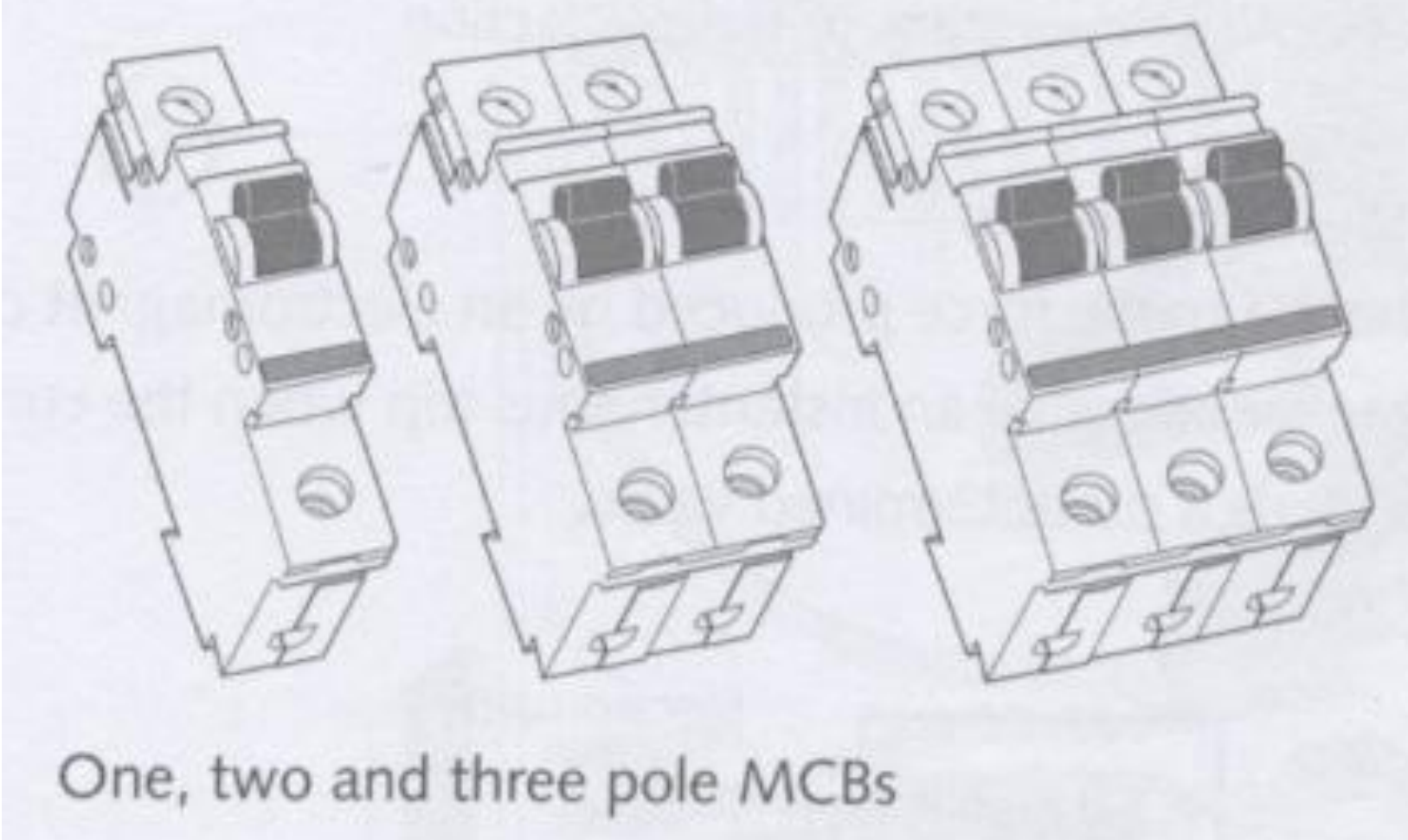
Circuit Protection

Circuit breaker and isolating transformer

Objectives

At the end of the lesson, students are able to :

- ✓ Describe the construction and operating principles of MCBs and isolating transformers
- ✓ Understand time –current curves for circuit breakers.
- ✓ Understand isolating transformer and its working in protection.



