



# SAFETY

## Electrical Fire Prevention

Discover how to mitigate risk of fire for new and existing commercial buildings

[schneider-electric.com/fire-prevention](https://schneider-electric.com/fire-prevention)

Life Is On

**Schneider**  
Electric

Tested and certified products and equipment combined with innovative solutions from Schneider Electric® help you to mitigate risk of fire ignited in electrical installations in new or existing buildings.



# Contents

Introduction: Electrical fires	4
01 LV main, secondary and control switchboards	6
IP level, insulation distances and heat dissipation issues	7
Power connection issues	9
Detection of abnormal heating	12
02 Power and distribution circuits	14
Conductor insulation failure	15
Protection against insulation failure	16
Monitoring for earth leakage (TN system)	21
Selecting conductors	22
03 Final distribution boards and circuits	24
Conductor insulation failure	25
Arc faults	27
Power connection issues	30
04 Summary	31
Additional resources	34

# Introduction: Electrical fires

Electricity is a common cause of fires in buildings and not all risks—including insulation based fires and loose connections—are addressed by overcurrent protection.



To understand the impact electrical fires can cause, consider these global statistics:

- According to the [International Association of Fire and Rescue Services](#) (CTIF), 35% of fires in the world that require firefighter intervention, start in buildings.
- Organizations such as the [European Fire Academy](#) (EFA), and property and insurance companies that track building damages, declared that 25% of building fires are electrical in origin.
- [AXA Insurance](#) has also found that half of all organizations that suffer a fire will close within the next five years.
- In the U.S., according to the U.S. Fire Association (USFA) ~10% of fires in nonresidential buildings are directly caused by electricity (15% in educational, 19% in retail or offices, 16.5% in basic industry). This number grows to 30% if we include overheated electrical loads in industrial segments.
- According to the [German Insurance Association](#), 31.7% of fires in Germany are caused by electricity.
- 56% of industrial disasters in India are due to electrical faults.

#### Examples of debilitating electrical fires include:

- Paris's Montparnasse train station in 2018 ([France 24 article](#))
- Atlanta's Hartsfield-Jackson airport in 2017 ([Electrical Contractor article](#))
- Rome's Fiumicino airport in 2015 ([ABC's article](#))

## INTRODUCTION: ELECTRICAL FIRES

Electrical fires can generate huge losses in commercial buildings from the loss of business continuity, business opportunity costs, assets, and production loss. These losses can be so significant that they can even destroy companies.

If an electrical design follows requirements, including IEC standards and national regulations, and uses compliant equipment, the electrical fire risks from over-current, over-voltages and overheating of electrical appliances should be reduced. **However, electrical installations can deteriorate with time**, often due to environmental factors, such as heat and humidity. Additionally, damage can occur during use or as a result of corrosive chemical reactions.

**This Guide considers the risk of fire caused by electrical currents that fall below overcurrent protection thresholds.**

It focuses on the latest solutions to help mitigate such hazards in both new and existing installations. Even professionally designed installations can be exposed to electrical fire risks. Figure 1.1 illustrates risk areas and causes, even for installations which have followed the standards.

## Areas of fire risks

### Chapter 1 - LV main, secondary and control switchboards

- IP level, insulation distances and heat dissipation issues
- Power connection issues

### Chapter 2 - Power and distribution circuits

- Conductor insulation failures
- Connection issues (derivation box)

### Chapter 3 - Final distribution boards and circuits

- Conductor insulation failures
- Arc faults
- Power connection issues (wiring devices)

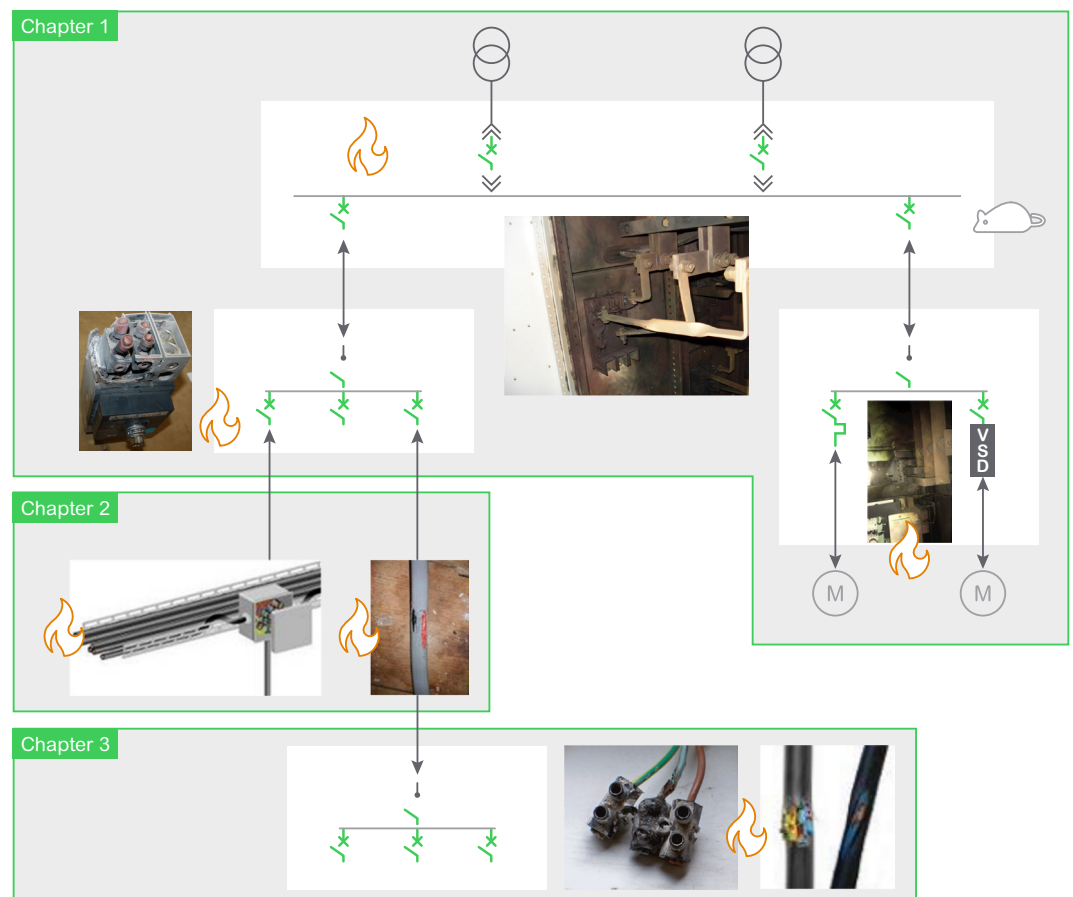


Figure 1.1. Risk areas and causes

01

---

LV main, secondary  
and control switchboards

# IP level, insulation distances and heat dissipation issues

Fire prevention begins with equipment and switchboards designed to meet IEC 61439 requirements. Other standards to consider include IEC/TR 61641 and the IEC 60204 series.

Fire-risk characteristics that can be found in low-voltage (LV) main and secondary switchboards include: high intensity in normal operation, high short circuit currents, bar busbars in some compartments creating a temperature rise concern, power connection issues and the possibility of internal arc faults. These risks need to be addressed as part of any fire risk-reduction strategy.

Machine control panels with a high number of connections, switches and, in particular, variable speed drives, auxiliary supplies and transformers also need to be carefully designed and manufactured to mitigate the risk of electrical fires.

Designing equipment and switchboards in accordance with IEC 61439 standards ensures a proper IP level and significantly reduces the risk of fire due to insulation failure or excessive temperature rise. The IEC 61439 standard sets a wide range of requirements, including: designing a “system” compliant in all aspects, checking interactions and consistency between switchgear and equipment, providing protection against electrical, mechanical and structural hazards, and simplifying system maintenance and upgrading cycles. Among the 13 points of verification, Figure 1.2 shows the 8 points that are directly linked to the risk of fire.



