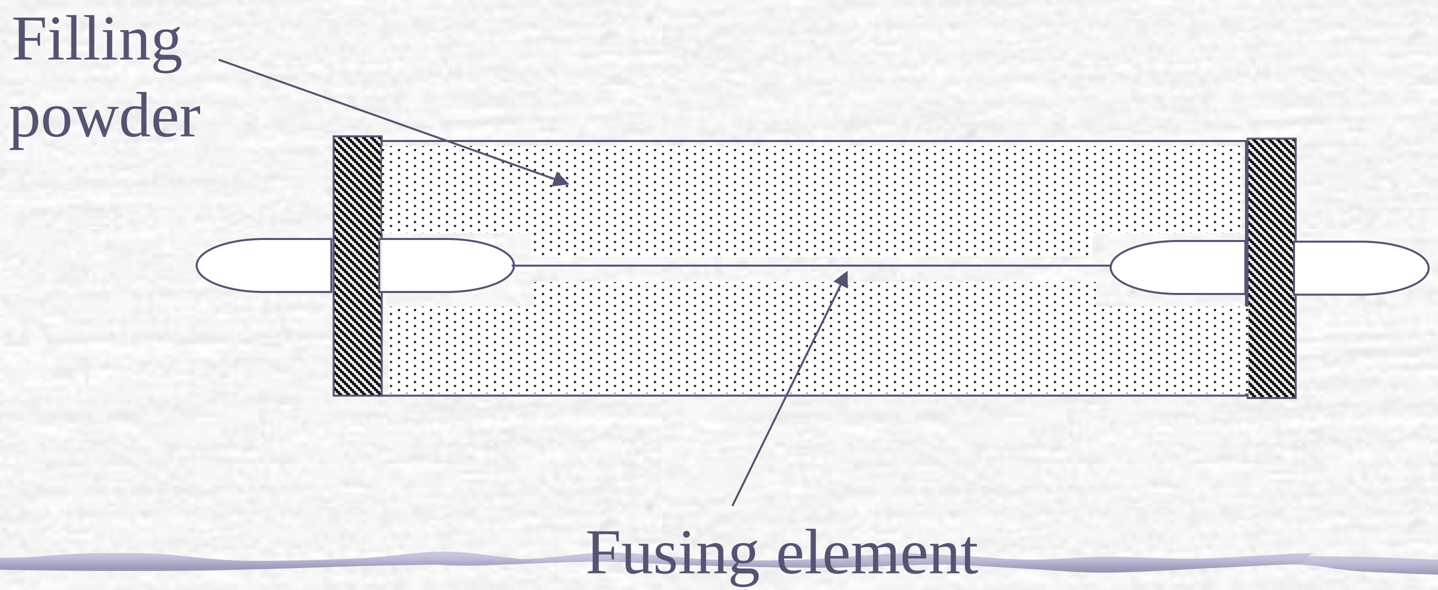




Nominal current (I_n)
Operating current (I_2)
Fusing factor = I_2/I_n

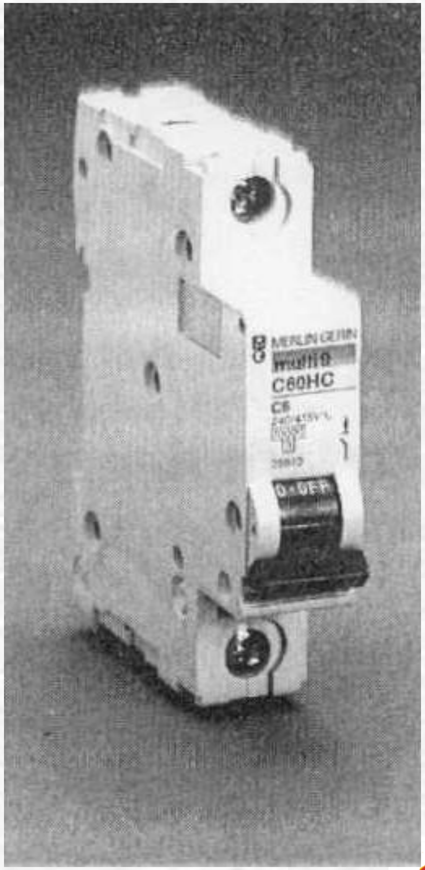
HBC FUSES

- HBC fuses has quenching materials inside to quench the arc produced during the breaking process
- Breaking capacity --- 10 – 20 kA

