

# Electrical safety

Power plants and substations

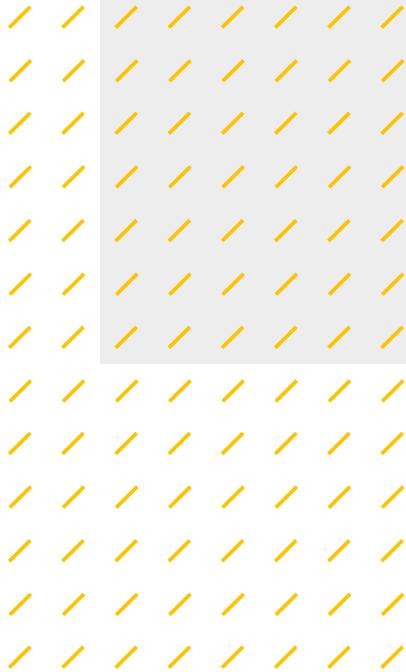


Design the future  
of energy



# Electrical safety in power plants and substations

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## **Bender solutions for sustainable and reliable operation of power plants and substations**

High reliability and efficiency are essential factors that enable power plants and substations to operate economically. Bender systems enable high availability and electrical safety at the same time. They ensure continuous monitoring of the installation.



# Maximum safety and economic efficiency

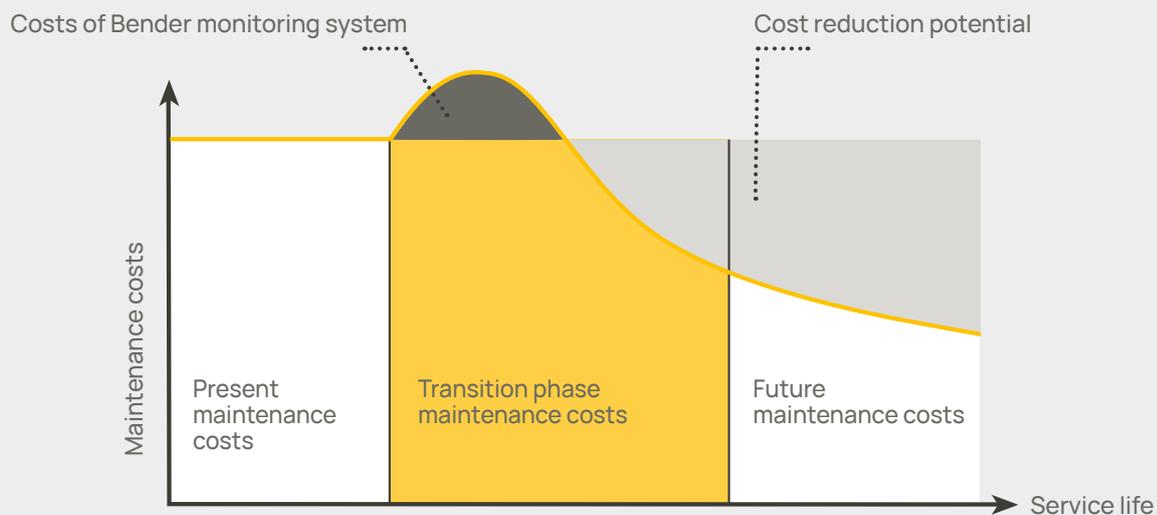
Operational failures, malfunctions or circuit interruptions within a power plant are among the worst-case scenarios for operators and those in charge, since every failure or malfunction in these high-availability systems and installations can be very costly.

In order to ensure a high level of reliability and fail-safe operation, selecting the right protection technology and the right power supply system type is of particular importance. The effects of problems that can be detected at an early stage are usually underestimated and range from the sudden triggering of protective devices to fire, environmental damage or even injury to persons.

Often the choice of the system type is a matter of habit, not of cost, technology or safety. The advantages of an IT system (unearthed system) are obvious, especially for critical systems in power plants and substations.

Designing the electrical system as an IT system guarantees less downtime, facilitates maintenance, reduces the fire risk and thus leads to higher returns and lower costs in the long term.

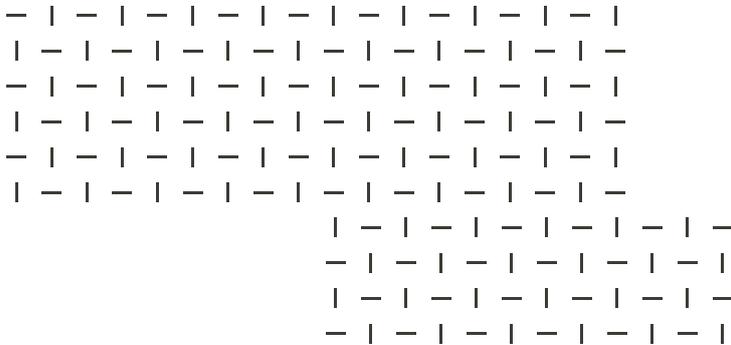
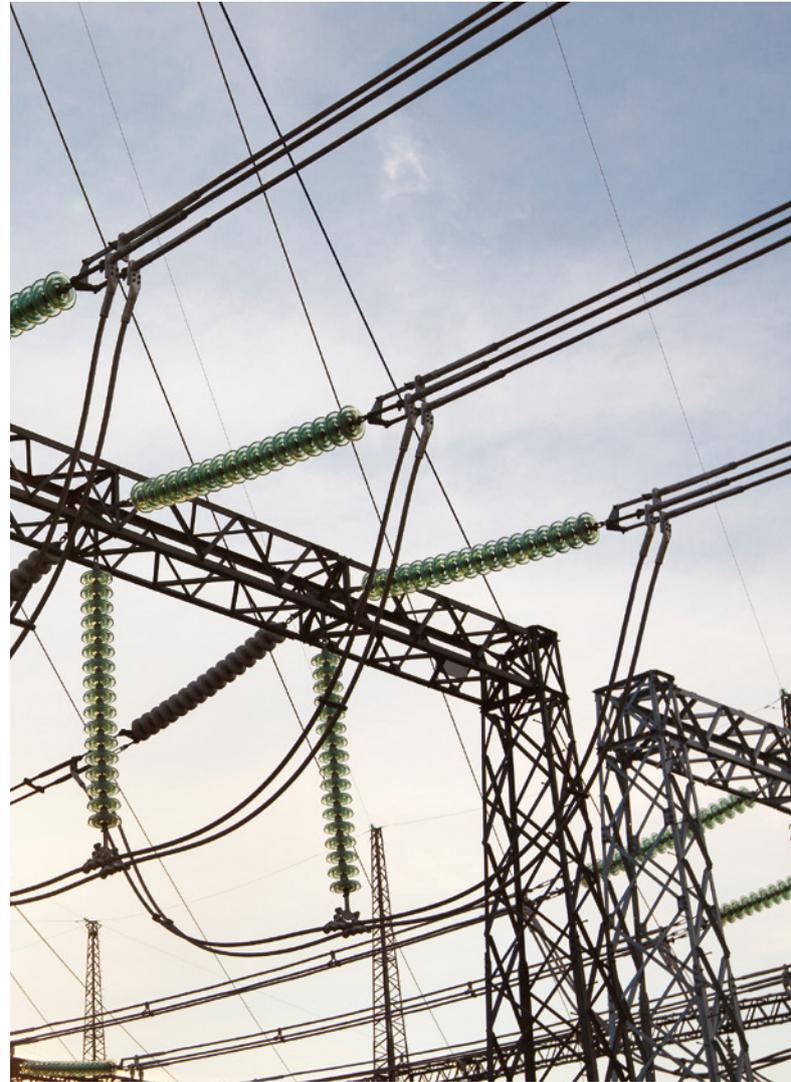
**Bender monitoring systems ensure a trouble-free power supply and thereby offer convincing advantages to operators of electrical installations.**



