

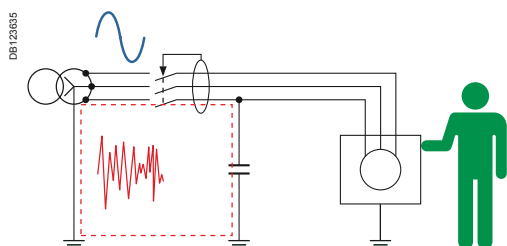
# Electrical and electromagnetic interference

## Operation of earth leakage protection devices

Some types of electrical and electromagnetic interference caused by the network or its environment may affect the operation of earth leakage protection devices and result in:

- **Nuisance tripping** (tripping in a non-dangerous situation). Such tripping is often repetitive, which is highly detrimental to satisfying the user's energy requirements.
- **Risk of non-tripping** in dangerous situations. This risk must be carefully analysed, because it affects people's safety. The standards define three categories of earth leakage protection devices according to their ability to control these types of situation.

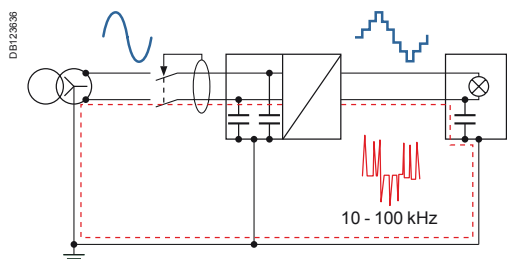
- The risk of interference must be taken into account when selecting earth leakage protection devices (see module CA902000), according to the loads supplied and the environment.
- The explanations given below specify the main types of interference, their origin and how Schneider Electric's earth leakage protection devices respond, according to their type.



### Nuisance tripping

This type of tripping is caused by the combination of two factors:

- A transient or continuous high-frequency voltage that is superimposed on the normal network voltage (50 Hz).
  - The presence of capacitors between the electrical network and the earth (or frames). As these capacitors are exposed to a high-frequency voltage, a current which can trip an earth leakage protection device flows to earth.
- The causes, duration and frequency spectra of such interference, which is often difficult to identify, can vary greatly, as shown in the examples below.



### High-frequency harmonics

The current absorbed by non-linear loads such as IT equipment power supplies, frequency converters, variable speed drive motor controls, electronic ballast lights, etc. includes high-order harmonics.

If the natural capacitances of the protected circuit are significant (between the cables and earth, or between the live parts of the devices and their frames), earth leakage protection devices may be tripped, although no danger is present.

This risk of nuisance tripping is all the more likely to occur when a large number of identical loads are supplied in parallel and protected by the same earth leakage protection device.

### Low-frequency continuous leakage currents

These leakage currents are mainly generated by the filtering capacitors in the power supply stage of electronic devices. Depending on the number of devices protected by the same earth leakage protection device, these leakage currents may:

- Increase the risk of tripping in the event of high-frequency interference.
- Cause frequent tripping

To guarantee satisfactory operation, these continuous leakage currents must not exceed 25% of the sensitivity ( $I_{\Delta n}$ ) of the earth leakage protection device, by limiting the number of "interfering" loads protected by the same earth leakage protection device.

- If more accurate data is unavailable, the leakage current can be estimated on the following basis, for a 230 V, 50 Hz network:

- heating floor: 1 mA / kW,
- fax, printer: 1 mA,
- PC, workstation: 2 mA,
- photocopier: 1.5 mA.

If long cables are installed downstream of the earth leakage protection devices, it may be necessary to take the natural capacitance formed by the cable/earth pair into account (order of magnitude: at 230 V, approximately 1.5 mA for 100 m).

# Electrical and electromagnetic interference

## Operation of earth leakage protection devices (cont.)

### Switching capacitive or inductive components

- Switching on capacitors creates a transient inrush current similar to that shown in Fig. 1.
- Switching off inductive components, such as power supply transformers used for lighting (halogen or fluorescent) creates brief voltage surges, the frequency of which can reach 10 MHz.

### Common mode voltage surges

Electrical networks can be exposed to transient voltage surges caused by:

- Lightning strikes: these voltage surges are represented normatively by a 1.2/50  $\mu$ s voltage waveform (see Fig. 2). The currents induced by these voltage surges are represented by a normalised 8/20  $\mu$ s waveform (see Fig. 3).
- Sudden changes in network operating conditions (faults, blown fuses, inductive load switching, MV switchgear operations, etc.).

When a fault occurs in an IT system (isolated neutral), a transient leakage current is created due to the sudden change in potential with respect to earth. A similar phenomenon can occur when a UPS switches between the mains supply and the battery supply, whilst the output neutral is briefly disconnected from the earth (then reconnected with a slight phase lag).

