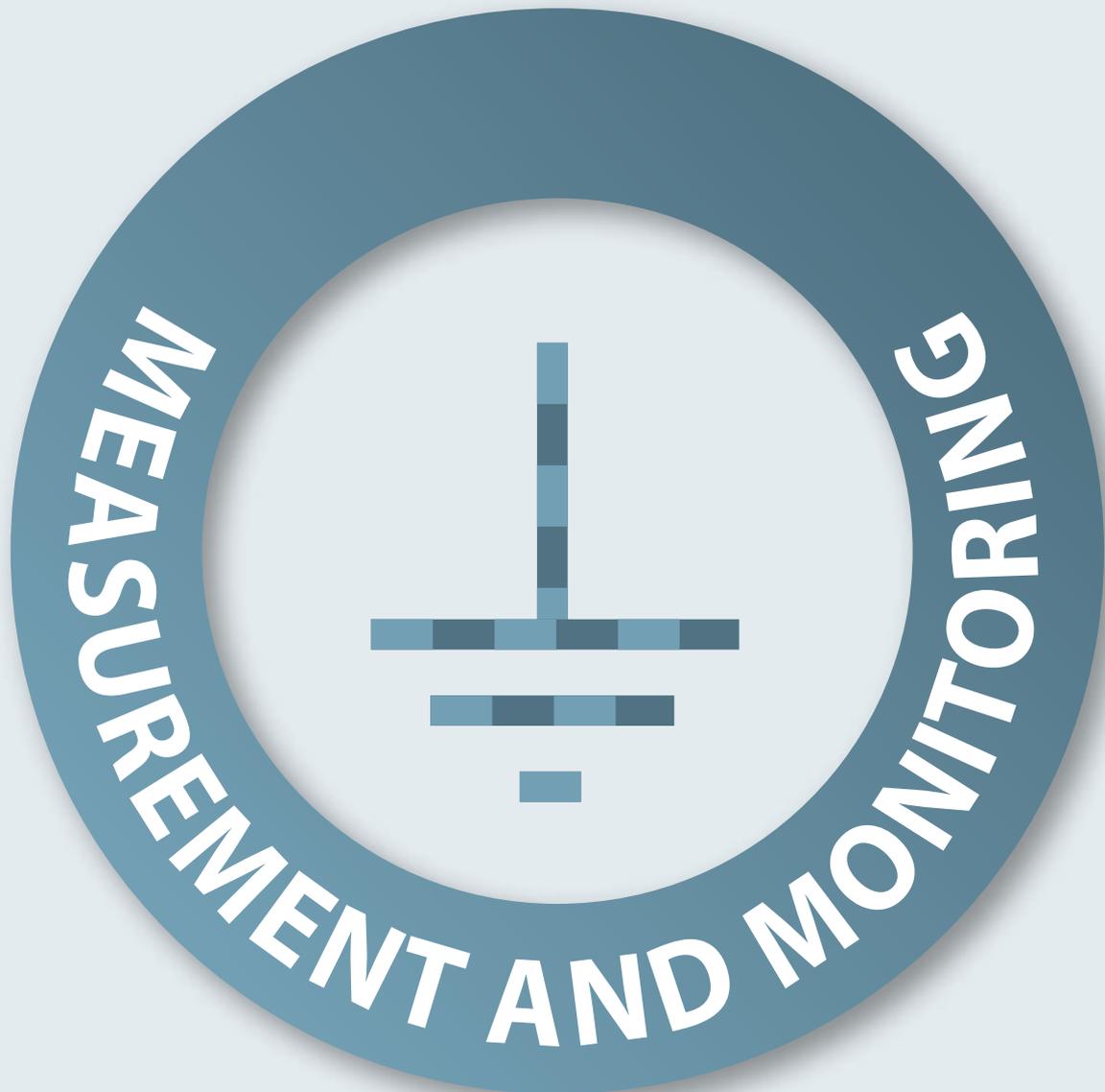


Take control of your insulation with unearthed IT systems

Energy Efficiency



About the author



Pierre-Henri Herr has spent the major part of his working life in industry, in the design and commercialisation of electrical equipment including digital storage oscilloscopes, motors and multifunction meters. He is an active member of international technical committees IEC TC 13, IEC TC 38 and IEC TC 85 for which he is the project leader of the WG20 working group in charge of drafting standard IEC 61557-12 on Power Metering and Monitoring Devices (PMD). He also participates in cross-discipline working groups on energy efficiency dealing with defining the metering plan or power quality of electrical installations.

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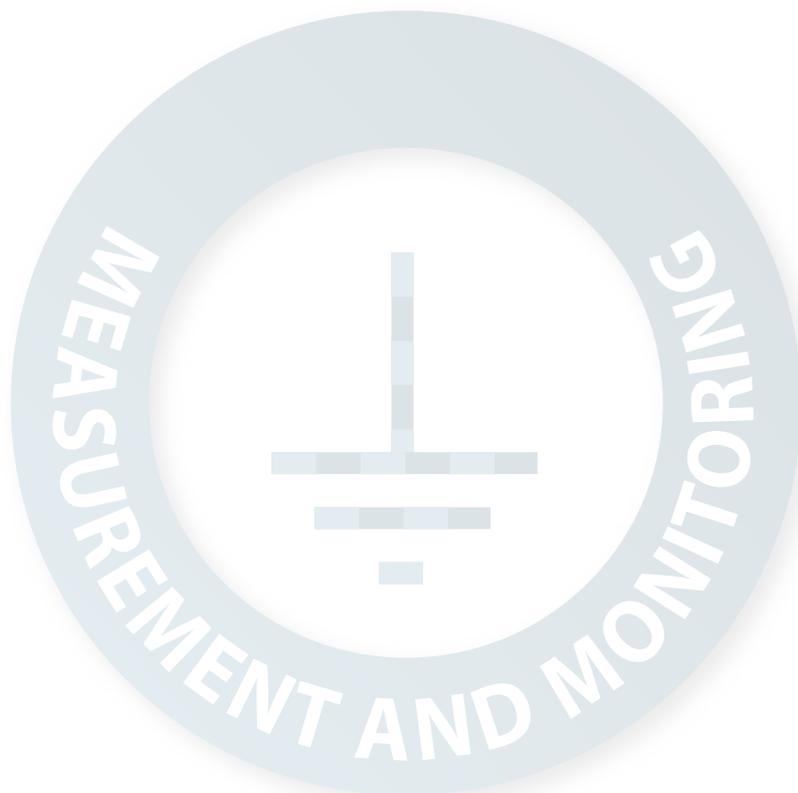
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A.