One, two and three pole MCBs

Miniature Circuit Breaker (MCB)

- Has tripping mechanisms that cause it to open on short circuit or overcurrent
- Contain a set of silver contacts enclosed within an arc chute
- Arc created during opening of the contacts is electromagnetically drawn to the arc chute.
- This lengthens, cools and deionises the arc, extinguishing it safely
- The contacts are opened by a spring-loaded trip mechanism actuated by thermal and electromagnetic current sensor elements
- The two sensors may work individually or in combination

The 2 sensors Mechanisms (Thermal and Electromagnetic) provide

- Relatively long time delay for small overloads of up to 5 times the rating of the MCB (thermal action only)
- Very short time delay for heavy overlaods of up to 10 times the rating of the MCB (thermal and electromagnetic action)
- Instanteous tripping on short circuit currents above 10 times the rating of MCB (electromagnetic action only)

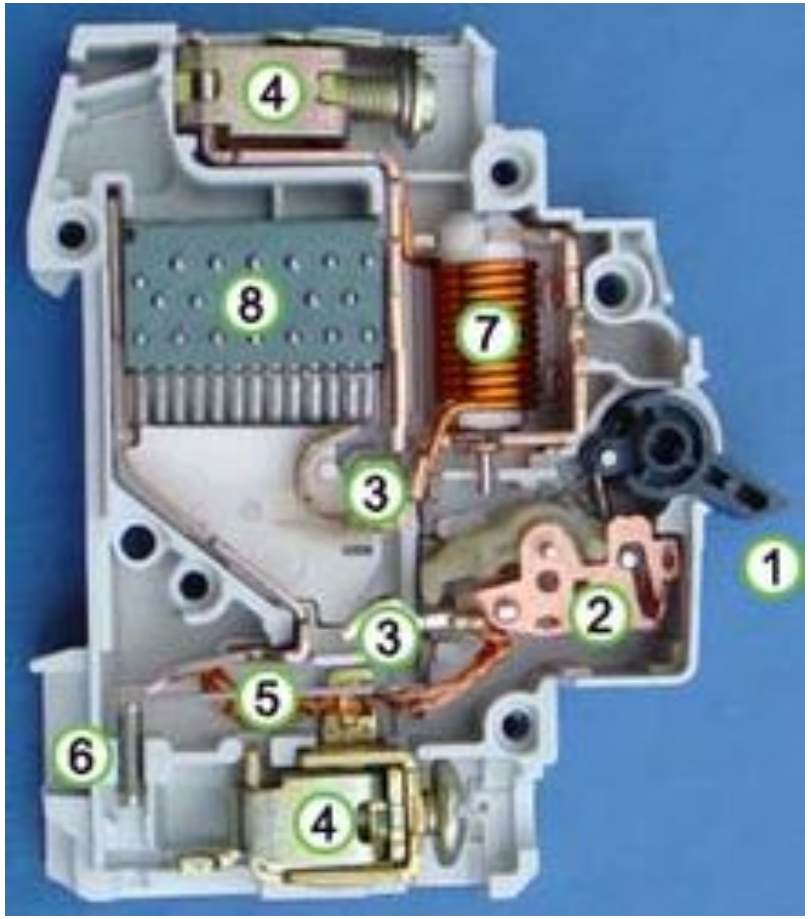
Tripping Factor

The ratio of minimum overcurrent that will trip an MCB to its current rating

i.e.

$$\text{Tripping Factor} = \frac{\text{Min. tripping current}}{\text{MCB current rating}}$$

