

# Electrical safety

in railway technology

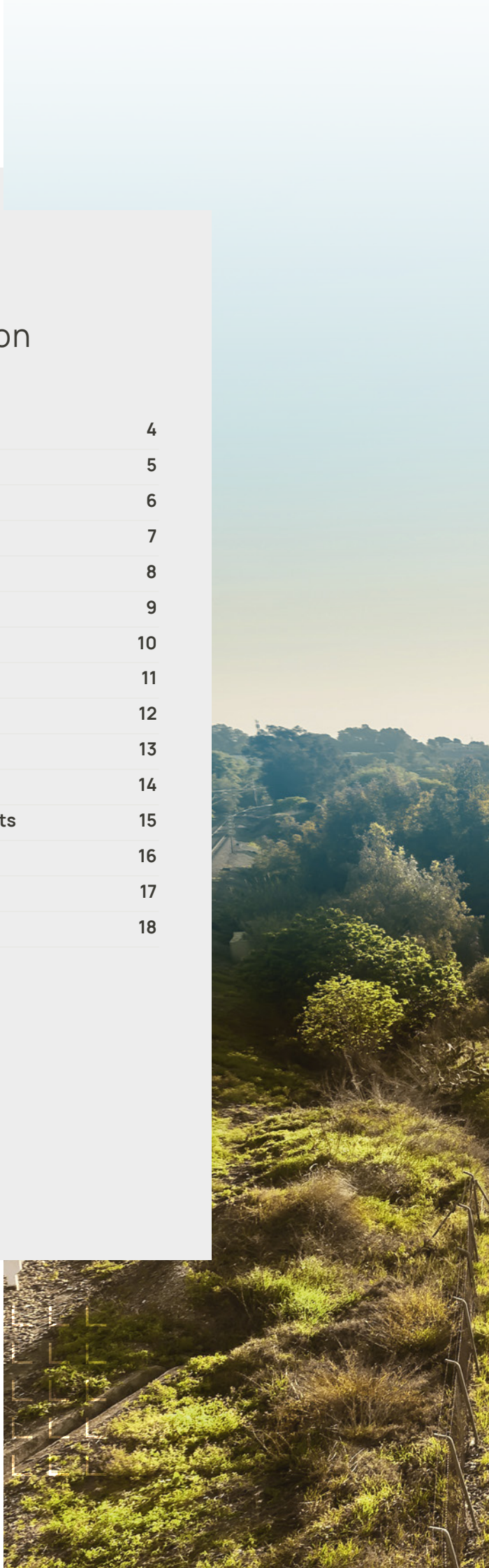


Design the future  
of energy



# Electrical safety for smooth railway operation

Safe railway technology: high availability and cost effectiveness	4
Why the IT system is the better choice	5
Signal box, control and safety technology	6
Track field illumination and safety lighting	7
Locomotives and motor coaches	8
Mast switch actuators	9
Points drive and points heating systems	10
Railway crossings and safety installations	11
Train safety systems	12
Electrical safety in tunnels	13
Portable generators	14
Building technology: Railway stations and depots	15
POWERSCOUT®	16
System control centre	17
Insulation fault location	18



The railway industry deals with extremely demanding tasks on a daily basis. The inspection of high-speed railway lines, rail construction and power supply systems is just as much a part of this as the transport of hazardous goods. Regardless of the pressure to be punctual, however, passenger safety remains the overriding priority.

Guaranteeing electrical safety is an essential component of smooth operation. This applies equally to signal boxes, signalling systems, operational buildings, tunnels and bridges as well as to the rolling stock.

**Bender system solutions monitor electrical installations and railway installations and help to prevent critical operating conditions.**



# Safe railway technology: high availability and cost effectiveness

## Standard-compliant solutions by Bender

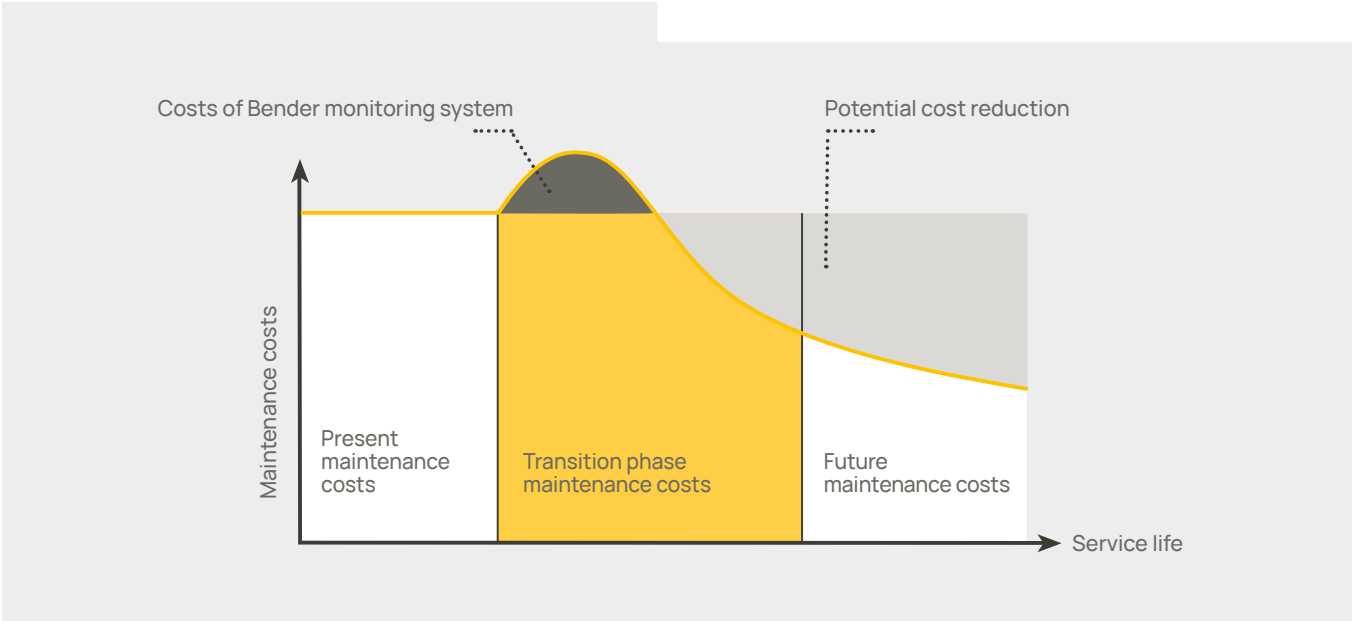
### Safe operation and reduced costs

Bender monitoring systems ensure fault-free power supply, help you to quickly locate insulation faults and enable you to prevent downtimes of important parts of the installation.

What is the cost of unscheduled maintenance, unavailability of route sections, insulation fault searches that last for hours or even days? Investing in modern monitoring technology from Bender quickly pays for itself.

