Coordination between circuit breakers
Discrimination (Selectivity)

IEC/EN 60947-2

What is discrimination?
It is the coordination of automatic cut-off devices for a fault that occurs at any point in the network to be eliminated by the upstream circuit breaker, the circuit breaker that is immediately upstream of the fault and by that circuit breaker alone!

Continuity of service
Discrimination is an essential element that must be taken into account as early as in the design of a low voltage installation to enable continuity of the electricity service.

Production and safety
Discrimination provides much convenience for all users, but it is an essential requirement when continuity of service is of utmost importance.

Discrimination means that only the part with the fault is disconnected. It enables:
- continuity of supply for adjacent circuits,
- localization of the faulty circuit.

For some installations or installation parts:
- operating theatre in clinics and hospitals,
- marine,
- safety equipment,
- production site.

The requirements for continuous electricity often make it necessary to verify the discrimination between upstream and downstream protection devices. If there is a total lack of discrimination, it will be necessary to try to achieve partial discrimination. Likewise, if there is a limit to the level of discrimination and this proves satisfactory in the majority of cases, it can still be attempted to make it total.

Of course, any modification must be made while observing the following main parameters:
- protection of personnel,
- are the thermal stresses \( I_t \) of the cables always taken into account?
- are the breaking capacities of the devices higher than the prospective \( I_{sc} \)?

Finally, when it is not possible to achieve discrimination and it is essential for the correct operation of the installation, the installation of uninterruptible power supplies (UPS) must be considered. Generator units, inverters, etc. are then used.

There are several types of discrimination that can be used separately or together. For protection against overcurrent, this generally concerns current discrimination and time discrimination. The principle is as follows.
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Current and energy discrimination

Discrimination involves ensuring coordination between two circuit breakers in series, so that, in the event of a fault, only one circuit breaker, located immediately upstream of the fault, trips. A discrimination current Is is defined so that:

- Ifault < Is: only D2 eliminates the fault, discrimination is ensured,
- Ifault > Is: both circuit breakers may trip, discrimination is not ensured.

Slight overcurrent or overload

Under the effect of an abnormal inrush current, for example an increase in the resistive torque of a motor, the current going through the circuit is higher than the rated current. These currents may damage the installation (risk of an electrical fire). Devices to protect against overcurrent can be characterized by their operating curves as a function of prospective current Ip:

- the operating curve is time-based when the breaking time is greater than 50 ms (curve t = f (Ip)). Discrimination is achieved if the ln upstream / In downstream operation threshold ratio is > 1.3 and if the current offset of the magnetic curves is observed.

This is current discrimination

The greater the difference between the ratings of the upstream and downstream circuit breakers, the more “extensive” the discrimination.

Short circuit

For example when there is contact between two phases we are faced with a full insulation fault which risks damaging the installation.

The function that makes it possible to protect against this type of fault is magnetic protection.

To ensure discrimination, we must maintain a ratio between the upstream and downstream protection devices. This is energy discrimination.

- Energy: when the intervention time is less than 50 ms and more particularly less than the time of one half wave (10 ms) of current with limiting circuit breakers.

This is energy discrimination
**Time discrimination**

The principle is based on the time difference ($\Delta t$) of the upstream magnetic curve.

To achieve this, it is necessary to have an upstream circuit breaker with time-delay bands.

The delay introduced must make it possible to improve discrimination without endangering the cable or busbars which would then have to withstand the overcurrent for longer (greater thermal effects $I^2t$ and electrodynamic stresses).

**Total or partial discrimination**

Discrimination may be partial or total, up to the breaking capacity of the downstream circuit breaker. For total discrimination, the characteristics of the upstream device must be higher than those of the downstream device (higher than the breaking capacity of the downstream circuit breaker MCCB).

Standard IEC 60947-2 on industrial circuit breakers, and in particular Appendix A, deals with coordination between a circuit-breaker and another device to protect against short circuits combined in the same circuit. This protection device may be a fuse or another circuit breaker.