For this reason, standards, e.g. IEC 60364-5-56:2008, started to require unearthed systems with a suitable insulation monitoring device for electrical equipment that serves safety purposes.

Our years of experience with the specific requirements of the energy sector make us the right contact partner for the safety of your electrical installation.

As your partner, we use our know-how combined with the quality of our pioneering work in the field of electrical safety to guarantee the highest possible level of availability and reliability for your electrical installation. This way you are always on the safe side.



## Maintenance strategies

### Corrective

#### Downtime-oriented

- Reaction after direct damage event
- Unscheduled downtime

### Preventive

#### Time-dependent

- Established timelines
- Frequent exchange of intact components

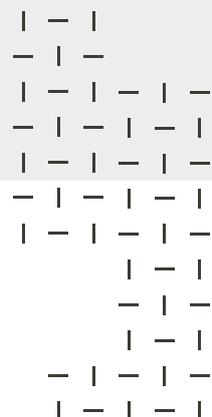
#### Condition-oriented

- Reaction to warning thresholds concerning the system condition, even before a downtime occurs
- Optimum use of service life (wear margin)

### Predictive

#### Analysis-supported monitoring

- Forecast of the ideal point in time for maintenance
- Maintenance is plannable

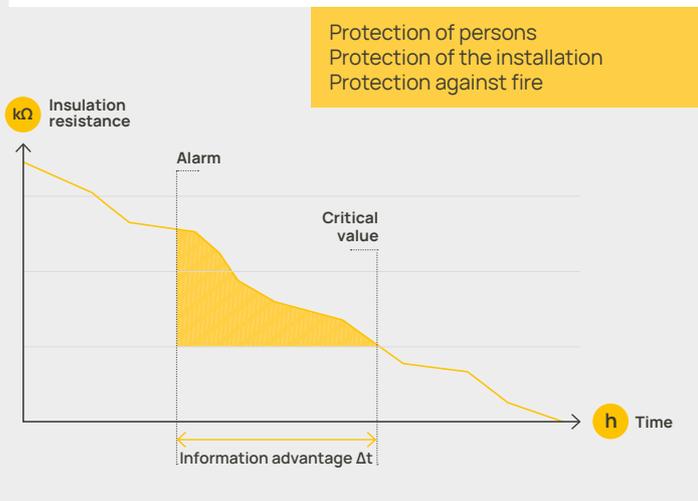


# Continuous monitoring of auxiliary and control circuits for maximum availability

The advantage of an unearthed system: Knowing what will happen. The electrical system that a power plant requires for operation needs the so-called auxiliary and control voltage circuits. These must be monitored continuously and reliably to guarantee the safety of the installation. An undetected electrical fault frequently results in unplanned downtimes of an installation or increases the risk of fire significantly.

## Choosing the right type of monitoring – Bender know-how makes it easy

Insulation monitoring devices and insulation fault location systems can be retrofitted. The basic requirement is a system with an isolated star point. Bender provides standard-compliant state-of-the-art solutions and offers advice on the selection of the most suitable monitoring system.



## Reliable and efficient

Monitoring the auxiliary and control voltage in AC or DC systems is essential for the operation of power plants and substations. As optimum addition to the insulation monitoring device required for unearthed systems a modern insulation fault location device is recommended.

With an iso685-...-P insulation monitoring device, an EDS440/441 insulation fault locator and suitable current transformers, insulation faults are located in a reliable and precise way. These advanced measuring devices are a standard-compliant solution and inform you reliably about all insulation fault types in the installation, and whether faults are asymmetrical or symmetrical.

Especially systems with an isolated star point (IT systems) show their advantages here. Because with these systems a fault does not lead to a failure but to an acoustic and visual signal from the insulation monitoring device. For this reason the standard IEC 60364-5-55: 2016-07, Selection and erection of electrical equipment – Other equipment, Section 557.3.4.1, recommends an unearthed system for auxiliary circuits in applications requiring high availability.

### Insulation monitoring device iso685



- Combination of modern measuring methods
- Ethernet interface
- For systems up to 690 V AC, 1000 V DC

### Insulation fault locator EDS440/EDS441



- Up to 600 channels
- Two alarm relays
- Highly sensitive with high system leakage capacitances

### Only active measurement is correct measurement

The product standard DIN EN 61557-8 requires that insulation monitoring devices must detect both symmetrical and asymmetrical faults. As a result, the "3-lamp systems" or "Voltmeter methods" often used in the past are no longer permissible. Bender provides standard-compliant solutions for new installations as well as for retrofitting measures.