IT system: availability at the service of performance



Introduction: the major challenge facing electrical installations

Electricity has become omnipresent and an essential element of our daily lives at home, in the workplace or transportation. It has significantly improved the living conditions for billions of people.

The sustainability of a company's activity is a triple challenge: **ensuring the economic development of the business in a positive social context and a viable environmental context.**

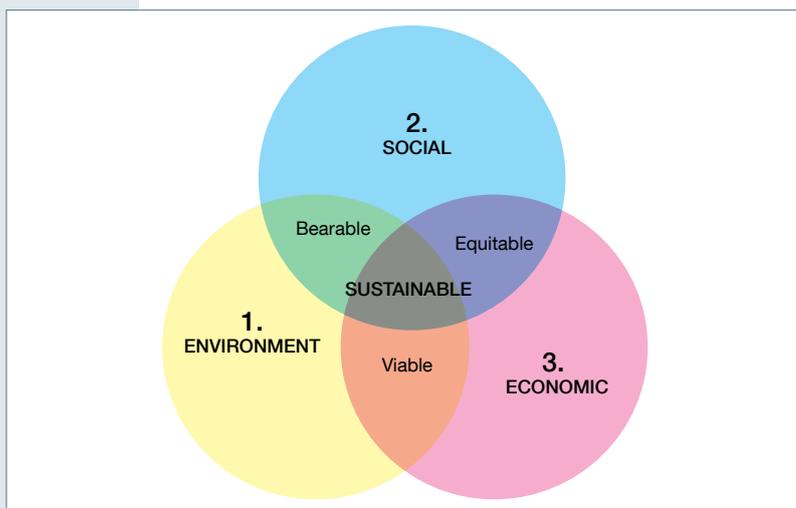


Fig. 1 - Venn diagram: sustainability challenge for companies.

1. Environment

The planet is in danger and the ecology now has to be at the core of the design of installations and the various operating methods.

2. Social

The social factor is equally important. The comfort, safety of people and assets are now prerequisites for modern companies where risks are assessed, analysed and managed.

3. Economic

Designers are also facing increasingly complex processes which require efficient electrical installations to ensure their profitability.

The incredible progress made in digital technologies (miniaturisation, calculation power, rapid and robust communication) must enable virtuous procedures and policies to be put in place, aiming at achieving this sustainability.

Electrical installations are particularly concerned by this challenge. Design engineers, installers and operators are required to design, operate and maintain electrical installations which meet the sustainability requirements of the business.



Implementing virtuous procedures and policies for sustainability

Towards high-performance electrical installations

High-performance electrical installations are needed in order to reach the sustainability objective of the associated business.

They hence need to be distributed efficiently, facilitating access to monitoring consumption per usage, electrical load or zone, while enabling to control certain groups of loads.

High-performance electrical installations must be secure and available. The ideal installation does not put lives at risk, does not shut down in the event of an insulation fault on one of its distribution circuits and does not stop working in the event of a loss of power supply.

High-performance electrical installations ensure the supply of high-quality electrical power. They control the quality of the energy they distribute and alert in the event of a deviation which could lead to operating losses or impact the conditions of consumers and components of their system.

Finally, high-performance electrical installations have an extended lifetime thanks to properly adapted service and maintenance. In the long term, their operating costs are reduced, while ensuring the previous points.

Efficiency

Safety and availability

High-quality electrical energy

Extended lifetime



Based on **ISO 50001 Energy management systems**, the **IEC 60364-8-1** standard: **Energy efficiency of electrical installations** covers areas mentioned above. It is organised into 4 chapters:

- recommendations for the design of the installation,
- determining zones, usages and meshes,
- developing a system for managing energy efficiency and loads,
- maintenance and enhancement of the performance of the installation.

The performance of electrical installations is evaluated based on the levels of **safety, availability, quality and efficiency** it is capable of providing.

The IT system, by providing continuity of service in the event of a first insulation fault fully contributes to this performance.



Consumption analysis

Monitoring system

From analysing consumption to monitoring the installation

Understanding the different types of consumption is essential in order to optimise the use of electrical energy. The implementation of measuring devices is a prerequisite for achieving this objective. New electrical installations are now equipped to monitor consumption by usage, zone or electrical load.

Improving the safety and availability of electrical installations also encourages designers and users to utilise monitoring systems capable of assessing the actual health of the electrical distribution network and the behaviours of the main equipment.



The **IEC 61557-12 standard** specifies requirements on PMD (Power Metering & Monitoring Devices) designed for **metering and monitoring the reliability and the quality** of electrical energy. It ensures:

- the availability of all necessary electrical parameters for monitoring an electrical installation,
- reliable and accurate measurements in the installation environment,
- products which are safe for the user.

New measuring and monitoring instruments open up perspectives for dynamic control of the installation and active management of assets and equipment. This development applies to monitoring devices associated with the IT system.

Changing requirements

From curative to predictive

Improving the real performance of an installation requires monitoring.

This monitoring is able to identify the emergence of a feared event before the occurrence of an accident, an insulation fault or energy wastage. This way, operators have the opportunity to move from a curative action mode to a predictive action mode.

Predicting the behaviour of the electrical installation therefore provides:

- an improved control: awareness and anticipation of operating deviations help put appropriate actions in place,
- a reduction in losses: reduced financial losses due to stopping a production line, damaging equipment or reduced energy losses due to unjustified consumption.

In the following example, for a production site, the **power prediction** exceeds the subscribed power threshold (500 kW). To anticipate this risk of overconsumption leading to financial penalties, the user may implement some load shedding in parts of its electrical installation or start up a genset to provide the surplus power required.



