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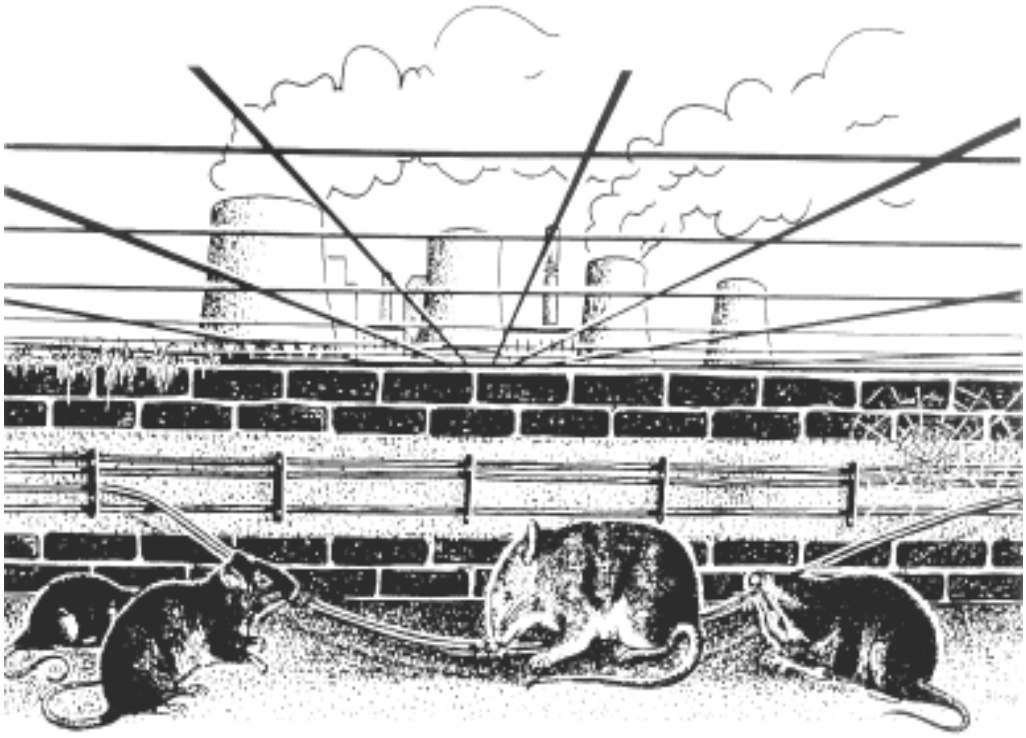

*Insulation Fault Location System*
*for IT AC systems 20-265V*
*and IT DC systems 20-308V*

# EDS473

## Operating Manual

Quality System Certified ISO 9001

CE

TGH 1321E

**Insulation Fault Location System EDS473 - Operating Manual**

**TGH 1321E**
(PRC470 - Softwareversion 1.81 upwards)

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# Contents

# 1 General

One determining factor for the availability of an electrical installation is the insulation resistance. It is first on the list of items to be considered with regard to electrical safety. This applies generally and regardless of the type of distribution system.

Planning the installation of a safe, reliable power supply aiming the highest availability means:

- Set-up of the power supply as IT system. In comparison with a distribution system with intentional earth connection of the active conductors, an improved operating reliability, improved fire protection, improved accident prevention as well as a higher permissible earth resistance are thereby achieved.

- Use of the suitable insulation monitoring device. The advantages named in the previous paragraph stand or fall by the selection of the appropriate A-ISOMETER for the respective application. The advantages of the IT system cannot be used without a reliable monitoring system. A desired high level of the insulation resistance cannot be maintained in the long term without continuous monitoring.

- Reduction of maintenance costs and downtimes thanks to the installation of an insulation fault location system. The quick localisation of an insulation fault immediately after it occurred is a long-cherished wish of the maintenance personnel. Without interruption and possible night and weekend work, the fault is located and indicated. The actual repair work can be carried out at an appropriate time.

For the reliability of the power supply, it is decisive to maintain the good state of insulation. This is only possible by means of suitable monitoring devices. These devices cannot prevent insulation faults or the deterioration of the insulation. However, maintenance is considerably simplified by an early and quick detection with indication of the fault location.

In the past, fault location often was time-consuming and complicated. Frequently, weekend work was necessary to localise the fault with the installation shutdown.
The **modern EDS473 insulation fault location system** resolves these problems. Thanks to the automatic localisation of the insulation fault, the necessary repair becomes very simple, the required high insulation level is maintained. **Fault localisation is carried out during operation and it is not necessary to shut down the system.**

For setting up a power supply as IT system, the relevant regulations (IEC60364-4-41, DIN VDE 0100 T. 410) require that after the first insulation fault occurs, it must be eliminated as quickly as possible. These requirements can be met by means of the insulation fault location system EDS473. Thus, the risk of an interruption of the power supply due to a possible second fault is significantly reduced.

EDS473 is an open modular system. For this reason, it can at an optimum be adapted to the individual conditions of the system. Later extensions are very simple and require only few devices and set-up work.

## Operating range of the nominal voltage

The EDS473 system can universally be applied in DC, AC and 3 AC systems. AC and 3 AC systems can be monitored in a range of AC 20 to 265 V, DC systems in a range of DC 20 to 308 V. The operating range of the frequency is 45 to 65 Hz.

## Basic standards

The standard IEC61557-9 deals with devices for insulation fault location in operational IT AC systems, IT AC systems with galvanically connected DC circuits and IT DC systems. This international standard lays down special requirements for insulation fault location systems in IT systems of up to AC 1000 V and DC 1500 V.

BENDER's insulation fault location system EDS473 is based on this standard IEC61557-9. As far as possible, this operating manual attempts to use the terminology of the draft standard, including the term insulation fault location system. **This indicates that not only insulation faults with 0 Ω (earth faults) are found, but also insulation faults which involve higher resistance.**

**The CE mark, which all the components of the EDS473 system have, indicates compliance with the corresponding EC directives.**

## Use of the EDS system

The EDS473 system is commonly used for the insulation fault location in unearthed control voltage systems. The low test current of 1 or 2.5 mA will not lead to control errors even in sensitive systems (SPS, for example).

In control circuits even high resistant insulation faults can cause fault currents which then can lead to control errors. The quick location and elimination of these faults is therefore of elementary significance, especially in systems with safety orientated controls.
The EDS473 system is especially suitable for these high standards. Here are some important features of the system at a glance:

- use in IT systems AC 20-265 V and DC 20-308 V,
- automatic location of the faulty subcircuit,
- no system shutdown during the insulation fault location,
- early location of insulation faults thanks to the high response sensitivity,
- no influence on the control by the EDS473 system thanks to low test currents of 1 or 2,5 mA.

Common places of use for the EDS473 system are:

- power stations,
- chemical industry,
- IT systems with SPS,
- IT systems with 30 mA RCDs.

The EDS473 system is not suitable for electrical systems with high system leakage capacitances, excessively high leakage currents or high electrical interferences. In case of doubt ask a BENDER product specialist.

## For systems with higher voltages: EDS470

For the insulation fault location in control voltage systems with higher operation voltages the EDS470 is available:

| | AC systems | DC systems |
|---|---|---|
| without AGE470 coupling unit | 20-575 V | 20-500 V |
| with AGE470 coupling unit | 20-790 V | 20-960V |

## About this manual

The EDS470 operates with test currents of 10  or 25 mA which are uncritical in main power supply systems, but can be a problem in control voltage systems. The EDS470 system is not described in this operating manual. There are separate documents available.

Great care has been taken in the preparation of this manual. However, faults and errors can not be completely ruled out. BENDER shall not assume any liability for personal injury or damage to property resulting from faults or errors in this operating manual.

# 2 Safety instructions

## Intended use

The EDS473 system is exclusively designed for the location of insulation faults in IT systems of AC 20 to 265 V and DC 20 to 308 V. For this purpose, the fault curve in chapter OPERATING PRINCIPLE must be observed.
Any other use, or any use which goes beyond the foregoing, is deemed to be improper. The BENDER companies shall not be liable for any loss and damages arising therefrom.
In the following the EDS473 system is also referred to in the shortened form of EDS system.

Intended use also includes

- observing of all notes in the operating manual and
- adherence to any inspections intervals.

As a basic principle, our ”General Conditions of Sale and Delivery” shall apply. These shall be available to the operator no earlier than the time when the contract is concluded.

## Warranty and liability

Warranty and liability claims in the event of injury to persons or damage to property are excluded if they can be attributed to one or more of the following causes:

- improper use of the EDS473 system,
- improper assembly / fitting, commissioning, operation and maintenance of the EDS473 system,
- failure to take note of the operating instructions concerning transport, storage, assembly / fitting, commissioning, operation and maintenance of the EDS473 system,
- unauthorized structural modifications of the EDS473 system,
- failure to take note of the technical data,
- improperly performed repairs and the use of spare parts or accessories which are not recommended by the manufacturer,
- cases of disaster brought about by the effect of foreign bodies or force majeure,
- the assembly and installation of non-recommended combinations of devices.

In order to handle the EDS473 system in accordance with safety requirements and to ensure its trouble-free operation, the fundamental prerequisite is a knowledge of the basic safety information and the safety regulations.

## Personnel

Everyone who works with the EDS473 system must take note of this operating manual, and in particular of the safety regulations.
In addition to this, the rules and regulations concerning accident prevention which are valid for the operating location must be obeyed.

Only suitably qualified staff may work with the EDS473 system. The term ”qualified” means that such staff are familiar with the assembly, commissioning and operation of the product and that they have undergone training which is appropriate to their activities.

The EDS473 is built according to the state-of-the-art and the recognised safety engineering rules. During use, it is nevertheless possible that dangers will arise to the life and limb of the user or of third parties, or that the EDS473 system or other items of property may be impaired. The EDS473 must only be used:

- for the purposes for which it is intended
- when it is in perfect condition as regards safety engineering aspects

Any faults which might impair safety must be eliminated immediately. Inadmissible modifications, and the use of spare parts and additional devices which are not sold or recommended by the manufacturer of the devices may cause fires, electric shocks and injuries.

## Explanation of symbols and notes

The following designations and symbols for hazards and warnings are used in BENDER documentation:


This symbol means an immediate threat of danger to human life and health.
Failure to observe these warnings means that death, severe bodily injuries or substantial damage to property **will** occur if the corresponding precautions are not taken.


This symbol means a possible threat of danger to human life and health.
Failure to observe these warnings means that death, severe bodily injuries or substantial damage to property **may** occur if the corresponding precautions are not taken.


This symbols means a possible hazardous situation.
Failure to observe these warnings means that slight bodily injuries or damage to property may occur if the corresponding precautions are not taken.

This symbol gives important information about the correct way to handle the EDS473.
Failure to comply with this information may result in faults on the EDS473 or in its environment.

This symbol guides you to application tips and particulary useful items of information.
These will help you to make optimal use of all the functions on the EDS473.

## Inspection, transport and storage

Inspect the despatch and equipment packaging for damage, and compare the contents of the package with the delivery documents. In the event of transport damage, please notify the BENDER company immediately.
The components of the EDS473 must only be stored in rooms where they will be protected against dust, moisture, and sprayed or dripping water, and where the indicated storage temperatures are maintained.

## Warranty obligations

BENDER provides a warranty for fault-free execution and faultless material quality on the EDS473 with all its components for a period of 12 months as from the date of delivery, under normal operating conditions.
This warranty does not extend to any maintenance work, regardless of its nature.
The warranty is only valid for the initial purchaser, and does not extend to products or individual parts thereof which have not been correctly used or to which modifications have been made. Any warranty whatsoever shall lapse if the EDS473 system is operated under abnormal conditions.