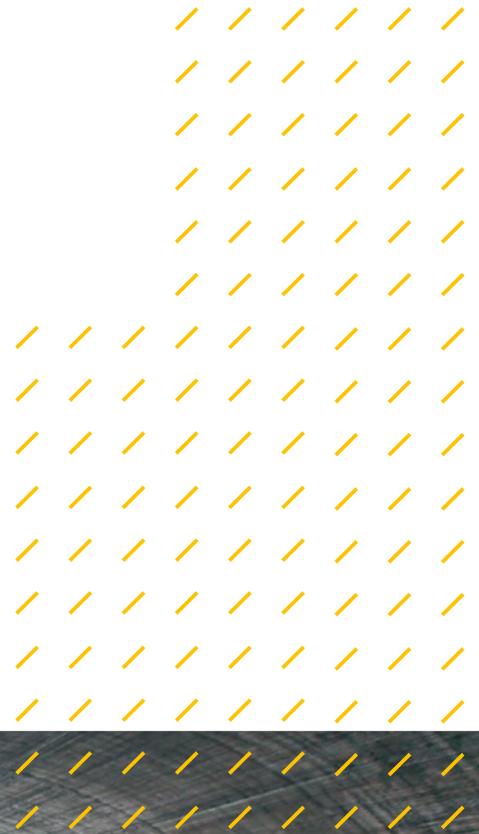
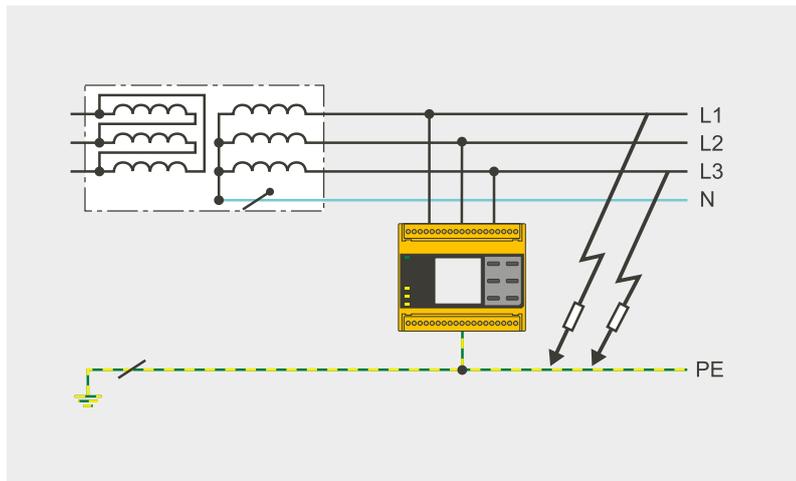
Bender insulation monitoring devices signal symmetrical faults that cannot be detected using traditional methods.

The Bender ISOMETER® as well as the insulation fault location device not only meet the corresponding product standards (IEC 61557-8, IEC 61557-9), but offer additional functions suitable for practical application which provide many advantages. These include, for example, an installation wizard or the web server, which allows individual settings and the assignment of customised texts.

### Insulation fault locator EDS195P

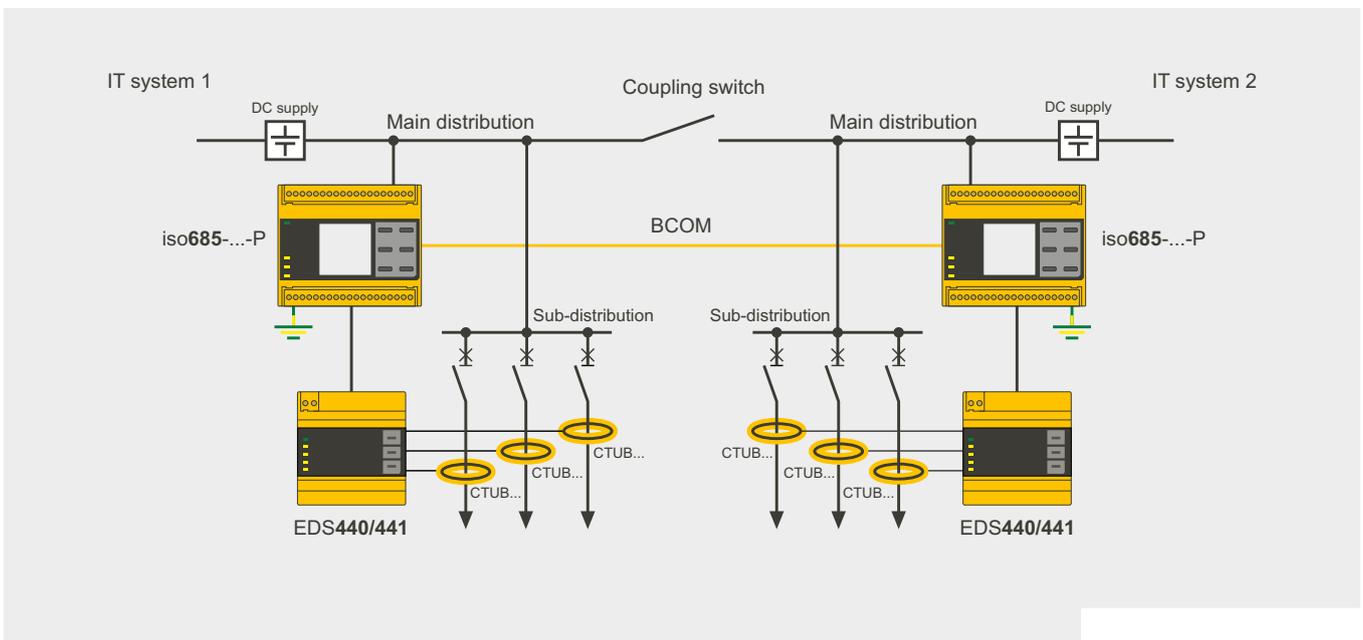


Portable Bender insulation fault location systems complement Bender systems perfectly. They help locate faults in a fast and precise way.



# Standard-compliant insulation monitoring in coupled IT systems

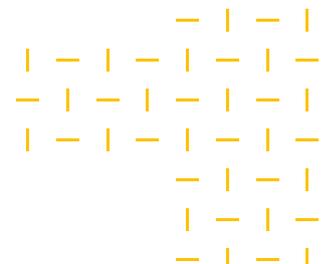
In power plants and substations, specific parts of the electrical systems are dimensioned according to the principle of the (n-1) reliability criterion, in nuclear power plants, the (n-2) criterion. The (n-1) criterion states that in an electrical grid with forecast maximum transmission and supply requirements, reliability of the grid must be guaranteed even if a component, such as a transformer or a circuit, fails or is switched off. The resulting redundant structure of the electrical systems is a particular challenge for the monitoring systems in the installation.