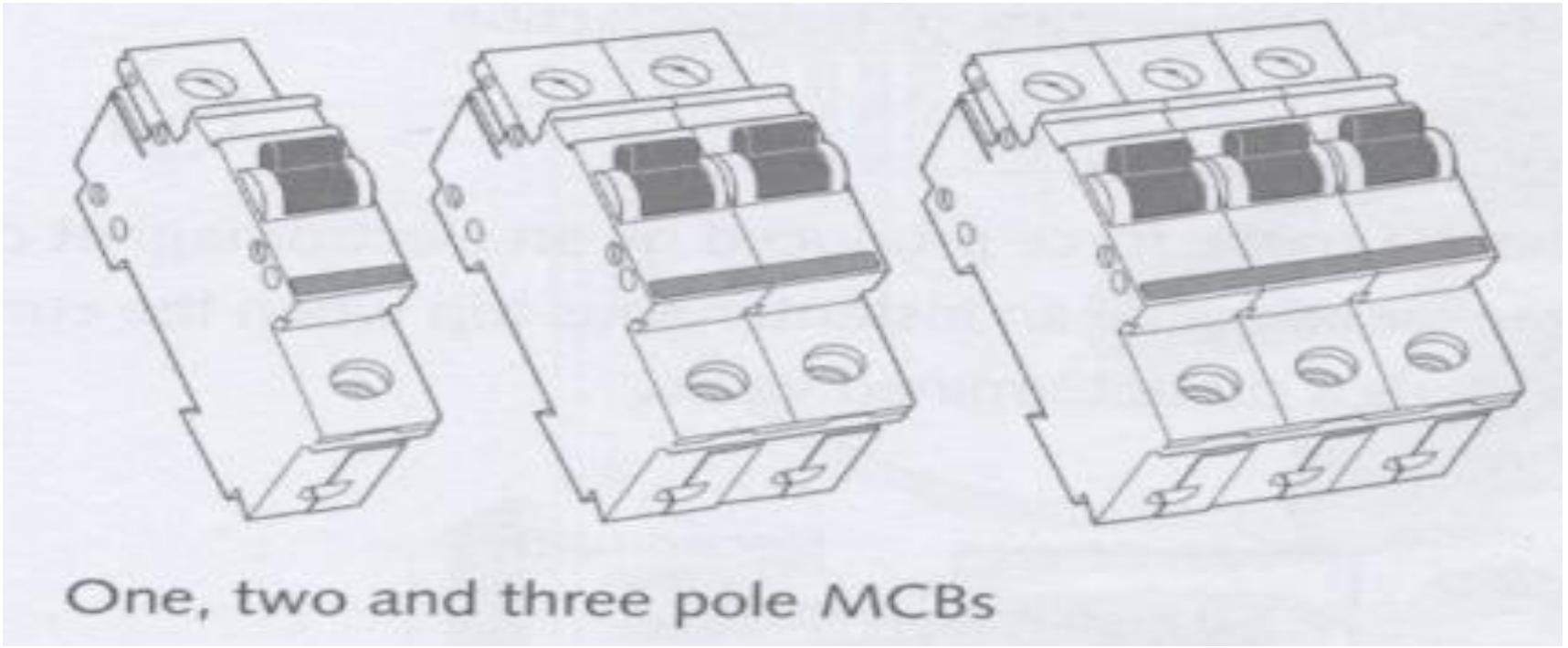
- 1 Actuator lever
- 2 Actuator mechanism
- 3 Contacts
- 4 Terminals
- 5 Bimetallic strip
- 6 Calibration screw
- 7 Solenoid
- 8 Arc divider/extinguisher