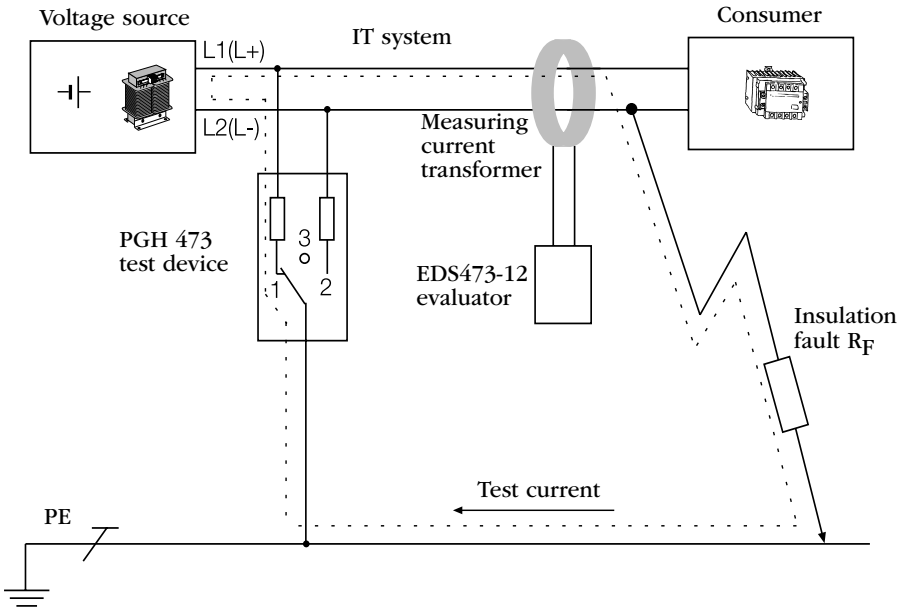
The warranty obligation is limited to the repair or exchange of a product which has been sent in to BENDER within the warranty period. It is also a qualifying condition of warranty that BENDER shall acknowledge that the product is faulty, and that the fault cannot be attributed to improper handling or modification of the device, or to abnormal operating conditions.

Any warranty obligation whatsoever shall lapse if repairs to the EDS473 are undertaken by persons who are not authorised by BENDER.
The foregoing warranty conditions shall apply exclusively, and in the place of all other contractual or legal warranty obligations, including (but not limited to) the legal warranty of marketability, suitability for use and expediency for a specified purpose of use.
BENDER shall not assume any liability for direct and indirect concomitant or consequent damages or losses, regardless of whether these may be attributable to legal, illegal or other actions.

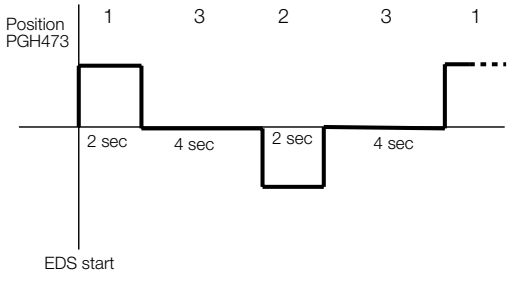
When a first insulation fault occurs in IT systems, a fault current flows which is essentially determined by the system leakage capacitances. The basic concept in fault location is therefore to close the fault current circuit for a short period over a defined resistance. As a result of this principle, the system voltage itself drives a test current which can be evaluated.

Caution

The test current is generated periodically by the PGH473. The test current is limited in amplitude and time. As this happens, the system conductors are connected alternately to earth over a defined resistance. The test current which is generated in this manner depends on the size of the present insulation fault, and on the system voltage. **It is limited to a maximum of 2.5 or 1 mA dependend on the setting of the PGH473**. For planning purposes, take care that no system components are present in which this test current can bring about a damaging reaction, even in unfavourable cases.




The test current pulse flows from the test device via the live leads, taking the shortest path to the location of the insulation fault. From there, it flows via the insulation fault and the PE back to the test device. This test current pulse is then detected by the measuring current transformers located in the insulation fault path, and is evaluated by the connected evaluator.



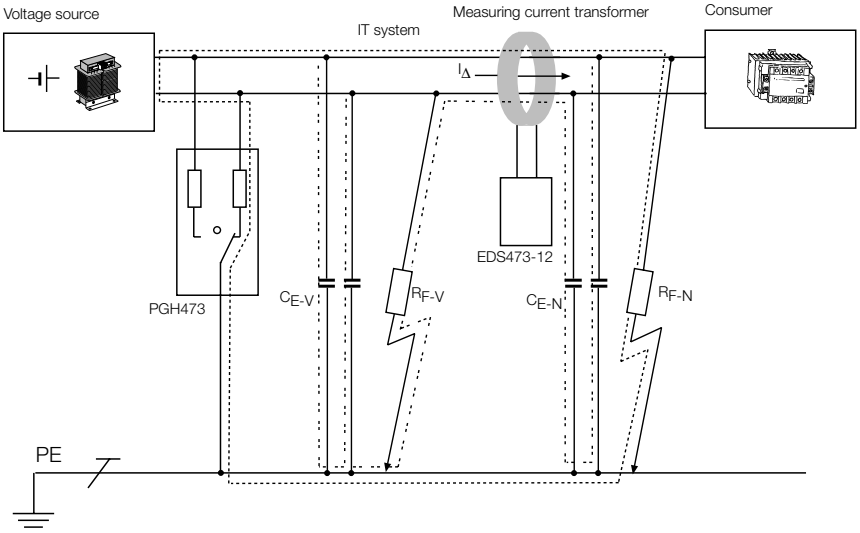

The test cycle of PGH473 in different switch positions (1, 2, 3) is shown in the diagram on the left.

## Response values

The response value is determined by the sensitivity of the insulation fault evaluator EDS473-12 (or EDS165-3). In DC as well as AC and 3 AC systems, this is **0.5 mA as an arithmetic mean value**.

The accuracy is +/- 0.2 mA of the displayed measurement value. System interferences and excessively high system leakage capacitances may have a negative influence on the accuracy. Information about the reachable sensitivity can be found in the chapter SETTINGS AND ADJUSTMENTS (characteristic curves 1-3).

In this operating manual, certain measurement engineering terms will occur repeatedly. The most important of these terms are demonstrated and explained with the help of the following sketch.




| | |
|---|---|
| $I_\Delta$ | Residual current through the measuring current transformer: $I_{\Delta max}$ > 1 A = FAULT (in AC systems) |
| $C_{E-V}$ | Upstream capacitances, system leakage capacitances upstream the measuring current transformer |
| $C_{E-N}$ | Downstream capacitances, system leakage capacitances downstream the measuring current transformer |
| $R_{F-V}$ | Insulation fault upstream the measuring current transformer |
| $R_{F-N}$ | Insulation fault downstream the measuring current transformer |
| PGH473 | Insulation fault test device |
| EDS473-12, EDS165-3 | Insulation fault evaluator |
| - - - - - - - - - - - | Loop of the test current $I_{pr}$ ($I_{pr\,min}$ = 0.5 mA, $I_{pr\,max}$ = 2.5/1 mA) |
| -- -- -- -- -- -- | Residual currents $I_\Delta$ (in AC systems) |

The insulation fault location system EDS473 detects insulation faults downstream of the measuring current transformer ($R_{F-N}$), subject to the condition that the test current is more than 0.5 mA.

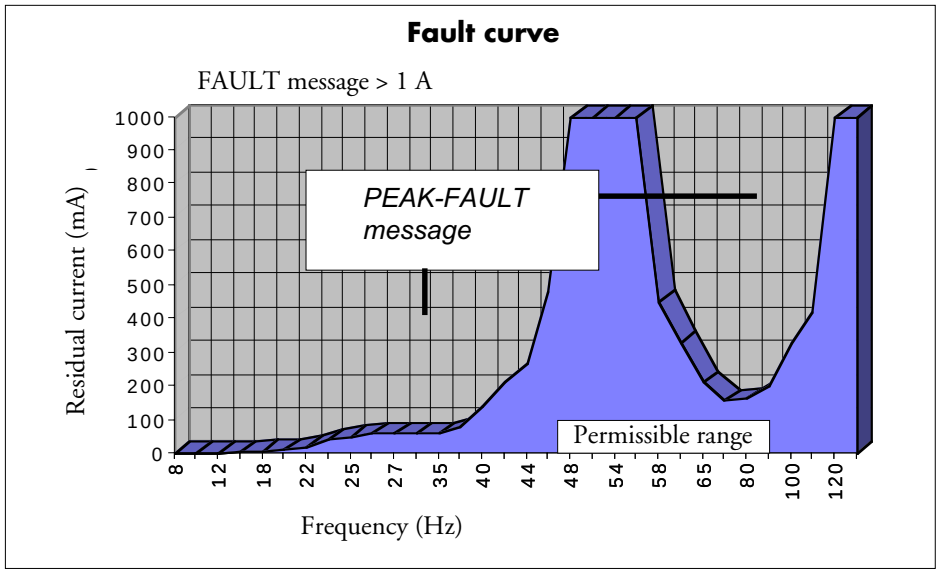
The total residual current through the measuring current transformer consists of the test current and the residual currents that develop from the capacitances $C_{E-V}$, $C_{E-N}$ and/or from insulation faults $R_{F-N}$.
The total residual current through the measuring current transformer may be a maximum of 1 A. If higher residual currents occur, a FAULT message to this effect is given, and no evaluation is possible on this channel. On this point, please refer to the FAULT curve on the next page as well.

The upstream capacitances $C_{E-V}$ must be at least as large as the downstream capacitances $C_{E-N}$ ($C_{E-V} \geq C_{E-N}$). If this condition is not satisfied, false tripping alarms may be given.

**Note:** under certain circumstances, balanced insulation faults downstream of the measuring current transformer are not detected.

## FAULT curve

The possible frequency range is shown by the curve (FAULT curve) which follows. This indicates the range in which residual currents are displayed as a FAULT. In general, residual currents > 1 A are displayed accordingly, and independently of the frequency.
Outside of the admissible range, PEAK-FAULT messages may be given if residual currents occur. Likewise, excessively high leakage capacitances can lead to PEAK-FAULT messages. These messages are indicated in the display of the EDS165-3 or PRC470.




*EDS473 electrical interference. The curve indicates the residual current from which on a PEAK-FAULT indication is given.*

A sophisticated filter circuit and electronic system avoids malfunctions due to residual currents < 1 A.

The FAULT LED is located in the front panel of the EDS473-12. It flashes to indicate the following states:

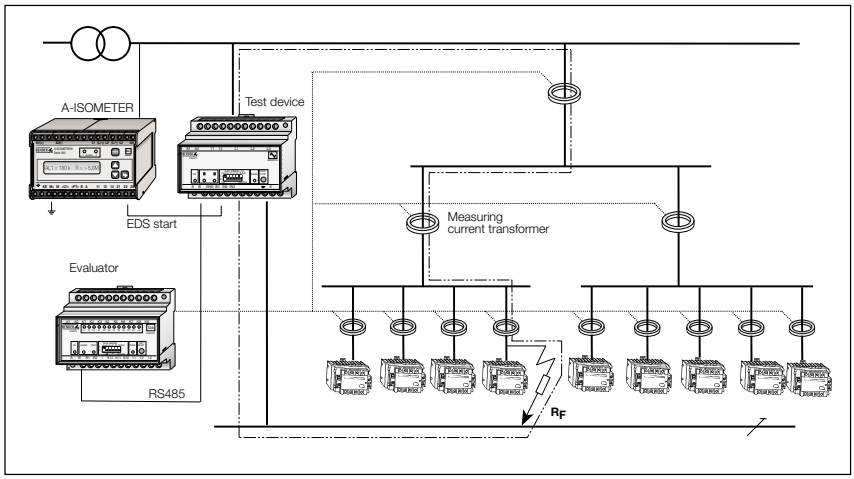
- short-circuited current transformer connection. The EDS system omits this current transformer subcircuit and continues with the subsequent one.
- Interrupted current transformer connecting lead, or no current transformer connected. The EDS system omits this current transformer subcircuit and continues with the subsequent one.
- A residual current > 1 A through the current transformer. The EDS system omits this current transformer subcircuit and continues with the subsequent one.
- The current transformer signal cannot be evaluated due to interferences. The EDS system makes max. **n** attemps to take a measurement at this current transformer subcircuit. In this case, **n** is the number of scanning cycles which has been set (PEAK) in menu 10 of the PRC470 (refer to the chapter on SETTINGS AND ADJUSTMENTS).
- The leakage capacitances in the system, or in a subcircuit of the system, are too high.