Clause 10 design verification	Clause 11 routine verification	Point of verification	Mitigation of fire risk ignition
10.2 10.2.3 10.2.3.1		Strength of material and parts <ul style="list-style-type: none"> <li>• Properties of insulation materials                             <ul style="list-style-type: none"> <li>» Thermal stability</li> <li>» Resistance to abnormal heat</li> </ul> </li> </ul>	Addresses the risk of short circuit including insulation fault inside the switchboard that causes internal arc fault
10.3	11.2	Degree of protection of enclosures	Thanks to the protective insulation covers up to form 4 in equipment that cannot be damaged by bad usage of tools, loose parts or be penetrated by animals like rodents
10.4	11.3	<ul style="list-style-type: none"> <li>• Measurement of clearances distances</li> <li>• Measurement of creepage distances</li> </ul>	Addresses risk of short circuit including insulation fault inside the switchboard that causes internal arc faults
10.6	11.5	Incorporation of switching devices and components	Addresses connection issues and temperature rises
10.7	11.6	Internal electrical circuits and connections	
10.8	11.7	Terminals for external conductors	
10.9	11.9	<ul style="list-style-type: none"> <li>• Dielectric properties</li> <li>• Power frequency withstand voltage</li> <li>• Impulse withstand voltage</li> </ul>	Addresses risk of short circuit including insulation fault inside the switchboard that causes internal arc faults
10.10		Temperature-rise limits (including test)	Manages heating dissipation and temperature rise limits to avoid abnormal heat, hot points and potential fire

Figure 1.2. List of design and routine verification point related to risk of fire in IEC 61439-1

In addition to these requirements, the internal arc fault behavior can be evaluated according to IEC/TR 61641 Guide for testing under conditions of arcing due to internal fault.

Control panels and other enclosures for electrical equipment in machines should comply with the IEC 60204 series. This standard addresses behavior in the case of a short circuit, thermal behavior overload protection of motors, etc. It refers to IEC 61439 where relevant. (IEC 60204-1 2016 Clause 4.2.2 Switchgear).

Particular attention should be paid to behavior in case of short circuits in motor-starters. Contactors and overload relays or soft-starters need to be coordinated with overcurrent protection to avoid the risk of fire in case of short circuit. (IEC 60204-1 Clause 7.2.10 Rating and setting of overcurrent protective devices).

**Schneider Electric's Solution: Prisma, Okken**

Schneider Electric provides solutions for 100% IEC 61439-compliant switchboards such as **Prisma** or **Okken** ranges.



Figure 1.3. Prisma Switchboard

Figure 1.4. Okken Switchboard

**Additional Resources:**

For more information regarding design and routine tests visit:

- [Distribution Switchboards, Electrical Installation Wiki](#)
- [Asynchronous Motors, Electrical Installation Wiki](#)



# Power connection issues

Faulty power connections pose a significant fire risk. Lineryg busbars, wiring systems and EverLink™ power connections help mitigate this risk.

One of the leading causes of electrical fires in low-voltage equipment is faulty power connections of cables, busbars, and circuit breakers, particularly when the connections are completed onsite. A faulty power connection can lead to an increase in electrical contact resistance which, in turn, can induce a thermal runaway.

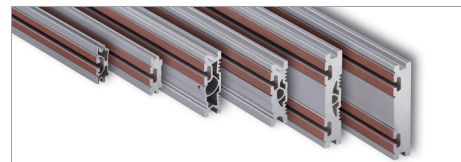
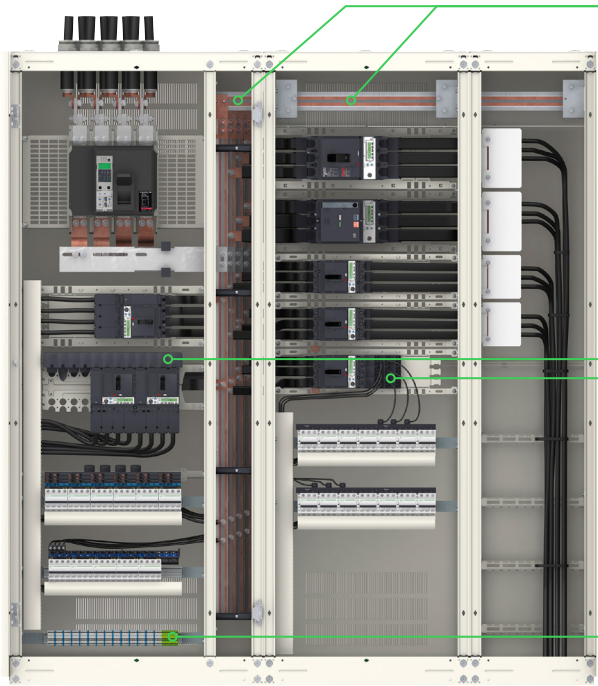
## Busbar distribution systems

### Schneider Electric's Solution: Lineryg

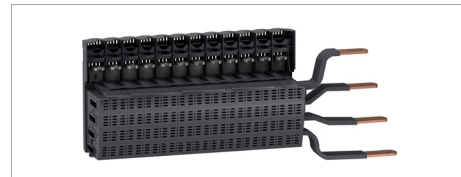
Schneider Electric provides a wide range of connection and distribution systems for electrical distribution switchboards or control panels.

The Lineryg range of products includes power busbars, distribution blocks and device feeders designed and tested to work together and with the related switching and protective devices, including circuit breakers, motor starters, etc.

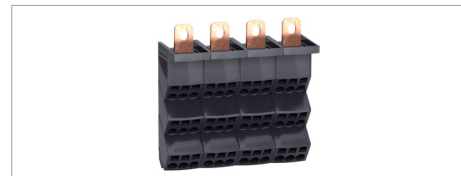
This range of accessories simplifies wiring and helps to improve the reliability of power connections inside the switchboard.



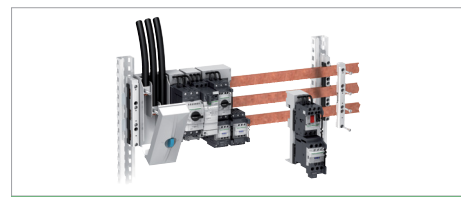
Lineryg LGYE (Busbars) for reliable power connection without drilling



Lineryg FC (Distribution Block) for clean and reliable connections between circuit breakers



Lineryg DP (Device Feeders) for reliable and simple installation between circuit breakers



Lineryg BZ: Power distribution for motor starter

Figure 1.5 Display of Lineryg range of products

## Patented power connections

### Schneider Electric's Solution: EverLink™

Schneider Electric's EverLink is a creep-compensating technology that mitigates the loosening effects of creeping.



Figure 1.6. EverLink Power Connection Solution Video



Figure 1.7. EverLink patented technology

EverLink offers a more reliable connection than a classic screw power connection, by providing a spring-pressure reserve on cables in the event of thermal dilatations, creeping, or loosening as a result of external vibrations. This pressure reserve maintains the connection in a wide range of operational environments by ensuring lower contact resistance, and thus, a lower temperature rise. Not only does this reduce the risk of thermal runaway, which can potentially lead to a fire, it also diminishes the risk of the cables being pulled out of their power connections during a short circuit.

### EverLink terminals are available on:



ComPact NSXm molded case circuit breakers



PowerPact B Multistandard molded case circuit breakers



TeSys GV4 motor circuit breakers

### Additional Resources:

To learn more about EverLink:

- Download White Paper: [How to ensure a secure, long-lasting power connection within your electrical installation](#)



## Continuous thermal monitoring

Continuous thermal monitoring helps to prevent electrical fires with:

### Early detection of faulty connections

- Monitors the temperature of busbar, cable, transformer, and withdrawable circuit breaker connections
- Detects temperature deviations from normal operating conditions before they result in equipment failure

### Temperature alarming and reporting for faster response

- Sends pre-alerts and alerts in case of abnormal temperature rise
- Enables easy reporting of the thermal status of the electrical installation

### Replacement of periodic thermographic inspections

- Continuous thermal monitoring is more cost effective in the long-run than infrared thermographic surveys

### Schneider Electric's Solution: Easergy TH110 and EcoStruxure™ software

Continuous thermal monitoring is part of Schneider Electric's EcoStruxure offerings, including the Easergy TH110 and CL110 wireless thermal sensors and edge control software. The Easergy TH110 battery-free and CL110 wireless are thermal sensors for continuous thermal monitoring of all critical onsite connections, such as cable and busbar connections.