Types of MCB

- Based on Tripping Curve.
- Based on number of poles

Based on number of poles

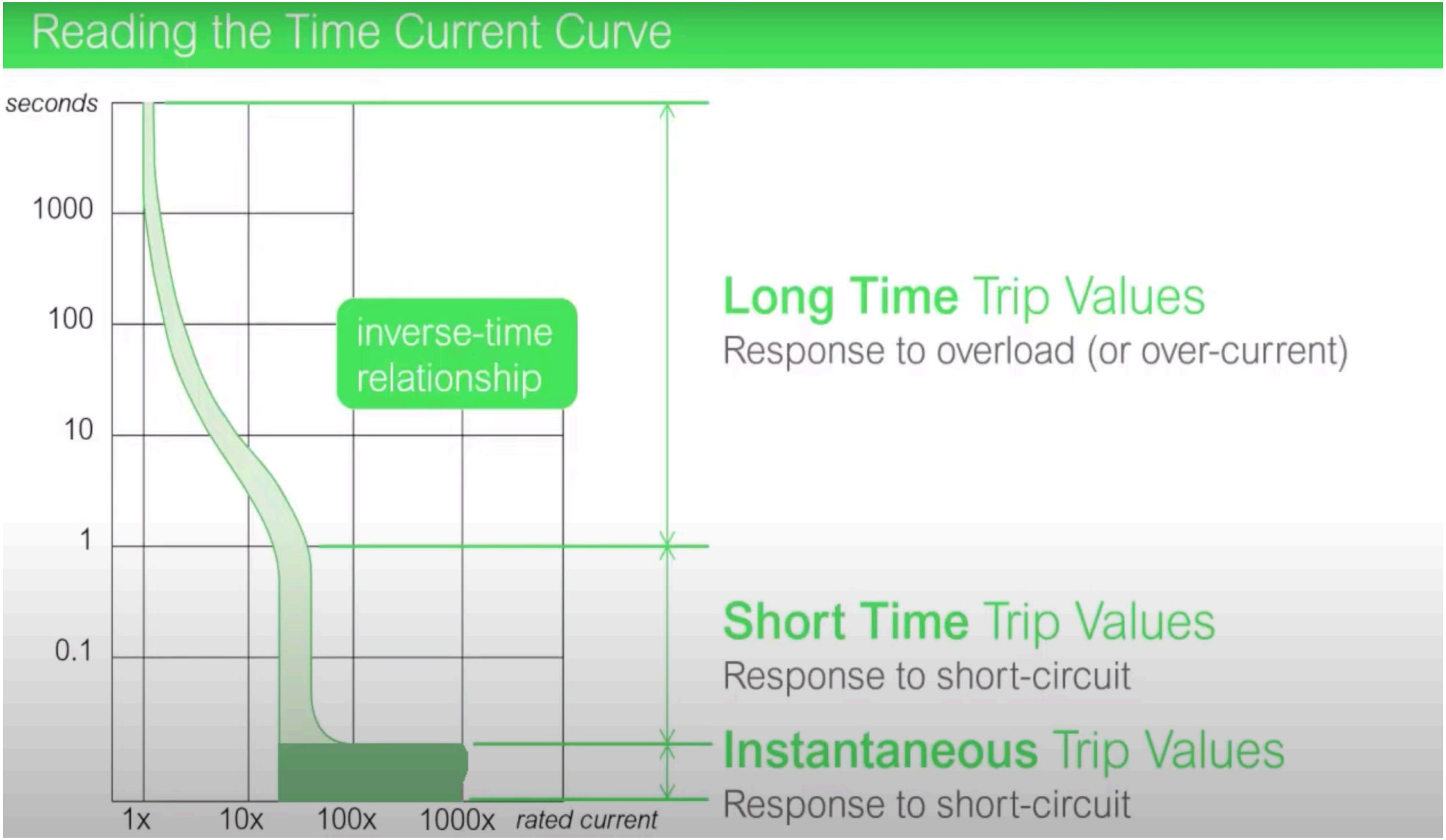


One, two and three pole MCBs

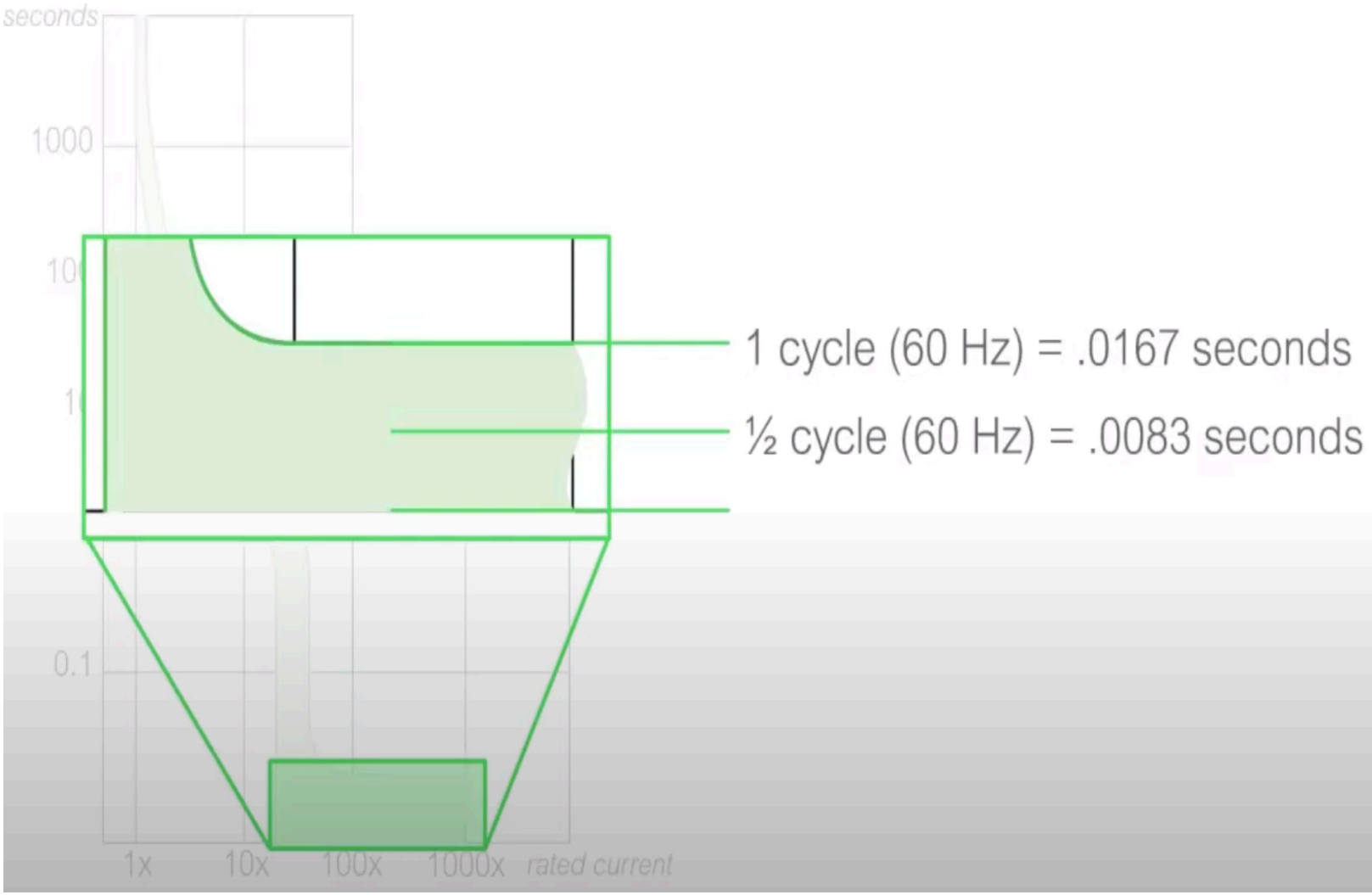
Based on tripping Curve

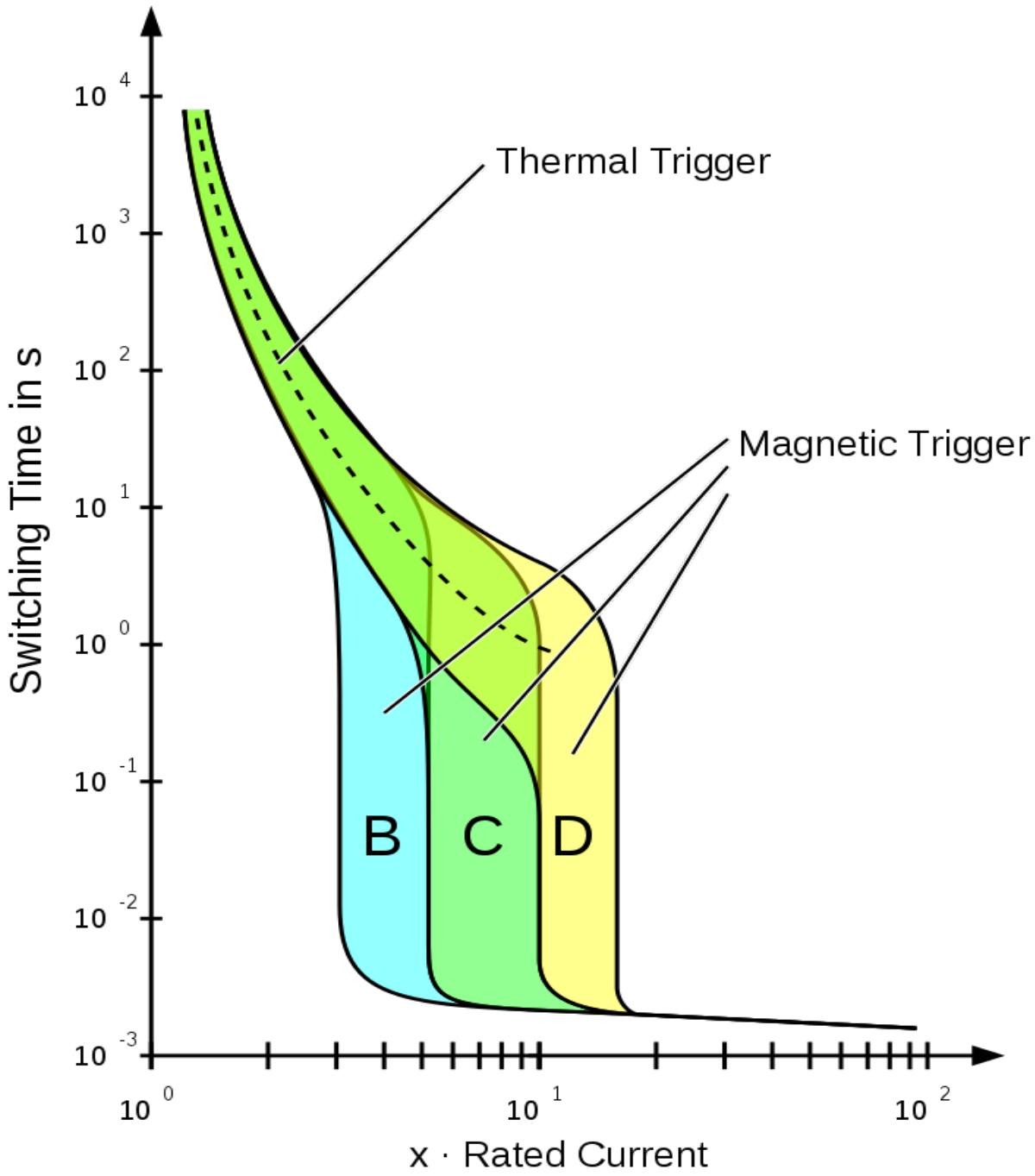
Sr. No.	Tripping Curve Type	Description (Instant Tripping At)	Application
1.	Type **B**	**3 To 5** Times of its rated current	**Resistive & Small Inductive** Loads (Residential & Small Commercial)
2.	Type **C**	**5 To 10** Times of its rated current	**High Inductive** loads (Small Motors & Florescent lighting)
3.	Type **D**	**10 To 20** Times of its rated current	**Specific Commercial & Industrial** Use (X-Ray Machine, Industrial Welding Machines, Large Winding Machine....)