The FAULT LED itself does not distinguish which of the faults listed above has actually occurred. This information can be obtained from menu 5 (POSITION) of the PRC470. In the event of a short-circuited or interrupted current transformer connection, no explanation of the FAULT message will be given. Residual currents > 1 A are indicated by the display ”ID > 1 A”, and current transformer signals which cannot be evaluated are indicated by the display ”PEAK”.

## Basic components

A basic EDS473 system at least consists of the following components

- Insulation fault test device PGH473
- Insulation fault evaluator EDS473-12
- Measuring current transformers W1-35/8000, W08/8000 or WS50x80/8000




For insulation monitoring, an appropriate insulation monitoring device must be provided which starts the EDS system. **Devices of series IRDH265/365 and IR475LY… are especially suitable for this purpose.**

One insulation fault test device PGH473 is required for one system as well as one measuring current transformer for every subcircuit to be monitored. The measuring current transformers are connected to the evaluators EDS473-12. Up to 12 measuring current transformers can be connected to each EDS473-12, thus the number of required EDS473-12 results from the total number of measuring current transformers divided by 12.

For central control and information, the control and indicating device PRC470 should be used. The PRC470 allows important settings and display possibilities as well as adjustment to system interferences.

The PRC470 communicates with the insulation fault test device PGH473 and the evaluators EDS473-12 via an RS485 interface. On the LC display, it indicates amongst other information faulty subcircuits, informs about the insulation fault location system and controls the test sequence.

Except for the measuring current transformers, all devices are suited for installation into standard distribution panels according to DIN 43 871 and for DIN rail mounting according to DIN EN 50 022 or for screw mounting.

Additional components for system extension are described in chapter SYSTEM EXTENSIONS AND OPTIONS.

**With or without PRC470 ?**

The modular EDS473 system offers the possiblility to realize an economical insulation fault location with minimum equipment. This minimum equipment consists of

- insulation monitoring device of series IRDH265/365 or IR475LY (possibly already available),
- insulation fault test device PGH473,
- insulation fault evaluator EDS473-12.
- respective number of measuring current transformers.

Such a system can be used in simple interference-free IT systems.

In operation without the PRC470 and without a serial connection from the EDS473-12 to the PGH473, the EDS473-12 scans all the connected transformers in a rhythm of 25 seconds, even though the PGH473 insulation fault test device is not active. In this case, faults (ID > 1 A or interferences) can also be reported.

The control and indicating device PRC470 should be used for central control and information. Without the PRC470 you do without important setting and display possibilities as well as without adjustment to system interferences.

Apart from the control functions and the extended scanning possibilities, the PRC470 allows for adapting the EDS473 system to different system parameters. In addition, it makes the entire EDS473 system more comfortable and easier to use.

It is generally possible to retrofit an existing EDS473 system without PRC470 with a PRC470, if this becomes necessary due to modifications in the system.
Already during planning, the considerations and the decision for an EDS473 system with or without PRC must be made. In case of doubt, and EDS473 system with PRC470 must always be preferred. Ask for technical help from Bender if there are uncertainties.

If one or more of the following points apply, it is necessary to use a PRC470:

- important setting and display possibilities, for example the adjustment to system interferences,
- requirement for central scanning of all connected insulation fault evaluators,
- requirement for central control of all connected insulation fault evaluators and test devices,
- setting of different types of measuring current transformers,
- limitation of the current transformer scanning for each insulation fault evaluator,
- display of the test current for each measuring current transformer,
- targeted scanning of one measuring current transformer,
- serial connection to PCs by means of RS485 interface,
- requirement for central test functions.

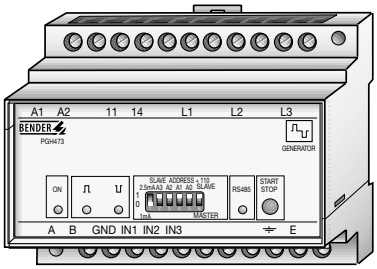
When several PGH473 or a PGH473 and a PRC470 are connected via the RS485 bus they work after the MASTER/SLAVE principle. In this case the PRC470 is the MASTER. All the other devices are SLAVES.
**As a basic rule:** in a EDS473 system there can be only one MASTER.

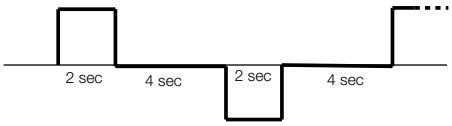
## PGH473

The PGH473 is activated by an external voltage free contact (e.g. NO contact of an insulation monitoring device).

The insulation fault test device PGH473 produces a test current signal if an insulation fault in a system occurs. To drive the test current, the existing voltage in the system is used. Thus, the value of the produced test current depends on the value of the existing insulation fault and the supply voltage. It is limited to max. 2.5 / 1 mA. The changeover beween 2.5 and 1 mA takes place via the DIP switch at the front plate.

The test current flows from the system via the PGH473 and then back to the system via the protective conductor (PE) and the insulation fault(s). The test current signal is detected by the measuring current transformers in the fault current circuit and the faulty subcircuits are indicated by the EDS473-12 or PRC470, when the response value of 0.5 mA is exceeded.
If the PGH473 is active, the cycle LEDs light up alternately during the respective test cycle.




*Time of the test cycle*

Danger !

If the device is connected to a system, which is live due to operation, by means of the terminals L1, L2, L3 (or L1, L2), the terminal ⏚ must not be separated from the protective earth conductor (PE).

Danger !

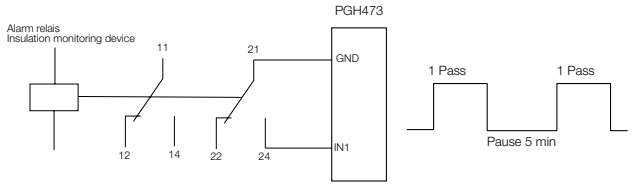
The test current flows between system and earth. In case of unfavourable constellations (insulation fault of low-impedance in conjunction with the test cycle), the possible influence of SPS controls by the test current of 2.5/1 mA has to be taken into account. This possibility must be considered before using the system.
Please take into consideration that depending on the type of equipment leakage currents may cause malfunctions.

Functions of the test device PGH473:

- Generation of the test current,
- limitation of the test current to 2.5 mA resp. 1 mA,
- starting insulation fault location e.g. via the contacts of the insulation monitoring device,
- communication with the control and indicating device PRC470 and the insulation fault evaluators EDS473-12 via the RS485 bus,
- the control of the disconnection from the insulation monitoring device with the internal contact 11/14,
- control of EDS473-12 for systems without a control and indicating device PRC470,
- control of the number of passes of the EDS473 system.

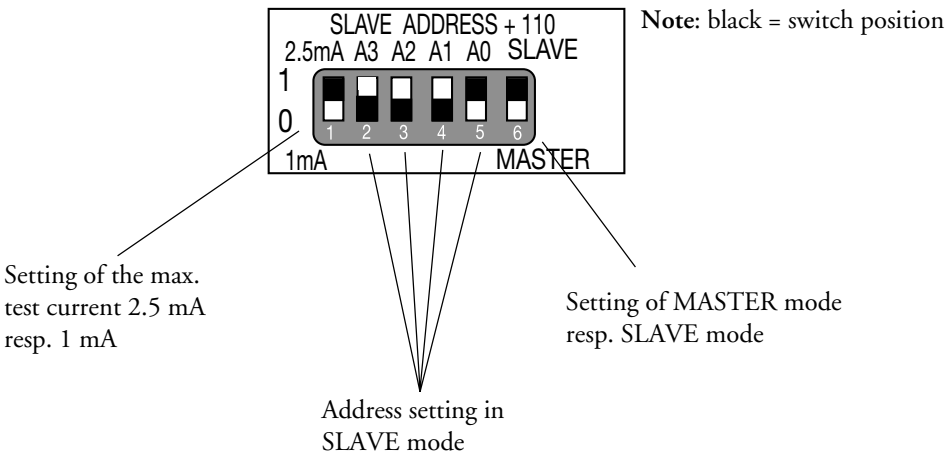
The insulation fault system is started by a potential-free NO contact on the insulation monitoring device. The following functions are possible in this case, depending on the particular connection:

- connection of the NO contact (21/24) to terminals **GND and IN1**:
  the insulation fault location runs as long as the contact is closed. After every pass of the system, there is a pause of 5 minutes during which the insulation monitoring device can record new measurement values.




- Connection of the potential-free NO contact to terminals **GND and IN2**:
  The insulation fault location is started **for one pass** after which it is stopped. To be able to start the EDS system again, the input must be closed for approximately 6 seconds.
- Connection of the NO contact (21/22) to terminals **GND and IN3**:
  Suppression of the test cycle. No test cycle is emitted. This function is required if the insulation fault location system is monitoring several IT systems, and is being controlled centrally by one PRC470. In this case, a test cycle can only be emitted by the PGH473 insulation fault test device in the IT system where the insulation fault has occurred.
  **Note:** this kind of connection only makes sense in coupled systems.

**DIP switch PGH473**



## Address setting PGH473

**Switch position for address setting**

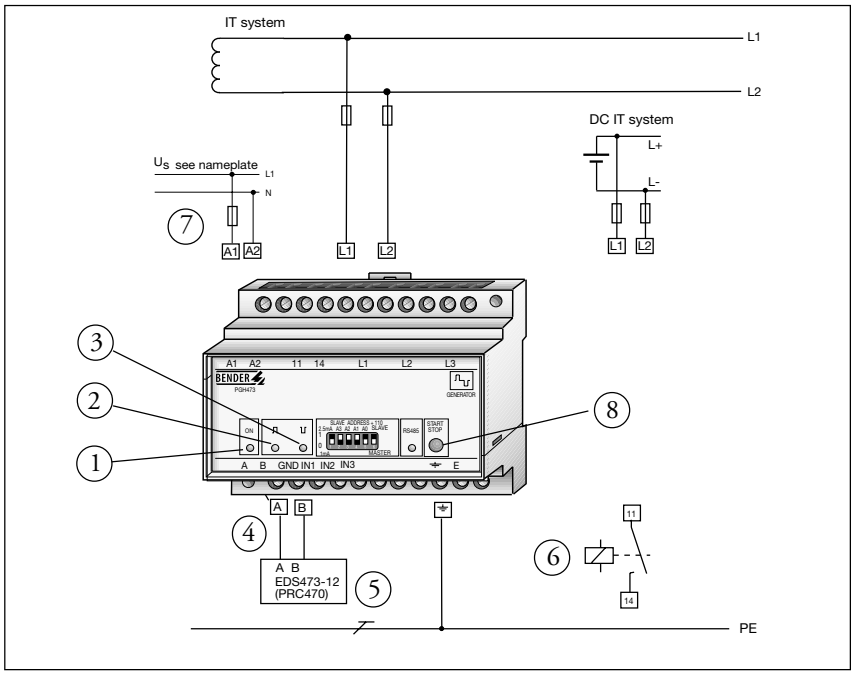
| Adress | A3 | A2 | A1 | A0 |
|---|---|---|---|---|
| 111 | 0 | 0 | 0 | 1 * |
| 112 | 0 | 0 | 1 | 0 |
| 113 | 0 | 0 | 1 | 1 |
| 114 | 0 | 1 | 0 | 0 |
| 115 | 0 | 1 | 0 | 1 |
| 116 | 0 | 1 | 1 | 0 |
| 117 | 0 | 1 | 1 | 1 |
| 118 | 1 | 0 | 0 | 0 |
| 119 | 1 | 0 | 0 | 1 |

9 different address settings are possible. Thus, up to 9 PGH473 can be controlled with one PRC470.