Edge control software, such as EcoStruxure Power Monitoring Expert and/or EcoStruxure Power SCADA Operation offers continuous thermal monitoring function.

For continuous thermal monitoring of assets, EcoStruxure Asset Advisor can provide analytics with condition-based, pro-active recommendations through periodic reports.

---

Continuous data recording and visualization with a centralized monitoring system enables live data monitoring, pre-alarming and event alarming, notification of operators, visualization of trends and historical reporting.

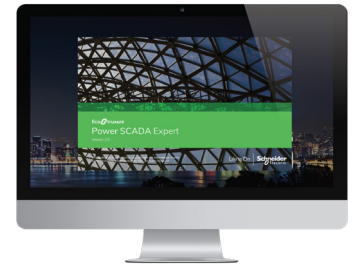
---



Figure 1.8. Set of Easergy TH110 sensors fixed on the 3 phases of an electrical connection



EcoStruxure™ Power Monitoring Expert



EcoStruxure™ Power SCADA Operation

### Additional Resources:

- For support with continuous thermal monitoring: [Contact your local field services for existing installations](#)
- Download the [Digital Applications for Large Building & Critical Facilities guide](#)
- Download White Paper [How thermal monitoring reduces risk of fire more effectively than IR thermography](#)
- Check out the [Digital Applications for Large Building & Critical Facilities guide](#) for more information on continuous insulation monitoring.

# Detection of abnormal heating

Loose cable connections can contribute to thermal runaway. PowerLogic HeatTag sensors identify potential problems before they get out of control.

Cable connections can start to deteriorate due to improper tightening torque or constant vibrations over time. Deterioration can also occur because of damaged surfaces, due to corrosion, excessive pressure or excessive friction.

These conditions can be exaggerated by frequent temperature cycling. Fluctuations between cold nights and hot days, or low and high current, cause increased and decreased connection tightness. This, in turn, contributes to loosening.

In any of the conditions noted above, a critical sequence of events can begin: increasing electrical contact resistance induces a rise in temperature that accelerates the damage and the result is a thermal runaway that leads to overheating wire connections and/or overheating cables.

## Schneider Electric's Solution: HeatTag

HeatTag is neither a fire detector nor a smoke detector. As shown in Figure 1.9, between 170°C and 200°C, typical LV cable-insulation materials, such as PVC / XLPE / EPR, are subject to invisible transformation. These abnormal conditions can be detected by HeatTag.

After 200°C, the insulation material begins to change color.

At approximately 300°C this transforms into cable smoke, melted insulation material or even fire. These conditions can be detected with a fire or smoke detector; however, at that point, the damage has already occurred in the electrical switchboard.

HeatTag detects and analyzes the different gases and particles in the air of the switchboard (14 gases measured, along with particles), applies a complex algorithm to select internal cable issues from other phenomena, and can distinguish abnormal situations that indicate a cable is overheating and sends an alarm via email or SMS.

HeatTag is an innovative smart sensor able to analyze gas and particles in the switchboard and alerts before any smoke or insulator browning occurs.



Figure 1.9. How does it work?

## Switchboard maintenance

Maintenance is critical to ensure switchboards continue to operate safely and efficiently throughout their lifespan. Power-connection maintenance—regular cleaning, visual inspection, and thermographic inspection—are key elements in this process, and help to ensure proper operation and reduce the risk of fire.

### Case of cluster connections for withdrawable circuit breakers

Electrical power connections on withdrawable devices need special care, as drawing out/in magnifies the aging process beyond their general operating conditions. It is difficult to check via thermal inspections, as it is inside the chassis. Connection clusters should be regularly assessed to enhance power connection reliability.

### Schneider Electric's Solution: Cluster diagnosis

Field service engineers from Schneider Electric offer a dedicated cluster diagnosis, allowing maintenance managers to reach the last-meter assessment of power connections.

The Schneider Electric field services cluster diagnostic tool indicates whether or not the cluster condition is within its technical specifications. The assessment delivers unique information about:

- Cluster surface condition - key indicator of the previously described aging phenomenon.
- Cluster mechanical contact pressure - measured with a proprietary contact pressure meter.

### Additional Resources:

- Find out more about onsite maintenance: [Schneider Electric: Preventive and condition based maintenance for electrical distribution.](#)



02

---

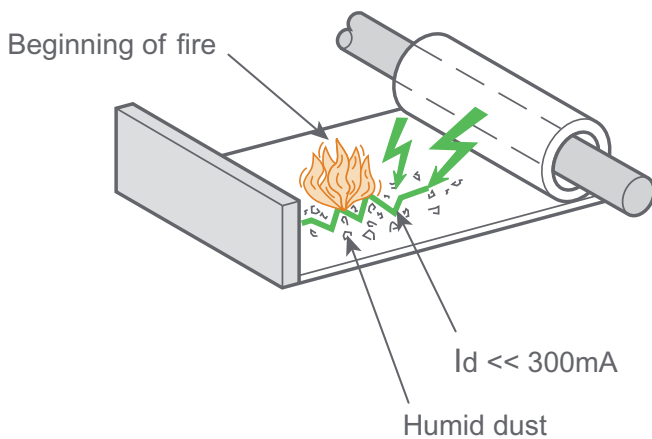
# Power and distribution circuits

# Conductor insulation failure

Low-intensity arc faults are a real risk in humid and dusty environments. Residual current devices can sense these hazards before they reach dangerous levels.

An insulation failure between a line conductor and earth—for example—in dusty and humid environments can lead to an arc fault of low intensity according to the line conductor withstand, but still be high enough to start a fire. Some tests have shown that even a fault current as low as 300mA can induce a real risk of fire (see Figure 2.1).

A polluted and damp insulation surface can enable small electrical discharges, causing carbon deposits that increase conductivity. If the current leak exceeds 300mA, the carbon deposits and insulation can quickly ignite and cause a fire hazard. Residual current devices (RCDs) can be effective in protecting against these hazards as they sense leakage currents below 300mA.



**Figure 2.1.** The response time of residual current devices with a sensitivity of 300mA is recognized as effective protection against fires generated by leakage currents.



# Protection against insulation failure

Solutions exist to improve the sensitivity of circuit breaker below overcurrent threshold in case of insulation faults: residual current device (RCD) and ground fault protection (GFP).

The majority of electrical short circuits in low-voltage installations are line-to-earth insulation failures. The protective measures against electric shock will ensure automatic disconnection of the supply in case of a fault between a line conductor and an accessible conductive part that could be dangerous. But a fault between a line conductor and earth with lower amplitude than the cable overcurrent protection threshold (and no risk of indirect contact) is also possible.