The benefits of prediction

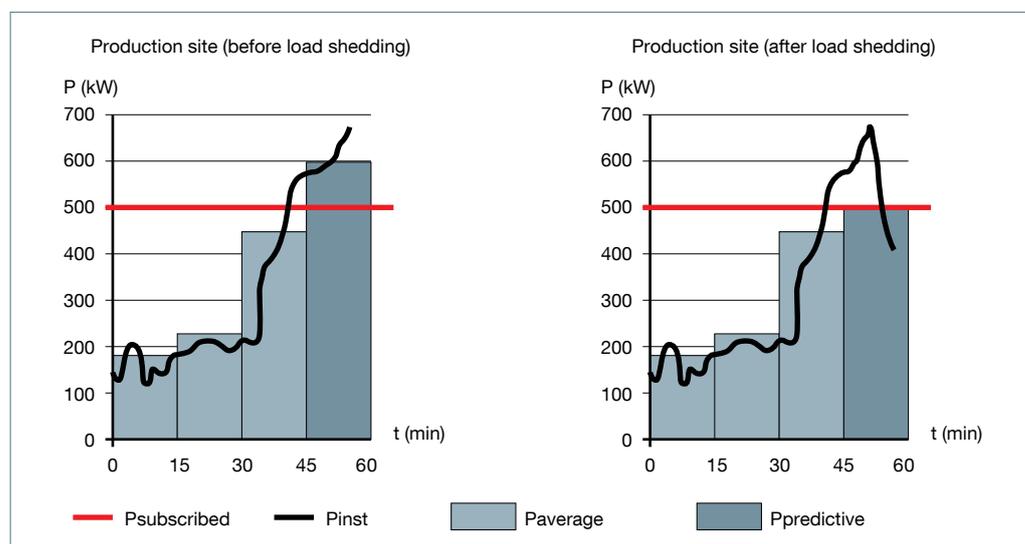


Fig. 2 - Anticipating overconsumption by calculating predictive power: calculating predictive power enables load shedding actions to be managed.



Predicting an overconsumption or a failure on an electrical distribution network requires **the monitoring of multiple parameters**.

Thanks to a predictive action mode, the Facility Manager can schedule **a timely intervention** by maintenance teams, limit the number of faults and extend **the lifetime of the installation**.

Impacts of the earthing system on performance

Insulation faults



Insulation faults represent approximately 80 % of origins behind tripping protective devices, all earthing system types included

Type and origin

Insulation faults are created by impedance drops between one or more live conductors and the exposed-conductive-parts. These anomalies arise in particular during the lifetime of the installation when it is subject to unforeseen mechanical events (damaged insulators, broken connections) and environmental events (humidity, corrosion due to salt sprays).

They generate abnormal current flows and voltages making the installation potentially hazardous. In addition to electrical safety, the availability of the supply may be jeopardised.

The electrical installation must be protected against these insulation faults by installing measuring, monitoring and protective devices.

Regulatory and standard obligations

The usual installation standards associated with low-voltage distribution (IEC 60364 series) cover insulation faults by implementing a series of actions designed to:

- prevent,
- locate,
- and eliminate them.

These actions are made possible by implementing the right earthing system and the adapted protection systems.

Effects and consequences

The effects of insulation faults are multiple:

- stray currents,
- magnetic effects, electro corrosion,
- transient, temporary overvoltages,
- overcurrents.

They may cause malfunction, damage or render equipment hazardous.

These effects therefore have a direct impact on the availability of the electrical supply and the safety of assets and individuals.

Common location

The location and occurrence of insulation faults are directly associated with the architecture of the electrical installation. Most insulation faults appear on terminal circuits, due to their natural exposure to mechanical or environmental constraints.

These faults may also appear on busbar trunking and head equipment commonly located towards the main low voltage distribution board.

Availability and safety of the electrical power supply

The proper functioning of the electrical installation depends on the condition of the cables and equipment distributing electrical power.

Availability may be improved by:

- using equipment such as Automatic Transfer Switches (ATS) and Uninterruptible Power Supplies (UPS) to compensate for the loss of the power supply,
- the redundancy of the electrical distribution to prevent any failure in the event of an insulation fault on one of the supply circuits,
- the use of an unearthed IT system.

How the earthing system can help prevent insulation faults

The three main earthing system types are taken into account by the electrical installation standard IEC 60364 series covering insulation faults.

1st letter Position of neutral on the supply transformer in relation to the Earth	Neutral connected to Earth Neutral insulated from Earth	T* I
2nd letter Connection of equipment's exposed conductive parts	Exposed conductive parts connected to Earth Exposed conductive parts connected to Neutral	T N

Table 1 - Earthing system symbols.

* Historically, "T" from the French word "Terre" = Earth.

TT system

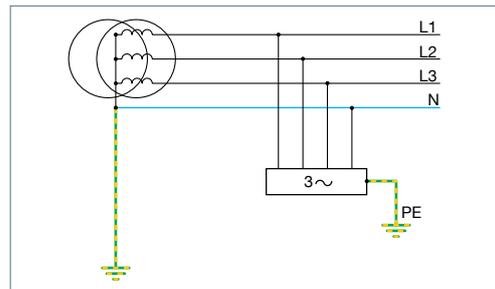


Fig. 3 - TT system.

In the TT earthing system, the transformer neutral is directly connected to earth. The exposed-conductive-parts of the electrical installation are connected to earth electrodes which are electrically independent of that of the transformer. In the event of an insulation fault, there is an automatic shutdown of all or part of the supply of all loads. The shutdown is mandatory from the first fault. A residual current device (RCD) must be positioned at least at the origin of the installation. The TT system is mainly found in residential and small businesses.

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TN system

In the TN earthing system, the transformer neutral is directly connected to earth. The exposed-conductive-parts of the electrical installation are connected to the protective conductor distributed throughout the installation. The neutral conductor (N) and protective conductor (PE) can be combined (TN-C) or separated (TN-S). A clean insulation fault leads to a short-circuit: the overcurrent protective devices protect the installation. Residual Current Devices (RCD) are also used in TN-S. Thanks to a more cost efficient implementation than TT or TN-S systems, the TN-C system is frequently found on industrial sites.