### Standard-compliant solutions

When it comes to satisfying the stringent safety standards in electrical railway systems, monitoring systems that comply with the applicable standards are indispensable. The most important standards for railway operation are EN 45545 (Fire protection on railway vehicles), DIN EN 50155 (Railway applications – Rolling stock – Electronic equipment) and DIN EN 50121 (Electromagnetic compatibility). Bender solutions are specialised in meeting the challenges of this industry and provide you with the necessary information advantage. This enables you to intervene before critical conditions arise.



+ + + +  
+ + + +  
+ + +  
+ + +

+ + + + +  
+ + + + + + + + +  
+ + + + + + + + +  
+ + + + + + + + +  
+ + + + + + + + +  
+ + + + + + + + +  
+ + + + + + + + +  
+ + + + + + + + +

# Why the IT system is the better choice

## The aim: reliable power supply – high availability

Technical installations increasingly depend on their electrical power supply. At the same time, the follow-up costs of unexpected downtimes increase. How well a reliable power supply and high availability of an installation can be implemented later on is already decided when a power supply system is chosen.

## TN system, TT system or IT system?

In principle, planners can choose between different system types whose design differs with regard to earthing relations of power supply source and equipment, as well as in the type of neutral conductor and protective conductor. When considered with high availability in mind the IT system may be the best choice.

Operators can evaluate installation data according to their own requirements and use the data for improvements of the installation as well as to correlate the measurement data to other events in the installation. This is a valuable tool to also find the causes of short-time insulation faults.

For often maintenance teams do not stand a chance of reacting to fault messages, of locating and eliminating them within a few hours. Stationary equipment for insulation fault location offers a crucial advantage for such cases.



## The five most important advantages of an IT system:

### Advantage 1: Continued operation after the first insulation fault

One of the crucial advantages of the unearthed system (IT system) is that the installation can still be operated after the appearance of a low-impedance insulation fault.

### Advantage 2: Fire protection

Insulation faults are the most common cause of fire. IT systems reduce the fire hazard due to insulation faults to a minimum.

### Advantage 3: Locating the fault during ongoing operation

Suitable devices permit fast insulation fault location without the need to interrupt operation.

### Advantage 4: Reduced testing effort

Insulation monitoring devices reduce cost and time expenditure since the  $R_{ISO}$  measurement for periodic verification is not required. Therefore, operational interruptions are not necessary.

### Advantage 5: Increased personal safety

Operators of an installation that use IT systems, offer their employees, visitors, and customers the highest possible level of protection.

**Due to the various economic and technical advantages, an unearthed system with high-performance insulation monitoring is almost always profitable in comparatively complex installations.**

# Signal box, control and safety technology

## Monitoring safe railway operation

The smooth operation of the whole railway network is the predominant focus of the signal box and the control and safety technology. A voltage swell in the event of a fault is a particular hazard.

In addition to gauging insulation, the insulation monitoring devices by Bender comply with IEC 61557-8 and measure the line-to-line voltages and the line to earth voltage. This allows early detection of these hazards.

## Fault search? Made easy!

To prevent interruptions to operation even in the event of a fault, Bender insulation fault location systems enable a fault search – also in switched off installations (or areas thereof).

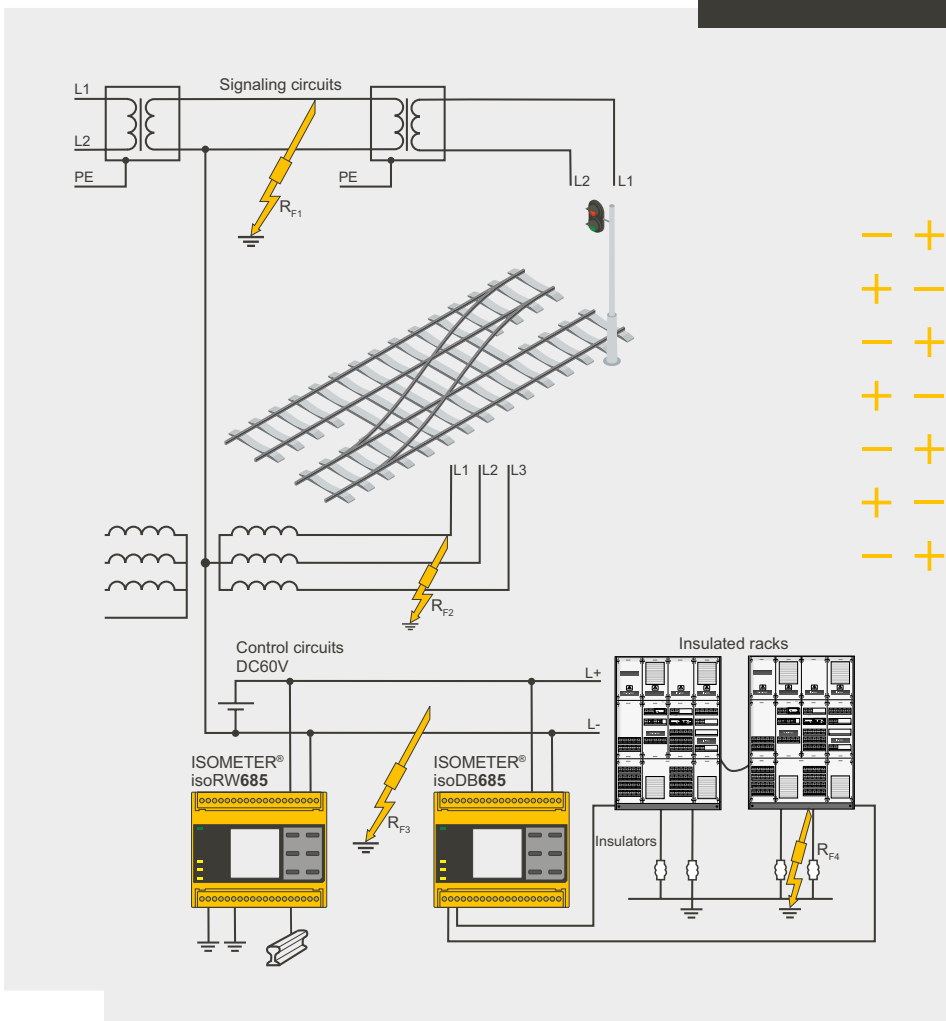
Even large installations can be monitored reliably by Bender insulation monitoring devices. With the size of the installation, the leakage capacitance value increases, however, Bender insulation monitoring devices determine the leakage capacitance value and adjust to it.

## Insulation monitoring during an earth-to-rack short circuit

Bender insulation monitoring devices also enable the monitoring of ohmic-coupled systems.

### Example Germany, requirement of Deutsche Bahn AG: eliminate insulation fault below 30 kΩ within ten working days

In practice, traditional technology often only detects faults from 0 kΩ to approx. 7 kΩ. Bender offers solutions that can detect faults in a range from 0 kΩ (dead short to rack or earth) to 100 kΩ. These solutions can be implemented without shutting down the installation, both as stationary and/or as portable systems.