* factory setting

**Notes:**
During fault location of the EDS473 the switch positions must not be changed. In the MASTER position, the device is operated without PRC470 and represents the MASTER itself.
In the SLAVE position, the PRC470 represents the MASTER. In this case, the address and the maximum test current can be set via the DIP switch.

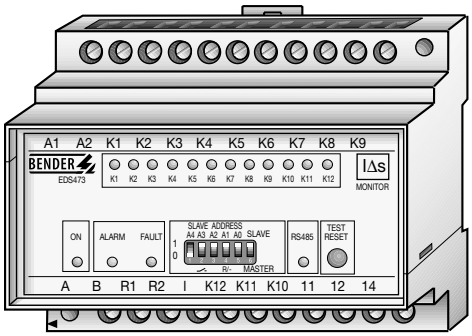
## Wiring diagram PGH473




1 Power On LED
2 LED to indicate the positive test cycle
3 LED to indicate the negative test cycle
4 RS485 interface for the connection to the evaluators EDS473-12 and to the control and indicating device PRC470
5 Insulation fault evaluator EDS473-12 (or PRC470)
6 Output relay with 1 NO contact in N/O operation
7 Fuse supply voltage (6 A) (two-pole in an IT system)
8 Start/Stop button for manual control of the EDS473 system

**Note:** Each PGH473 is delivered with 2 resistors 120 Ω/0.4 W to terminate the serial interface.

## EDS473-12




The EDS473-12 is controlled by means of a microcontroller. Together with the measuring current transformers it is used to evaluate the test current signals generated by the PGH473. Up to 12 measuring current transformers can be connected.

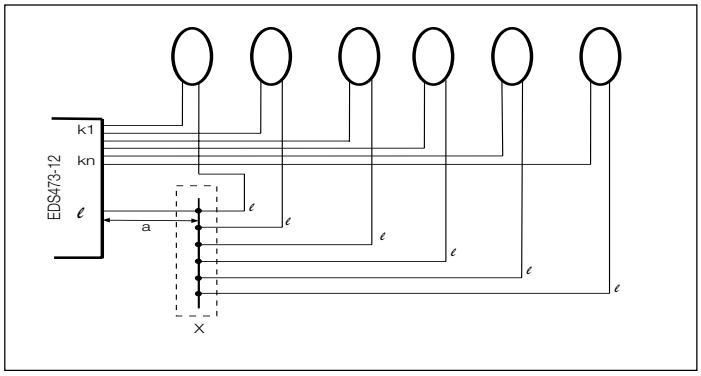
In a given time pattern which is synchronized with the test cycle of the PGH473, the device subsequently evaluates the signals from all measuring current transformers. If the fault current detected by a measuring current transformer exceeds the response value, the respective alarm LED and the alarm LED light up and the alarm relay switches. The alarm relay outputs a collective message for all measuring channels.
When operating without an interface connection, the memory behaviour is set at the EDS473-12 itself. When operating with the control and indicating device PRC470, the memory behaviour is set via the PRC470.
If fault memory is activated, the fault message of a channel remains stored until the RESET key is pressed or System-Reset at the PRC470 is activated.

Some settings can only be carried out by means of the control and indicating device PRC470. The settings

- **split-core measuring current transformer; or no current transformer connected**
- **change of memory behaviour,**
- **change of N/O operation N/C operation,**
- **PEAK,**
- **number of the connected measuring current transformer**

are only possible via a control and indicating device PRC470.

A system-reset and the reset of all alarm messages also can only be carried out via a PRC470.




Connection 1 of the measuring current transformer must be wired in a star connection to the common terminal block X.

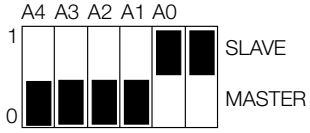
The maximum cable length (a) of the common 1-connection to the terminal block X is:

25 cm for a wire cross section of 2.5 mm²
15 cm for a wire cross section of 1.5 mm²

The terminal block must not be earthed!

## DIP switch EDS473-12

The DIP switches for setting the device parameters are partially double assigned. The function of the individual switches depend on the setting SLAVE or MASTER.



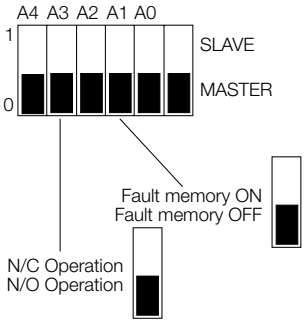

**Note:**
Black = switch position

In the **SLAVE position**, the device is operated with a control and indicating device PRC470 or an insulation fault test device PGH473. In this case, only the setting of the address EDS473-12 by means of the table below is possible. The initial setting is address 001.

Address setting EDS473-12

| Adr. | A4 | A3 | A2 | A1 | A0 | |
|---|---|---|---|---|---|---|
| 1 | 0 | 0 | 0 | 0 | 1 | * |
| 2 | 0 | 0 | 0 | 1 | 0 | |
| 3 | 0 | 0 | 0 | 1 | 1 | |
| 4 | 0 | 0 | 1 | 0 | 0 | |
| 5 | 0 | 0 | 1 | 0 | 1 | |
| 6 | 0 | 0 | 1 | 1 | 0 | |
| 7 | 0 | 0 | 1 | 1 | 1 | |
| 8 | 0 | 1 | 0 | 0 | 0 | |
| 9 | 0 | 1 | 0 | 0 | 1 | |
| 10 | 0 | 1 | 0 | 1 | 0 | |
| 11 | 0 | 1 | 0 | 1 | 1 | |
| 12 | 0 | 1 | 1 | 0 | 0 | |
| 13 | 0 | 1 | 1 | 0 | 1 | |
| 14 | 0 | 1 | 1 | 1 | 0 | |
| 15 | 0 | 1 | 1 | 1 | 1 | |
| 16 | 1 | 0 | 0 | 0 | 0 | |
| 17 | 1 | 0 | 0 | 0 | 1 | |
| 18 | 1 | 0 | 0 | 1 | 0 | |
| 19 | 1 | 0 | 0 | 1 | 1 | |
| 20 | 1 | 0 | 1 | 0 | 0 | |
| 21 | 1 | 0 | 1 | 0 | 1 | |
| 22 | 1 | 0 | 1 | 1 | 0 | |
| 23 | 1 | 0 | 1 | 1 | 1 | |
| 24 | 1 | 1 | 0 | 0 | 0 | |
| 25 | 1 | 1 | 0 | 0 | 1 | |
| 26 | 1 | 1 | 0 | 1 | 0 | |
| 27 | 1 | 1 | 0 | 1 | 1 | |
| 28 | 1 | 1 | 1 | 0 | 0 | |
| 29 | 1 | 1 | 1 | 0 | 1 | |
| 30 | 1 | 1 | 1 | 1 | 0 | |

* Factory setting

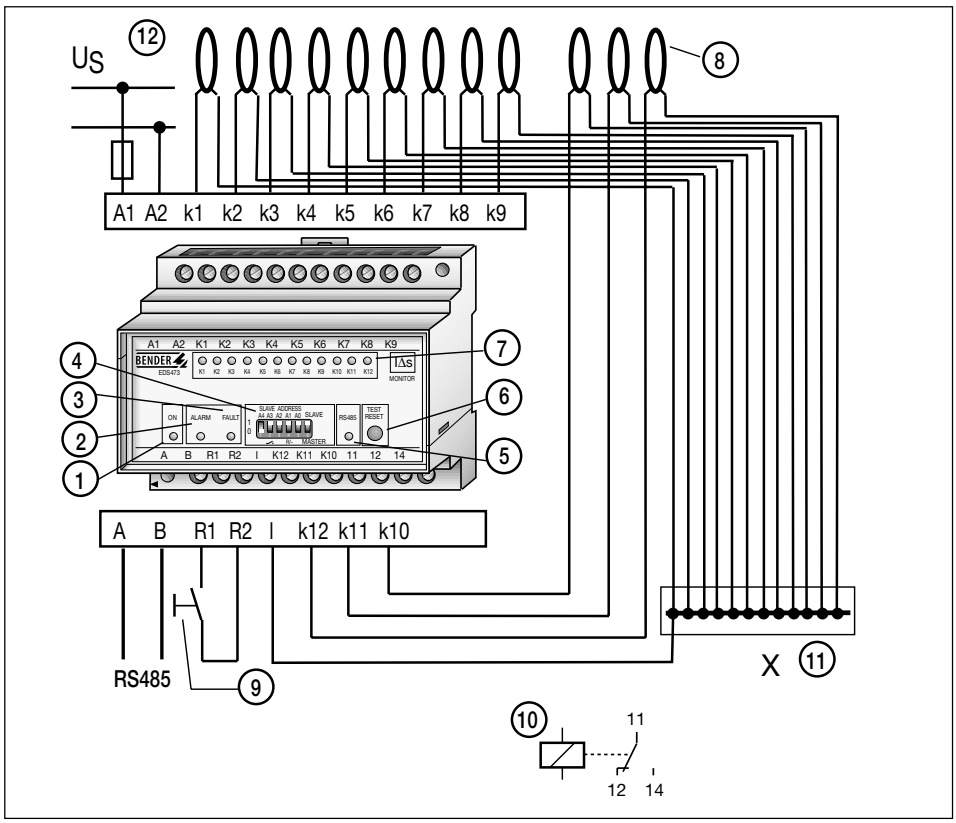



**Note:**
Black = switch position

In the **MASTER setting**, the device is operated without interface connection and represents the MASTER itself. In this case, the operating mode of the alarm relay and the memory behaviour are set by means of the DIP switch. The position of the switches A4, A2 and A0 is insignificant in this case.

If there is no interface connection with PGH473, all measuring current transformers are continuously scanned in succession in this operating mode, even though the PGH473 is not yet active. In the course of this faults (e.g. FAULT) can be indicated but the alarm relay does not switch.

**Wiring diagram EDS473-12**



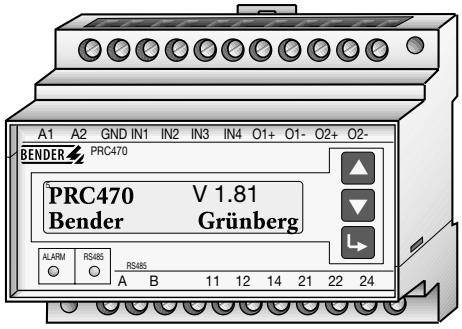

1 Power On LED
2 LED "alarm" lights up when the response value is exceeded in one or more channels (test current through the respective measuring current transformer > 0.5 mA).
3 LED "fault" flashes when during the evaluation of a measuring current transformer signal
- the measuring current transformer is short-circuited,
- no measuring current transformer is connected or the connecting lead is interrupted,
- a residual current of > 1 A flows through the measuring current transformer (refer to FAULT curve about that),
- the measuring current transformer signal cannot be evaluated due to interferences.

4 DIP switch device settings.
5 LED lights up if RS485 is active and transmits data.
6 Combined test and reset button. Press < 1 sec: Reset, > 2 sec: Test.
7 Alarm LEDs light up when the threshold is exceeded in the respective channel.
8 Measuring current transformer.
9 External TEST / RESET button, with the same function as button (6).
10 Alarm relay switches when a channel has responded (collective message).
11 Terminal block X for connections 1 of the measuring current transformers.
12 Fuse 6 A

**Attention:** keep the common connection between terminal 1 of the EDS473-12 and terminal block X as short as possible. The maximum length is 25 cm for a cross section of 2.5 $mm^2$ or 15 cm for a cross section of 1.5 $mm^2$. If longer cables are used, the function of the current transformer monitoring cannot be guaranteed.

