PERFORMANCE TESTS FOR PROTECTION DEVICES

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Power-system protection

Power-system protection is a branch of electrical power engineering that deals with the protection of electrical power systems from faults through the isolation of faulted parts from the rest of the electrical network. The objective of a protection scheme is to keep the power system stable by isolating only the components that are under fault, whilst leaving as much of the network as possible still in operation. Thus, protection schemes must apply a very pragmatic and pessimistic approach to clearing system faults. For this reason, the technology and philosophies utilized in protection schemes can often be old and well-established because they must be very reliable.

Components

Protection systems usually comprise five components:

- Current and voltage transformers to step down the high voltages and currents of the electrical power system to convenient levels for the relays to deal with
- Protective relays to sense the fault and initiate a trip, or disconnection, order;
- Circuit breakers to open/close the system based on relay and autorecloser commands;
- Batteries to provide power in case of power disconnection in the system.
- Communication channels to allow analysis of current and voltage at remote terminals of a line and to allow remote tripping of equipment.

For parts of a distribution system, fuses are capable of both sensing and disconnecting faults.
Failures may occur in each part, such as insulation failure, fallen or broken transmission lines, incorrect operation of circuit breakers, short circuits and open circuits. Protection devices are installed with the aims of protection of assets, and ensure continued supply of energy.
Switchgear is a combination of electrical disconnect switches, fuses or circuit breakers used to control, protect and isolate electrical equipment. Switches are safe to open under normal load current, while protective devices are safe to open under fault current.

Protective devices

Protective relays control the tripping of the circuit breakers surrounding the faulted part of the network

Automatic operation, such as auto-re-closing or system restart

Monitoring equipment which collects data on the system for post event analysis

While the operating quality of these devices, and especially of protective relays, is always critical, different strategies are considered for protecting the different parts of the system. Very important equipment may have completely redundant and independent protective systems, while a minor branch distribution line may have very simple low-cost protection.

There are three parts of protective devices:

- Instrument transformer: current or potential (CT or VT)
- Relay
- Circuit breaker

Advantages of protected devices with these three basic components include safety, economy, and accuracy.

Safety:

Instrument transformers create electrical isolation from the power system, and thus establishing a safer environment for personnel working with the relays.

Economy:

Relays are able to be simpler, smaller, and cheaper given lower-level relay inputs.

Accuracy:

Power system voltages and currents are accurately reproduced by instrument transformers over large operating ranges.

Performance measures

Protection engineers define dependability as the tendency of the protection system to operate correctly for in-zone faults. They define security as the tendency not to operate for out-of-zone faults. Both dependability and security are reliability issues. Fault tree analysis is one tool with which a protection engineer can compare the relative reliability of proposed protection schemes. Quantifying protection reliability is important for making the best decisions on improving a protection system, managing dependability versus security tradeoffs, and getting the best results for the least money. A quantitative understanding is essential in the competitive utility industry.

Performance and design criteria for system-protection devices include reliability, selectivity, speed, cost, and simplicity.