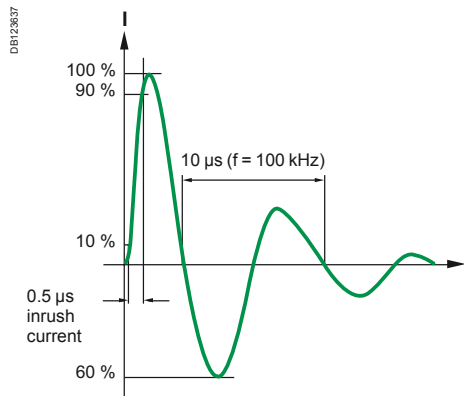


Fig. 1: 0.5  $\mu$ s/100 kHz normalised current waveform

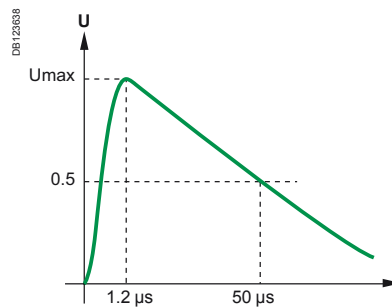


Fig. 2: 8/20  $\mu$ s normalised current waveform

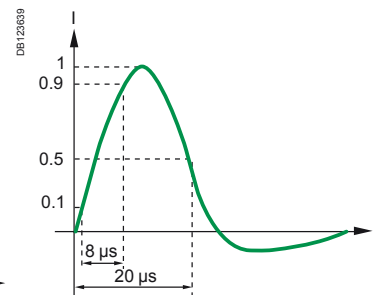


Fig. 3: 1.2/50  $\mu$ s normalised voltage waveform

## Immunity of Schneider Electric earth leakage protection devices

The *SI* earth leakage protection devices, exclusive to Schneider Electric, demonstrated their immunity to nuisance tripping in all the cases of interference indicated below:

| Interference                                                                                                    | Non-tripping test conditions                           | Performance required by the IEC 61008 / 61009 standards | Performance of Schneider Electric's <i>SI</i> type earth leakage protection devices |
|-----------------------------------------------------------------------------------------------------------------|--------------------------------------------------------|---------------------------------------------------------|-------------------------------------------------------------------------------------|
| <b>Continuous interference</b>                                                                                  |                                                        |                                                         |                                                                                     |
| Flow of harmonic currents to earth                                                                              | 1 kHz sine wave                                        | -                                                       | 8 x $I_{\Delta n}$                                                                  |
| <b>Transient interference</b>                                                                                   |                                                        |                                                         |                                                                                     |
| Voltage surge induced by a lightning strike                                                                     | 1.2/50 $\mu$ s pulse (IEC/EN 61000-4-5)                | 4 kV between 5 kV conductors / earth                    | 4.5 kV between 5.5 kV conductors / earth                                            |
| Current induced by a lightning strike                                                                           | 8/20 $\mu$ s pulse (IEC/EN 61008)                      | 250 A                                                   | 5 kA                                                                                |
| Operating transient current; indirect lightning strike current                                                  | 0.5 $\mu$ s/100 kHz waveform (IEC/EN 61008)            | 200 A                                                   | 400 A                                                                               |
| Surge protective device operation downstream of the earth leakage protection device; switching on of capacitors | 10 ms pulse                                            | -                                                       | 500 A                                                                               |
| <b>Electromagnetic compatibility</b>                                                                            |                                                        |                                                         |                                                                                     |
| Switching of inductive loads, fluorescent lighting, motors, etc.                                                | Repeated bursts (IEC 61000-4-4)                        | 4 kV / 2.5 kHz                                          | 5 kV / 2.5 kHz<br>4 kV / 400 kHz                                                    |
| Fluorescent lighting, circuits controlled by thyristors                                                         | 150 kHz to 230 MHz conducted RF waves (IEC 61000-4-16) | 3 V (IEC)<br>10 V (EN)                                  | 30 V                                                                                |
| Radio waves (TV and radios, transmitters, telecommunication, etc.)                                              | 80 MHz to 1 GHz transmitted RF waves (IEC 61000-4-3)   | 3 V / m (IEC)<br>10 V / m (EN)                          | 30 V / m                                                                            |

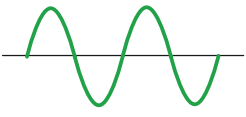
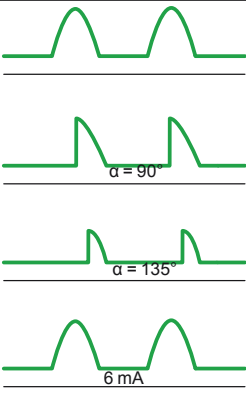
# Electrical and electromagnetic interference

## Operation of earth leakage protection devices (cont.)

### Risk of non-tripping in a dangerous situation

When an insulation fault occurs in the DC stage of a switch-mode power supply (e.g. variable speed drive) or on a DC network supplied by a converter, the leakage current is rectified and is no longer a sine wave. This current waveform may not be transmitted correctly by the transformer located inside the earth leakage protection device. Consequently, a leakage current with a dangerous amplitude (greater than the nominal sensitivity of the earth leakage protection device) may not cause it to trip.

In order to select earth leakage protection devices that are appropriate to each situation, the IEC 60755 and IEC 61008 standards define three types of earth leakage protection devices, according to the waveforms that cause them to trip.

| Type of earth leakage protection device | Checking fault-current tripping                                                                 |                    | Supply circuit protection                                                                                                      |
|-----------------------------------------|-------------------------------------------------------------------------------------------------|--------------------|--------------------------------------------------------------------------------------------------------------------------------|
|                                         | Waveform                                                                                        | RMS value          |                                                                                                                                |
| AC type                                 | DB123640<br>   | $I_{\Delta n}$     | Current loads                                                                                                                  |
| A type                                  | DB123641<br>  | $1.4 I_{\Delta n}$ | Single-phase loads with rectifiers (low-power variable speed drive, rectifier/charger, etc.)                                   |
| B type                                  | DB123642<br> | $2 I_{\Delta n}$   | Three-phase loads with rectifiers (three-phase high-power high-duty variable speed drive, three-phase rectifier/charger, etc.) |

Schneider Electric's **SI** earth leakage protection devices are also protected against the risk of non-tripping due to atmospheric conditions:

- Very cold temperatures (risk of mechanical parts freezing up): up to  $-25^{\circ}\text{C}$ .
- Corrosive chemical agents (risk of corrosion of alloys used to manufacture sensitive mechanical components). For information on using earth leakage protection devices in corrosive atmospheres, see module CA908027.