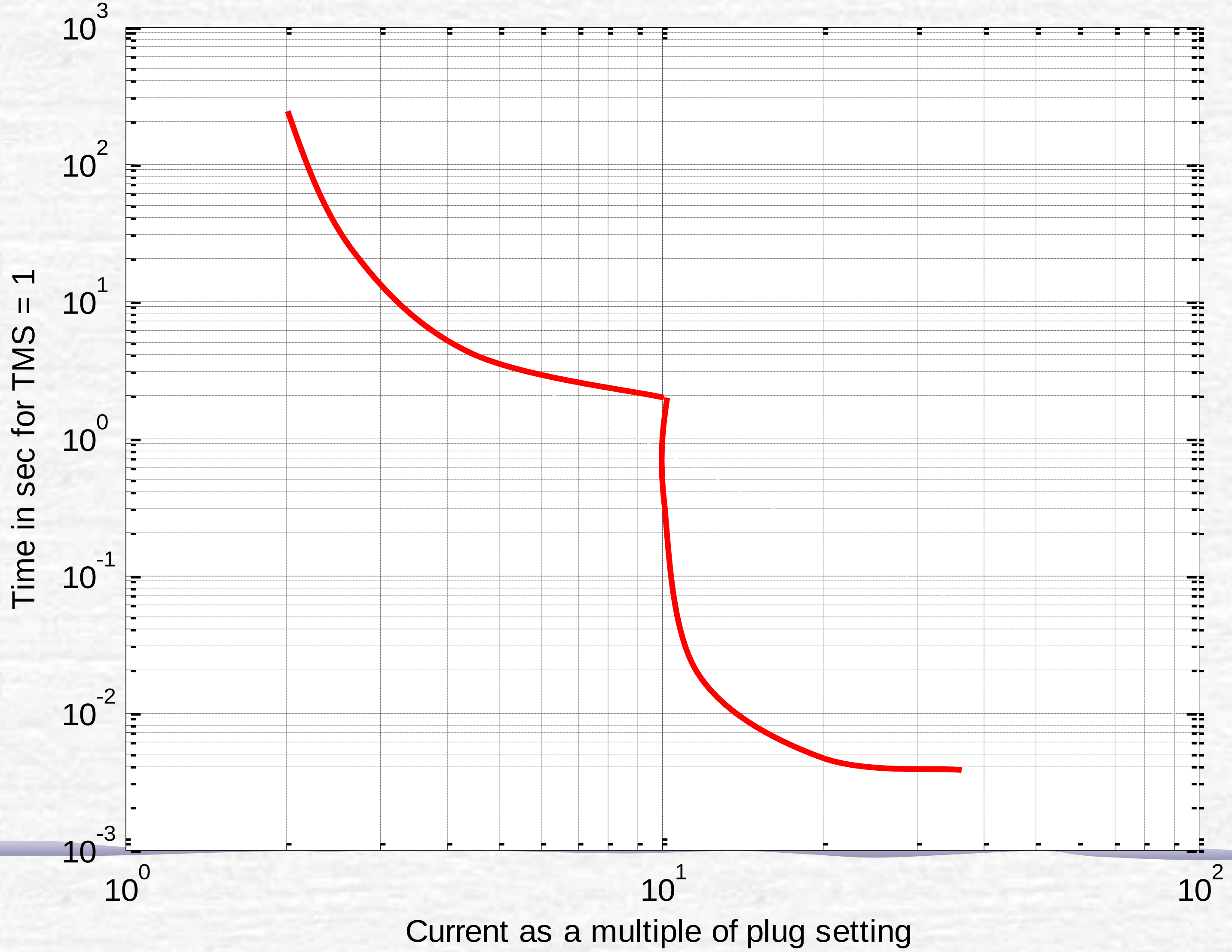


MINIATURE CIRCUIT BREAKER (MCB)

- MCB is fitted with
  - Magnetic coil – for very fast operation under short circuit
  - Bimetallic strip – for slow operation for overload currents



MINIATURE CIRCUIT BREAKER (MCB)