For several power supplies that are connected in parallel, one insulation monitoring device per supply is recommended. The insulation monitoring devices must be interconnected in such a way that only one device performs a measurement, regardless of the state of the coupling switch.

The ISOMETER® variants with ISOnet function (iso685-D-B or iso685-D-P) are a standard-compliant solution, since this function enables the operation of several insulation monitoring devices in coupled systems without any mutual interference.

When an ISOMETER® has detected an insulation fault, it initiates the insulation fault location. The EDSsync function aided by the insulation fault location devices EDS440/EDS441 ensures that insulation faults are located reliably even in coupled systems. This allows reliable fault diagnosis and also proactive and fast maintenance measures. In addition, the EDSsync function enables insulation fault location in diode-decoupled systems, such as those used in most power plant and substation supply systems.



## To make sure everything works in case of an emergency: Monitoring an Uninterruptable Power Supply (UPS)

Specific parts of a power plant, such as the control voltage, must not fail. These systems are connected to a UPS. The electrical safety of UPS systems must be monitored always and continuously.

Monitoring UPS systems by means of the Bender ISOMETER® provides optimum availability and ensures proper functionality in case of an emergency. For not all malfunctions in the UPS are immediately visible. An ISOMETER® detects and signals these problems, and provides you with quick diagnostic steps or preventive measures.

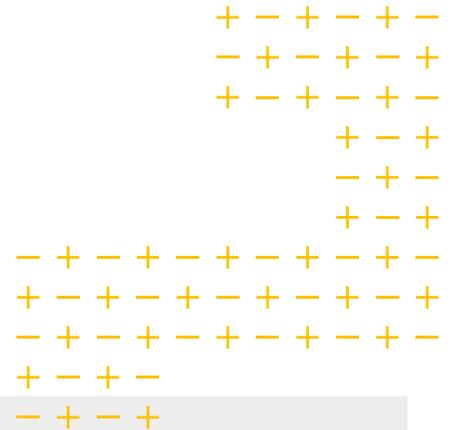
## Generator monitoring in power plants

A large part of the the entire energy production world-wide is generated by rotating machines. As generators, these convert mechanical energy into electrical energy in power plants of all kinds. Their reliable operation is a prerequisite for a well-functioning energy supply.

### The problem of ageing

Electrical machines contain insulation and several carbon brushes that are subject to rapid ageing processes. Rapid ageing often leads to failures. The best way to prevent such failures is to continuously monitor the condition of an electrical machine via its insulation state. Insulation monitoring can be realised both as online and offline monitoring. With continuous insulation monitoring potential problems and risks can be identified quickly. Also the high harmonics caused by the excitation system of the generator can be taken into account perfectly when insulation is measured with an ISOMETER®.

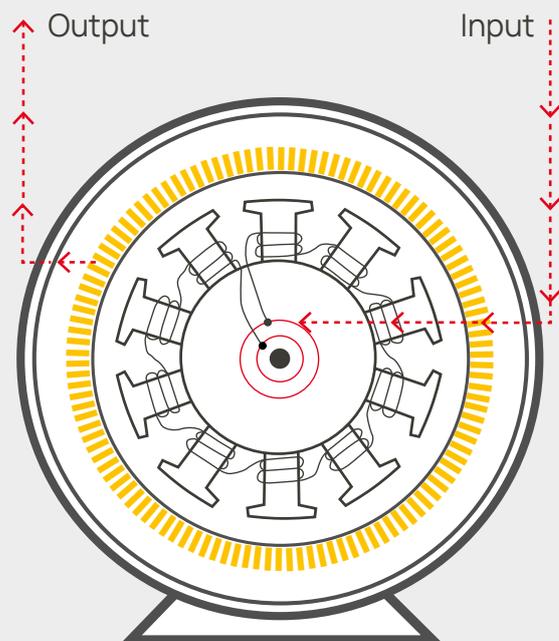
- ... Deterioration of the cable insulation
- ... Damage to the excitation system
- ... Soiling in the electrical grid



### The solution

Early detection thanks to continuous monitoring using an ISOMETER®.

€ This measure is proven to reduce your maintenance costs.



# Monitoring of de-energised equipment

## Always ready, always reliable

In cases of temporarily or predominantly de-energised loads, such as fire pumps, slide-valve drives, lift motors or emergency power generators, insulation faults may occur during downtime due to moisture or other impacts on the supply line or the load. Without monitoring, these insulation faults are not detected and, therefore, the protective device may prevent operation when the system is switched on or in more severe cases, motor fires may occur.

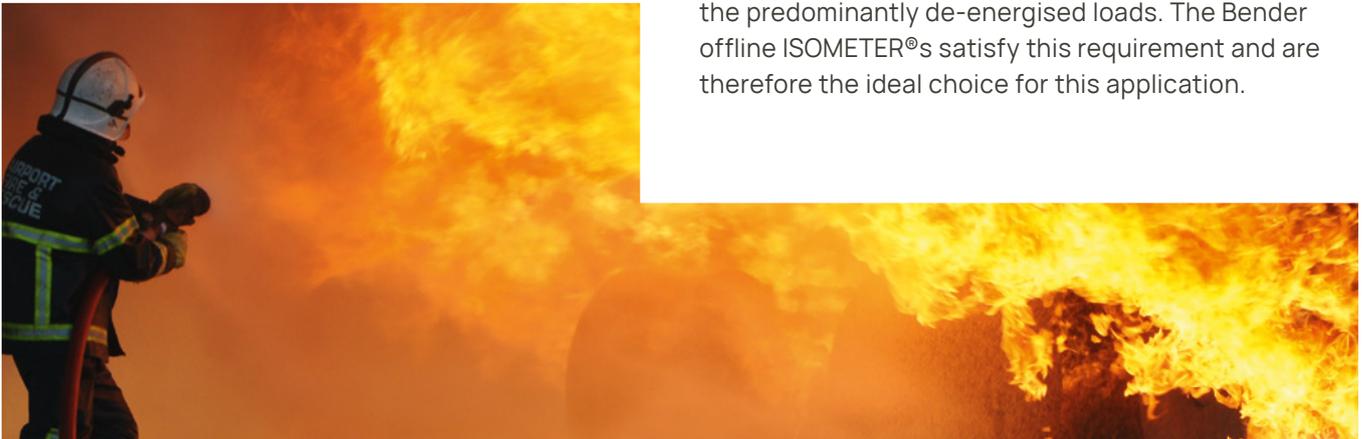
In these cases, the use of special offline ISOMETER®s is easy and efficient. Also, the operator can be sure that the equipment can be operated whenever it is needed.

