

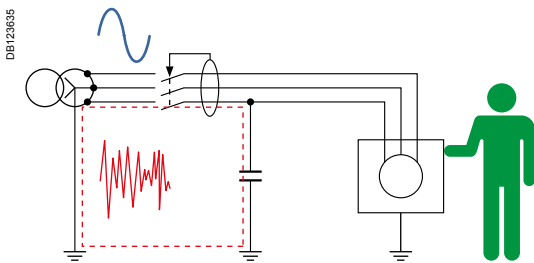
Electrical and electromagnetic interference

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 catalog module CA902000E), 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.

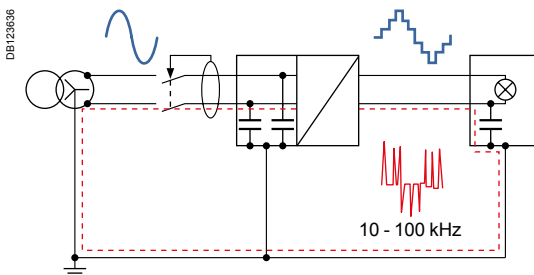


Nuisance tripping

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).

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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 μ s voltage waveform (see Fig. 2). The currents induced by these voltage surges are represented by a normalised 8/20 μ 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).

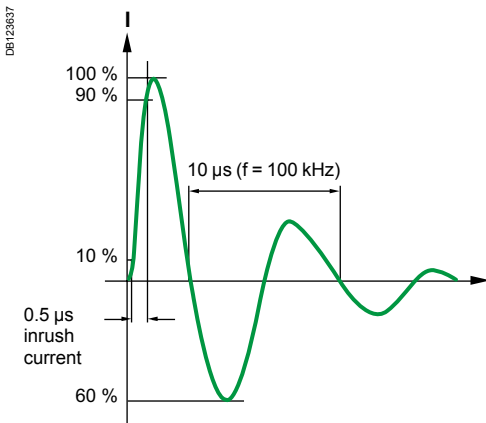


Fig. 1: 0.5 μ s/100 kHz normalised current waveform

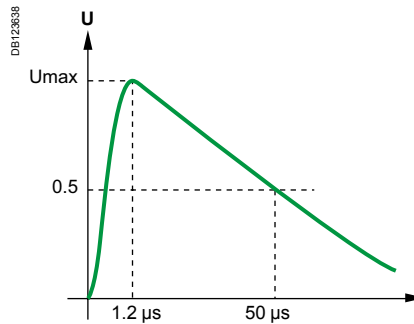


Fig. 2: 1.2/50 μ s normalised voltage waveform

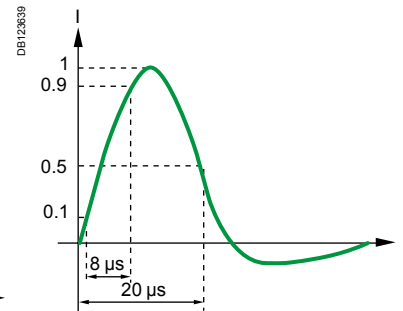


Fig. 3: 8/20 μ s normalised current waveform

Immunity of Schneider Electric earth leakage protection devices

The A-SI type 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 A-SI type earth leakage protection devices
Continuous interference			
Flow of harmonic currents to earth	1 kHz sine wave	-	$8 \times I_{\Delta n}$
Transient interference			
Voltage surge induced by a lightning strike	1.2/50 μ s pulse (IEC/EN 61000-4-5)	4 kV between conductors 5 kV between conductors and ground	4.5 kV between conductors 5.5 kV between conductors and ground
Current induced by a lightning strike	8/20 μ s pulse (IEC/EN 61008)	250 A peak	3 to 5 kA peak
Operating transient current; indirect lightning strike current	0.5 μ s/100 kHz waveform (IEC/EN 61008)	200 A peak	400 A peak
Surge protective device operation downstream of the earth leakage protection device; switching on of capacitors	10 ms pulse	-	500 A peak
Electromagnetic compatibility			
Switching of inductive loads, fluorescent lighting, motors, etc.	Repeated bursts (IEC 61000-4-4)	4 kV / 2.5 kHz	5 kV / 2.5 kHz 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) 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) 10 V / m (EN)	30 V / m




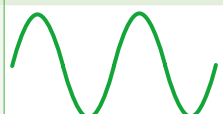

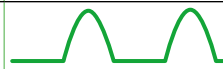
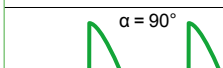
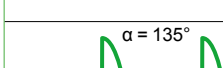
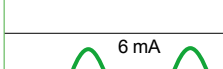



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Operation of earth leakage protection devices (cont.)