## PRC470

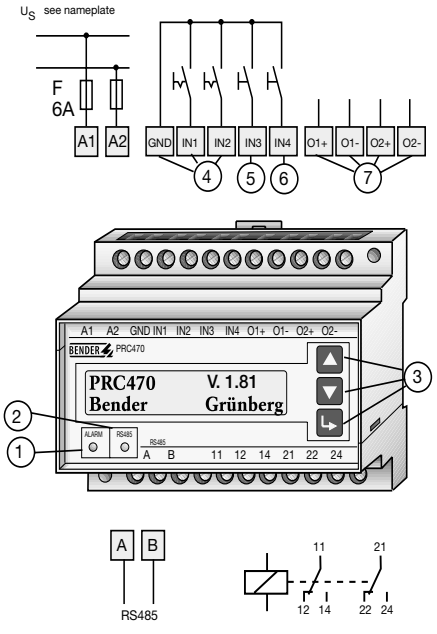
In an EDS473 system, the control and indicating device PRC470 takes over the central control and monitoring function. The information exchange between the individual components of the EDS473 system takes place via the RS485 interface.




**Within the system, the PRC470 takes over the following functions:**

- starting the insulation fault location, alternatively via the menu keys, digital inputs or RS485 interface. **Recommondation: start via the test device PGH473 and a serial interface connection to PGH473.**
- Control and synchronisation of the test cycle together with the test device PGH473 and the evaluator EDS473-12, including a better detection of insulation faults in case of interferences in the system.
- Display of the measuring current transformer subcircuits in which the measured value was exceeded. The respective test current is displayed.
- Display of the measuring current transformer subcircuits in which the connection to the measuring current transformer is interrupted or short-circuited (connection monitoring).
- Setting of the fault memory, setting of the operation mode of the alarm relays (N/O or N/C operation).
- Setting of the measuring current transformer types used on the EDS473-12.
- Test functions for testing all devices connected via RS485 interface including testing of the measuring current transformer circuits.
- Position functions, specific scanning of individual measuring current transformers.
- Elongation of the measuring time for current transformer subcircuits under fault condition (Peak function).

## Wiring diagram PRC470




1 Power On LED.
2 RS485-LED, shows activities of the RS485 bus.
3 Operator buttons for the menu control.
4 Inputs GND/IN2 resp. GND/ IN2: system start.
5 Input GND/IN3: system reset.
6 Input GND/IN4: introduces a system test that must be continued interactively via the operator buttons.
7 Inputs O1 … O2: are not used within an EDS473 system.

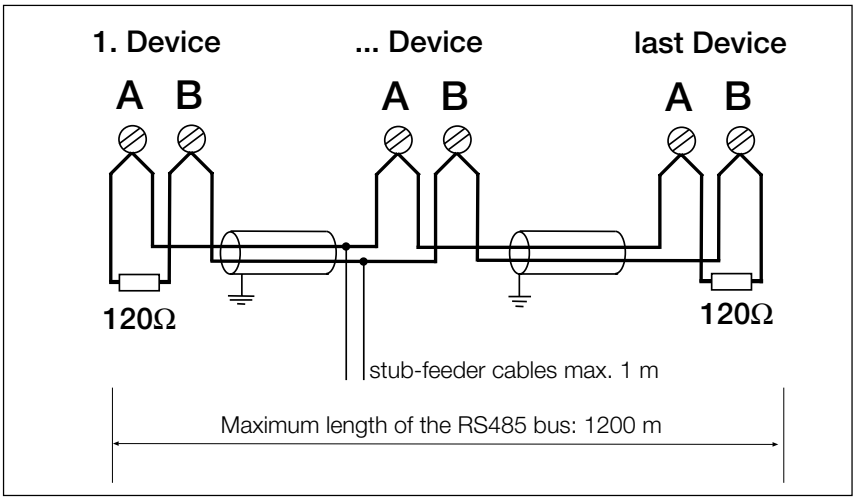
## Serial interface RS485

The communication between several evaluators EDS473-12 and with the control and indicating device PRC470 as well as the test device PGH473 is carried out by means of a standardized serial interface RS485. The interface is a two-wire connection (device terminals A and B).
The specification of the interface RS485 restricts the maximum cable length of the bus to 1200 m. For longer cables, additional measures (installation of repeaters, see chapter SYSTEM EXTENSIONS AND OPTIONS) are necessary.

If interface cables are realized as subcircuits, the maximum cable length is restricted to 1 m. Longer subcircuit cables must be tested taking into consideration the conditions of the respective installation. The safe communication cannot be guaranteed for longer stub-feeder cables.

## Terminating serial interface

The serial connection must be terminated at both ends with a resistor of 120 Ω (0.4 W) (see picture). For each PRC470 and each PGH473 are 2 resistors included. **Attention: stub-feeder cables are not terminated.**




The standardized interface RS485 allows a connection with other RS485 devices. Such devices can be computer systems, SPS controls, etc. Users can write and use their own programs, provided that they have a good knowledge of interface programming, and are familiar with the interface protocol which is used and the EDS473 commands. The data transfer protocol is a special format for BENDER measuring device interfaces (BMS protocol).
Information about the interface commands can be requested from BENDER.

The data transfer is generally carried out by means of ASCII characters. The interface data are:

| | |
|---|---|
| Baud rate: | 9600 baud |
| Transfer: | 1 start bit, 7 data bits, 1 parity bit, 1 stop bit (1,7,E,1) |
| Parity: | even (P=0) |
| Checksum: | sum of all bytes transferred = 0 (without CR and LF) |
| Adress: | 001 … 255 and 000 (= general adress) |

## Interface protocol

Protocols:

| | |
|---|---|
| Master | :;XXX:ABCDE 12345&XYZ<CR><LF> |
| Slave | ::XXX:ABCDE 12345&XYZ<CR><LF> |

| | |
|---|---|
| :; | Detection start of transfer Master |
| :: | Detection start of transfer Slave |
| XXX | Adress |
| : | Startbyte for command |
| ABCDE | Command consisting of 5 ASCII characters max. |
| (blank) | Start byte for data |
| 12345 | Data consisting of 5 ASCII characters max.<br>Content: 65 535 |
| & | Start byte for checksum |
| XYZ | Checksum consisting of 3 ASCII characters max. |
| <CR><LF> | End of transfer (carriage return, line feed) |

The command and the data can be smaller than 5 bytes or be entirely omitted. The end is detected by means of the start byte of the next character type.

## Addresses

| | | |
|---|---|---|
| **Adresses:** | 000 | General address, applies to all devices connected to the interface. |
| | 001 … 030 | Insulation fault evaluator (e.g. EDS473-12) |
| | 031 … 060 | Signal converter SMO480-12 |
| | 091 … 099 | A-ISOMETER |
| | 100 | PRC470 |
| | 101 … 103 | Additional masters (e.g. PC) |
| | 111 … 119 | PGH473 |

## Measuring current transformers

The measuring current transformers W1-35/8000, W08/8000 and WS50x80/8000 convert the residual currents into an AC current which can be evaluated.
According to the local conditions, they are either directly mounted on the cable or by means of appropriate mounting brackets.

The following measuring current transformers are suitable for the EDS473 system:

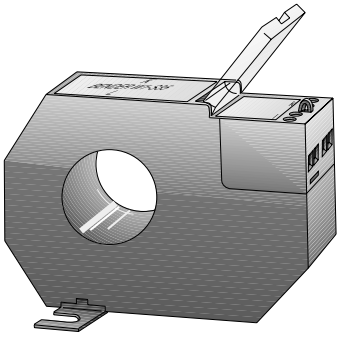
| Type | Internal diameter | Design | Setting PRC470 menu | Connection |
|---|---|---|---|---|
| W1-35/8000 | 35 mm | Circular | Standard | Screw terminals |
| W08/8000 | 8 mm | Circular | Standard | Cabel |
| WS50x80/8000 | 50x80 mm | Split-core | Split-core | Screw terminals |

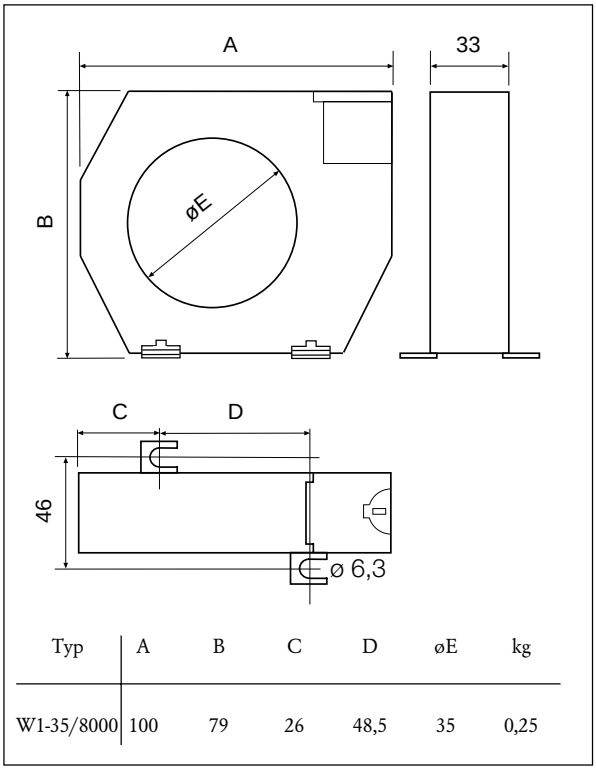
*These measuring current transformers have an integrated suppressor circuit.*

When using split-core measuring current transformers WS50x80/8000 the EDS473-12 must be set to "split-core measuring current transformers" in the software menu (m8 – set sensor) by means of the PRC470.

**Note:** other measuring current transformers which are commercially available are not suitable for the EDS473 system and must not be used.

## Measuring current transformer W1-35/8000

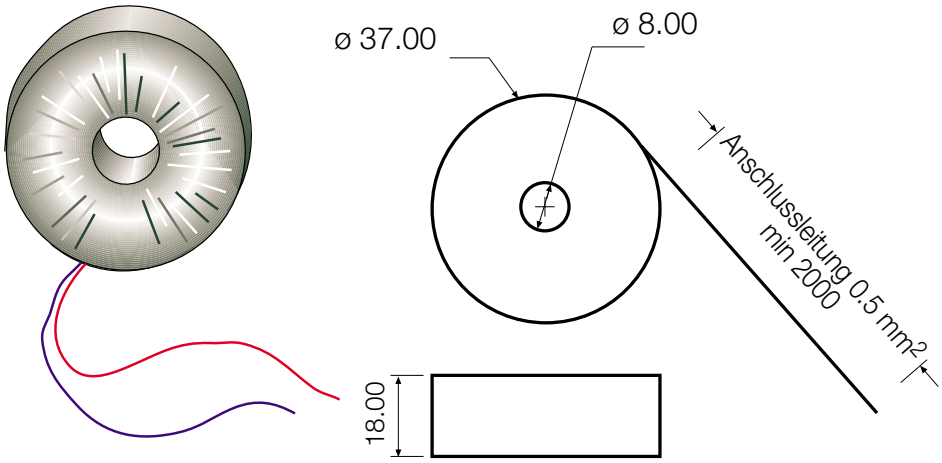





| Typ | A | B | C | D | øE | kg |
|---|---|---|---|---|---|---|
| W1-35/8000 | 100 | 79 | 26 | 48,5 | 35 | 0,25 |

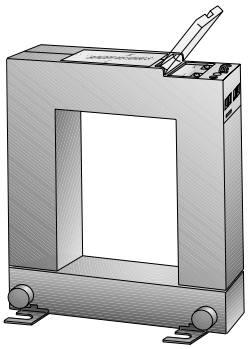
Dimensions in mm

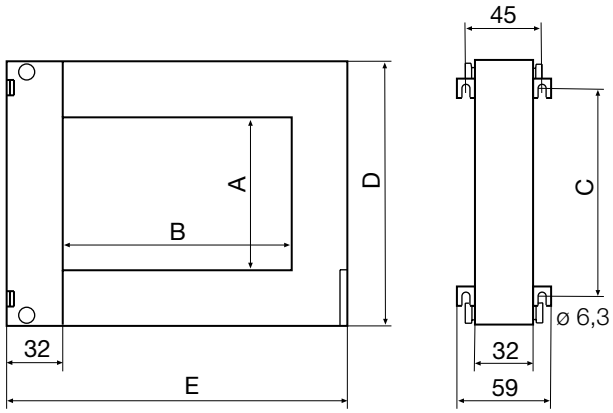
## Measuring current transformer W08/8000




Dimensions in mm

## Split-core measuring current transformer WS50x80/8000






Dimensions in mm

| Type | A | B | C | D | E | Weight |
|---|---|---|---|---|---|---|
| WS50x80/8000 | 50 | 80 | 78 | 114 | 145 | 0,90 kg |

## Insulation monitoring devices

The EDS473 system itself does not include an insulation monitoring device. Nevertheless, it is an indispensable component of any IT system and is urgently demanded by the international standard IEC 60364-4-41. In most cases, a monitoring concept with an EDS473 system is structured as follows:

- continuous insulation monitoring with a suitable insulation monitoring device.
- Advance warning if the value falls below a specified insulation resistance, (e.g. 100Ω/V) using response value 1 of the insulation monitoring device (11/12/14).
- If the insulation value falls below the response value 2 of the insulation monitoring device, the EDS 473 system will be started through the alarm contact of the insulation monitor connected to the inputs GND/IN1 or GND/IN2 of the insulation fault test device.