## The following equipment must be continuously monitored so that it is ready for operation when required:

- Automatic fire pumps
- Drives of emergency slide-valves (gas, water)
- Motor-controlled locking systems
- Submersible pumps, cooling water and other pumps
- Lifts, anchor windlasses
- Flue gas dampers
- Emergency power generators

## Standard-compliant solution

A prerequisite for offline measurement is automatic disconnection and re-connection of the insulation monitoring device depending on the operating state of the predominantly de-energised loads. The Bender offline ISOMETER®s satisfy this requirement and are therefore the ideal choice for this application.



If the insulation resistance of predominantly de-energised equipment is not continuously monitored, the following risks exist when it is switched on:

Protective device does not trip, the faulty equipment is started

Protective device trips and prevents the equipment from powering up

High fault current leads to fire, damage to property, high costs

Critical in case of e.g. fire pumps, gas slide valves and lifts

**Solution: Monitoring with an ISOMETER®**

# Analogue undervoltage/ overvoltage relays

### Proven analogue technology

Power plant operators who decide against using software-controlled device functions also in the future want a reliable analogue solution.

This is guaranteed by the VMD258. Due to its fully analogue mode of operation, none of the hard-to-detect dynamic faults can occur, e.g. those caused by faulty software.

### Undervoltage/overvoltage relays for monitoring of three-phase AC systems up to 690 V in purely analogue technology

The voltage relay VMD258 from Bender monitors three-phase AC systems for undervoltage and overvoltage (window mode). A star point connection is not required, which makes it suitable for 3 AC systems up to 690 V. The supply voltage for the electronics is taken from the system to be monitored. The supplies for the electronics, the relays and the connection for the external energy storage device are isolated from the system by means of double insulation.

### Normative basis

The analogue VMD258, which has been tailored to the special requirements of the energy providers regarding power plants and substations, complies with the device standard IEC 60255-127.

### What happens in the event of a power failure?

Even in the event of brief power failures, the availability of the protective devices and monitoring devices must be guaranteed. In particular for such cases, the VMD258 can be expanded with the energy storage device ES258 so that power continues to be supplied for at least 5 s, and a possible power outage can be bridged.

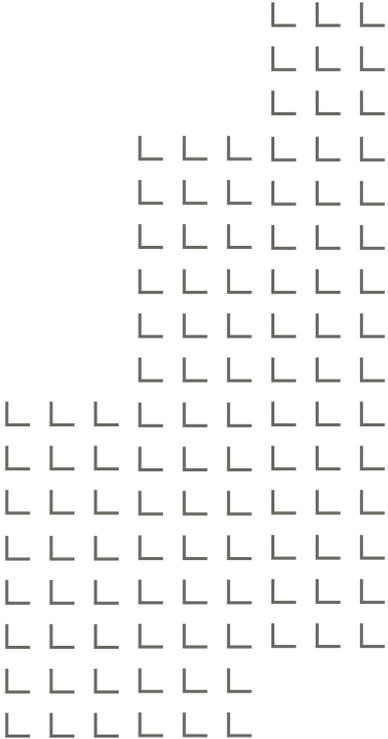
### Undervoltage/overvoltage relay: VMD258



- No external power supply required
- Completely analogue
- For 3 AC up to 690 V
- In accordance with IEC 60255-127

### How about something a little more digital...?

Bender offers a wide product range of digital and multifunctional monitoring relays for various applications in AC or DC systems.



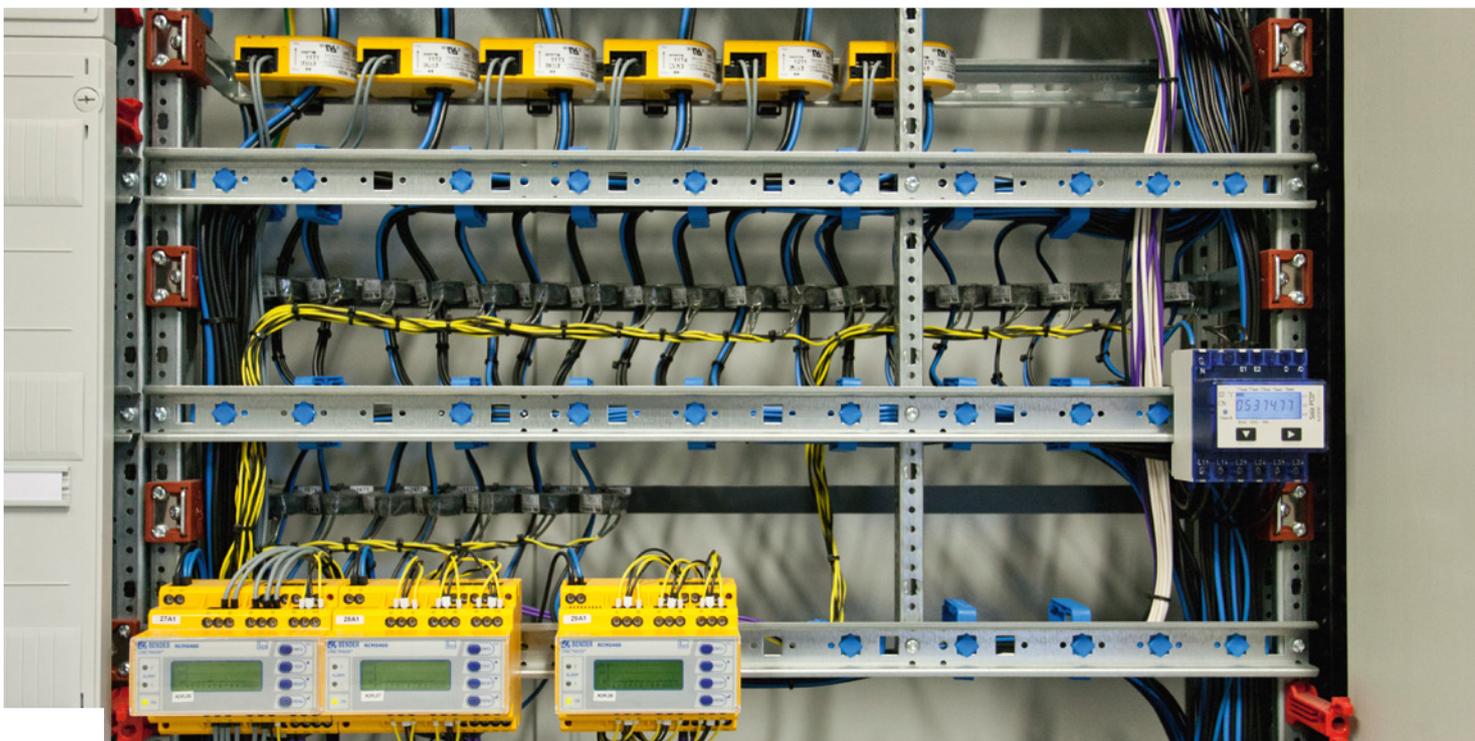
## Continuous monitoring of residual currents: Measuring without switch-off in accordance with the periodic verification requirement