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	
B type 	F type 	AC type 	Waveform  <small>DB428234.eps</small>	RMS value $I_{\Delta n}$	Current loads
		A type 	 <small>DB428261.eps</small>	$1.4 I_{\Delta n}$	Loads including rectifiers (low power speed drives, rectifiers / chargers...) powered by single-phases network
	$\alpha = 90^\circ$  <small>DB428310.eps</small>				
	$\alpha = 135^\circ$  <small>DB428311.eps</small>				
	6 mA  <small>DB428312.eps</small>				
	B type 		10 mA  <small>DB428312.eps</small>	Frequency composition 10 Hz, 50 Hz, 1 kHz	Loads including single phase speed drives: washing machine, HVAC, heat pump, food processor...
		 <small>DB428313.eps</small>	<ul style="list-style-type: none"> ■ $2 I_{\Delta n}$ direct current ■ $1.4 I_{\Delta n}$ ■ Frequency of current 150 Hz 0.5 to $2.4 I_{\Delta n}$ ■ Frequency of current 400 Hz 0.5 to $6 I_{\Delta n}$ ■ Frequency of current 1000 Hz 1 to $14 I_{\Delta n}$ 	<ul style="list-style-type: none"> ■ Loads including rectifiers (3-phase high-power industrial speed drives, three-phase rectifier / charger...) powered by three-phase network ■ Single phase voltage elevator 	

Complementary technical information

Environments with special conditions

Schneider Electric's A-SI type earth leakage protection devices have been designed to answer to environments with special conditions:

- **Low air temperature:** A-SI type devices can operate under temperatures down to -25°C.
- **Atmospheres with high concentrations of chemicals or dust:** A-SI type devices can operate in this kind of environment if the appropriate protective measures are taken (see Table 1).

Table 1: classification for external influences in the presence of corrosive or pollution substances and required protective measures (IEC 60364-5-51)

Class from IEC 60364-5-51	External influences	Characteristics	Applications and examples	Recommendations for equipment characteristics and protective measures
AF1	Negligible	Negligible quantity or nature of corrosive or polluting agents	-	Normal
AF2	Atmospheric	Presence of corrosive or polluting atmospheric agents	Installations situated by the sea or near industrial zones producing serious atmospheric pollution, such as chemical works, cement works; this type of pollution arises especially in the production of abrasive, insulating or conductive dusts	According to the nature of substances (compliance to salt mist test according to NF C 20-702: test Ka)
AF3	Intermittent or accidental	Intermittent or accidental action of certain common chemicals	Locations where some chemicals products are handled in small quantities and where these products may come only accidentally into contact with electrical equipment; such conditions are found in factory laboratories, other laboratories or in locations where hydrocarbons are used	<ul style="list-style-type: none"> ■ Protection against corrosion according to equipment specification ■ Cabinet made of unprotected ferrous materials or natural rubber are unsuitable ■ Plastic cabinets are generally suitable
AF4	Continuous	Permanent action of corrosive or polluting chemicals	<ul style="list-style-type: none"> ■ Chemical works ■ Farms (piggery or dairies) ■ Technical room of swimming pool 	Equipment specifically designed according to the nature of substances. It is necessary to specify the nature of the chemical agent to allow the manufacturer to define the type of protection of the equipment. Protection is provided by special paints, appropriate coatings or surface treatments or by choice of material.

Example: a technical local of swimming pool must be considered as AF4 because it is subject to the permanent presence of corrosive chlorinated derivatives. The materials must be specially studied according to the nature of the agents: reinforced A-SI type of Acti9 offer and cabinet in overpressure.

Table 2: choice of earth-leakage protection device

Product function	Product range	Class from IEC 60364-5-51			
		AF1	AF2	AF3	AF4
RCCB	iID, iID K, iID bico, RCCB-ID 125A	■	A-SI	A-SI and sealed cabinet, class IP65 or higher	A-SI and cabinet in overpressure
	RCCB-ID B, REDs, REDtest		Sealed cabinet, class IP65 or higher	Sealed cabinet, class IP65 or higher	Cabinet in overpressure
RCD Vigi add-on	Vigi iC60, Vigi C120, Vigi NG125		A-SI	A-SI and sealed cabinet, class IP65 or higher	A-SI and cabinet in overpressure
RCBO	iSPN Vigi, iC60 RCBO				

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3.2	9/07/2018	Add F type page 4 and change texts page 5	Sonovision
3.1	25/04/2018	Add table about corrosive environments	Sonovision
3.0	04/04/2017	New charte	Sonovision
2.1	04/10/2011	"A si" change in "SI"	Sedoc
2.0	23/05/2011	InDesign CS5	Sedoc
1.0	22/11/2010	Creation	Sedoc
Indice	Date	Modification	Name