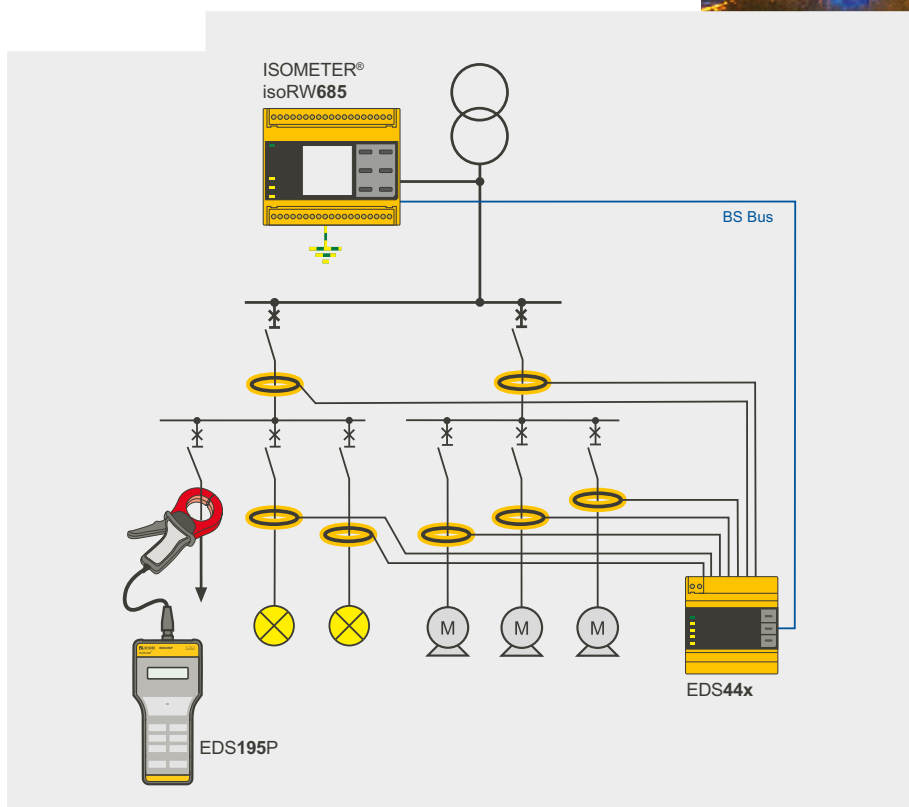
# Track field illumination and safety lighting

## Shunting - better with lighting!

The power supply system for track field illumination is often designed as IT system. Bender offers insulation monitoring devices that comply with IEC 61557-8. These also adjust to larger systems with several lighting poles, parameterisation of the system size is not required.

Apart from the insulation, Bender insulation monitoring devices measure line-to-line and line and earth voltages. This permits the early detection of voltage swells in the event of a fault.

Also in systems consisting of several lighting poles, an insulation fault can be found quickly. When insulation fault location systems are used, insulation faults can be allocated even to the individual illumination elements.



+ - + - +  
- + - + -

# Locomotives and motor coaches

## Safe power supply for drives and auxiliary units

In locomotives and trains hauled by motor coaches different IT systems are employed in parallel. Bender provides solutions for the most different voltage levels. Insulation monitoring devices measure the insulation resistance, the voltage and the system leakage capacitance to earth/chassis.

There are also solutions for the electrical safety of TN systems with different voltage levels: Residual current monitoring continuously monitors different system components and identifies faults. Bender voltage and current relays reliably monitor the different voltage levels and phase sequences even at 16.7 Hz.

### Remember: Measuring current at the central earthing point

Bender provides equipment for measuring current at the central earthing point.

## Minimising delays – adhering to scheduled timeframes and deadlines for maintenance

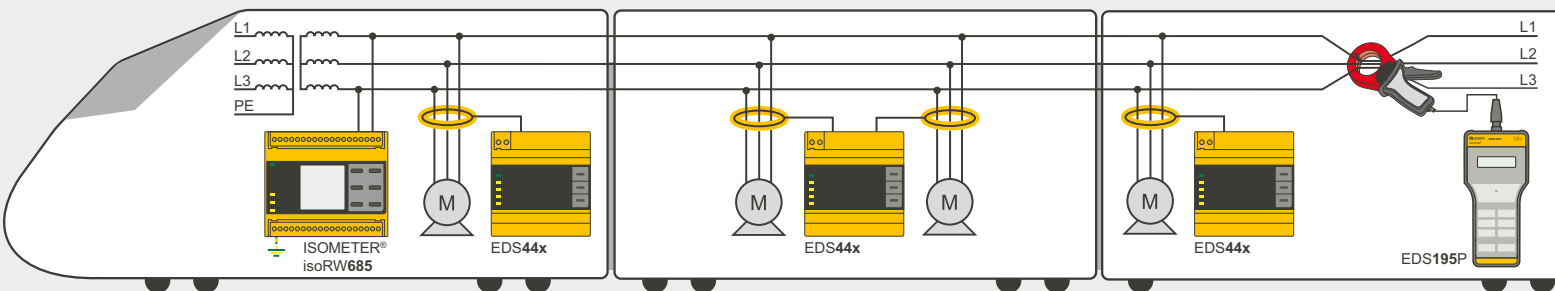
When they are installed as stationary systems, Bender insulation fault location systems permit the fastest fault detection – ready for locating at any time. Alternatively, mobile equipment can also be used in the fault search.

## Facilitating standardised work

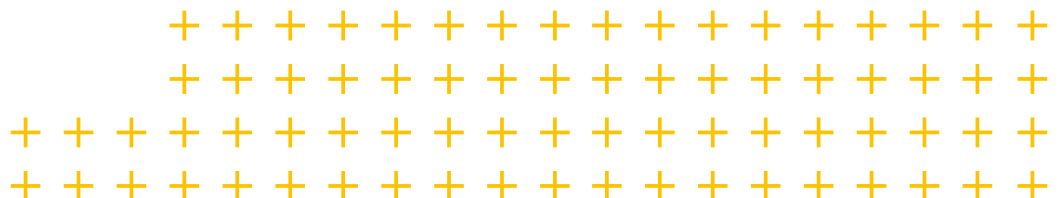
Bender portable insulation fault location systems enable standardised work processes. Quality levels and timing goals for maintenance can hence be achieved even when employing subcontractors (e.g. an ECM).

### EN 50155 – higher vibration level and increased environmental influences

The Bender devices of the RW version have been tested according to EN 50155.

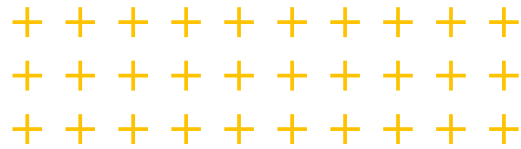


Portable insulation fault location systems use current clamps, which must be positioned around the cables. Ideally, cable input and cover design have already been considered during the engineering planning phase.