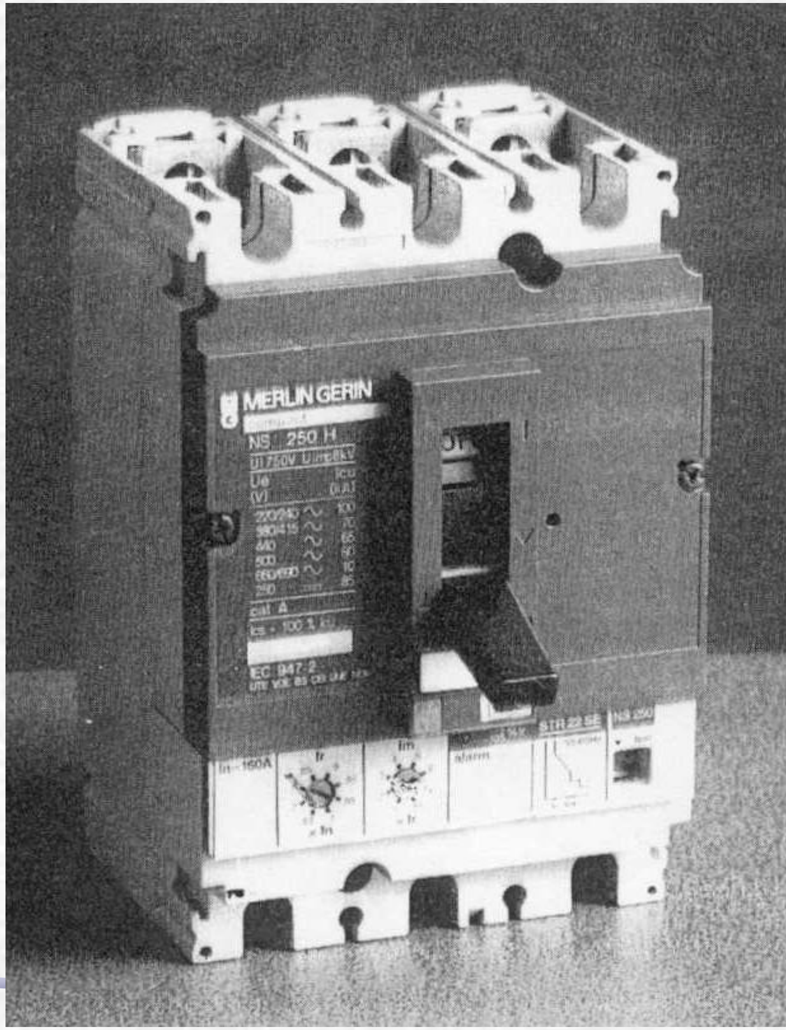


Example

- A final circuit is protected with a 20 A MCB. For a fault current of 1000 A, the MCB operating time is 0.01 sec. If the permissible duration of an earth fault is given by the following equation, select a suitable conductor for the protective conductor.

$$t = \frac{115^2}{\left(\text{Fault current density in A/mm}^2\right)^2}$$

MOULDED CASE CIRCUIT BREAKER (MCCB)



- Rating can be adjusted

Wire selection

- As discussed before Current carrying capacity (For the smallest cable I_z) of the cable should be selected such that

$$I_n < I_z$$

- What determines the CCC of a cable

1. Cross-sectional area of Cu conductor

Current carrying capacities and associated voltage drops

Cross sectional area (mm^2)	2 cables single phase ac or dc		3 or 4 cables three phase ac	
	Current (A)	Drop in mv/Amp-meter	Current (A)	Drop in mv/Amp-meter
1.0	13.5	44.00	12.0	38.0
1.5	17.5	29.00	15.5	25.0
2.5	24.0	18.00	21.0	15.0
4.0	32.0	11.00	28.0	9.5
6.0	41.0	7.30	36.0	6.4
10.0	57.0	4.40	50.0	3.8
16.0	76.0	2.80	68.0	2.4
25.0	101.0	1.75	89.0	1.5
35.0	125.0	1.25	110.0	1.1

For single-core p.v.c insulated cables, non-armoured, copper conductors enclosed in conduit or trunking; Ambient temperature 30^0 C