• TN-C system

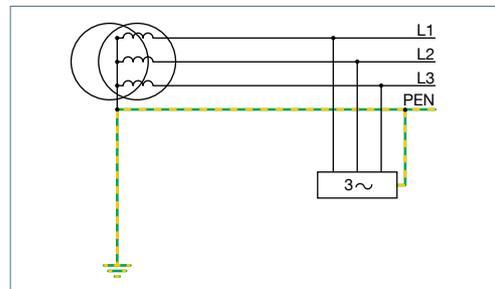


Fig. 4 - TN-C system.

The neutral conductor (N) and protective conductor (PE) are combined. The resulting PEN conductor (Protective and Neutral) must never be disconnected.

• TN-S system

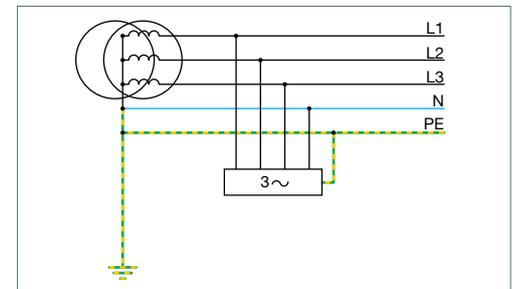


Fig. 5 - TN-S system.

The neutral conductor (N) and protective conductor (PE) are separated. A TN-S network may be created downstream of a TN-C network. The reverse is prohibited.

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IT system

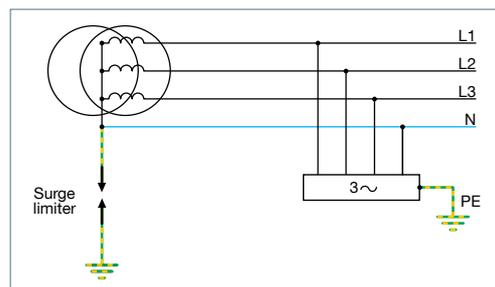


Fig. 6 - IT system.

In the IT system, in contrast with other systems, the neutral of the transformer is not connected to earth or voluntarily connected via a high-value impedance (usually 1500 Ω). The exposed-conductive-parts of the electrical installation are earthed, electrically distinct from that of the transformer.

The IT system is adapted for installations where continuity of service is essential.

WP 248 A GB



For residential and small businesses



For buildings and industrial sites



For the applications requiring continuity of service

Opting for an IT system: a logical step for many installations

Installations with IT systems

The IT system is used in areas where continuity of service is essential:

- hospital operating rooms: so as not to jeopardise surgery,
- emergency lighting, smoke clearing circuit: to prioritise the safety of individuals,
- industrial process: so as not to interrupt a production line,
- public reception area: to protect visitors from a power outage (shopping centres, airport terminal etc.),
- refrigerated rooms: so as not to affect the conservation of perishable food.

It is also present on sites with a high risk of fire or explosion.

- mines, quarries, oil rigs,
- shipbuilding,
- nuclear power plants,
- photovoltaic fields,
- ATEX sites.

IT system operation

This earthing system is used when the outage associated with an insulation fault impacts operations or the safety of individuals.

During the first fault, the current flows through the leakage capacitances of the installation and possibly through the impedance inserted between neutral and earth. This current will be low enough so as not to cause a hazardous contact voltage (50 V on the AC network). The first fault does not create dangerous overcurrent for the installation and does not constitute a hazard for the operator.

This way, the installation may continue to operate and ensure continuity of service. The defective circuit must be identified and repaired to prevent a second fault.

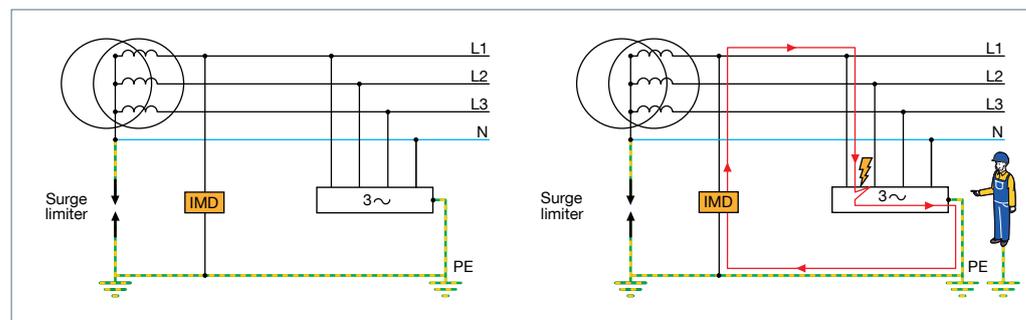


Fig. 7 - Occurrence of a first fault.

The use of an Insulation Monitoring Device (IMD) is mandatory in order to alert of the presence of the first insulation fault. It must emit an audible or visual alarm.

Locating and eliminating the first insulation fault is also mandatory. In order to meet this regulatory requirement, permanently installed or portable Insulation Fault Locators (IFL) provide an appropriate solution for the methods to be implemented to rapidly locate the first faults and to eliminate them.

It is then necessary for installations to be equipped with an effective Insulation Fault Location System (IFLS) that is adapted to the type and size of installation and that can rapidly and accurately locate the insulation fault.

The second fault corresponds to the connection of another active conductor on a piece of equipment with an exposed-conductive-parts to earth. The occurrence of a second fault causes a short-circuit between phases leading to an outage by the overcurrent protective devices.



A first insulation fault corresponds to the total or partial involuntary connection of an active conductor on a piece of equipment with an exposed-conductive-parts to earth.

Insulation monitoring in an IT system and leakage capacitances

The leakage capacitances inherent to each installation participate in the insulation impedance of the network. The IMD must take into account these leakage capacitances so as not to interpret them as insulation faults.

Origin of leakage capacitances

The type, length and method for installing electrical cabling naturally impact the value of the leakage capacitance between active conductors and earth. These leakage capacitances are the origin of current flow between active conductors and earth.