# Mast switch actuators



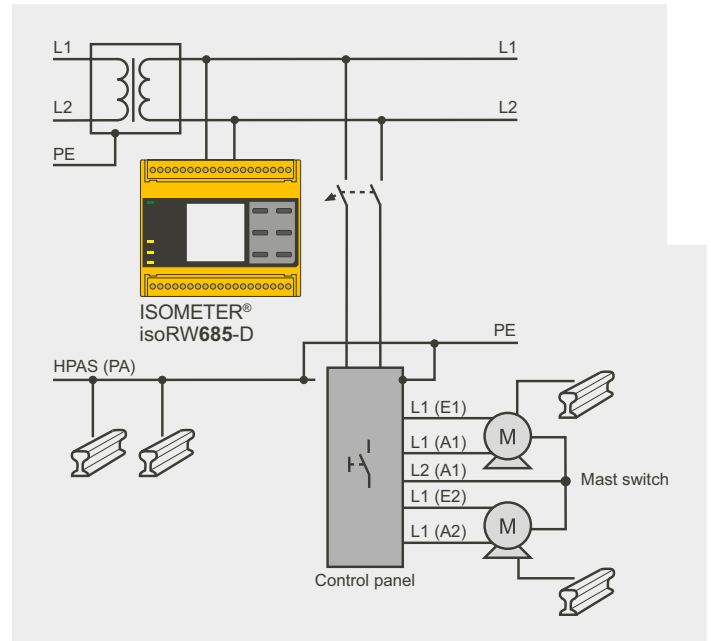
## Monitoring safe railway operation

Mast switch actuators are switching devices that, during regular operation, during construction work, after lightning strikes or after accidents must switch the overhead lines reliably. Their functionality can be ensured by insulation monitoring devices that monitor the power supply system continuously. They automatically adapt to the size of an installation and report critical conditions to the supervising system.

The tendency of insulation values to decrease slowly over time can be made visible via Bender technology. When communication interfaces are used, predictive maintenance and analysis are possible.

## Finding insulation faults easily and without disconnecting

Insulation faults can be found quickly in systems consisting of several poles and mast switches when insulation fault location systems are used. For the faults can then be attributed to the individual mast switches.



# Points drive and points heating systems

## Heating the points safely in the winter

Frozen points present a safety problem and are the main cause of delays in winter. Continuous offline monitoring of the power supply system guarantees that the points heaters will function when needed, as offline insulation monitoring devices report critical conditions to the supervising system even in switched off condition.

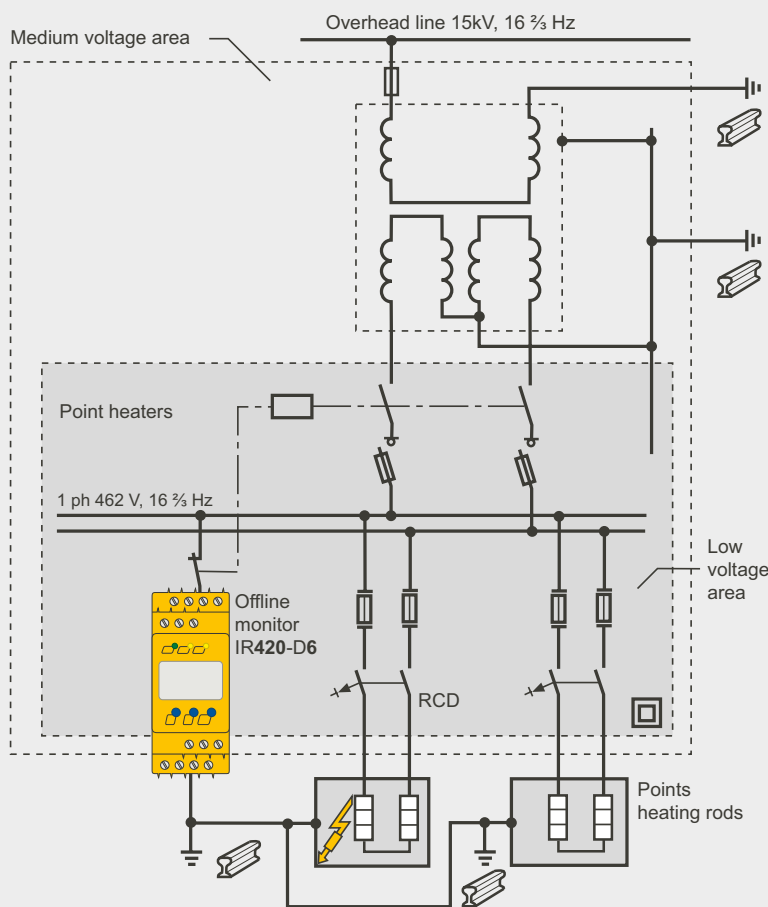
## Setting the right course for electrical safety

Points drives are only used when points are switched. To assure that they function reliably when needed, monitoring the power supply system continuously with insulation monitoring devices is recommended. These devices report critical conditions to the supervising system.

When modern communication interfaces are employed, measured data can be analysed and correlated to other events in the installation. This is a valuable tool that helps to find also the causes of temporary insulation faults.

## The risk of downtimes

During downtimes, undetected insulation faults may occur due to moisture or other factors impacting on the supply line or the load. When the installation is then reconnected, the protective device trips or motor fires occur, and operation is not possible. Such a situation can be prevented by continuous insulation monitoring that reports insulations faults at an early stage.



Bender technology visualises the behaviour of insulation values over time which makes predictive maintenance and analysis possible.

# Railway crossings and safety installations

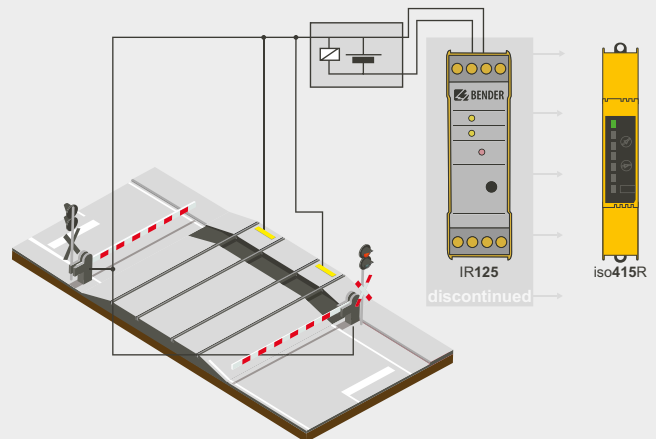
## Electrical safety has the right of way

Reliably functioning railway crossings and safety installations are of vital importance for all transport users. When driving over sensors the train triggers the opening and closing of gates. A failure of these safety installations would bring the train to stop or block cross traffic.

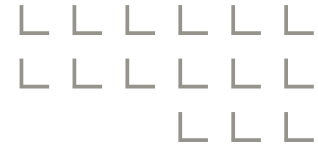
When insulation faults cause control malfunctions, danger arises. These faults can be prevented with Bender technology as it enables continuous monitoring of insulation values over time. Slowly deteriorating values are visualised centrally via the communication interfaces, predictive maintenance and analysis become possible.