Wire selection

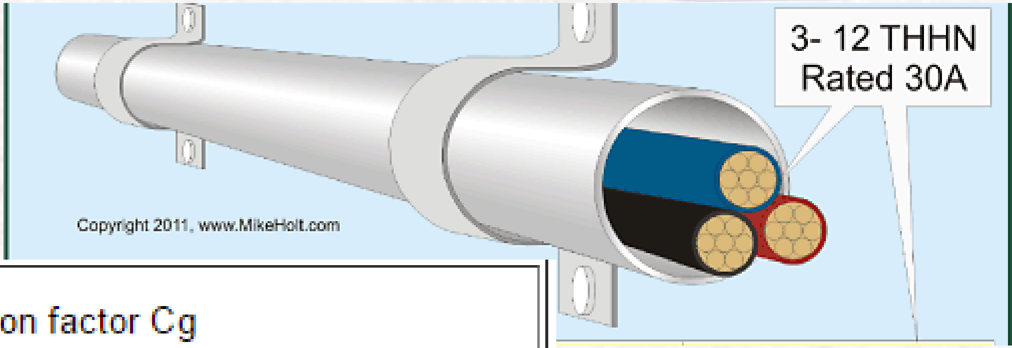
2. Ambient Temperature

Table 4.3 Correction factors to current rating for ambient temperature (Ca) (from [Tables 4C1 and 4C2] of BS 7671: 1992)

Ambient temperature	Type of insulation			
(°C)	70°C p.v.c	85°C rubber	70°C m.i	105°C m.i
25	1.03 (1.03)	1.02 (1.02)	1.03 (1.03)	1.02 (1.02)
30	1.00 (1.00)	1.00 (1.00)	1.00 (1.00)	1.00 (1.00)
35	0.94 (0.97)	0.95 (0.97)	0.93 (0.96)	0.96 (0.98)
40	0.87 (0.94)	0.90 (0.95)	0.85 (0.93)	0.92 (0.96)
45	0.79 (0.91)	0.85 (0.93)	0.77 (0.89)	0.88 (0.93)
50	0.71 (0.97)	0.80 (0.91)	0.67 (0.86)	0.84 (0.91)
55	0.61 (0.84)	0.74 (0.88)	0.57 (0.79)	0.80 (0.89)

Grouping factor

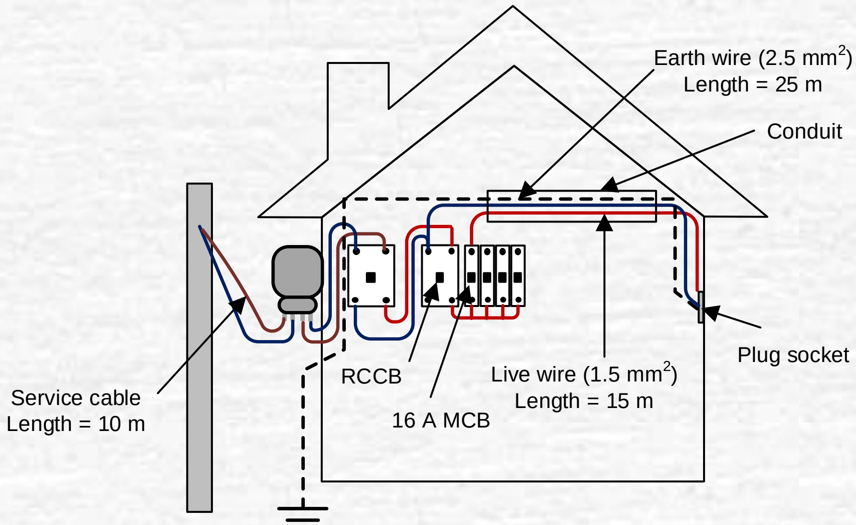
3. Grouping factor



Number of circuits	Correction factor Cg		
-	Enclosed or clipped	Clipped to non-metallic surface	
-	-	Touching	Spaced*
2	0.80	0.85	0.94
3	0.70	0.79	0.90
4	0.65	0.75	0.90
5	0.60	0.73	0.90
6	0.57	0.72	0.90
7	0.54	0.72	0.90
8	0.52	0.71	0.90
9	0.50	0.70	0.90
10	0.48	----------	0.90

Wire selection

- CCC in IET table x Ambient Temperature factor x Grouping factor > I_n of the protective device