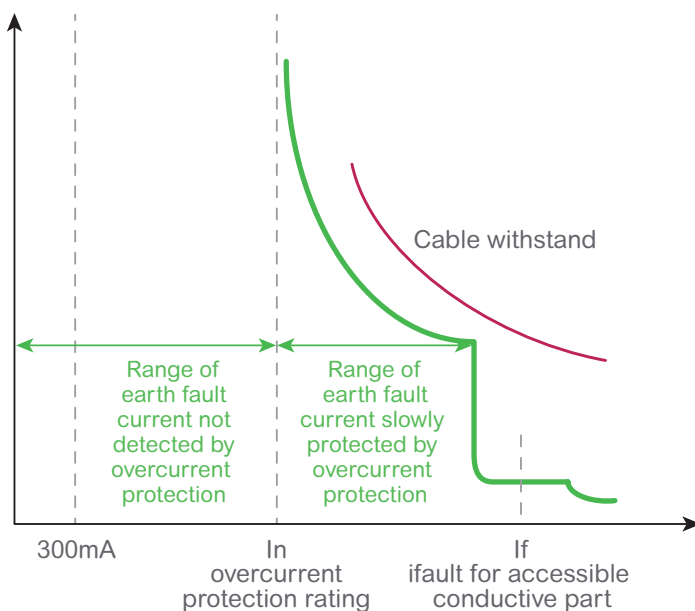


Figure 2.2. Overcurrent protection curve and earth fault potential current



## Protection with residual current device - RCD (TT, TN-S, IT)

The IEC 60364 series recognizes the use of residual current devices (RCDs) with sensitivity below 300mA to protect against fire ignition due to leakage current caused by insulation failure. It's mandatory for the following applications:

- Location with a particular risk of fire due to the nature of stored or processed material which include the presence of dust in barns, wood-working shops, paper factories, etc. (IEC 60364-4-42 2010 422.3)
- Agricultural and horticultural buildings (IEC 60364-7-705 2006 411 & 422)
- Notably, TN-C system is not accepted in such applications



## 02 POWER AND DISTRIBUTION CIRCUITS

### Schneider Electric's Solution: Vigi products

Schneider Electric offers a wide range of solutions to ensure the RCD function for power and distribution circuits:

- Circuit breaker with overcurrent and integrated RCD function
  - » Molded case circuit breaker with integrated earth leakage protection, such as **ComPact NSXm** with MicroLogic Vigi 4.1 and **ComPact NSX** MicroLogic Vigi 4 or 7 and Compact NS MicroLogic 7
  - » Air circuit breaker with embedded advanced technologies, like the **MasterPact™ MTZ** with MicroLogic 7.0X
- Circuit breaker add-on RCD (**Vigi add-on**)
- Circuit breaker with separate earth leakage relay (any circuit breaker with **VigiPact** range)

All RCDs from Schneider Electric follow the same rules for sensitivity and tripping time, even if they are covered by different standards (IEC/EN 61009-1, IEC/EN 60947-2 Annex B or Annex M, IEC 61008).

The 300mA innovation is integrated within the breaker's trip unit, complementing the original ComPact NSX overload and short circuit protection. This smart device can measure the earth leakage current, which could detect insulation failure.

When a standalone relay is used, it should operate with a device that has a breaking capacity of the maximum earth fault current at the point of installation.



Figure 2.3. Standalone earth leakage relay VigiPact RH99



Figure 2.4. Molded case circuit breaker with integrated earth leakage protection

## Selecting the appropriate RCD

Residual current devices (RCDs) should be coordinated properly to achieve total selectivity, in addition to overcurrent protection. As shown in Figure 2.5, the selection of the appropriate type of RCD, in particular the type (AC, A, B, etc.) follows the same rule for fire prevention as for protection against electric shock. See [when to use each type of RCD](#).

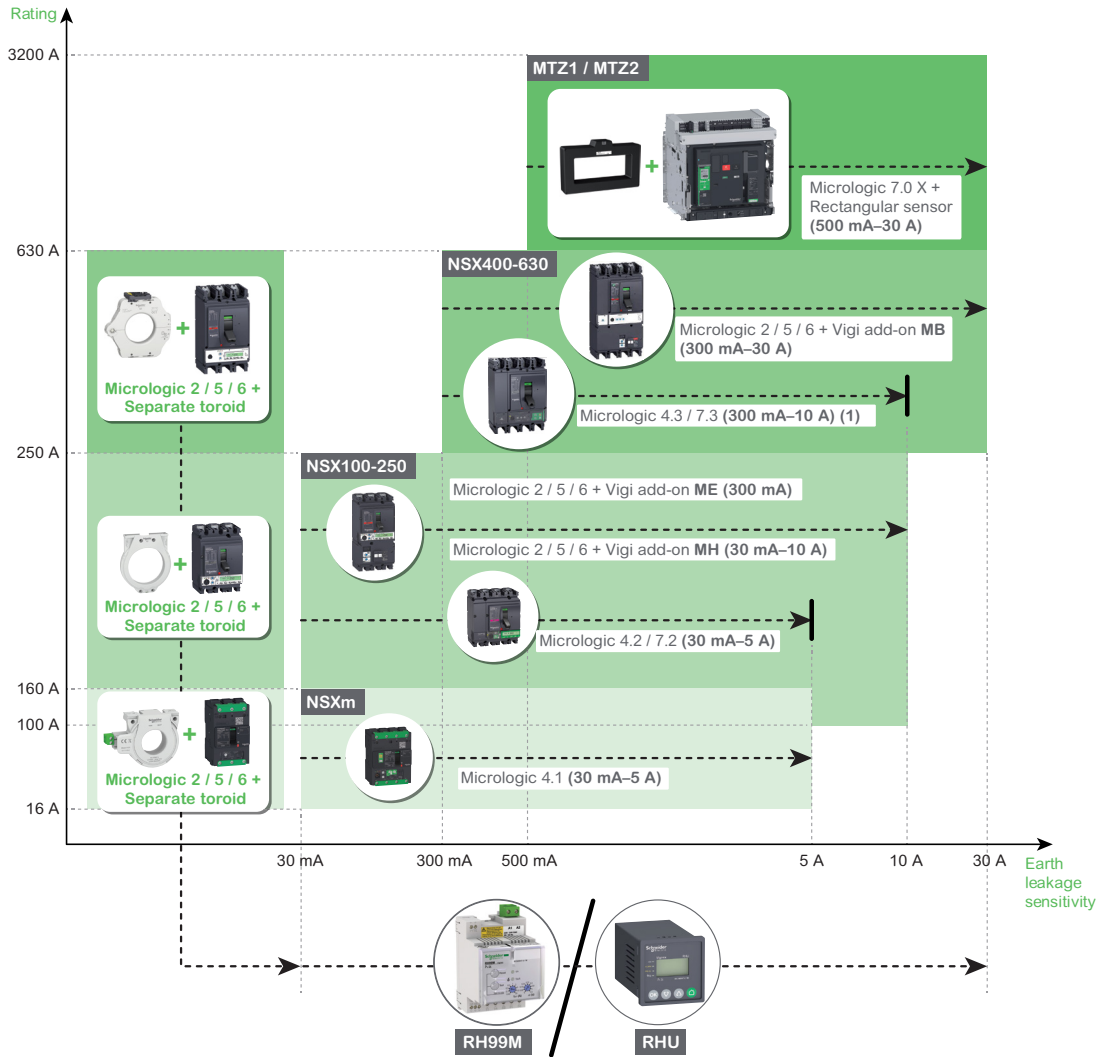


Figure 2.5. Overview of Schneider Electric RCD ranges for power and distribution circuits

### Additional Resources:

- See: [Coordination of residual current protective devices, Electric Installation Wiki](#)

## Protection with ground fault device - GFD (TN system)

In TN-S systems, and particularly when cables are installed in metallic conduit ducts, an insulation failure protection approach that is less sensitive than an RCD, but more sensitive than short circuit current, offers a good compromise for fire protection.

This ground fault protection can also be used in TN-S with no disconnection of the neutral (3 pole circuit breaker and external neutral current transformer) where a requirement for an RCD embedded in the circuit breaker is not applicable.

In TN-C systems, RCD protection cannot be used, as the measurement of earth fault current by a sensor around line conductors and PEN will lead to permanently incorrect measurements and unwanted trips. As a result, earth fault with a tripping value equal to the rating of the circuit breaker is recommended.

In North America this protection is commonly used and known as “ground fault protection.” It is mandatory at the main entrance of the installation to be equal to or greater than 1200A.

### Different types of ground fault protections (GFP)

Different types of GFP may be used, depending on the measuring device installed:

- Source Ground Return (SGR): The insulation fault current is measured in the neutral – earth link of the MV/LV transformer. The current transformer is outside the circuit breaker.
- Residual Sensing (RS): The insulation fault current is calculated using the vectoral sum of currents of line and neutral current transformers. The current transformer on the neutral conductor can be outside the circuit breaker.