Companies or power plant operators are responsible for the safety of their employees. Among other things, they must assess the danger of electrical installations and equipment and implement the respectively applicable requirements for accident prevention.

For electrical installations and stationary electrical equipment, periodic verification must be carried out to maintain the proper condition. Section 6.5 of IEC 60364-6:2016-04 states that this requirement is also fulfilled if the installation is continuously monitored by electrically skilled persons. The time-consuming insulation measurement, which is usually difficult to perform, is not necessary if the electrical system is monitored in accordance with the basic standard DIN IEC 60364-6 (VDE 0100-600):2017-06 by a residual current monitoring system in accordance with IEC 62020 or an insulation fault location system in accordance with IEC 61557-8. The Bender ISOMETER®s as well as the RCM series fulfil the applicable standards and are ideally suited for this application.

**Bender technology eliminates the need for the time-consuming insulation measurement required as part of the periodic verification and thus offers electrically skilled persons an ideal solution for monitoring in accordance with the applicable regulations.**

This makes the often unfeasible disconnection of devices for the measurement and a shutdown of the installation a thing of the past. Similarly, no expensive interruptions of operations are necessary. The Bender ISOMETER® also performs the self-test required by DIN IEC 60364-6 (VDE 0100-600):2017-06 fully automatically.



# Power quality and energy measurement

## Transparency for electrical installations

Electrical supply systems are becoming increasingly bigger. Frequently, failures and malfunctions are caused by overloaded installations. When measuring devices of the PEM series are incorporated into the monitoring system, they can provide the necessary information for an estimate of the risks due to overloads or changes in energy consumption prior to an expansion.

### Structure of the monitoring system

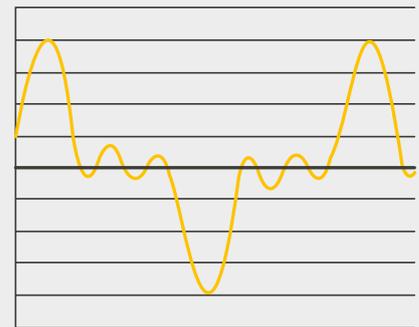
A granular, i.e. fine-grained structure of the monitoring system allows:

- Cost centre specific energy data acquisition
- Faster localisation in the event of a fault
- Economic pyramid design

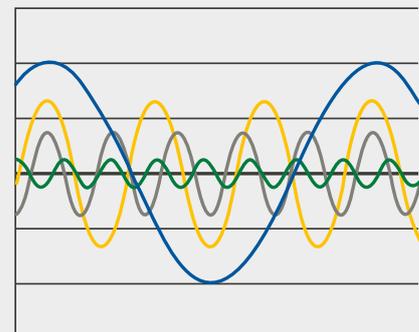
The aim of a monitoring system must always be to detect even small changes in the relevant measured quantities, such as leakage current or harmonic content, and issue a prewarning in the event of deviations as early as possible.

Trends of relevant measured quantities for voltage quality or leakage currents cannot be appropriately monitored with one single measuring point in an electrical installation. Several measuring points are required which must be adjusted to the structure of an installation.