Understanding the time current curves for MCB



Reading the Time Current Curve

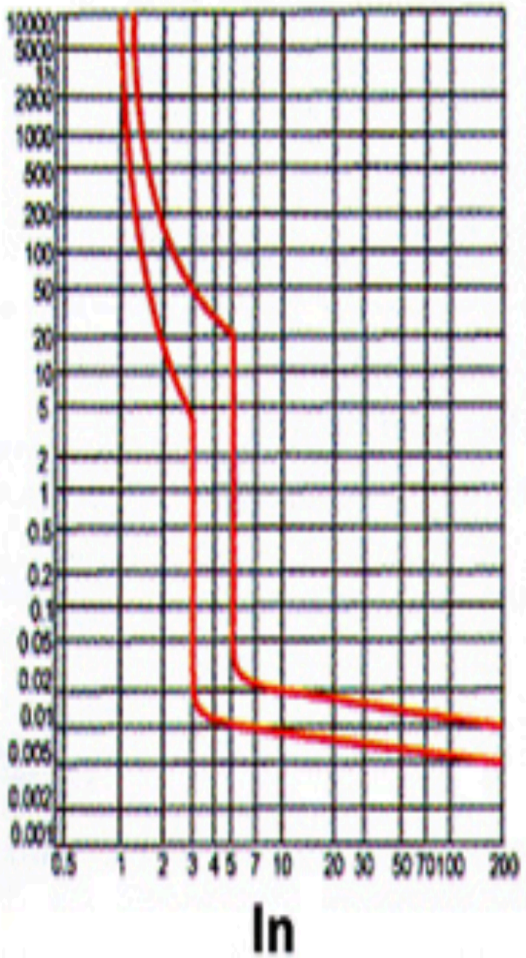



Switching Time in s
10 4
10 3
10 2
10 1
10 0
10 -1
10 -2
10 -3
10 0
10 1
10 2
x · Rated Current
Thermal Trigger
Magnetic Trigger
B
C
D