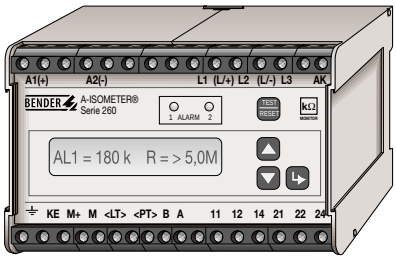
BENDER types IRDH265/365 and IR475LY are suitable insulation monitoring devices. These devices operate with the patented AMP measuring principle. With this *"adaptive measuring pulse"* measuring principle, it is possible to determine the insulation resistance of an IT system in a manner which is both reliable and (to a large extent) independent of the system conditions (DC leakage currents, leakage capacitances, or low-frequency interference signals).

## IRDH265-3 IRDH365-3

There are different versions available:

IRDH265-3
Plastic enclosure suitable for DIN rail mounting or screw mounting.

IRDH365-3
Enclosure for surface mounting 144x72 mm.



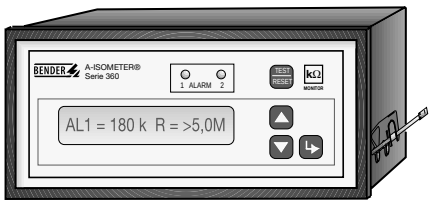

*IRDH265*

IRDH265-3 and IRDH365-3
Internal DC resistance: 28 kΩ
Response value $R_{Alarm1}$ and $R_{Alarm2}$:
2 … 200 kΩ (factory preset 40/10 kΩ)
Operating range of the nominal voltage:
AC 0 … 500 V, 0.5 … 400 Hz, DC 0 … 285 V
Max. system leakage capacitance: 500 µF (factory preset).

The setting of the device parameters is carried out via the operator buttons and the LC display.

Special notes for the use of the IRDH265/365-3:

- software version must be at least V. 2.5 (see nameplate),
- use contacts 11/12/14 for prewarning (alarm 1),
- use contacts 21/22/24 for starting the EDS473 (alarm 2),
- operating mode alarm relay: N/O, operation (corresponds to factory preset)
- coupling monitoring: deactivated (**no factory setting**),
- measuring principle: AMP (corresponds to factory preset),
- set the insulation monitoring device to test mode via the terminals PT during EDS fault location (see wiring diagrams),
- disconnect the insulation monitoring device from the system during the pass of the EDS473 (see chapter "Disconnection of the insulation monitoring device"),
- fault memory OFF (remove bridge <LT>).




*IRDH365*

## IRDH265-4
## IRDH365-4

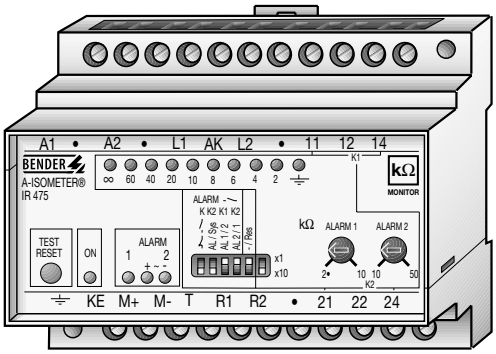
The versions IRDH265/365-4 correspond to the already introduced versions IRDH265/365-3 with following differences:

| | |
|---|---|
| Internal DC resistance: | 120 kΩ |
| Response value $R_{Alarm1}$ and $R_{Alarm2}$: | 10 … 990 kΩ (factory preset 180/40 kΩ) |
| Max. system leakage capacitance: | 500 µF (factory preset 150 µF) |

## IR475LY-4

In contrast to the IRD265/365-X series, the IR475LY insulation monitoring device does not have an LC display. All the device parameters are set by means of hardware.

Plastic enclosure with 45 mm cutout, for DIN rail mounting or screw mounting.




*IR475LY-4*

| | |
|---|---|
| Internal DC resistance: | 200 kΩ |
| Response value $R_{Alarm1}$: | 2 … 100 kΩ; $R_{Alarm2}$ : 10 … 500 kΩ |
| Operating range of the nominal voltage: | (3) AC 0 … 820 V, 15 … 400 Hz, DC 0 … 480 V |
| Max. system leakage capacitance: | 20 µF |

Special notes for the use of the IR475LY:

- use contacts 11/12/14 for prewarning (alarm 1),
- use contacts 21/22/24 for starting the EDS473 (alarm 2),
- operating mode alarm relay: N/O operation (corresponds to factory preset),
- set the insulation monitoring device to test mode via the terminal <T> during EDS fault location (see wiring diagrams),
- fault memory OFF.

## Recommendations for Isometer selection

**Recommendations**:

The **IR475LY** insulation monitoring device is suitable for use with the EDS473 system over the entire voltage range (AC 20-265, DC 20-308 V).

For the IRDH265/365 series:

Use the IRDH265/365-3 versions in DC systems with 24 V nominal voltage.
Use the IRDH265/365-4 versions in DC systems with nominal voltages above 24 V.

When using devices in AC systems, decide by means of the response range of the devices which version is more suitable for your use.

## Planning assistance

The EDS473 system is simple for the user to plan and install. Detailed planning assistance you can find in the operating manual "planning assistance for EDS systems" (TGH 1282). The following basic points should be taken into consideration during planning:

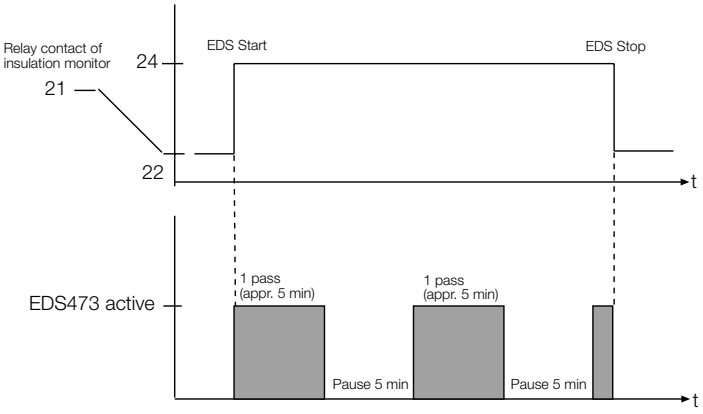
- nominal voltage of the system to be monitored.
- Number of the subcircuits to be monitored?
- Which measuring current transformer diameter is required?
- Which type of measuring current transformer is appropriate? Might any split-core measuring current transformers be required?
- Specify the number of the EDS473 devices which are required. To obtain the number, divide the number of measuring current transformers by 12.
- Consider the cable length between the measuring current transformer and the insulation fault evaluator.
- Shall all the EDS473-12 devices be controlled centrally via one PRC470? Indeed, is a PRC470 indispensable due to complexity of the system or due to interference influences?
  Note: one PRC470 can control up to 30 EDS473-12, that is to say up to 360 measuring current transformer subcircuits.
- Take account of the measuring time for the system. Note: the measuring time does not increase if additional EDS473-12 insulation fault evaluators are installed, since all EDS473-12 are scanned in parallel.
- Consider the length of the interface cable between the individual devices! The total cable length must not exceed 1200 m. Stub-feeder cables must be limited to a maximum of 1 m in length.
- Are any particular interferences to be expected in the system? The cases of such interferences may include variable-speed drives, power converters, actuators, suppressor filters, SPSs, or controlling elements which cause DC parasitics or transients. In these cases, please speak with BENDER´s product specialists.

**Insulation fault location system without a PRC470:**
Connect the PGH473 and EDS473-12 in series via the RS485 bus. Set the PGH473 as MASTER and all the EDS473s as SLAVES.

**Insulation fault location system with a PRC70:**
Connect the PRC470, PGH473 and the EDS473s in series via the RS485 bus. Set the PRC470 as MASTER (factory setting) and PGH473 as well as all the EDS473s as SLAVES.

**Starting the insulation fault location system:**
A potential free output contact (change-over contact) should be used in order to start up. In this case, the NO contact shall be connected to terminals GND/IN1…IN2 of the PGH473. Important: never use both the inputs IN1 and IN2 at the same time.

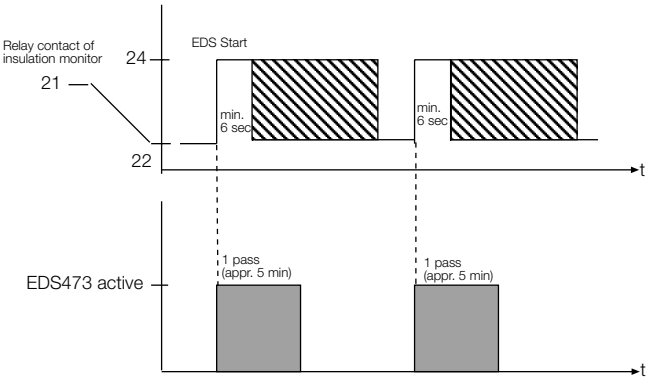
- Connection of the NO contact (21/24) to the terminals **GND and IN1**:
  The insulation fault location is started and is continued as long as the contact is closed. After each pass there is an idle period for 5 minutes in which the insulation monitoring device can detect new measuring values. In systems with low interferences the maximum measuring time for one pass (max. 360 measuring current transformer) is approx. 5 minutes.




The EDS473 system can be stopped by:

- opening of GND/IN1,
- operating the STOP button on the PGH473,
- software stop in menu 2 (EDS START) of the PRC470,
- closing GND/IN3.

- Connection of the NO contact to terminals **GND** and **IN2**:
  The insulation fault location is started for **one pass** after which it is stopped. To be able to start up the EDS473 system again, the input must be closed for approximately 6 seconds.




The EDS473 system can be stopped by:

- operating the STOP button on the PGH473,
- software stop in menu 2 (EDS START) of the PRC470,
- closing GND/IN3.

- Connection of the NO contact to terminals **GND** and **IN3**:
  Suppression of the test cycle. No test cycle is emitted. This function is required if the insulation fault location system is monitoring several systems, and is being controlled centrally by one PRC470 as it does so. In this case, a test cycle can only be omitted by the PGH473 insulation fault test device in whose IT system the insulation fault has occurred.
  **Note:** this kind of connection only makes sense in coupled systems.

Please consider the length and cross section of the current transformer connecting cables and interface cables listed in the technical data.