Ground fault protection can be included in the circuit breaker or performed by a standalone relay. In all cases, the device operated by the GFP shall have the breaking capacity of the maximum fault current at the point of installation, alone or in coordination with another overcurrent protective device.

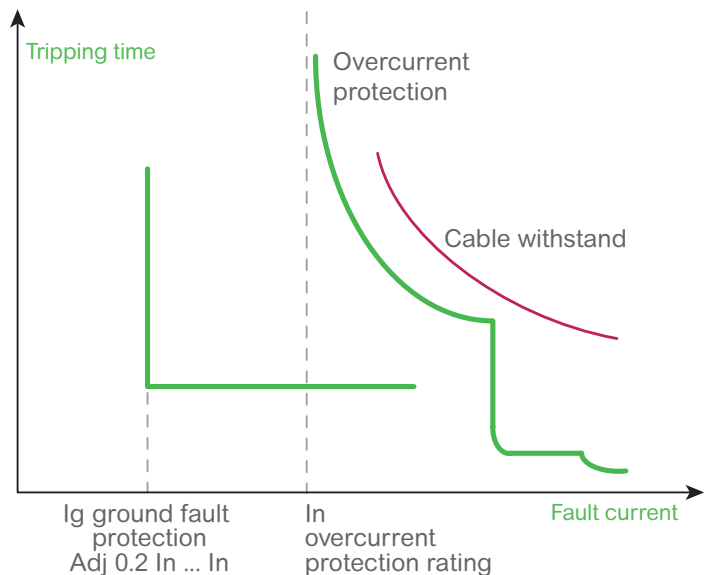


Figure 2.6. Example of tripping curve of RS type ground fault protection

**Schneider Electric's Solution: MicroLogic 6 and TeSys GV4 ComPact NSX, ComPact NS, MasterPact** equipped with MicroLogic Type “6” control units and **TeSys GV4 P** include ground fault protection with adjustable settings. TeSys GV4 P includes ground fault protection with fixed settings.



Figure 2.7. Example of ComPact NSX630 with integrated residual sensing ground fault protection MicroLogic 6.3E and external neutral current transformer (CT)

## Protection with insulation monitoring device - IMD (IT earthing system)

The great value of IT systems is that, in the case of the first insulation failure, continuity of service and protection against electric shock is ensured. But due to this failure, the system is no longer isolated – rather it behaves as a TN system.

Therefore, an insulation monitoring device is mandatory to keep and maintain the IT system's core values. An alarm will be triggered if there is an insulation failure, allowing maintenance staff to quickly resolve the problem and get the system back to a healthy electrical distribution state.

The insulation monitoring device (IMD) provides:

- Permanent measurement of the system's insulation resistance and leakage capacitance
- Preventive alarm, in case the system's insulation resistance begins dropping below the set threshold

### Schneider Electric's Solution: Vigiholm and EcoStruxure software

When **Insulation Fault Locator** (IFL) capability is combined with an IMD, it reduces the time for diagnosis by providing:

- Permanent measurement of each individual branch/feeder, in terms of insulation resistance and leakage capacitance
- Alarm in case the insulation resistance of one of the branches were to drop below the set threshold for curative action
- Continuous insulation monitoring using system software by visualizing the total hazard current (A) or resistance (kOhms) in diagrams, trending, and reporting



Figure 2.8. Example of IMD by Schneider Electric: **Vigiholm IM400**

Permanent monitoring is done through software such as **EcoStruxure™ Power Monitoring Expert**:

- Live data display for insulation monitoring status and the absolute value (Ohm)
- Events and alarms for insulation fault, fault location (per feeder/group of sockets) and transformer electrical fault (overload, overtemperature)
- Report including isolated power report

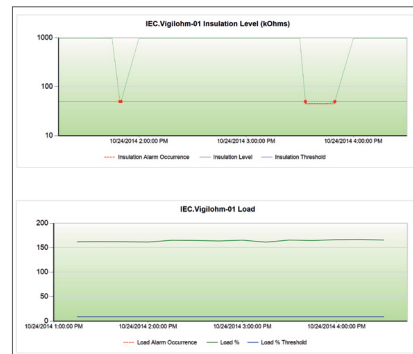


Figure 2.9. Insulation Monitoring Diagram

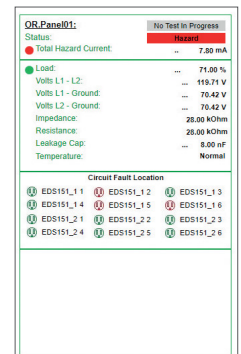


Figure 2.10. Operating Room Isolated Power report IEC

# Monitoring for earth leakage (TN system)

Permanent insulation alarms for earth leakage without tripping allows for early detection of insulation deterioration.



Increasing the sensitivity of a protection system will reduce the risk of fire, but can also increase the risk of unexpected tripping from disturbances that are not real faults. Where the balance between sensitivity and continuity of service is challenging, the monitoring of earth leakage without tripping can be beneficial. In countries such as China, they consider earth leakage monitoring as a fire detection and alarming system.

Earth leakage monitoring and alarming allows:

- Early detection of deterioration of insulation
- Abnormal leakage currents

For permanent earth leakage monitoring, software such as EcoStruxure™ Power Monitoring Expert:

- Live data and trending display for earth leakage current
- Events and alarms for insulation fault

Schneider Electric's Solutions: ComPact NSX, TeSys T and TeSys island



Figure 2.11. Example of 250 A MCCB earth leakage monitoring device with measurement and alarming. (ComPact NSX MicroLogic Vigi 7.2AL)



Figure 2.12. Example of intelligent motor management system TeSys T with ground fault or earth leakage monitoring. This system shows an example of connected digital motor starters in TeSys island with a ground fault.

# Selecting conductors

Correct conductor and overcurrent-protection sizing is critical in reducing electrical fire risks. Busways can help designers get around the electrical fire risks that conductors can pose.

## Sizing and protection of conductors

Sizing of conductors and the related selection of overcurrent protection is a key step in the installation design. Undersized cables can generate overheating and mechanical stress in the event of short circuits: the first can produce insulation destruction and the second can damage the cable connection.

Special attention needs to be paid to neutral sizing when third harmonics and multiples of three are present in the current. Protection of neutral conductors must be provided to avoid cable oversizing.

**Schneider Electric's Solution: EcoStruxure™ Power Design EcoStruxure Power Design** (formerly Ecodial Advance Calculation) can be used to calculate the size of the electrical installation. It allows designers to optimize the choice of equipment, taking into account the tripping curves and wire dimensions. It also takes into account IEC 60364 requirements, numerous country standards, and is compliant with the CENELEC TR50480 technical report.

## Busway or cable?

Cable presents several challenges to the installer. Among these is the need to terminate multiple cables in switchboards. With cable, entry holes must be drilled on site, and particular care is needed to ensure accurate positioning of these holes, and to avoid the risk of swarf falling into the electrical connections, causing short circuits. Cable ladders would also need to be installed to support the cable during installation, as well as circuit protective conductors. These could require a dedicated team to set up. The cables would need to be tidied up, glanded into the switchboard and terminated. Each of these operations includes risk of damage to the insulation, to the core itself, and bad termination that increases the risk of fire. In contrast, busway is much more straightforward.



A single run of busway replaces several runs of cable, along with associated cable trays. Busway also needs fewer fixings than the equivalent length of cable.

Busway temperature rises and short circuit withstand are known and independent of the installation, they are tested and certified according to IEC 61439-6 standards. In addition, coordination of the Schneider Electric circuit breaker and busways ensure an optimized sizing with perfect protection against short circuit conditions.

Also, for high current circuits, multiple cables in parallel can lead to uneven distribution of currents and the risk of abnormal temperature rises. Installation standard IEC 60364 chapter 5.523.6 recommends busbar trunking systems (busways) above four parallel cables. In France, this is mandatory, according to UTE C 15-105 chapter B.6.2.