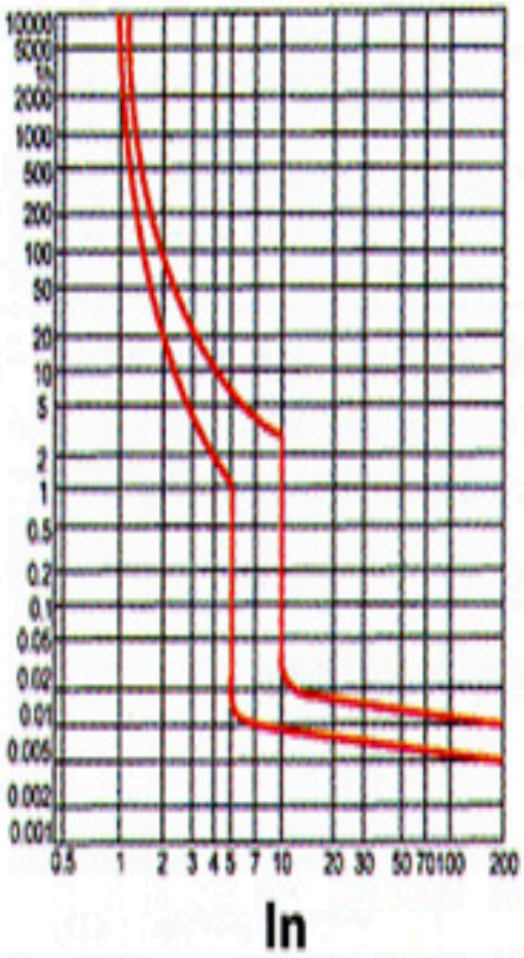
Trip Curves

Time(s)
(seconds)

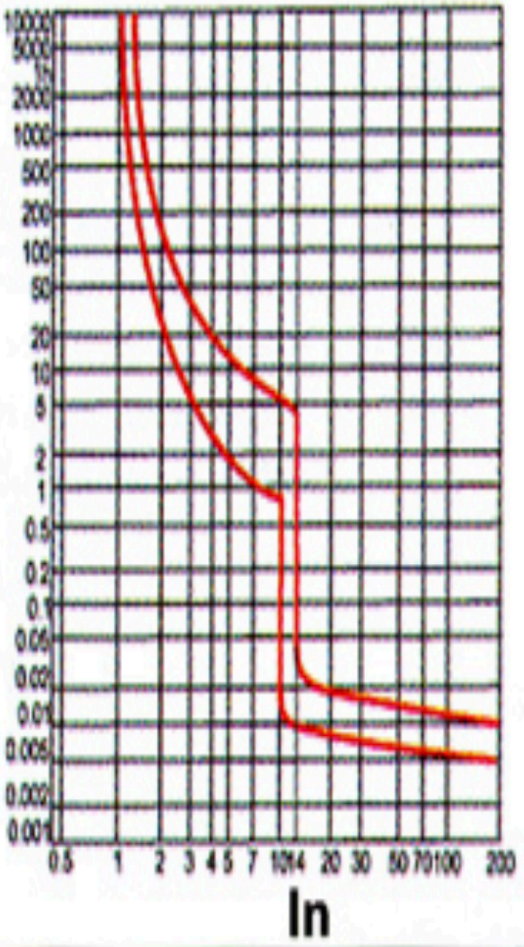
B Trip



C Trip



D Trip



- How quickly could it take for a 16A Ctype MCB take to trip at 48A?
- How quickly could it take for a 16A Btype MCB take to trip at 40A?
- How quickly could it take for a 32A Dtype MCB take to trip at 64A?
- How quickly could it take for a 10A Dtype MCB take to trip at 70A?
- How quickly could it take for a 6A Ctype MCB take to trip at 60A?

Effects of Poor Selection

- Underrated.
- Overrated.
- Incorrect category of duty.