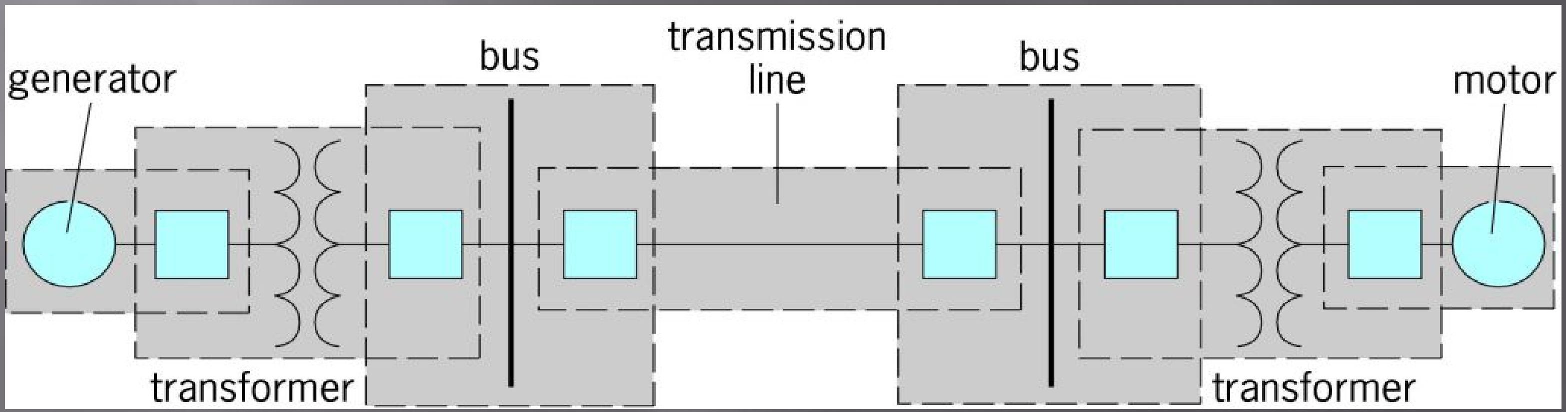
Reliability: Devices must function consistently when fault conditions occur, regardless of possibly being idle for months or years. Without this reliability, systems may result in high costly damages.

Selectivity: Devices must avoid unwarranted, false trips.

Speed: Devices must function quickly to reduce equipment damage and fault duration, with only very precise intentional time delays.

Economy: Devices must provide maximum protection at minimum cost.

Simplicity: Devices must minimize protection circuitry and equipment.



Protective relays

These are compact analog or digital networks, connected to various points of an electrical system, to detect abnormal conditions occurring within their assigned areas. They initiate disconnection of the trouble area by circuit breakers. These relays range from the simple overload unit on house circuit breakers to complex systems used to protect extra high voltage power transmission lines. They operate on voltage, current, current direction, power factor, power, impedance, temperature. In all cases there must be a measurable difference between the normal or tolerable operation and the intolerable or unwanted condition. System faults for which the relays respond are generally short circuits between the phase conductors, or between the phases and grounds. Some relays operate on unbalances between the phases, such as an open or reversed phase. A fault in one part of the system affects all other parts. Therefore relay sand fuses throughout the power system must be coordinated to ensure the best quality of service to the loads and to avoid operation in the non-faulted areas unless the trouble is not adequately cleared in a specified time.

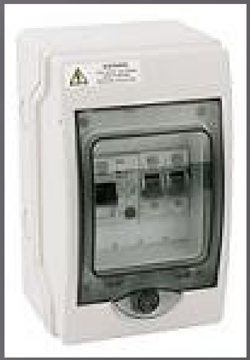
Residual Current Protective Devices (RCD)

Residual current protective devices protect against dangerous electric shocks caused by indirect contact. They are used for personal, material and fire protection, as well as for additional protection against direct contact. Special applications require special solutions: for example, personal and fire protection, as well as in networks loaded with direct current or installed in aggressive environments. The RCD has built-incondensation protection to ensure maximum safety and durability even under harsh conditions such as gas or moisture in the ambient air.

RCDs can be wired to protect a single or a number of circuits - the advantage of protecting individual circuits is that if one circuit trips, it will not shut down the whole house, just the protected circuit.

RCDs are available in at least 4 basic configurations:

As hard wired in units, where both the inputs and outputs are wired into the unit - ideal for a workshop etc where all the sockets within can be protected. Each individual circuit taken from the RCD is protected by a MCB of an appropriate value.



As protected outlets - normally a protected socket can be fitted as a direct replacement for a standard, no protected outlet socket.

As a plug-in unit which can convert any socket into to a protected circuit - this gives good flexibility as, for example, a lawn mower or a hedge trimmer can be plugged in at different times. However, as the individual appliance could still be plugged into an unprotected socket, you need to remember to fit the

As a plug for wiring on to the lead of an individual appliance, this does make it less flexible than the plug-in unit above but it does ensure that the piece of equipment is always protected. One very usefully use to to fit it to the end of an extension cable, then whatever you plug into the extension lead is protected.