## Problem case: temporary insulation faults

Short-time insulation faults are difficult to interpret. Frequently they are no longer present when the service staff arrives on site. In this case, the analysis of measured data and correlation to further events in the signal box help establish the cause.



# Train safety systems



## Safe control of trains in international railway operation

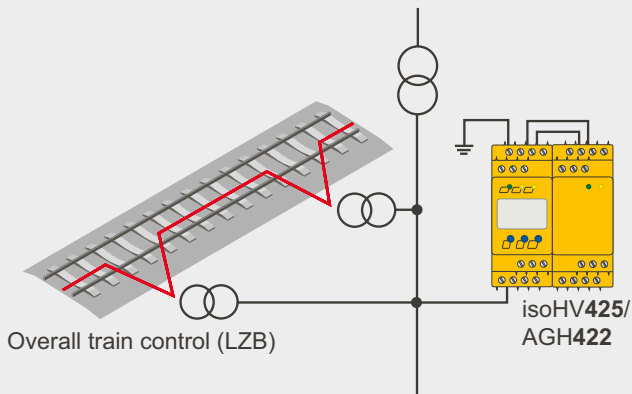
Safe railway traffic must be ensured across the entire railway network. To find insulation faults quickly also in the case of extensive installations and very long railway lines, insulation fault monitoring and locating systems are implemented. These systems can attribute insulation faults down to individual route sections.

### Insulation monitoring: isoHV425+AGH422



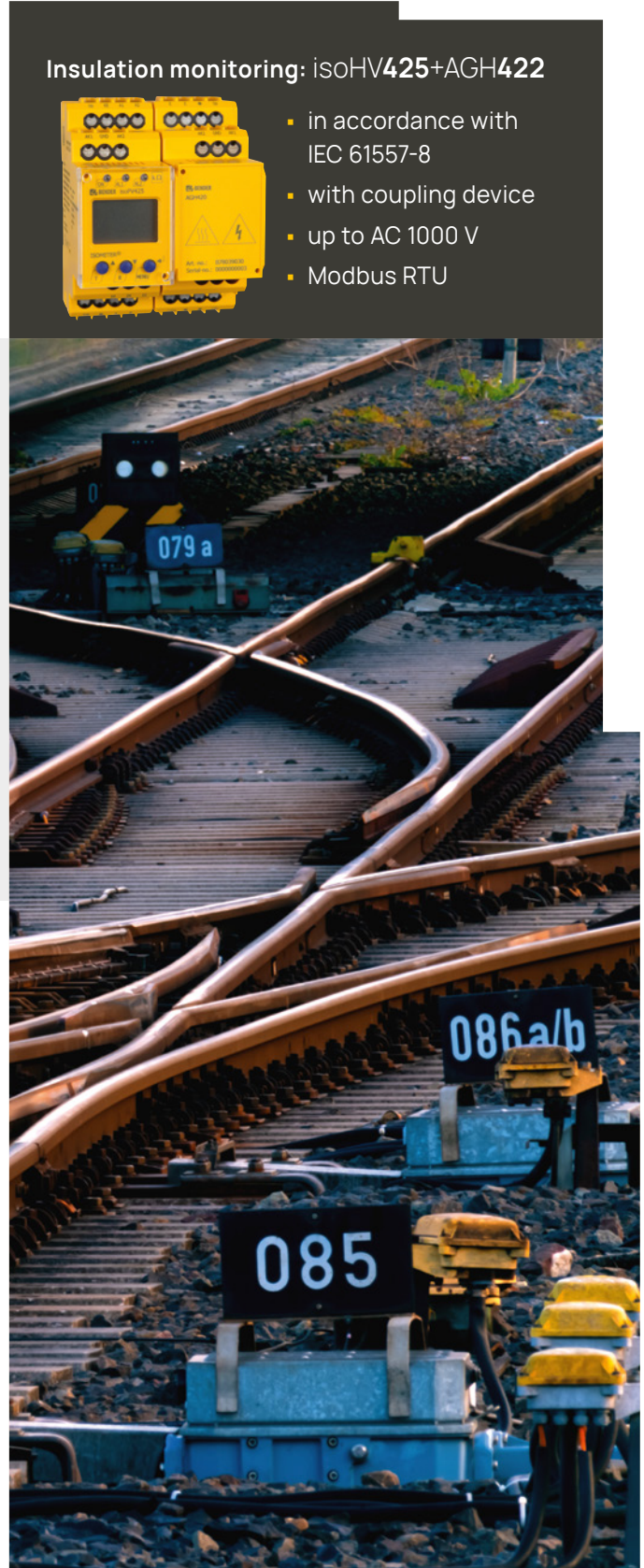
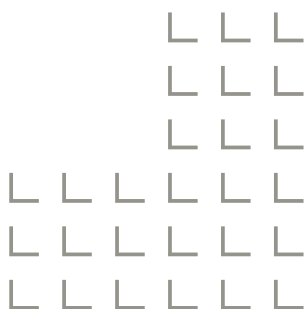
- in accordance with IEC 61557-8
- with coupling device
- up to AC 1000 V
- Modbus RTU

The following illustration shows how insulation monitoring is used for an automatic train control system.



## Train control at defined spots

A symmetrical fault to earth can disable the functionality of de-energised train controls at defined spots. The appropriate monitoring option here is continuous insulation monitoring of the de-energised track magnets.