Another major advantage of busway is the use of tap off units instead of a derivation box. These incorporate protective devices, which allow the busway to feed other sub-circuits in the building. A variety of protective devices are available, including modular circuit breakers and molded case circuit breakers. The

## 02 POWER AND DISTRIBUTION CIRCUITS

rated performances are standard compliant, irrespective of implementation, and the tap off units are seamless to install and deliver high contact quality during aging.

Mechanical protection of conductors significantly reduces the risk of insulation faults due to external factors, such as rodents, moisture and pollutants. IEC 60364-4-42 2010 422.3 mentioned earlier, states that busway need not be protected by 300mA RCDs in locations with special risk of fire, as they are not considered likely to cause a fire from insulation faults.

### Schneider Electric's Solution: Canalis

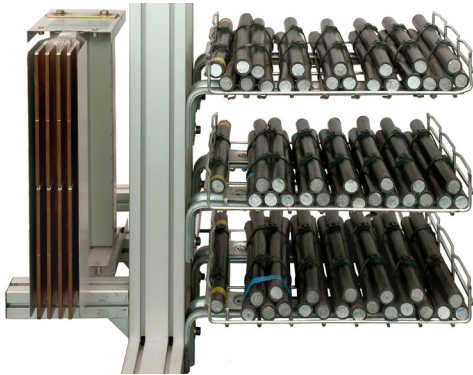


Figure 2.13. Canalis busbar trunking system copper

### Additional Resources:

- To learn more about EcoStruxure Power Design [Download the Technical Guide](#)

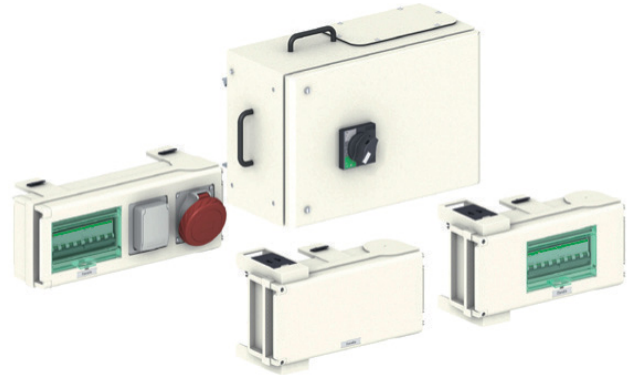


Figure 2.14. Various types of tap off units for Canalis



03

---

# Final distribution boards and circuits



# Conductor insulation failure

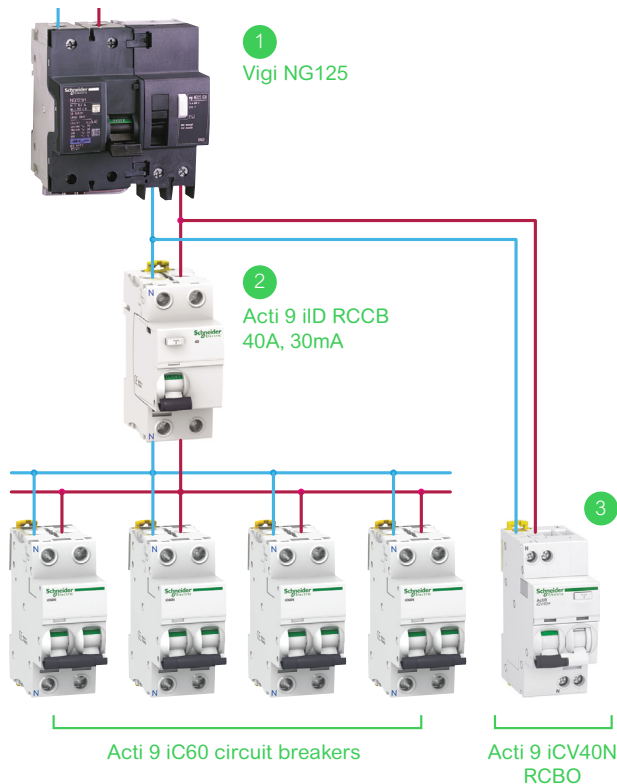
Final circuits should be protected against insulation faults, just as with power and distribution circuits.

The potential for electrical fires in final distribution boards and circuits is amplified by the quantity of connections, the low cross-section area, and the type of cable installation method.

According to the international IEC 60364 standards series and local related standards, the use of RCDs with sensitivity below 300mA to protect against earth leakage current is recognized as effective protection against the risk of fire caused by insulation failure.

## Schneider Electric's Solutions: Vigi NG and Acti 9

There are three categories of RCDs that can be used in secondary and final switchboard installations:



According to the international and local related standards, the use of RCDs with sensitivity below 300mA to protect against earth leakage current is recognized as effective protection against the risk of fire caused by insulation failure.

Final circuits may already be protected against insulation failures due to the requirement for protection against electric shock with 30mA sensitivity (e.g., socket outlet circuits). In this case, they are also protected against fire due to insulation failure.

RCDs should be coordinated properly to achieve total selectivity in addition to overcurrent protection. One RCD can be installed to protect several circuits, but in this case, selectivity will be lost.

The specification of RCD should follow the same rule for fire prevention, as for protection against electric shock.

### Additional resources:

- [Arc faults in cables and connections of final circuits, Electrical Installation Wiki](#)
- [Coordination of residual current protective devices, Electrical Installation Wiki](#)
- [Types of RCDs, Electrical Installation Wiki](#)

Figure 3.1. The three categories of RCDs

1. Vigi add-on is the most flexible RCD. It is installed in combination with a circuit breaker. (Vigi NG125 in the example)
2. Residual current operated circuit breakers without integral overcurrent protection (RCCB). (Acti 9 iID in the example)
3. Residual current operated circuit breakers with integral overcurrent protection (RCBO). (Acti 9 iCV40 in the example)