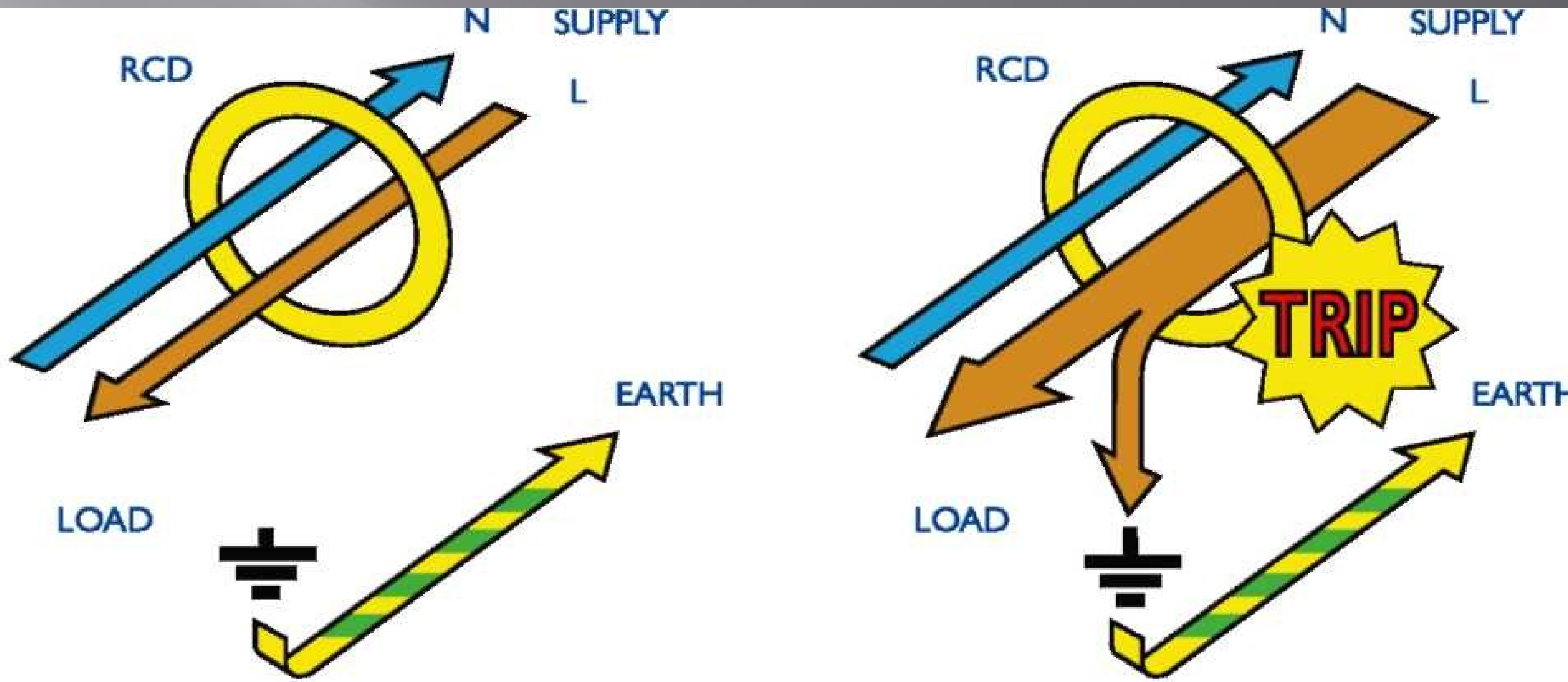
The basic principle of operation of the RCD

When the load is connected to the supply through the RCD, the line and neutral conductors are connected through primary windings on a toroidal transformer. In this arrangement the secondary winding is used as a sensing coil and is electrically connected to a sensitive relay or solid state switching device, the operation of which triggers the tripping mechanism. When the line and neutral currents are balanced, as in a healthy circuit, they produce equal and opposite magnetic fluxes in the transformer core with the result that there is no current generated in the sensing coil. (For this reason the transformer is also known as a 'core balance transformer').

