Earth leakage protection in polluted low voltage network

In present day irrespective of the application be it in process industry or in IT industry, Pollution of electrical network is on the rise. These electrical pollutions give rise to lot of problems in routine operations of the electrical products and system including safety devices which protects human against electrocution. The predominant contribution for network pollution is from wide use of electronic devices. Most of these electronic devices are non-linear in nature which contributes harmonics into power networks.

Some of the serious issues which have to be taken into consideration during electrical network design as well selection of protection devices. The consequences of this pollution are

- Nuisance tripping of protection devices
- Overloading of equipment due to harmonics
- Voltage and current distortions
- Increase in temperature cables and generators
- Poor reliability of electrical network.

The most common non-linear loads are VFD’s, Electronic ballast, Lift electronics and Computer equipment. The distortions might lead to malfunctioning of equipment and create an unsafe electrical distribution.

We will analyze in this document the effect of distortions on earth leakage protection devices and counter measures to be taken to ensure safety of the people.

According standards IEC 61008 and 61009, Type AC and A are clearly defined type Residual protection devices. The application is clearly defined in the standards.
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Type AC residual protection devices are suitable for only alternating current system (AC system)

Type A residual protection devices are suitable for alternating or pulsating current with DC component.

Typical wave form is shown below.

One more type of RCD is introduced by international standards under IEC 62423. It is categorized as Type B. Type B RCD’s shall comply to IEC 62423 as well IEC 61008/61009.

The standards clearly define the connected load parameters to these RCD’s. The device is required to detect fault current up to 1000Hz. This type of RCD’s are specifically designed for use in electrical network which are having current or voltage distortions.

This avoids use of standard RCD’s with higher current sensitivity in these networks (to protect against unwanted tripping) and ensures safety of people are not compromised.
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The below curve indicates the distorted wave form due to 5\textsuperscript{th} harmonic.

![Distorted Wave Form](image)

One need to take note that the Type B defined in Annex M of IEC 947 is different from Type B defined in IEC 62423.

The earth leakage protection devices considered shall be based on electrical network conditions at site. When a network is polluted, the selection of RCD’s shall be based on the following so that no unwanted tripping takes place.

- Environment which are polluted due to harmonics.
- Environments subjected to overvoltage due to lightning
- Fluorescent lamps with electronic ballasts can create unwanted tripping due to
  - Permanent leakage currents value can be from 0,5 to 1mA for each device according to the lamp type.
  - Switching peaks are caused when the devices are switching ON/OFF. These peaks can reach higher current during 10\(\mu\)s transitory.

- IT apparatus (computers or electronic devices)
  - These devices generate permanent leakage currents of 50 Hz, of the order of 0,5-3,5 mA for each instrument. If this value reached 30% if sensitivity of standard RCD, any disturbance in the network leads to nuisance tripping.
The RCD’s which are used in these types of networks requires special design to overcome these surges without compromising the safety of the people. The devices are required to very special filtering circuits which ensures no unwanted tripping takes place at the same time protection is guaranteed.

When RCD used with both over current and earth leakage protection, care needs to be taken in selecting RCD with short circuit withstand capacity. For example, in a distribution board, Miniature circuit breaker selected is with 10kA breaking capacity, then RCD’s which are part of same distribution board shall also have same breaking capacity.

In India, most of the cases MCB’s used are of 10kA breaking capacity and accordingly breaking capacity required for RCD’s are also has to be of 10kA only.

Another important aspect which has to be taken into consideration is that selective type RCD should not considered when a device is connected closed to load where people are required to be protected. The following conditions are to be taken in to consideration before using Selective type devices.

- Upstream $I\Delta n > 3 \times$ downstream $I\Delta n$
- Upstream non-operating time $\Delta t >$ downstream total time $\Delta t$.

Selectivity can be achieved based on sensitivity current as well as use of selective type. The following charts gives overview of selectivity in residual current devices.
ABB offers complete range special type of RCD for this type application. These are APR type RCD’s.

The range is available from 30,100 and 300mA sensitivity. As a customer choice breaking capacity is available from 4.5kA (30mA), 6kA and 10kA. ABB is having complete range products which can provide perfect selectivity between upstream and downstream devices. The RCBO has a standard feature of trip indication for in the event residual current has initiated the trip. This gives the benefit to customer to know whether tripping is due to earth leakage of over current.

**These devices are perfectly suited for application in IT industries, Data centers, Industry where huge number of non-linear loads are present.**