## Selecting the appropriate RCD

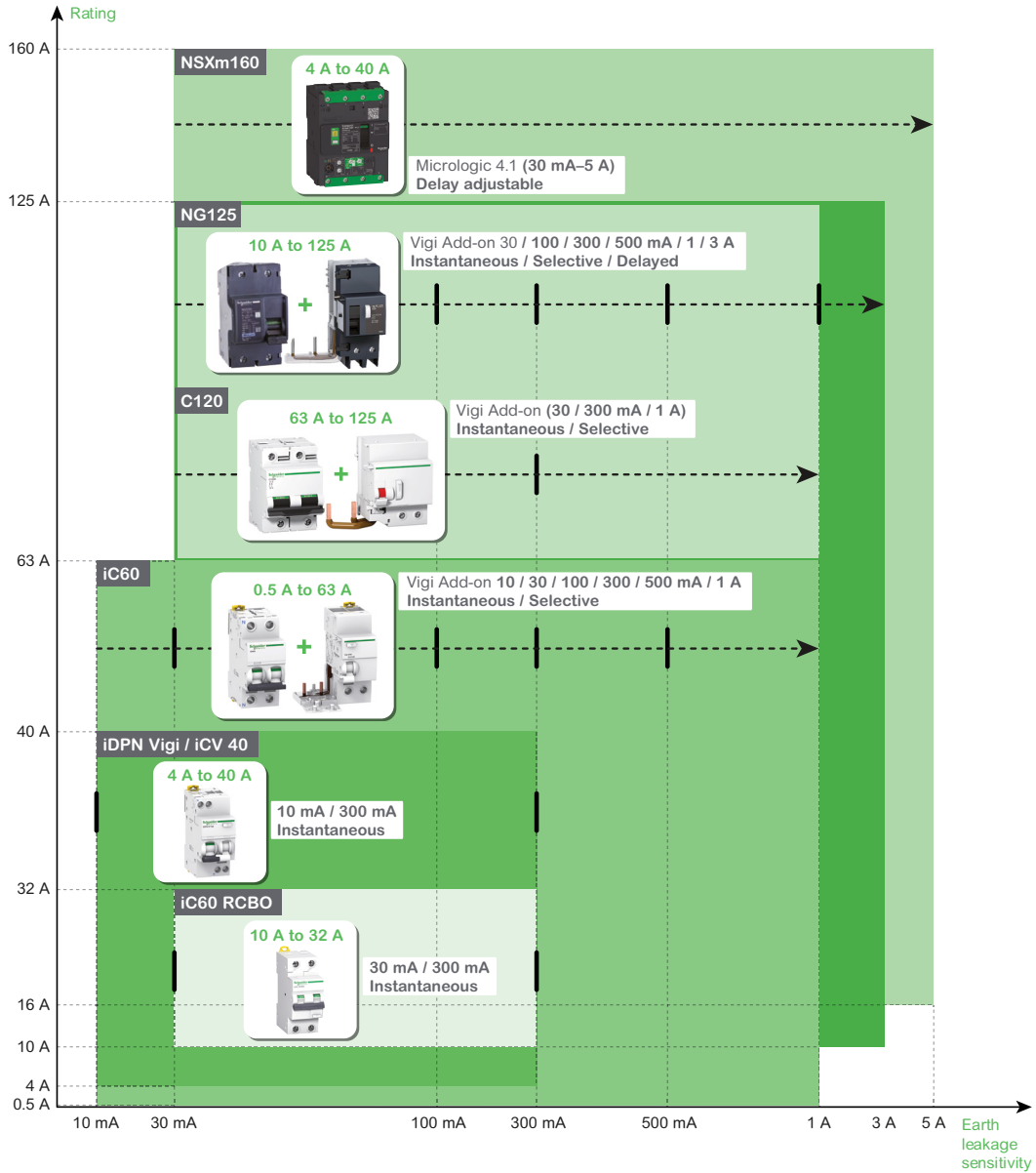


Figure 3.2. Overview of Schneider Electric RCD ranges for final distribution circuits

# Arc faults

Low cross-section areas, low mechanical protection, and high numbers of derivations and connections can increase the risk of damage to the interior core conductor in the final circuits.

When a cable is damaged, or an electrical connection comes loose, there are two phenomena which could initiate a fire due to an electric arc:

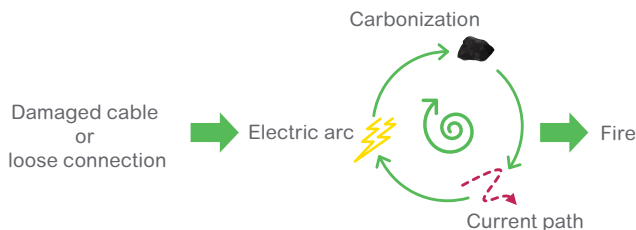


Figure 3.3. Arc fault generation

## Carbonization:

This phenomenon is behind the series of arc faults that results from an arc between two parts of the same conductor. Whenever a conductor is damaged or a connection is not properly tightened, a localized hot spot occurs which carbonizes the insulating materials in the vicinity of that conductor.

Because carbon is a conductive material, it enables the flow of the current, which becomes excessive at various points. Since the carbon is deposited in a non-homogeneous manner, the currents which pass through it generate electric arcs to facilitate their paths. Then each arc amplifies carbonization of the insulating materials, a reaction thus occurs which is maintained until the quantity of carbon is sufficient for an arc to inflame it spontaneously.

## Resistive short circuit:

This phenomenon is behind the parallel arc that happens between two different conductors. Whenever the insulating materials between two live conductors are damaged, a significant current can be established between the two conductors, but it is too weak to be considered a short circuit by a circuit breaker and is undetectable by residual current protective devices as this current does not go to earth.

When passing through these insulating materials, these leakage currents optimize their paths by generating arcs that gradually transform the insulating materials into carbon. These carbonized insulating materials then amplify the current leak between the two conductors. Thus, a new chain reaction occurs, amplifying the quantity of arc current and carbon until the first flame appears from the carbon lit by one of the arcs.

The common feature of these phenomena is the ignition of the fire by arcs which inflame the carbon: that is why detection of the presence of arcs is one way to help prevent fires from occurring.

---

Detecting the presence of  
arcs is one way to prevent fires  
from occurring.

---

## Arc fault detection devices

Arc fault detection device (AFDD) technology makes it possible to detect arc faults and improve the protection of installations.

Such devices have been deployed successfully in the United States since the early 2000s, and their installation is required by the National Electric Code. Since 2013, AFDDs have been covered by the IEC 62606 international standard.

### Schneider Electric's Solution: Acti 9

Speed is of the essence as an electrical arc can degrade in a flash (literally), igniting any nearby flammable material and causing a fire. According to IEC 62606, AFDDs should react quickly in case of arc faults and isolate the circuit within a limited time (see Figure 3.4). These electric arcs are not detected by residual current devices nor by circuit breakers or fuses.



Figure 3.4. Schneider Electric Acti 9 IARC AFDD

### Installation of arc fault detection devices

Arc fault detection devices (see Figure 3.5) are designed to limit fire risks caused by the presence of arc fault currents in the final circuits of a fixed installation. They are installed in electrical switchboards to protect circuits supplying power sockets and lighting and are especially recommended for renovations.

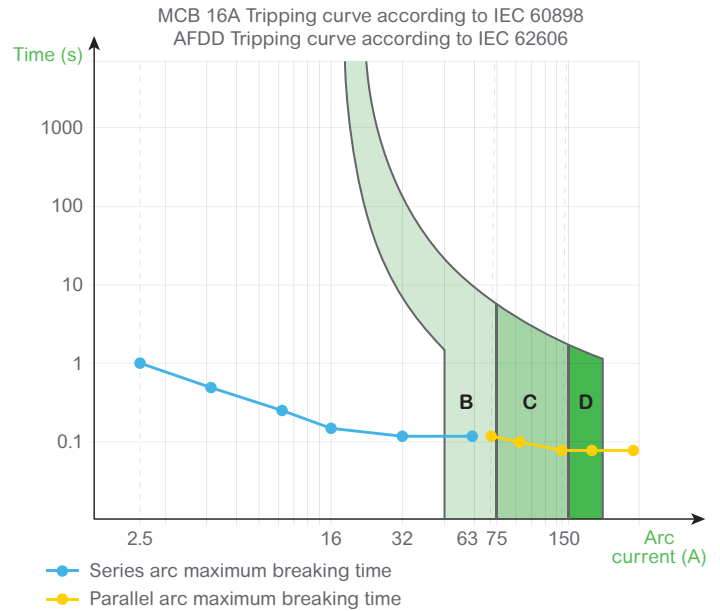


Figure 3.5. MCB 16A Tripping curve according to IEC 60898  
AFDD Tripping curve according to IEC 62606

Since 2014, International Standard IEC 60364 - Electrical installations of buildings - Part 4-42 makes the following recommendations surrounding the installation and application environments of AFDDs in residential and commercial buildings:

- In locations with sleeping accommodation (e.g., hotels, nursing homes, bedrooms in homes)
- In locations with risk of fire due to high quantities of flammable materials (e.g., barns, wood-working shops, stores containing combustible materials)
- In locations with combustible construction materials (e.g., wooden buildings)
- In fire-propagating structures (e.g., high-rise buildings)
- In locations where irreplaceable goods are housed (e.g., museums)

It is recommended that AFDDs be installed at the place of origin of the low voltage final circuit to be protected (i.e., switchboard of an electrical installation).

### 03 FINAL DISTRIBUTION BOARDS AND CIRCUITS

More specifically, the installation of an AFDD is highly recommended to protect circuits with the highest risk of fire, such as:

- Protruding cables (risk of knocks)
- Outside cables (greater risk of deterioration)
- Unprotected cables in secluded areas (like storage rooms)
- Aging, deteriorating wiring or wiring for which the connection boxes are inaccessible

#### Additional Resources:

- To find out more about arc fault detection devices, download the white paper [How Arc Fault Detection Devices Minimize Electrical Fire Threats.](#)

---

Speed is of the essence as an electrical arc can degrade in a flash (literally), igniting any nearby flammable material and causing a fire.

---



# Power connection issues

The sheer number of switches, sockets and other devices raises the risks of poor connections in final distribution systems. Tool-free solutions reduce the potential for error.