## Notes on the measuring period

Each channel is scanned for approx. 24 seconds. This corresponds with two positive and two negative impulses each of the test current with the pauses in between.
If a fault (FAULT) is detected, the measurement is interrupted early and the system switches over to the next channel. The following occurrences are considered as faults:

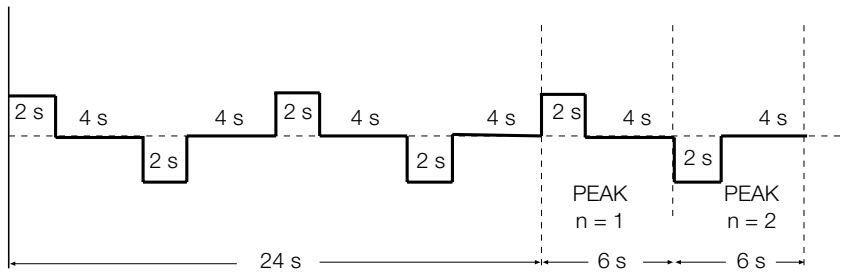
- short-circuit in the measuring current transformer connection,
- interruption to the measuring current transformer connection,
- residual current > 1 A (consider FAULT curve!).

Residual currents > 1 A can occur in systems with high operating currents or high system leakage capacitances.

**Note:** in the case of residual currents which vary from the admissible system frequency, a PEAK FAULT signal is given. In this case, the EDS473-12 measures a **maximum of n** times. **n** corresponds here to the number of PEAKS which are set in menu 10 of the PRC470. This also applies if there are excessively high leakage capacitances in the system or in one subcircuit of the monitored system.

The maximum measuring time for a cycle of the insulation fault evaluator EDS473-12 thus is approx. 5 min. (24 sec x 12 channels). This also applies when several EDS473-12 are operated with one PRC470, since all EDS473-12 are scanned in parallel.The maximum measuring time given above only applies to the standard setting PEAK=1 in the menu 10 of the PRC470 and if there are no or only very low interferences in the system. Please note the explanations concerning menu 10 in chapter SETTINGS AND ADJUSTMENTS.
The PEAK setting is carried out at the PRC470. Increasing the PEAK value increases the statistic probability of detecting an insulation fault in systems with interferences. PEAK corresponds to the maximum number of the set scanning cycles per measuring current transformer. However, it is not always necessary to pass the maximum number of PEAKs. As soon as the insulation fault is found, the system switches over to the next channel (measuring current transformer).

Zeitlicher Ablauf der Messung eines Kanals




The maximum total measuring time t results from the measuring time of one channel multiplied by the number of measuring current transformers connected.

$$t = a \cdot (24\ s + n \cdot 6\ s)$$

n = Setting of the PEAKs in menu 10 of the PRC470 and
a = the number of measuring current transformers connected to an EDS473-12

## Coordination with the insulation monitoring device

A prerequisite for operating the EDS473 system is a central insulation monitoring device. If an insulation fault falls below the set response value of the insulation monitoring device, this device activates the insulation fault location system EDS473. Depending on the type of the system, either the test device PGH473 is directly activated or the control and indicating device PRC470 is activated. Apart from system start by means of the insulation monitoring device it also can be started manually.

When choosing the insulation monitoring device, the condition of the entire installation must be considered. It is highly recommendable to use a device of the series IRDH265/365 or IR475LY. By means of this device DC, AC and 3AC systems can be monitored. Due to the AMP measuring principle, mixed systems or systems with variable-speed drives are also safely monitored.

During insulation fault location an active measurement of the insulation monitoring device is not possible because of the test current generated by the PGH473. It will be decoupled from the system and be set into an internal test mode.

As a basic rule the measurement input of the insulation monitoring device on the coupling side has to be disconnected from the system for the duration of the insulation fault location via the contact 11/14 of the PGH473. This will avoid influencing the response sensitivity. This applies to all insulation monitoring devices.

Reason: for safety reasons, the test current of the EDS473 system is restricted to 2.5 mA resp. 1 mA. If the insulation monitoring device remains connected during insulation fault location, part of the test current flows to earth via the internal resistance of the device. Thereby the sensitivity of the system is reduced. The degree of the influence depends on the internal DC resistance $R_i$ of the insulation monitoring device and the value of the insulation fault.

However, if several insulation faults occur, the measurement current which is available from the test device will also be split up on the insulation fault monitoring device, thus reducing the possibility of detecting several faults.

The following insulation monitoring devices are to be recommended:

| **Recommended nominal system voltage** | **A-ISOMETER** | **Notes on the use with the EDS473** | **Decoupling necessary?** |
|---|---|---|---|
| AC 20-265 V<br>DC 20-308 V | IR475LY | Capacitances up to 20µF, response value 2-100 kΩ,<br>type of casing | Yes |
| DC > 24 V<br>AC 20-265 V | IRDH265-4<br>IRDH365-4 | Capacitances up to 500µF, display, selection of measuring principle, response value 10-990 kΩ | Yes |
| DC 24 V<br>AC 20-265 V | IRDH265-3<br>IRDH365-3 | Capacitances up to 500µF, display, selection of measuring principle, response value 2-200 kΩ | Yes |

## Fuses

In accordance with IEC 60364-4-43, the supply voltage for all system components must be provided with protective devices for protection in the event of short-circuits. It is advisable to use 6 A fuses. This applies to:

the supply voltage of all the system components,
the coupling of the test device PGH473.

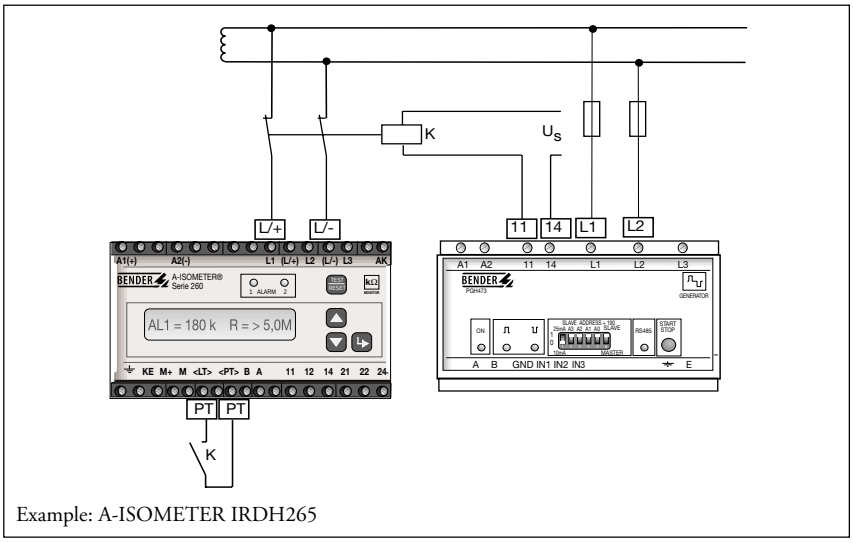
In IT systems all poles are to be protected!

For the system coupling of the insulation monitoring device, protective devices in case of short-circuits as described in IEC 60364 can be omitted, provided that the wiring or the cable are laid so as to limit the danger of a short-circuit to a minimum. In this instance, it is advisable to install at least the wiring short-circuit-proof and earth-fault-proof.
In most cases, it is very difficult to minimize the possibility short-circuits, and to decide whether this objective has been achieved. In cases of doubt, it is appropriate to install protective devices in the event of short-circuits at these points as well (6 A fuse).

## Disconnection of the insulation monitoring device

**Example**: an insulation monitoring device with $R_i$ of 28 kΩ in a DC system of 220 V nominal voltage causes a current flow to earth of approximately 4.5 mA. Without decoupling this would lead to an influence on the EDS system (**Note:** because of the symmetrical coupling of the insulation monitoring device the current **cannot** be calculated with 220V/28kΩ). A decoupling is therefore absolutely necessary.

The insulation monitoring device can be disconnected by means of an auxiliary relay which is driven by the alarm contacts of the test device PGH473. The device must be disconnected at the mains port and not at the PE port.




Example: A-ISOMETER IRDH265

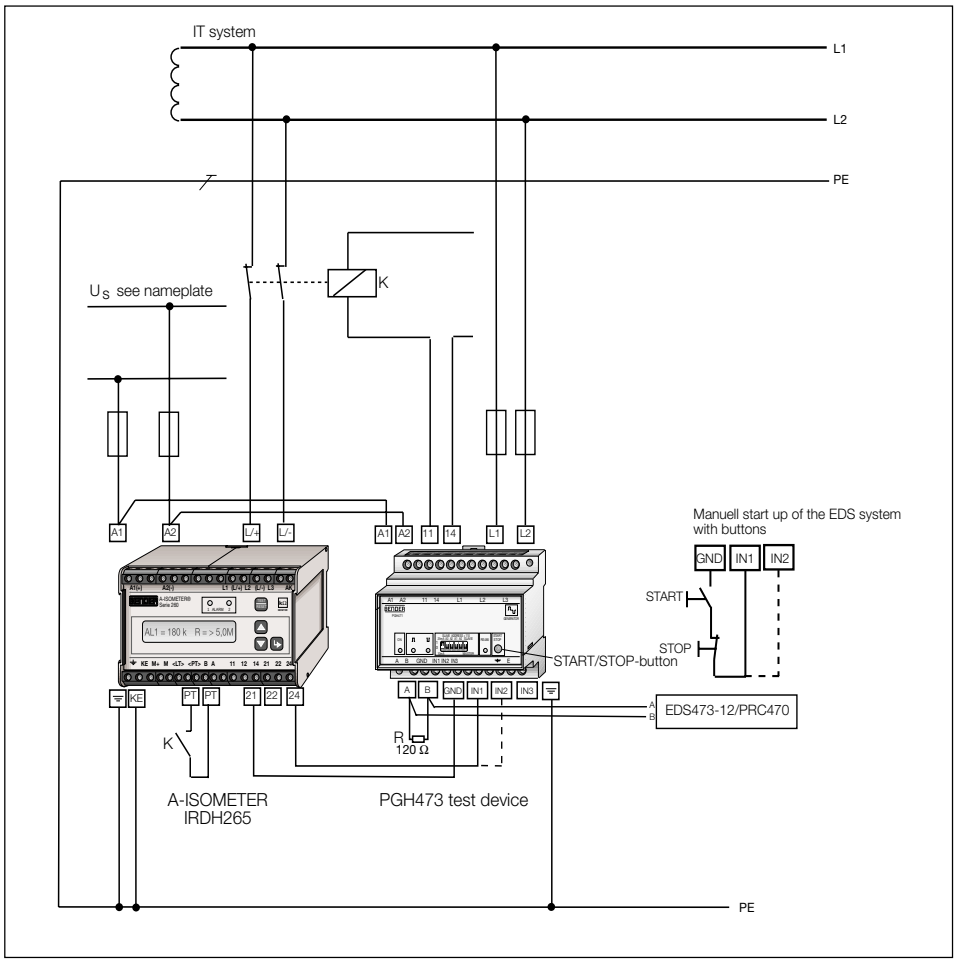
If the insulation monitoring device is equipped with connection monitoring, this must be deactivated. In case of devices of series IRDH265/365, the connection monitoring can be deactivated via the operating menu.

## Starting up the system with an A-ISOMETER

There are several possibilities of starting the EDS473 system:

- starting the system via the contacts of the alarm relay for the insulation monitoring device, and inputs GND and IN1 of the insulation fault test device. **Important:** inputs IN1 and IN2 must not be used at the same time.
- startingthe system via the contacts of the alarm relay for the insulation monitoring device, and inputs GND and IN1 or IN2 of the control and indicating device PRC470. **Important:** inputs IN1 and IN2 must not be used at the same time.
- starting the system manually using the Start/Stop button on the PGH473 or via software in menu 2 (EDS start) of the PRC470.

## Starting the EDS system automatically with an A-ISOMETER



Example for an AC IT system:

Start the system via the contacts 21/22/24 for the insulation monitoring device IRDH265, and the inputs PGH473. The following functions are possible:

- Connection of the NO contact (21/24) to terminals GND and IN1:
  The insulation fault location runs as long as the contact is closed. After every pass of the system, there is a pause of 5 minutes during which the insulation monitoring device can record new measuring values.