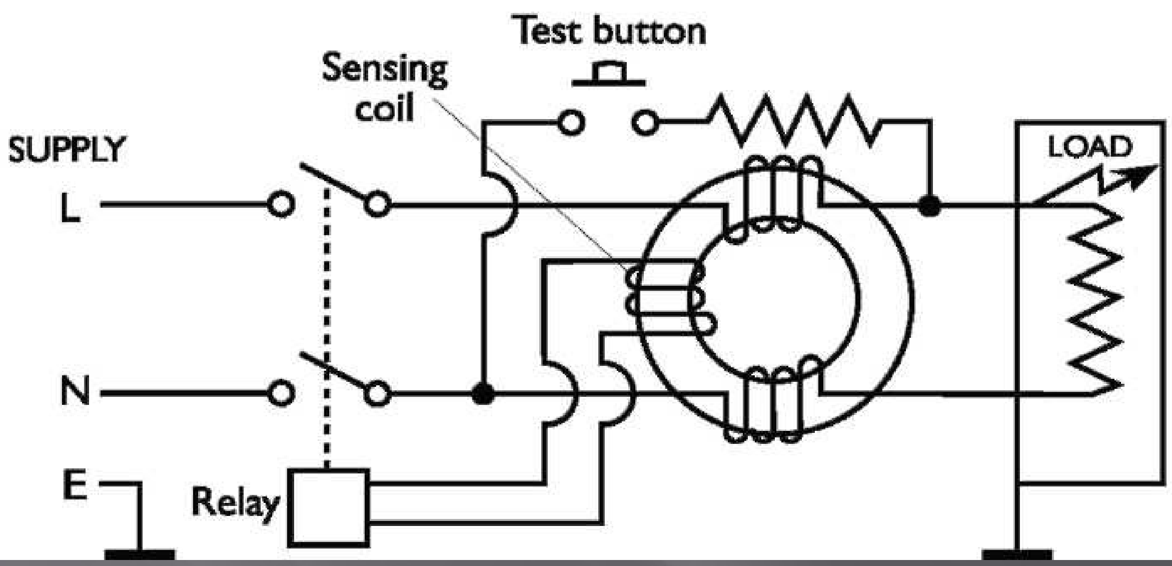
When the line and neutral currents are not balanced they create an out-of-balance flux. This will induce a current in the secondary winding which is used to operate the tripping mechanism.

It is important to note that both the line and neutral conductors pass through the toroid. A common cause of unwanted tripping is failure to connect the neutral through the RCD.

RCDs work equally well on single phase, three phase or three phase and neutral circuits, but when the neutral is distributed it is essential that it passes through the toroid.



1.2 Principle of RCD Operation



RCD Test Circuit

A test circuit is always incorporated in the RCD. Typically the operation of the test button connects a resistive load between the line conductor on the load-side of the RCD and the supply neutral.

The test circuit is designed to pass a current in excess of the tripping current of the RCD to simulate an out-of-balance condition. Operation of the test button verifies that the RCD is operational. It is important to note, therefore, that the test circuit does not check the circuit protective conductor or the condition of the earth electrode.

On all RCDs a label instructs the user to check the function of the RCD at regular intervals and to observe that the RCD trips instantly.

Residual Current Breaker with Overload protection (RCBO)

A **RCBOs** combines the functions of a MCB and a RCD in one unit. They are used to protect a particular circuit, instead of having a single RCD for the whole building. Generally these are used more often in commercial building than domestic ones.

Residual Current Circuit Breakers tests

Tripping Test and Performance of Test Device Test as per IS 12640-2000 and IEC 61008 Clause 9.1.3 (Annex D) listed below:

Tripping Test:

- Sensitivity Test: The RCCB should trip at a value of pre decided residual current (IAn); and should not trip at a value of 0.5 IAn.
- Speed of Operation Test: During the sensitivity trip test, time of tripping is recorded and compared with the limit.

Performance of Device Test: To check the function of the push button, whether the RCCB trips when push button is pressed.