For example, several dozen km of cables - equivalent to the length of the average industrial infrastructure - generate leakage capacitances of several μF .

In addition, the presence of decoupling capacitors in converters (RFI filters, switching power supplies etc.) naturally generate greater earth leakage currents. To that end, variable speed drives manufacturers generally recommend disabling EMC filters which may have a direct impact on the performance of non-adapted IMD and IFL. Today's measurement technologies on board the IMD/IFL are able to manage these phenomena, significantly limiting the impact of these disturbances on the insulation measurement.

Typical values per application

The scope of the installation and the type of connected loads play a major role in the presence of leakage capacitances. This way, an installation powering electrical sockets for electro medical devices as used in operating rooms will not exceed several μF .

Railway infrastructure, despite being highly extended, often power linear loads of the same type and with few EMC filters (signalling, points control), with leakage capacitance levels which are actually relatively low.

On the other hand, multiple loads (linear, non-linear, for example equipment power electronics) commonly found in industrial installations, generate high leakage capacitance levels. Extreme values are found in ships and high-power photovoltaic plants (approximately $1\mu\text{F}$ per MW).

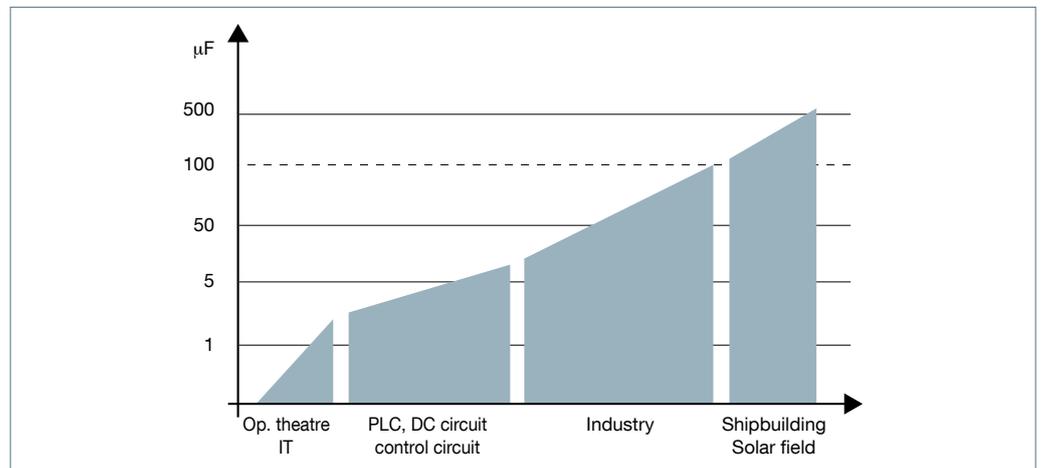


Fig. 8 - Typical leakage capacitance value per application.

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IMD:
Insulation Monitoring
Device

IMD measuring methods

The measuring method of the IMD must be selected based on the type of circuits to monitor:

- those which apply a DC measuring voltage on AC installations only,
- those which apply an AC measuring voltage on AC and DC installations.

Some IMDs are equipped with an adjustable or self-adjusting variable frequency measuring process. These devices enable the monitoring of all installations and in particular those with equipment (variable speed drives or any other power-based electronics supply equipment) generating frequencies which may disturb the IMD's measurement signals. The frequency of the measurement signal also needs to be adapted to the installation's level of leakage capacitance.

Generally speaking, variable frequency measurement technology is suitable for:

- networks with high leakage capacitance,
- disturbed industrial networks,
- networks comprising electronic equipment including variable speed drives,
- DC circuits.

Benefits of the IT system

Installations using an IT system electrical distribution thus have **several benefits**.

#1 Availability of electrical distribution

The IT system is the only choice that can prevent the interruption of power supply in case of a first insulation fault. This is the best solution to ensure maximum availability level for the electrical distribution.

#2 Safety of individuals

Similarly, this is the solution to reach an optimum level of safety by drastically limiting the earth fault currents in the event of an insulation fault and direct contacts with bare live parts.

#3 Low risk of fire and explosion

With a very low fault current (several dozen mA to several A), there is little risk of fire or explosion due to overheating or electric arc caused by an insulation fault.

#4 Safety of assets

In an IT system, and contrary to TT and TN systems, the fault current generated during a first insulation fault remains very low and does not risk damaging the loads or reducing their lifetime. This contributes to avoiding high costs and delays associated with potential repairs encountered with other earthing systems.

#5 Predictive maintenance

An Insulation Monitoring Device (IMD) is mandatory in unearthed IT systems. It measures the insulation resistance and monitors any degradation. It will therefore be possible to intervene even before the first fault occurs.



Conclusion

The unearthed IT system appears to be an obvious choice for designers and operators seeking performance not only for highly demanding installations (essential continuity of service or fire risk etc) presented in this chapter, but also for any type of installation requiring availability in their electrical distribution.

Indeed, the availability of the installation which is an inherent component of the IT system, has a direct impact:

- on the operational, economic or technical performance on the operating sites,
- on the safety of installations. In the event of an accident, this involves looking for responsibilities and potential legal proceedings taken against management.