# Electrical safety in tunnels

## Safe power supply even in case of a disaster

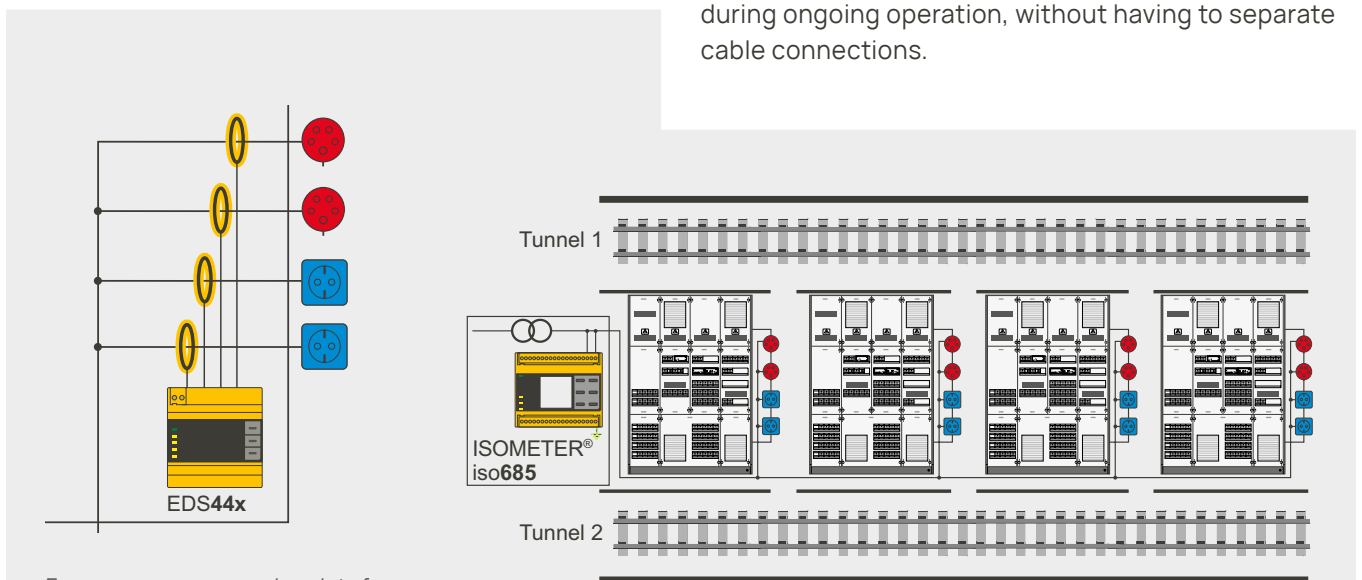
Train routes in mountainous landscapes lead across a sequence of tunnels and bridges. The route operator must be prepared for a train accident in a tunnel. Along the route rescue organisations are equipped for assistance in case of a disaster. To support the rescue plan, hydrants and emergency power supply points are installed in the tunnels. Rescue teams thus have quick access to water and electrical energy in sufficient quantities. According to guideline 954.0107, in Germany the power supply has to be designed as an IT system.

## Securing a functioning power supply for rescue teams even in case of a disaster

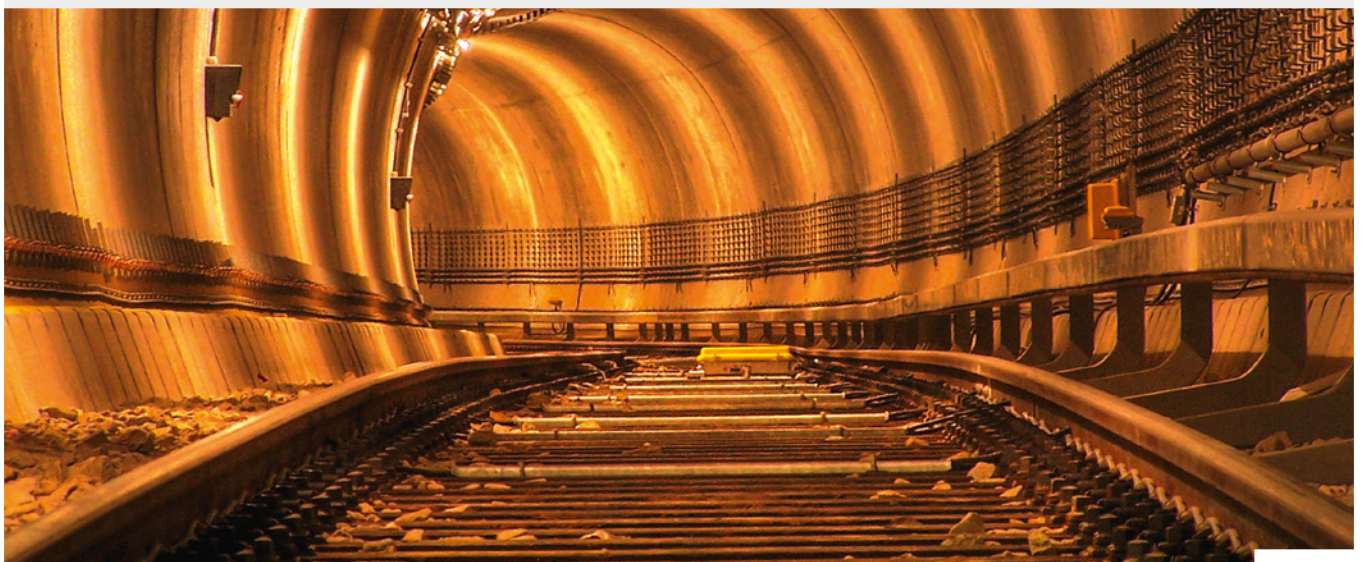
So that the emergency responders can rely on a functioning power supply in the event of a disaster, continuous insulation monitoring is required. With such monitoring, critical conditions of an installation are reported to the supervising system in time.

## Fast localisation of insulation faults

Even in the case of extensive electrical installations, Bender insulation fault locating systems can attribute electrical faults to individual tunnel sections. A further advantage: They can be used to find insulation faults during ongoing operation, without having to separate cable connections.



Emergency power supply points for rescue teams

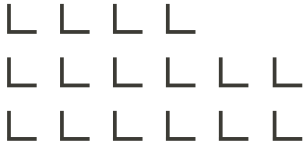


# Portable generators

## Electrical safety when using portable generators

Portable generators are implemented in maintenance measures and in the case of a disaster. They need to function quickly and reliably. The amendment of DIN VDE 0100-551 clearly specifies that periodic verification is no longer required when insulation monitoring according to DIN EN 61557-8 has been installed.

Furthermore, setting an earth spike is no longer required if the protection plan consists of protective separation with insulation monitoring. Bender offers solutions for insulation monitoring of the installation to secure electrical safety of portable generators and connected equipment.



# Building technology: Railway stations and depots

## Safer building technology for satisfied customers

Modern railway stations are service centres that depend on a safe power supply. The service centre should also be able to function if an electrical fault occurs in a small part of the installation. RCMS (residual current measuring systems) detect faults long before a normal residual-current circuit breaker would shut down. Therefore, availability of the system as a whole is increased.

**Technology that quickly pays for itself:** The RCMS improves and simplifies maintenance and fault location.

So that even the slowly deteriorating insulation values are detected, Bender technology uses modern communication interfaces for visualisation and thus enables predictive maintenance and analysis.

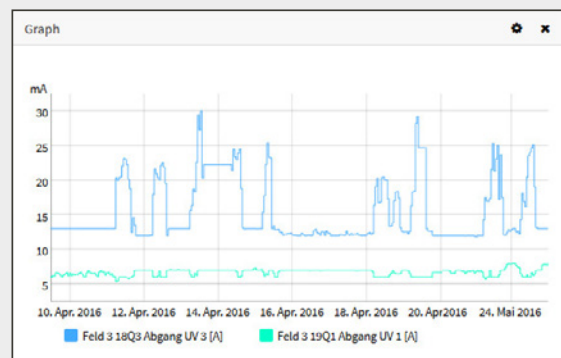


## Transparency for electrical installations

Power quality problems generate costs. Electrical overloads on equipment, overheating and disruptions do not have to be a given. These occurrences can be prevented by targeted energy management with the PQ devices from Bender.