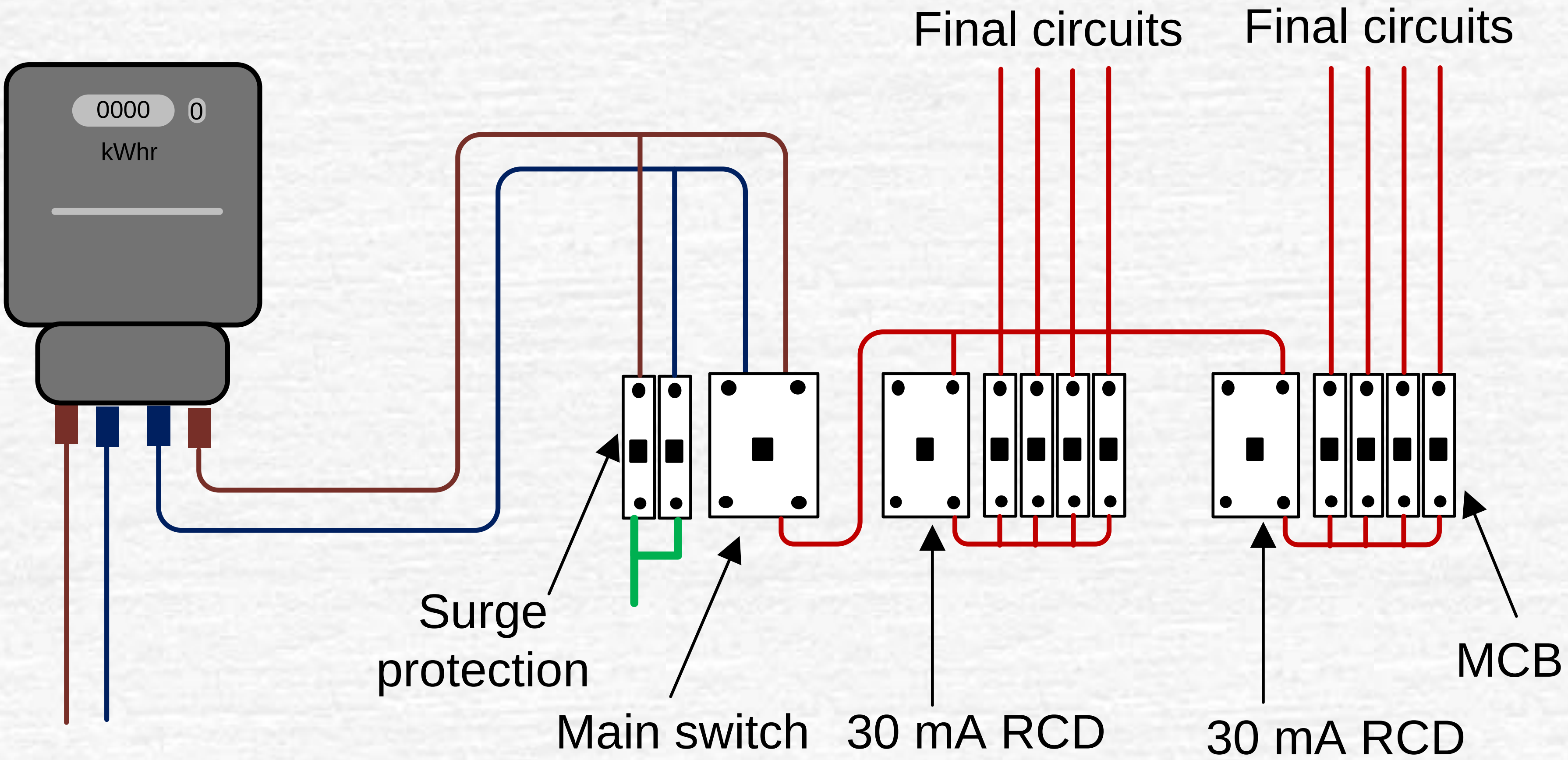
2 kW

If there are only two conductors (1 circuit) inside the conduit can 1.5 mm^2 be used? Assume that the ambient temperature is 35°C

What will happen if there are two circuits?

What is the voltage drop across the wire?

CONSUMER UNIT



Designing an Electrical Installation

- Assessment of general characteristics
  - Purpose and intended use of the building
    - Home
    - Hospital

    Way lights are operating
    Safety

  - Maximum current demand
    - CEB provides 30 A single phase or 90 A three phase connection
    - The Maximum demand is not the total connected load

Designing an Electrical Installation

1200-
1500 W

1500-2000 W

2000-3000 W

150-400 W

500 W

2000 W

Design for 35
- 40 A?