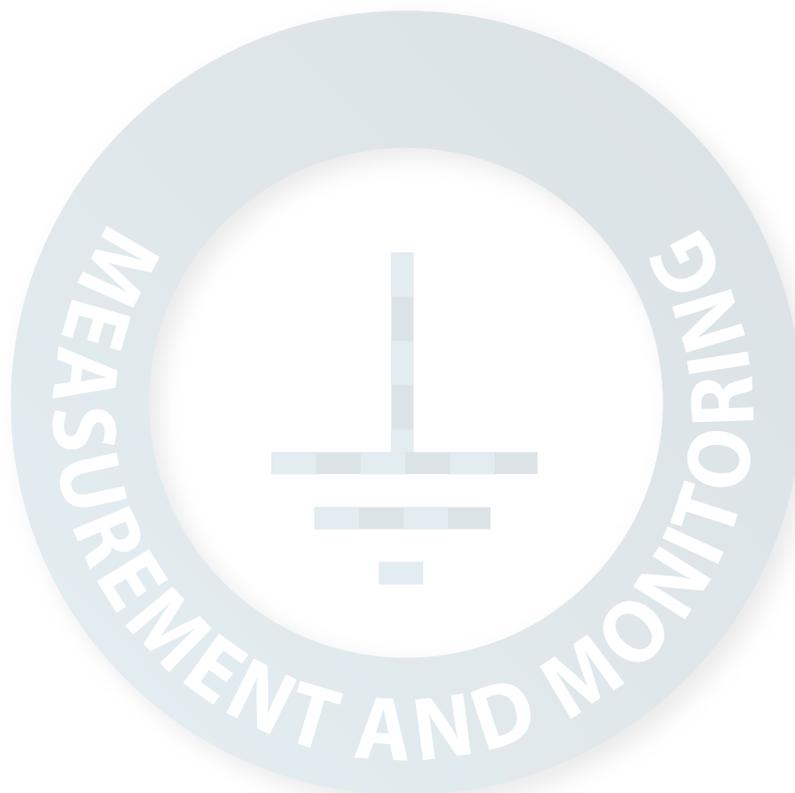
This way, implementing an IT system **reconciles installation performance, availability and safety** of the distribution.

However, an **effective Insulation Fault Location System** is required. It should be sufficiently user-friendly **to rapidly locate the first fault** within the installation and to eliminate it.

B.

ISOM Digiware:

combining power and
insulation monitoring



Socomec technology helping users

Socomec innovation



This is an innovative solution addressing the five benefits of the IT system (see page 13) while developing a new function specific to Socomec: global monitoring.

Selecting an IT system means giving priority to continuity of service and keeping control of the electrical network and its insulation to the earth. Your electrical installation will be stable and more reliable.

Socomec has chosen to support companies by developing a system which efficiently utilises the benefits of the IT system (#1 to #4) and particularly the **predictive maintenance (#5)**.

As explained in the introduction and chapter 1, developing the monitoring of supply circuits leads to more detailed measurement of loads in order to improve the performance of the installation. Insulation monitoring may easily be combined in order to carry out a complete predictive maintenance of the installation.

Global monitoring can therefore improve and maintain the quality of a company's electrical installation to ensure its availability and safety. To do so, the measurement of electrical parameters should be implemented to characterise:

- the loads and their distribution within the installation.

But also to detect:

- deviations,
- variations in voltage,
- the appearance of unbalances,
- the presence of harmonics,
- insulation faults.

By monitoring changes in these parameters, it is possible to anticipate or detect a deterioration in equipment over time as well as the risk of a process being interrupted. It ensures optimum use of the equipment, continuity of service and performance of the installation.



Global monitoring = supply circuits monitoring + insulation monitoring for a **predictive action mode**.

ISOM Digiware, leading innovative and customisable 2 in 1 solution system for insulation and power monitoring

Socomec proposes the DIRIS Digiware measurement system, the most effective solution for metering, measuring and monitoring the performance of the electrical installation on any industrial or commercial facility. It provides genuine operational flexibility combined with simple connection and configuration.

Socomec goes one step further by presenting the first system to combine the benefits of the Digiware measurement system with insulation monitoring in unearthed IT systems : **ISOM Digiware**.

Benefits of the system

2 in 1

2 in 1: combination of the measurement of electrical parameters and insulation values.



Rapid measurement of insulation faults: self-adjusting variable frequency measurement procedure reducing measurement time in the presence of a high leakage capacitance level. Fault location is carried out simultaneously on all monitored circuits.



Customisable & upgradable system: adapts to the electrical installation configuration and anticipates its evolutions.



Easy integration and configuration: Plug & Play.



Complete insulation mapping of the installation and electrical distribution thanks to OhmScanner, enabling a detailed analysis of the insulation on multiple circuits.

ISOM Digiware comprises the following elements

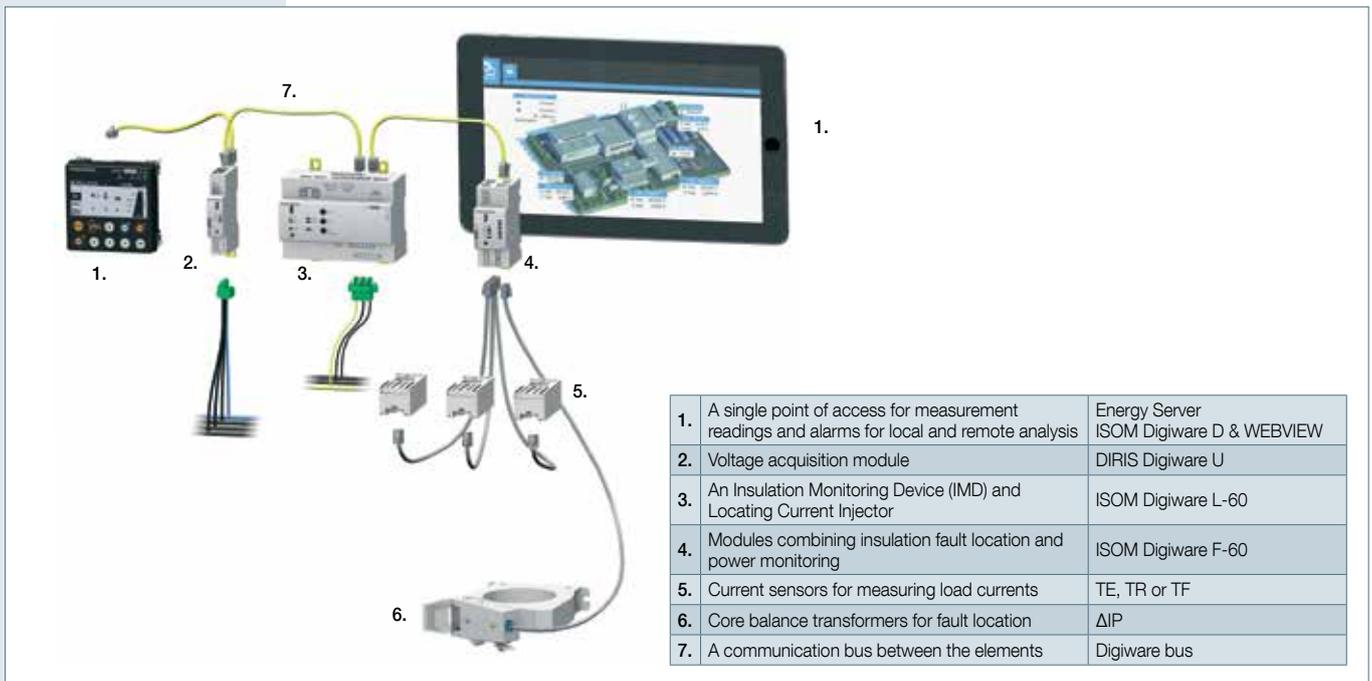


Fig. 9 - Example of ISOM Digiware configuration.