## Energy management

The Bender measuring devices of the PEM series also capture energy and performance data. Therefore, setting up measuring points for the purpose of invoicing becomes uncomplicated. Bender energy meters with MID compliance labelling are suitable for this, as they meet the corresponding calibration requirements.



Monitoring and analysis made easy with the browser-based POWERSCOUT® software

## Universal measuring device: PEM353



# POWERSCOUT®

## Find out today what won't happen tomorrow

Moisture, aging, dirt, mechanical damage or faults due to the impact of current, voltage and temperature cause malfunctions in every electrical installation. The web-based software solution POWERSCOUT® helps you detect malfunctions at an early stage and eliminate the causes in an economically reasonable way. This guarantees high safety and operational reliability of the installation and reduces costs.

### Analysis – as individual as your installation – as simple as possible

Predictive maintenance prevents downtimes, reduces costs and staff requirement. POWERSCOUT® informs you about the condition of your electrical installation at all times, since the informative visualisations with flexible dashboards can be retrieved via any display device, be it a smartphone, a tablet or a PC. On request, POWERSCOUT® sends you reports with the data shown as graphs at specified intervals.

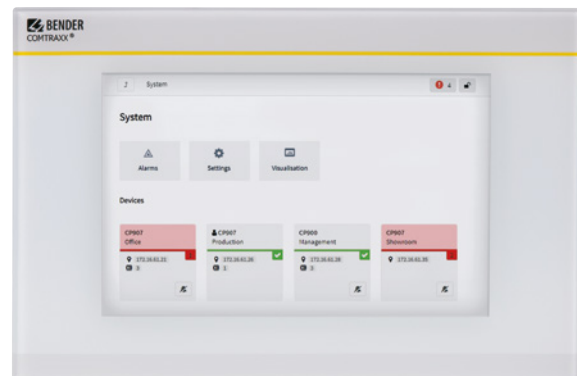
### Continuous monitoring instead of random tests

Manual data acquisition is time consuming, error prone and only provides random results. With POWERSCOUT® you have the complete data of your installation at your disposal at any time, since all measured values are saved automatically and continuously. Your data is stored reliably and remains available for years.

### Basis for periodic verification

The automated POWERSCOUT® report on residual currents forms the basis for measuring without switch-off in accordance with the periodic verification as per IEC 60364-6. Since this verification must be carried out to maintain the correct status of electrical installations and stationary electrical equipment, for example by continuous monitoring of the installation by electrically skilled persons.

In this case, it is a smart move to rely on continuous monitoring with multi-channel residual current monitoring systems (RCMS) and an evaluation adapted to the system (e. g. using the CP907-I). The automatic POWERSCOUT® reports based on this monitoring enable the electrically qualified person in charge to adjust the times when the insulation test shall be performed as part of the periodic verification.



Typical application: CP907-I

### Analyses

- Recording insulation values continuously
- Recognising connections and optimising maintenance
- Cross-installation evaluation options
- Access from any place
- Supporting investment decisions

### Preventive maintenance

- Higher availability
- Continuous monitoring
- Early detection of gradually developing insulation faults
- Early detection and reporting of temporary insulation degradation
- Lower costs due to unexpected malfunctions and shutdowns incurred

### Reports

- Historical comparisons
- Safe storage of measured values
- Event and alarm statistics



# System control centre

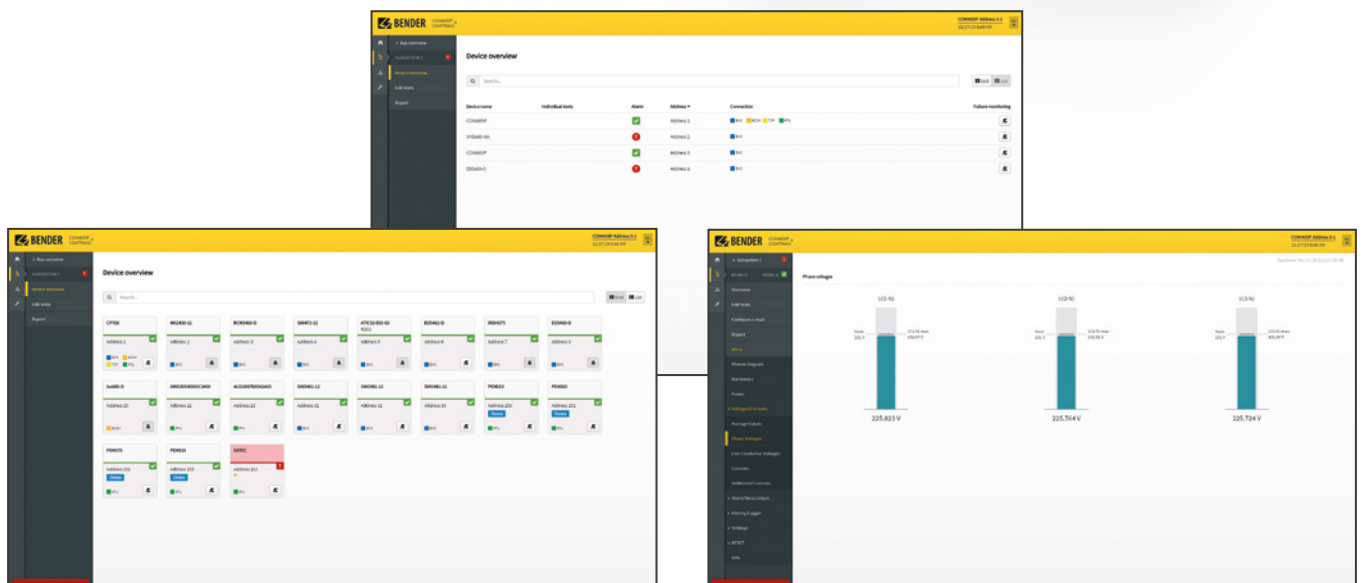
## Interconnection and visualisation made easy

The COMTRAXX® monitoring systems are used in a wide range of applications. However, what they have in common is that the user needs to obtain relevant information quickly and easily. In the event of an alarm, the system informs actively via e-mail, switch contacts or by forwarding information to supervising control systems. To carry out an analysis or create a report, the user can fall back on data that was captured previously. The Bender system control centre permits both alarms and the retrieving of history information – in one system. Data is collected from all connected measuring devices, evaluated and processed differently depending on the respective application. For this, the browser-based system offers many advantages:

- all users work live in one system (there are no locally stored system copies that have to be maintained manually)
- additional users can access the system with every device that runs on a browser (no user licences or additional hardware required)
- expandable, hence systems are adaptable in size and fit for the future (no additional hardware required when the installation is expanded)

- Software is updated only centrally (no local maintenance of user access and evaluation software)
- Support in real time by Bender Remote Assist

Starting with the overview over the entire installation with the integrated visualisation tool to the detailed power quality evaluations: The Bender system control centre supports users since operation is intuitive and it provides guided support during fault analysis.