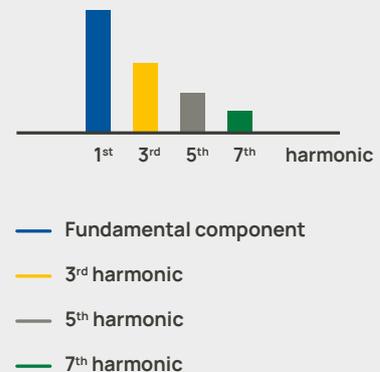
Distorted shape of current



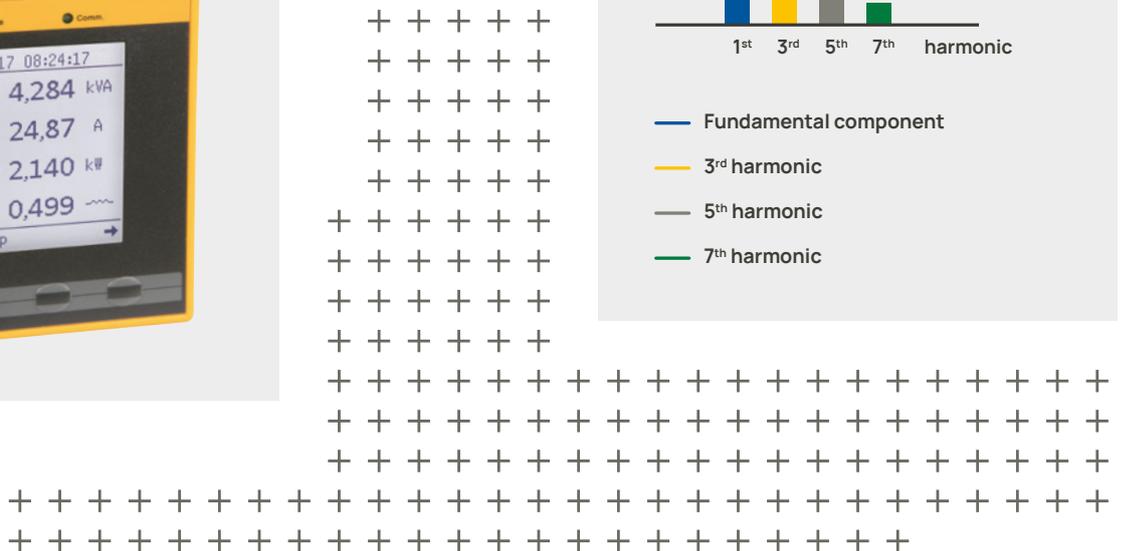
Analysis of the harmonics



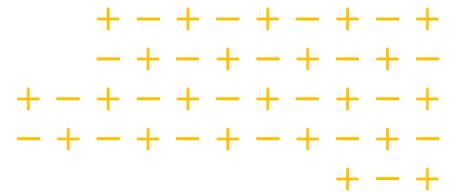
Spectrum of harmonics



Universal measuring device: PEM353



# POWERSCOUT®



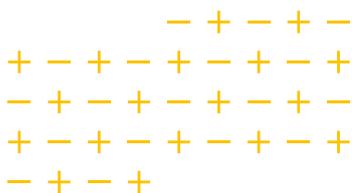
Moisture, ageing, dirt, mechanical damage or faults caused by the impact of current, voltage and temperature have a negative impact on every electrical installation.

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 of the installation and excellent operational reliability and reduces costs.

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. POWERSCOUT® brings together the data from your measuring and monitoring devices and creates easily understandable visualisations for all the important measured values.

Predictive maintenance prevents failures, saves costs and reduces personnel hours. With POWERSCOUT® you know the status of your electrical installation at all times.

Powerscout® is your tool: Already when it is set up, it can be adapted precisely to your installation and your monitoring requirements. Easy, clear and fast. Open the browser, log in, select the measuring devices and measured quantities you want, done.



## Analyses

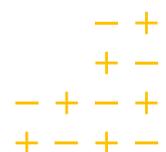
- Identify related issues and optimise processes
- Evaluation options beyond the individual installation
- Access from any location
- Energy data acquisition
- Support of investment decisions

## Predictive maintenance

- Higher availability
- Continuous monitoring
- Detecting fault currents early on
- Costs resulting from unexpected malfunctions and shutdowns reduced
- Early detection of gradually developing insulation faults

## Report

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





# Support during all stages

Comprehensive service for your installation: remote, by telephone, on site

**From planning to modernisation** – We are available to assist you with our extensive know-how during all stages of your project.

**In addition, with our first-class service we guarantee maximum safety for your electrical installations.** We offer services ranging from support over telephone to repairs and on-site service – with modern measuring devices and competent employees.

**Be on the safe side:**

- High availability of your system thanks to fast reaction to fault messages
- Increased return on your capital expenditure (CapEx) via optimised maintenance processes
- Targeted reduction of the operating expenditure (OpEx) due to reduced downtimes and shorter service visits

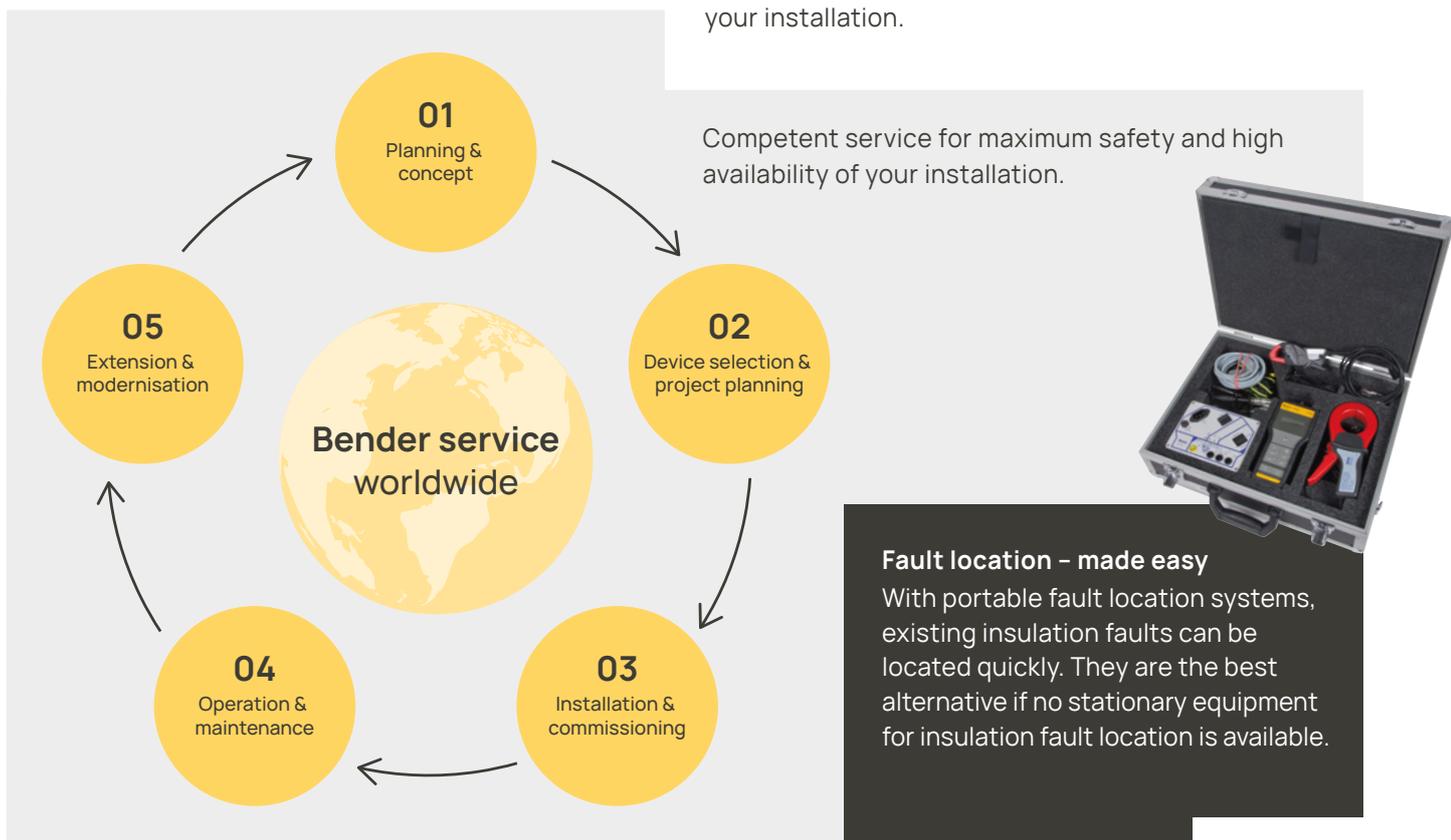
- Support for your predictive installation monitoring and regular checks of your installation/power quality/monitoring devices
- Automatic checks, analysis, correction, new settings/updates
- Competent support with setting modifications and updates