The ISOM Digiware complies with product standards:

- Power Metering and Monitoring Devices for measuring performance in installations IEC 61557-12,
- Insulation Monitoring Devices IEC 61557-8,
- Insulation Fault Locators IEC 61557-9.



ISOM Digiware is the leading insulation fault location system with integrated power monitoring function in order to combine (thanks to global monitoring):

- safety,
- availability,
- installation performance.

ISOM Digiware provides a full insulation mapping with the OhmScanner technology

An electrical installation with an IT earthing system is characterised by a global insulation impedance in Ohm, comprising:

- a capacitive part, linked with leakage capacitances of the electrical distribution including its components,
- a resistive part, representing insulation faults.



The complete mapping of insulation with OhmScanner support the identification of early insulation faults

OhmScanner maps the installation's insulation thanks to various elements:

- the ISOM Digiware L-60 IMD is able to accurately evaluate the insulation levels by distinguishing the capacitive and resistive parts of global impedance,
- the ISOM Digiware F-60 modules are distributed throughout the installation close to the loads to measure the insulation and locate faults. They monitor the insulation of individual circuits over time to prevent any degradation (Fig. 11),
- load current is measured using current sensors associated with the ISOM Digiware F-60. Synchronisation via the Digiware bus with voltage measurement by the DIRIS Digiware U module enables the calculation of other electrical parameters (power, harmonics, unbalance, power factor, dips or swells).

This way, a global mapping of the health of the installation is completed based on all measurements of insulation levels and electrical parameters closer to the loads.

The simultaneous recording over time of insulation and electrical parameters (voltage, current etc) on the WEBVIEW web server helps correlate the measurements and deviations to identify the origin of the faults (e.g. by superposing the load current over the insulation resistance).

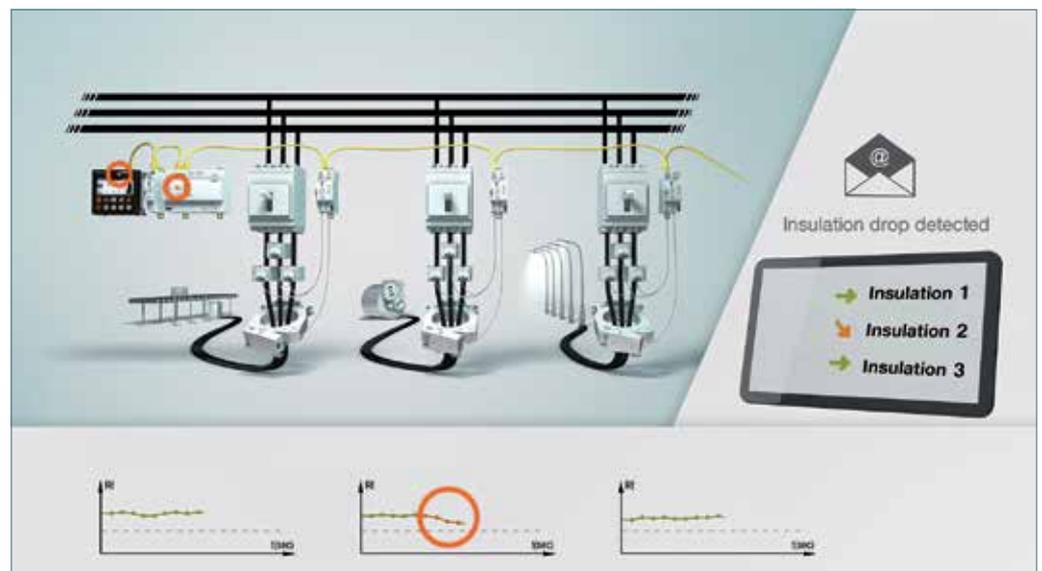


Fig. 10 - Monitoring the evolution of the insulation impedance of each outgoing circuit.

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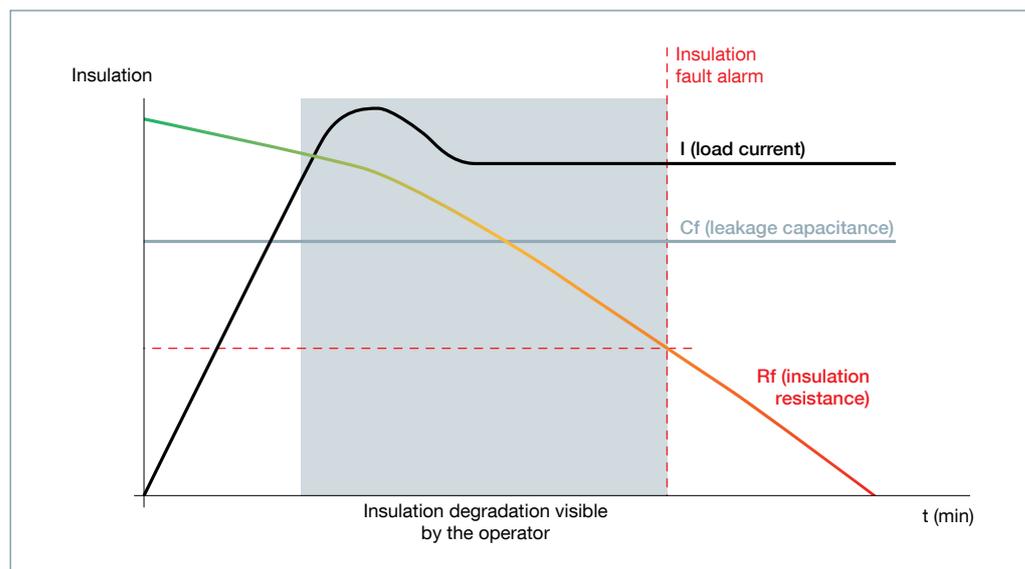


Fig. 11 - Focus on the circuit presenting insulation degradation.