Device data displayed on the web user interface (COM465IP)

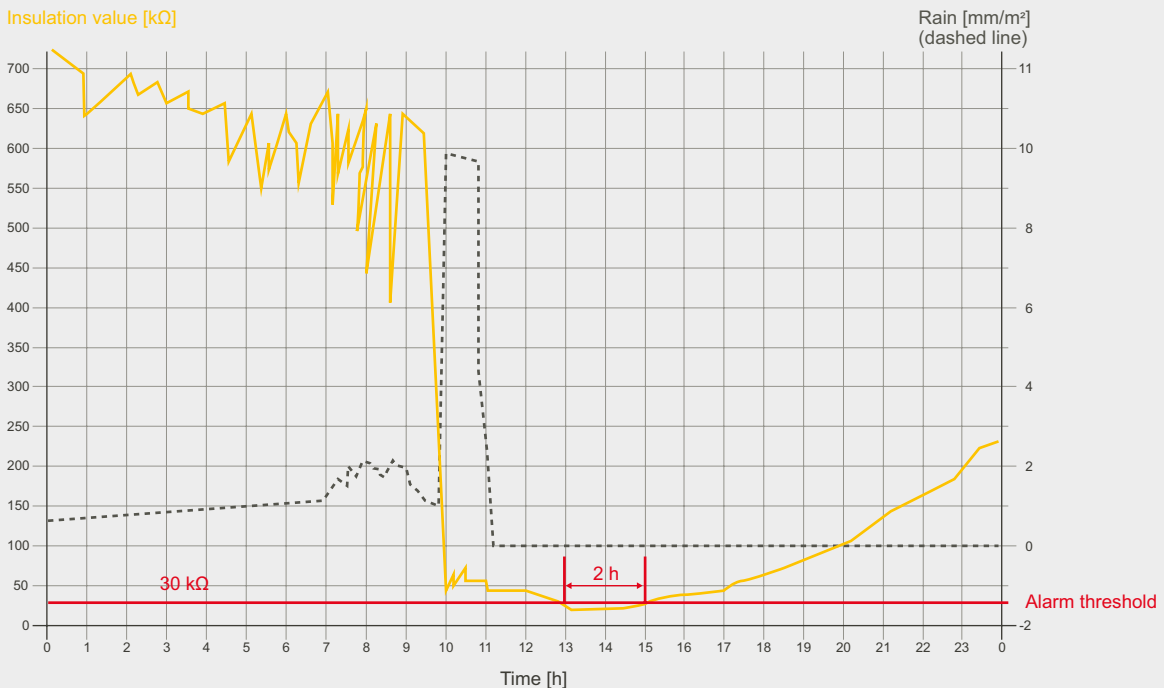
# Insulation fault location

## Interpreting short-time insulation fault messages correctly

Temporary insulation faults are difficult to interpret. If, for example, the insulation value falls below the alarm notification threshold value for only two hours and then rises again to a normal level, the on-site service technicians often do not stand a chance of finding the cause of the fault. Maintenance must then be ended without fault elimination, and the faulty insulation remains a hazard for the system.

## The solution:

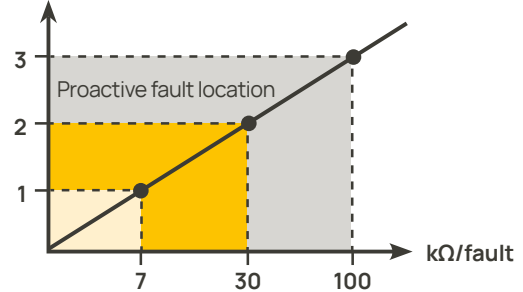
Modern communication interfaces and the browser-based POWERSCOUT® software bring together all measured data and permit correlating it to further events in the system. For example: comparison of insulation values to weather data. In many cases, rain showers significantly reduce the insulation value of damaged cable installations. Stationary insulation fault location systems can identify the affected route section or damaged component already when the rain starts to impact the installation.



### Proactive fault location

In practice, traditional technology often only detects faults from 0 k $\Omega$  to approx. 7 k $\Omega$ . Bender offers solutions that can find faults up to 100 k $\Omega$ . These insulation fault location systems can be employed as stationary and/or portable systems and supply the data about the installation condition that is important for proactive fault location.

Complexity in fault location



### Insulation fault location in switched-off areas of the installation

Insulation fault searches can be conducted also in switched-off sections of the installation. De-energised but galvanically connected cables, as well as single-conductor cables with low currents can be directly enclosed by current clamps or transformers. Bender insulation fault locators generate the measurement signals themselves.

### Fault location in cable installations made easy

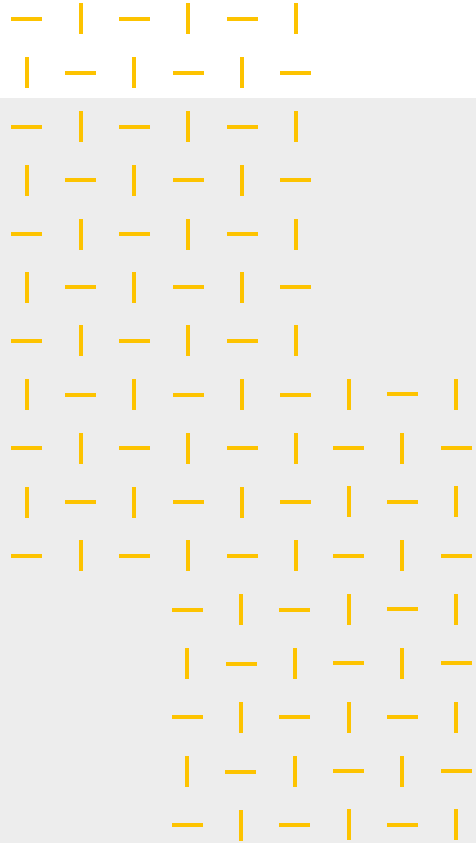
In order to rapidly find insulation faults also in the case of extensive electrical installations, the implementation of stationary insulation fault location systems is preferred. These systems can attribute insulation faults down to individual route sections. A further advantage is: Bender fault location systems find insulation faults during ongoing operation, without the need to disconnect cables.

### Insulation fault location during ongoing operation

Just as the stationary equipment, also the portable insulation fault location system EDS309x permits detection of insulation faults without cable disconnection.



**Good to know:** Stationary solutions for insulation fault location can also be retrofitted. Mobile and stationary solutions by Bender comply with IEC 61557-9.



**Bender GmbH & Co. KG261**

Londorfer Straße 65  
35305 Grünberg  
Germany

Tel.: +49 6401 807-0  
info@bender.de  
www.bender.de

Photos: AdobeStock (© TeacherPhoto, © Javier Romera, © hxdyl, © Halfpoint, © VanderWolf Images, © ON-Photography, © Adamus, © New Africa, © pavelgulea) and Bender archives.

2140en / 11.2023 / © Bender GmbH & Co. KG, Germany – subject to change! The specified standards take into account the version valid at the time of printing.