Underrated fuse

- Means the fuse rating is too small for the load current it is to carry
- Results in frequent rupturing and mechanical damage to the equipment it is protecting

Overrated fuse

- Means the fuse rating is too large to give adequate protection to the circuit
- Results in damage circuit cables connecting to the equipment

Incorrect Category of Duty

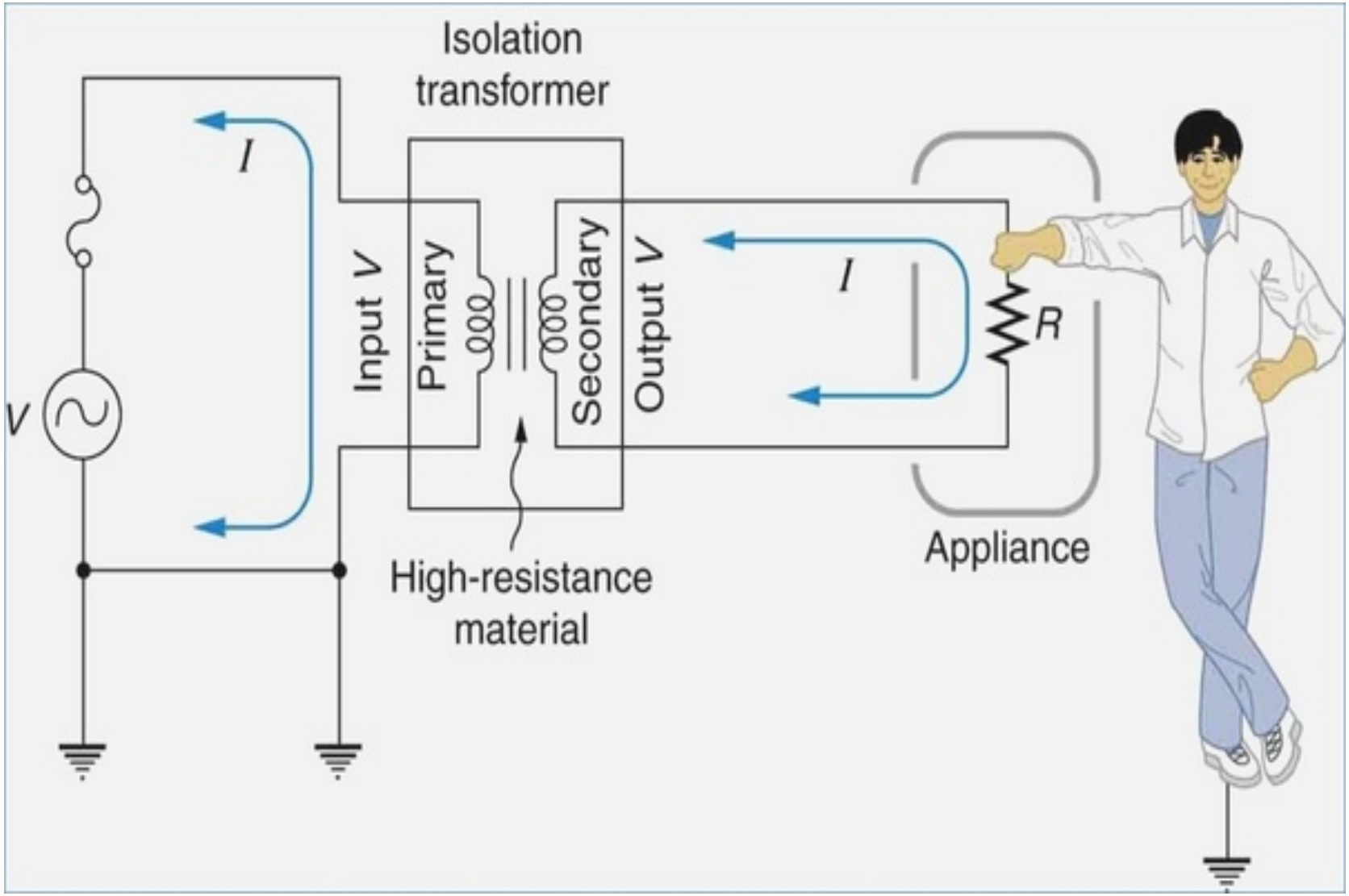
- Selecting a fuse link that has an incorrect category of duty could result in that link not being able to interrupt a major fault without causing damage to its surroundings.

Isolating transformer

As the name suggests, they are used to isolate the two circuits electrically by providing a galvanic isolation between them.

Galvanic isolation

- Galvanic isolation in power equipment refers to the fact that the output power circuit is electrically and physically isolated from the input power circuit.
- Electrical isolation is accomplished using an isolation transformer.
- Physical isolation means that the output power wiring does not touch or connect to the input wiring.


Isolation
transformer
I
Input V
Primary
Secondary
Output V
I
R
V
Appliance
High-resistance
material