Salient Features and Specifications:

- Leakage Current Ranges: 10 mA, 30 mA, 50 mA, 100 mA, 300 mA and 500 mA
- Current Adjustment: Between 10 mA to 550 mA
- Time Measurement: 5 digit with ranges: a. 0-99.999s & b. 1 ms
- Control: Sequence of operation and time measurement through specially designed micro controller based unit with PC
- Current Measurement: Digital Mill ammeter, 3 V2 digit, 3 ranges
- Fixture: Electro pneumatic fixture
- Protection: Through MCB
- Size: 850 mm X 650 mm X 500 mm

Impulse Voltage With-stand Test Eguipment (with automatic seguencing & polarity)

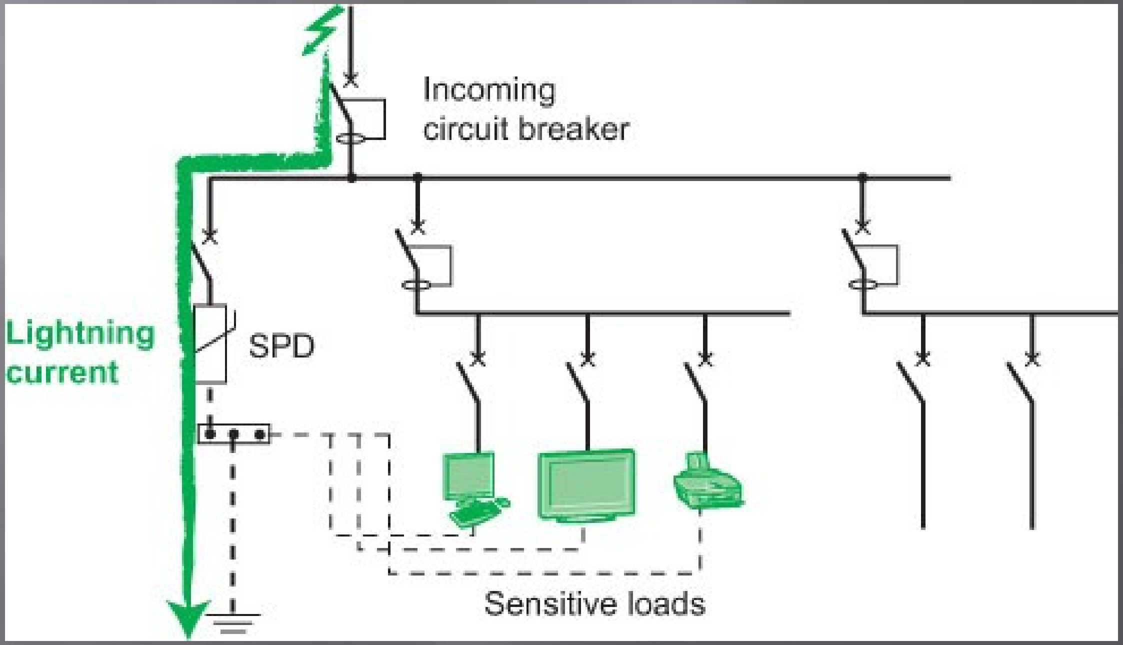
The Impulse Voltage Test Equipment is designed to generate impulse voltage (both polarity) of 1.0 KV to 20 KV depending on the model chosen. The waveform generated has a rise time of 1.2 micro second and 50 micro second duration. This instrument (suitable model based on peak voltage) incorporates testing as per the procedure described in IEC 61180, IEC 61010, IEC 60950, IEC 60065, IEC 60335-1, IEC 60230.

The equipment also incorporates testing as per the below standards:

- Low Voltage Switchgear and Control gear: IS/IEC 60947 -2004 Cl. No: 8.3.3.4.1
- Circuit Breakers: IS/IEC 60898:2002 Cl.no.: 9.7.6.1 & 97.6.2
- Residual Current Operated breakers: IEC 61008 & 61009 : Cl.no.: 9.20

The Surge Protection Device (SPD)

The Surge Protection Device (SPD) is a component of the electrical installation protection system.
This device is connected in parallel on the power supply circuit of the loads that it has to protect. It can also be used at all levels of the power supply network.
This is the most commonly used and most efficient type of overvoltage protection.



QUESTIONS ?

THANK YOU FOR YOUR ATTENTION!