In final distribution, the number of circuits and connections in the circuits (switches, sockets, etc.) can be very high. As a result, the risk of connection issues is extremely high. Spring and screwless solutions help to reduce the probability of incorrect installations and ensure better connections over time.

## Schneider Electric's Solutions: Linergy and Unica



Figure 3.6. Example of wiring accessories Linergy DX distribution block for final distribution



Figure 3.7. Example of screwless terminals for switch from Unica

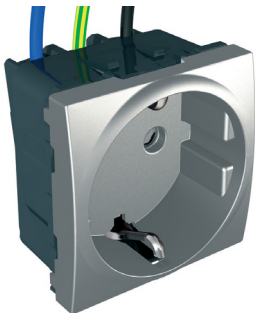


Figure 3.8. Example of screwless terminals, image from the front-socket outlet from Unica

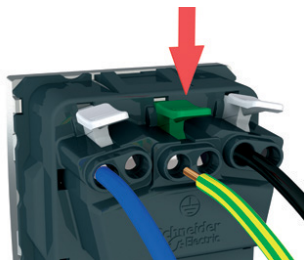


Figure 3.9. Example of screwless terminals, image from back-socket outlet from Unica



04

---

Summary

## How to improve your installation depending on earthing system

Earthing system	Standard protection	Added devices to increase fire protection	+	Switchboard fire protection  IEC 61439 + HeatTag + Linergy + Continuous Thermal Monitoring
TT power circuits	CB + RCD			
TT final circuits	CB + RCD	+ AFDD		
TN power circuits	CB	+ RCD (or GFP)		
TN final circuits	CB	+ RCD + AFDD		
IT power circuits	CB + IMD	+ RCD		
IT final circuits	CB + IMD	+ RCD + AFDD		

<b>Figure 4.1.</b>	AFDD : Arc Fault Detection Device
CB : Circuit Breaker (including motor starter)	GFP : Ground Fault Protection
RCD : Residual Current Device	IMD : Insulation Monitoring Device

## Key points to consider for specification of electrical fire prevention

In addition to compliancy to installation rules for overload, short circuit, overvoltage protection, for an improved mitigation of fire risk for electrical installations:	Existing installation	New installation or large retrofit
Select IEC 61439 compliant switchboard.		X
Select manufacturer's distribution and connection accessories inside switchboard and machine control panel.		X
Select devices when available, with terminals ensuring quality of contact (according to the range of current).		X
Perform maintenance according to manufacturer recommendation on circuit breakers and switchboard.	X	X
Install 300mA RCD on distribution circuits where particular risk of fire exists or where consequences of fire are unacceptable. RCD must comply with IEC/EN 61009-1, IEC/EN 60947-2 Annex B or Annex M, IEC 61008 or where RCD is not possible to install consider GFP.	X <sup>1</sup>	X
Install earth leakage monitoring system where continuity of supply is prioritized before fire risk.	X <sup>1</sup>	X
Install AFDD protection compliant to IEC 62606 in final circuits where particular risk of fire exists or where consequences of fire are unacceptable.	X <sup>1</sup>	X
Select busway compliant with IEC 61439-6 instead of cables where particular risk of fire exists or where consequences of fire are unacceptable.		X
Forbid selection of derivation boxes and select busway with tap off unit with IEC 61439-6 for distributed load along a circuit.		X
Install early detection of abnormal temperature rise in switchboard based on gas and particles emitted by conductor insulation material.	X	X
Install continuous thermal monitoring system on switchboard.	X	X

**Figure 4.2.** <sup>1</sup> ComPact NSX with MicroLogic Vigi 4.\* or 7.\* or MicroLogic 6.\* have the same footprint as a previous generation ComPact NS. They can be used easily in a retrofit of MCCB installed numerous years ago. Vigirex range offers openable toroid that allows installation on existing installation as well.



## Overview of electrical fire prevention devices

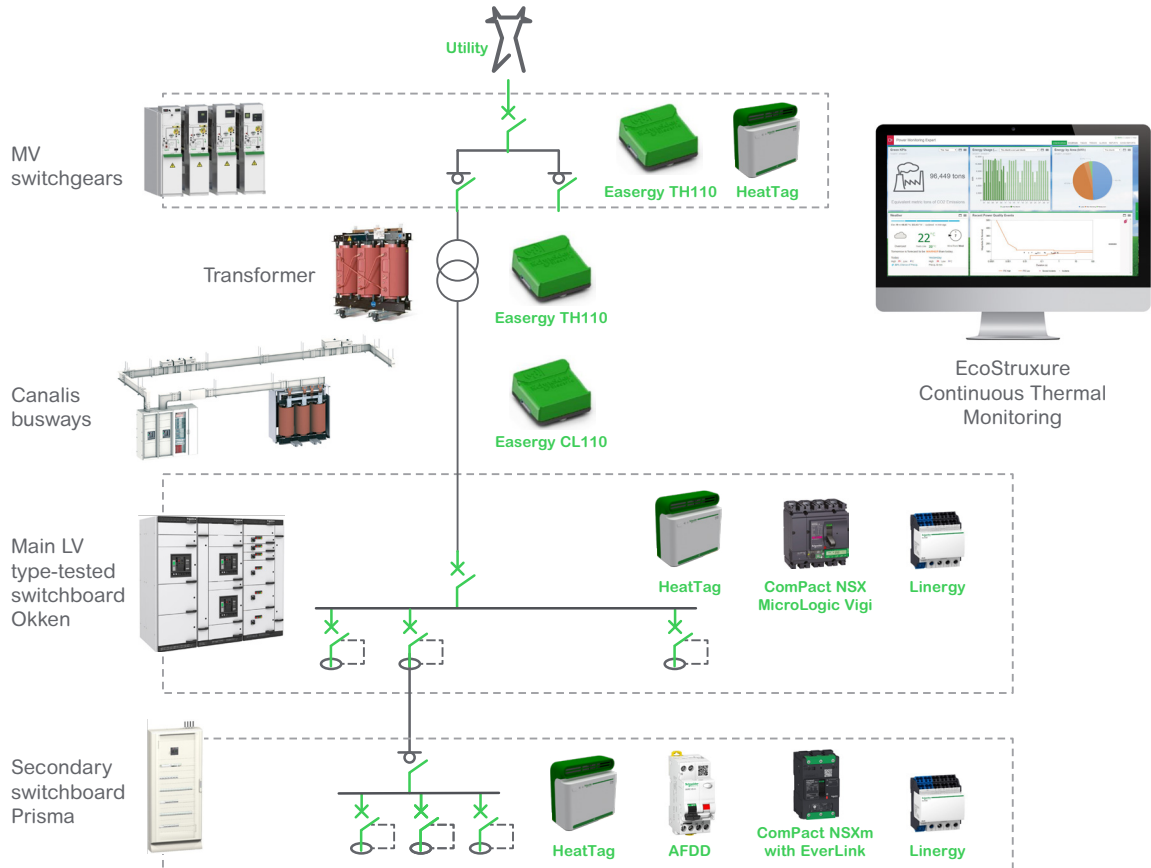


Figure 4.3. Overview of products

# Resources

## Forum

- Continue the discussion on Electrical Fire Prevention. This Community is aimed to support Power Distribution Professionals, involved in design or implementation of Power Distribution.

## White papers

- How to ensure a secure, long-lasting power connection for your electrical installation
- How thermal monitoring reduces risk of fire more effectively than IR thermography
- How Arc Fault Detection Devices Minimize Electrical Fire Threats
- Why to choose Type B earth leakage protection for safe and efficient people protection

## eGuide

- EcoStruxure Power Digital Design Guide

## Blogs

- Electical Fire Prevention blogs

## Wiki

- Electrical Installation Guide

[schneider-electric.com/fire-prevention](https://schneider-electric.com/fire-prevention)

Life Is On

**Schneider**  
Electric

Schneider Electric Industries SAS  
35, rue Joseph Monier - CS 30323  
F92506 Rueil-Malmaison Cedex