DIVERSITY

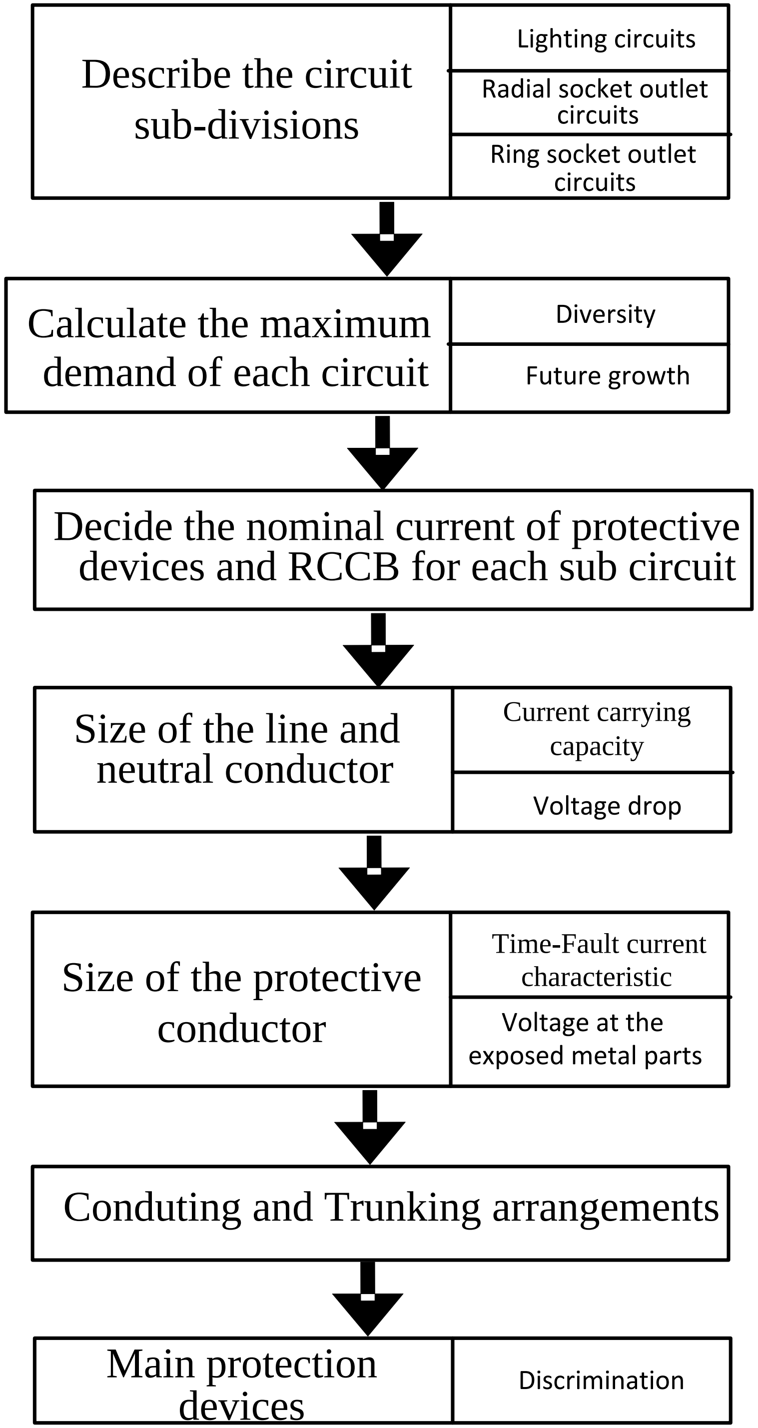
100 - 200 W

600-1500 W

Designing an Electrical Installation

- Compatibility
  - One part must not interfere with the other part
  - Especially with equipment having heavy starting currents

- Maintainability
  - How often maintenance will be carried out?
  - Provisions for maintenance → Separate circuits



Wiring Installation Design based on IET wiring regulation 18th Edition (BS 7671:2018)

Stationary and Movable equipment

- Stationary equipment:
  - These appliances are fixed.
  - Even if they are replaced in the future, they will be replaced with similar appliance.
  - Examples include oven, dishwasher, waste disposal units, water heaters, etc.
- Movable or portable equipment:
  - They may be connected to any socket outlet and therefore not considered when calculating the design current.
  - Instead the socket circuits are considered.
  - Remember during the life span of the electrical installation (house), these appliances will change, and more sophisticated appliances may come into the market.

Socket outlet circuits

- Appendix 15 of the BS 7671: 2018: IET wiring regulations gives the following socket outlet circuits

Type of circuit	MCB rating (A)	L & N conductor cross sectional area (mm^2)	Maximum floor area served (m^2)
Ring	30 or 32	2.5	100
Radial	30 or 32	4.0	75
Radial	20	2.5	50

- for a ring the following stationary appliances should not be connected:
  - Immersion heaters and electric space heaters
  - Cooker, ovens, and hobs with a rated power exceeding 2 kW:

Ring circuit