**Bender Remote Assist**

Bender Remote Assist offers you support via remote access, high-quality service and advice for your challenging task of ensuring consistently high safety in your installations.

For, in many cases service visits, fault clearance but also analyses and checks can be carried out remotely – without the expense of time and money that an on-site visit of a technician entails.

This fast, efficient help and advice by our network of experts ensures the highest possible availability of your installation.



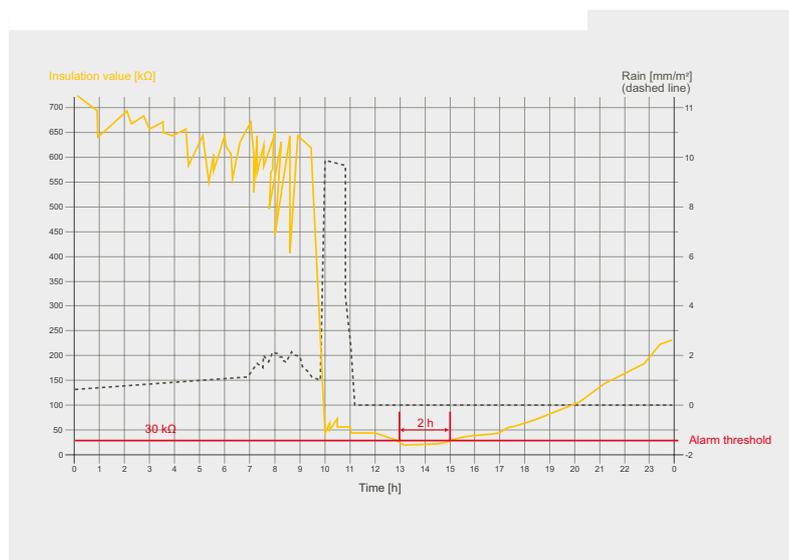
# Why the IT system is often the better choice

## Goal: Reliable power supply – high availability

Due to increasing complexity and automation, technical installations depend more and more on a reliable power supply. At the same time, the follow-up costs of unexpected downtimes increase. The selection of the power supply system already determines how well a reliable power supply and high availability of the installation can be implemented later.

## TN system, TT system or IT system?

In principle, planners can choose between different system types whose design differs with regard to earthing relationships of power source and equipment as well as in the design of the neutral conductor and the protective conductor. When all available options are considered, the conclusion is that the IT system is usually the better choice as system type.



Another plus: 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 with other events in the installation. This is a good help in finding also the causes of short-term 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 major advantages of an IT system:

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

One of the decisive advantages of the unearthed system (IT system) is that even if a low-impedance insulation fault occurs, the installation can continue to be operated.

### Advantage 2: Protection against fire

Insulation faults are the most common cause of fire. IT systems reduce the risk of fire caused by insulation faults to a minimum, which is also rewarded by insurance companies through lower insurance premiums.

### Advantage 3: Fault location during operation

With suitable equipment, fast insulation fault location is possible without interrupting operation.

### Advantage 4: Reduced testing effort

Since insulation monitoring devices eliminate the need for  $R_{ISO}$  measurement as part of the periodic verification, both costs and time are saved. Thus, no interruption of operation is necessary.

### Advantage 5: Increased protection of persons

Operators of an installation who implement IT systems offer their employees, visitors and customers the greatest possible protection.

Due to the various economic and technical advantages, in comparatively complex installations an unearthed system with high-performance insulation monitoring nearly always pays off.



**Safety for power plants - cost savings through reduced downtime**

Bender offers a practical solution that pays off and provides more safety. We are happy to advise you and find individual solutions for your needs and your technical application.

Please do not hesitate to contact us at [www.bender.de](http://www.bender.de)



# Bender. Making your world safe.

Our world is networked on a global scale; it is digital, mobile and highly automated. And no matter whether in hospitals, in industry, inside or outside buildings, in power stations, in trains, underwater or underground: it never stands still and it is more dependent than ever on a reliable and, above all, safe electrical power supply.

And exactly that is our mission: We make electricity safe. With our technologies, we ensure that electricity is permanently available and guarantee faultless protection against the hazards of electric shock. We protect buildings, installations and devices, and therefore your investments and plans. But what we primarily protect are the lives of the people behind the electrical installations.



Mechanical and plant engineering



Oil, gas



Renewable energy



Healthcare



Public power supply network



Mobile power generation



Ships and ports



Railway



eMobility



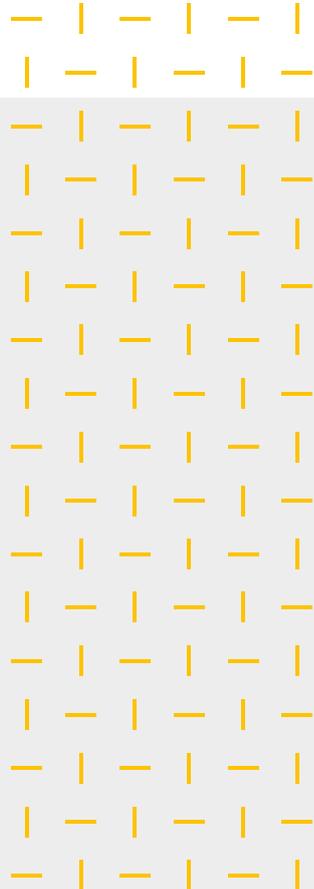
Data centres



Mining



Battery energy storage systems (BESS)



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