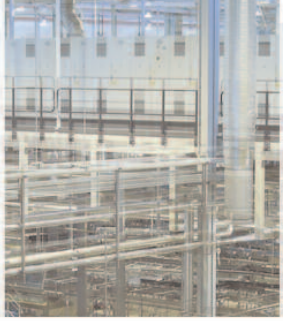


Instant guide to discrimination and back-up protection

ABB

Minimising the disruption and cost of guarding against electrical faults

Properly designed discrimination and back-up protection minimises the disruption and cost of guarding against electrical faults. Janet Roadway, Product Manager for power circuit breakers in the UK with ABB, argues that only those designers with real training and experience can achieve the right balance.

Protecting people and property is paramount in the event of a short circuit or overload. It's vital that a fault in the microwave of a hospital kitchen triggers a circuit breaker to cut the supply to the faulty oven to prevent a fire, for example. On the other hand, no one wants to disrupt the entire hospital with an electrical blackout each time a light bulb blows.

Striking a balance

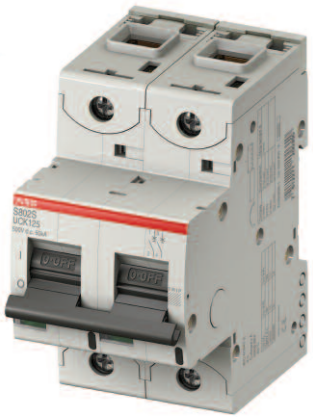
Striking a balance between minimising maximum protection for the minimum disruption is far from straightforward and best left to specialists. It has been observed that some electrical consultants are now attempting to pass this responsibility on to panel manufacturers or site contractors, who often lack the training and experience to tackle the job.

As a leading manufacturer of circuit breakers, ABB is increasingly being approached to carry out discrimination studies. Naturally, any responsible manufacturer will be able to provide discrimination tables and other relevant data on their equipment. However, factoring in protection against electrical faults is really a strategic job that should be carried out by whoever is designing the electrical system as a whole.

The first step in the process is a fault protection study, which asks, "what will happen if things go wrong?" Its first priority is to ensure full protection for people and property. Its secondary aim is to minimise disruption and provide continuity of service.

A system for distributing electricity throughout an office block or hospital typically has an inverted tree structure. At the top is the main switchboard, fed by a HV/LV transformer and protected by a large air circuit breaker (ACB). This feeds several out-going moulded-case circuit breakers (MCCBs).

Each of these then feeds a number of smaller distribution panels, which may be protected by more MCCBs, miniature circuit breakers (MCBs), or fuses, depending on the current they have to deal with in normal operation and the fault currents they may encounter. Eventually the electricity reaches the equipment that provides the load on the system, such as the microwave in our earlier example.



What is a discrimination study?

Discrimination is an important design aspect of electrical installations that is often overlooked. The ideal time to complete a discrimination study is during the design stage of a project and certainly before ordering switchboard and protection devices. However, the characteristics of such technology must be considered. If all parties involved within the design of electrical installations are aware of the potential discrimination issues, errors can be overcome and property owners can be confident that electrical equipment is satisfactorily protected.

Selective action through discrimination

Discrimination aims to ensure that only the protection device immediately upstream of a fault will trip, leaving the rest of the supply intact. If all the protection devices in a supply chain are set to blow instantly at the same threshold current, they may all trip at once if there is a short circuit. By equipping different points in the supply chain with protection devices that have adjustable tripping characteristics, the designer can provide the discrimination needed to minimise the disruption caused by a fault.

Three approaches to discrimination

There are three basic approaches to discrimination. The first is to use devices set to trip at higher threshold currents further up the supply chain. The second is to place a time delay on circuit breakers at a higher level in the chain. By the time a fault current would cause them to trip, a circuit breaker lower down the chain should already have isolated the fault and things should be back to normal. The third approach is to discriminate on the basis of the total energy passing through the circuit breaker. This is related to the square of the current and time. This third approach is the best way to achieve a system that is optimised for both current rating and physical dimensions.

1. Set devices to trip at higher threshold currents further up the supply chain
2. Place a time delay on circuit breakers at a higher level in the chain
3. Discriminate based on the total energy passing through the circuit breaker.

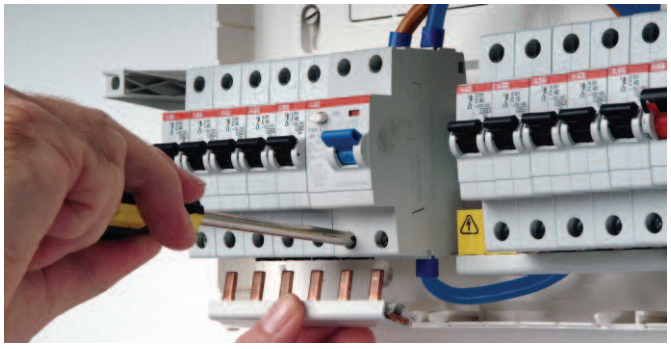
It all sounds fairly straightforward, but the relationship between different devices is complicated by the potential for interaction between them.