In this example, monitoring the insulation resistance in the IT system helps anticipate the occurrence of a fault: insulation resistance degradation is visible and is correlated with the variation in the load current. Without intervention of the operator, an installation fault alarm will be issued above a certain threshold set based on the characteristics of the installation.



OhmScanner technology key elements

OhmScanner offers operators a snapshot of the global insulation of the installation and of each circuit, including its evolution over time.

The **simultaneous measurement of insulation parameters and other electrical parameters of the distribution** favours the identification of correlations and the understanding of the origin of degradations or faults.

The OhmScanner technology supports a predictive mode of action which enables considerable savings in cost and time.

It perfectly meets benefit #5: **Predictive maintenance.**

Easy and rapid fault location in terminal circuits with **ISOM FP-60**



Fig. 12 - ISOM FP-60 Portable Insulation Fault Locator.

The portable insulation fault locator is used by operators to identify which terminal circuit is concerned after the occurrence of an insulation fault.

The use of efficient portable equipment such as ISOM FP-60 enables you to distinguish between resistive faults and leakage capacitance part of the installation. It helps maintenance teams rapidly identify the fault and implement immediate corrective actions.



A high-performance electrical installation in the IT system requires continuous monitoring of insulation and immediate fault elimination

The virtuous circle of performance

The following procedure is recommended for the maintenance of a high-performance system.

- 1 With ISOM Digiware F-60 & L-60, a continuous monitoring of mapped insulation closer to the loads helps anticipate a degradation.
- 2 Other electrical parameters are measured using DIRIS Digiware U modules and ISOM Digiware F-60 modules.
- 3 The correlation with continuous measurement of other electrical parameters of the installation is done using WEBVIEW.

This three-step approach helps understand the origin of a degradation and its location **4**.

- 5 Elimination of faults.

By this predictive approach, the operator benefits from a healthy and permanently maintained installation, at the desired level of insulation.



Fig. 13 - Predictive approach to maintain a high-performance insulation.

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Socomec services

Our Socomec experts support you with your safety strategy and in controlling your unearthed IT system's availability.

Audit

Audit: experts support you in inspecting your installation and detecting insulation faults.

Commissioning

Commissioning: experts also check the settings, wiring and the proper operation of the devices. A fault detection campaign can also be run to enable very rapid operation of the system, therefore ensuring optimum service continuity.

Assistance

Assistance: remote operation assistance or on-site intervention are available.

Training

Training: different training packages are available to discover the special features of the various earthing systems. Customised support and periodic training for maintenance teams also available.

Conclusion

How does *ISOM Digiware* facilitate implementing insulation monitoring and access to measurement ?

- **Easy and customisable:** Digiware is an easy-to-install solution thanks to the Plug & Play system facilitating connection between modules by Digiware bus. The current sensors and locating core balance transformers are connected and recognised thanks to an RJ12 connection. In addition, the solution can be customised depending on the development of the installation and business needs.
- **High-performance:** ISOM Digiware, a modular combination of an Insulation Monitoring Device (IMD) and Insulation Fault Locators (IFL), offers an appropriate and effective solution to prevent and locate insulation faults on all types of installations with an IT system.
- **Predictive:** ISOM Digiware shares measurement data from electrical parameters and insulation parameters in a single Energy Server. Using the OhmScanner technology, a complete mapping of the installation's insulation enables the monitoring down to the terminal circuits and the anticipation of insulation faults. Correlation with electrical parameters facilitates the understanding of the origin of any insulation drop.

Standards references

Electrical installation

- IEC 60364 series, Low-voltage electrical installations – Fundamental principles, assessment of general characteristics, definitions.
- IEC 60364-8-1, Low-voltage electrical installations – Energy efficiency.

Electrical installation and IT systems

- IEC 60364-4-41, Protection for safety – Protection against electric shock.
- IEC 60364-7-710, Requirements for special installations or locations – Medical locations.

Measurement devices

- IEC 61557-12, Electrical safety in low-voltage distribution networks – Power metering and monitoring devices (PMD).

Devices for IT systems

- IEC 61557-8: Electrical safety in low-voltage distribution systems – Insulation monitoring devices for IT systems.
- IEC 61557-9: Electrical safety in low-voltage distribution systems – Equipment for insulation fault location in IT systems.



For more information:
[http://go.socomec.com/
technical-note-IEC-
61557-12-standard_EN](http://go.socomec.com/technical-note-IEC-61557-12-standard_EN)



In addition

Technical note

- IEC 61552-12: reference standard.



Socomec: our innovations supporting your energy performance

1 independent manufacturer

3,200 employees
worldwide

10 % of sales revenue
dedicated to R&D

400 experts
dedicated to service provision

Your power management expert



POWER
SWITCHING



POWER
MONITORING



POWER
CONVERSION



EXPERT
SERVICES

The specialist for critical applications

- Control, command of LV facilities
- Safety of persons and assets
- Measurement of electrical parameters
- Energy management
- Energy quality
- Energy availability
- Energy storage
- Prevention and repairs
- Measurement and analysis
- Optimisation
- Consultancy, commissioning and training

A worldwide presence

12 production sites

- France (x3)
- Italy (x2)
- Tunisia
- India
- China (x2)
- USA (x3)

27 subsidiaries

- Australia • Belgium • China • France
- Germany • India • Italy • Netherlands
- Poland • Romania • Singapore
- Slovenia • Spain • Switzerland • Thailand
- Tunisia • Turkey • UK • USA

80 countries

where our brand is distributed

HEAD OFFICE

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