Interactive protection

As well as the designed-in tripping mechanism that responds to the size and duration of the fault current, a high fault current can generate magnetic repulsion between the contacts inside a circuit breaker. This effectively loosens the contact between the surfaces, increasing impedance and reducing the current flowing through the device. This in turn will limit the current flowing to the next device in the supply chain.

This is not something that will show up on the charts of time vs. current that are used to define and predict the way each protection device behaves. Very fast acting devices may also limit the current. This is because they act before the current has time to reach its peak.

Manufacturers therefore provide ***discrimination tables*** to give reliable predictions of how a particular combination of devices will behave in practice. These show that the level of discrimination actually available is often higher than the isolated behaviour of individual devices suggests.



In the end, however, total discrimination may not be feasible. The level of fault current that would need to flow or the time for which it would be allowed to run may simply cause too much stress and long-term damage to the distribution system. Achieving a balance between the potential damage and the disruption caused by a fault is ultimately a judgement call that is best made by experienced electrical consultants.

Optimising cost and protection

The other balancing act that the electrical consultant on any large project has to achieve is maximising the level of fault protection while minimising the cost and space devoted to protection devices. It's not just about initial equipment costs: Office buildings rent by the square metre, for example, so an oversized switch room will cost the owner a lot of money over the life of a building.

The ***regulations governing low-voltage distribution*** enable designers to optimise this using back-up protection. ***Back-up protection*** exploits the current-limiting effect of upstream circuit breakers to enable the installation of downstream devices that have a smaller rated breaking capacity than they apparently need. This is because the fault current the downstream breaker 'sees' is restrained by the upstream device. Instead, only the upstream device needs to have a breaking capacity to match the highest possible fault current.

It's obviously vital to get back-up protection right. If a circuit breaker experiences a ***higher fault current*** than it's rated for, it could be damaged or even worse explode.

The mechanisms behind backup protection are extremely complex. Added to this is the fact that data is almost always unavailable to the end-user, having been obtained from experiments carried out in specialist power laboratories. This effectively ties the designer to a single manufacturer who can guarantee that back-up protection matches the level required.

The other drawback of back-up protection is that it affects the possibility of ***total discrimination***. There is a threshold fault current called the takeover current, above which both the circuit breakers will trip. Total discrimination is only possible for fault currents below this level.

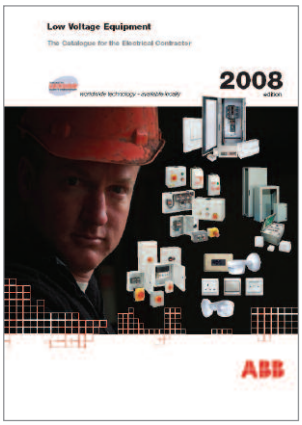
Even this brief discussion shows that there is more to designing an optimal fault protection system than just looking at the characteristics of individual protection products. Only by appreciating the potential for interaction between devices can a designer balance all the conflicting needs of safety, continuity of supply, space and cost.

Enjoy the benefits of investment

Investing in this technology and support makes sense if you consider the potential cost of damage caused by electrical faults. It takes an experienced practitioner to juggle all of the requirements and come up with the optimum solution for electrical fault protection. So it's always worth calling in specialist help, rather than relying on a general site contractor. The right designers will protect the installation from damage, minimise disruption and save money in the long run.

What can ABB offer?

ABB can provide a complete range of electrical fault protection devices. Our low voltage products and support can help you achieve top levels of production performance. For more information on ABB's low voltage product range, please visit the links below, call us on 02476 368 500, or email ***lv.products@gb.abb.com***. Ref. 'Discrimination Instant Guide'



For your copy of the 2008 Low Voltage Equipment Catalogue for the Electrical Contractor please contact ABB on 02476 368 500 or email lv.products@gb.abb.com, quoting reference '2008 contractor product catalogue' or visit ***www.abbsip.co.uk/catalogue***.

Recommended Reading:

Understanding properly designed discrimination and the back-up protection available can be an extremely useful first step in helping you to narrow down your choice of protection for both people and property for your installation and make a more informed choice. ABB can provide expert help and advice to help you find the best products and advice for your electrical installation.

The Circuit Breaker: A showcase of industrial product development by Fritz Pinnekamp

Discrimination of protection devices on installations by Janet Roadway

Learn more about the new 2008 Wiring Regulations

Line Protection Devices for built in safety and reliability

ABB delivers HV/LV upgrade project worth over £2 million to Bookham

Surge Protection Devices

Time delay ratings on circuit breaker

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