- Connection of the NO contact (21/24) to terminals GND and IN2:
  The insulation fault location is started for **one pass** after which it is stopped. To be able to start up the EDS system again, the input must be closed for approximately 6 seconds.

**Attention:** the inputs IN1 and IN2 must not be connected in parallel.

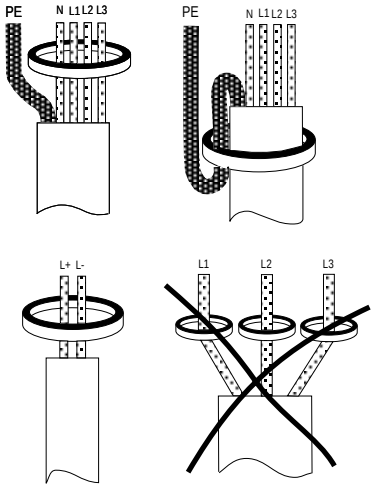
If the system is started with an insulation monitoring device without fault memory and via the terminals GND/IN1, the new measuring value is detected during the 5-minute pause. If this value is below the response value alarm 2, the alarm relay deenergizes and the insulation fault location is stopped.

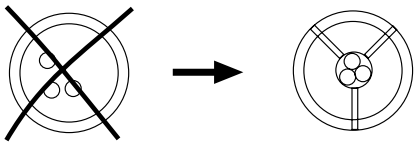
**Alternative manual start:** by means of the external START resp. STOP switch between GND and IN1/IN2.

**Note:** start and stop of the EDS473 systems are also possible by means of the start/stop button at the PGH473. This kind of direct control can be particularly useful in connection with the EDS3365 portable insulation fault location system.
After pressing the start/stop button at the PGH473 it can take up to 6 seconds before the PGH473 starts clocking.

## Installing the measuring current transformers

Various methods of passing cables through the measuring current transformers.



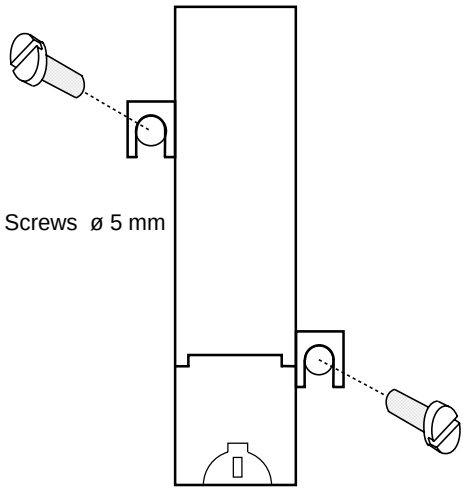



When laying the wires or cables through the measuring current transformer, aim for the greatest possible balance in the centre of the current transformer and a rectangular routing for the conductors.

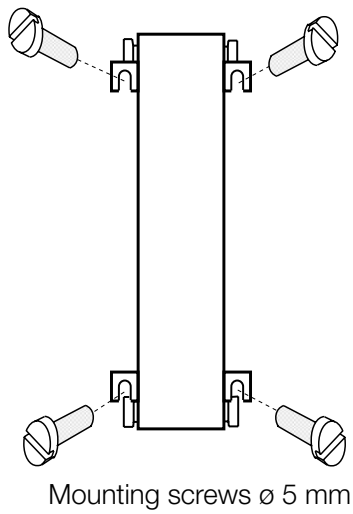
Magnetic alternating fields such as those caused by AC consumers, can influence the sensitivity of the measuring current transformers. Therefore do not install devices which produce magnetic fields close to equipment such as transformers, throttles, or neighbouring conductors with high currents.

Note: always choose the measuring current transformer with the smallest possible diameter. This will reduce the danger of influences from interference.

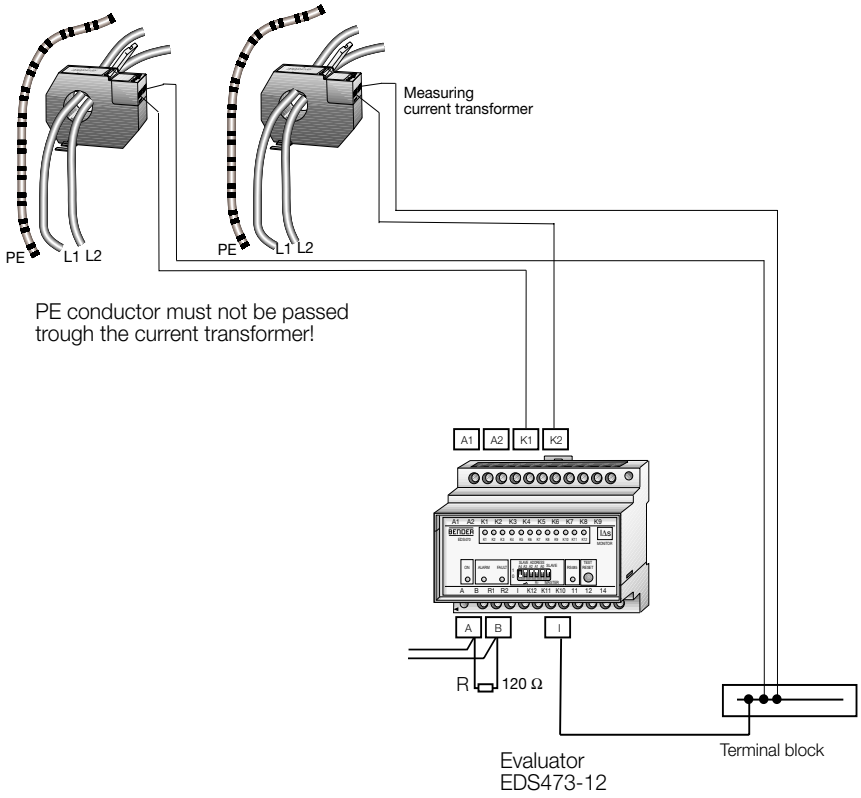
Fixing of measuring current transformers W1-35/8000




Fixing of measuring current transformers WS50x80/8000



## Connecting the measuring current transformers




Depending on the type of wiring between measuring current transformer and insulation fault evaluator EDS473-12, the following restrictions with regard to the cable length are to be observed:

Single wires: up to 1 m
Single wires, twisted: up to 10 m
Shielded cable: up to 25 m (e.g. LiYCY)
The shield is to be connected to terminal I. The shield must not be connected to earth. The use of shielded cables is also recommended for length of less than 25 m.

Under favourable conditions, wire lengths of more than 25 m are possible. However, this depends on the respective local conditions, and must be clarified on a case-by-case basis.

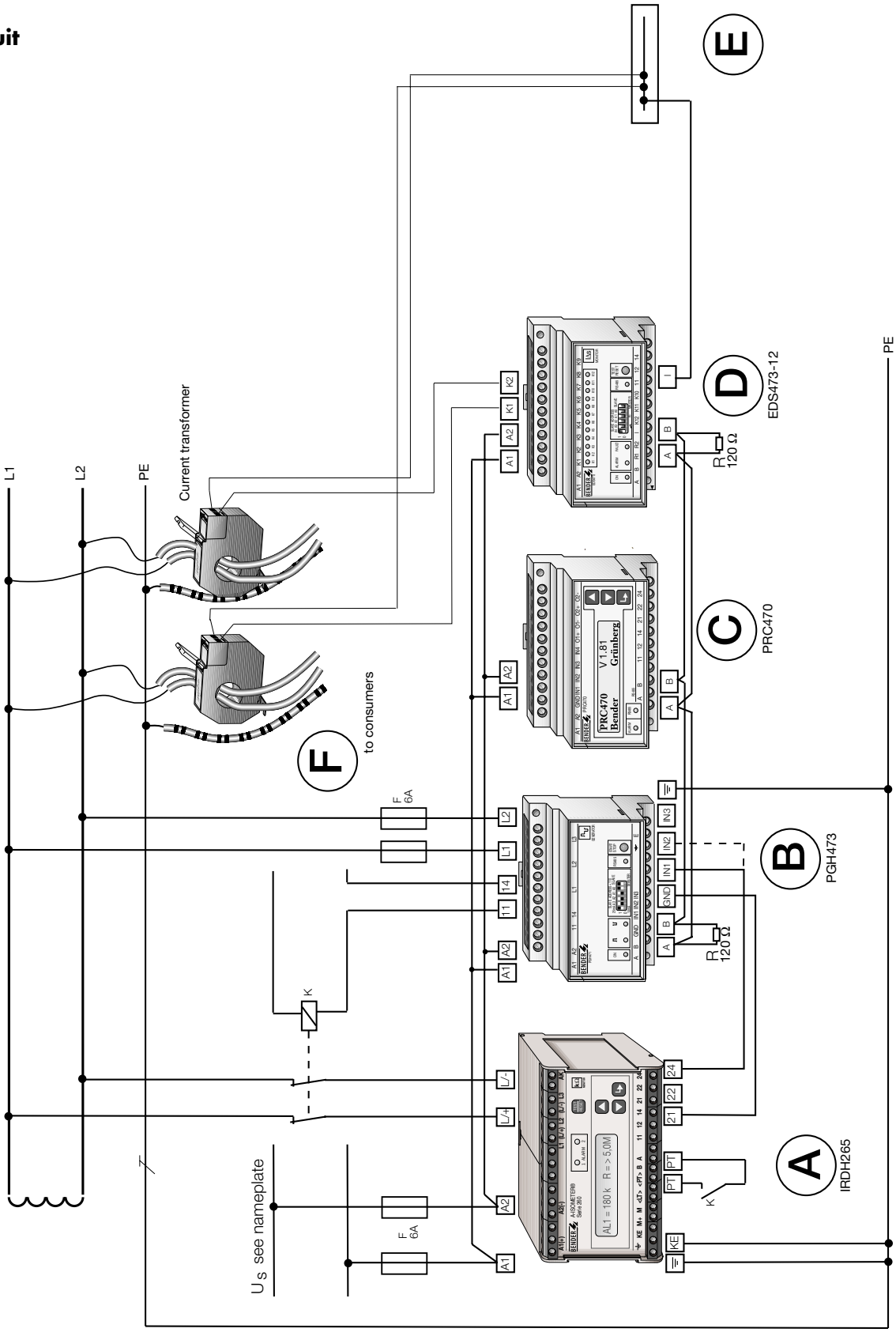
If a cable is connected to the terminals of the EDS473-12 without a measuring current transformer at its end, then both conductors of the cable must be short-circuited.

**When connecting the measuring current transformers, it is essential to keep the maximum length of the common I-connection** (25 cm for a cross section of 2.5 $mm^2$, 15 cm for a cross section of 1.5 $mm^2$).

**Note:** the consumer outputs may be passed through the measuring current transformer in any desired direction.

On the following pages there are some examples of complete circuits for EDS473 systems within different uses. The suggestions of complete circuits have been made to the best of our knowledge. Nevertheless please check whether the complete circuit is suitable for your specific use. In case of doubt ask a BENDER product specialist.

## Example of a complete circuit




*Example of a complete circuit 1:*
*Typical EDS473 system with PRC470 and insulation monitoring device IRDH265.*

**Legend for the example of a complete circuit 1:**
Typical EDS473 system in a AC system 20-265 V, the supply voltage of all system components is the same (always observe the nameplate of the device).

Ⓐ **Insulation monitoring device IRDH265-3, Ri = 28 kΩ**
Menu settings:

| | |
|---|---|
| AL1: 100 Ω/V | AL2: e.g. 10 kΩ |
| Operating principle of the alarm relay K1: | 12-11 14 |
| Operating principle of the alarm relay K2: | 22-21 24 |
| Fault memory: | OFF (remove wire jumper LT/LT) |
| Alarm 1: AC or DC | Alarm 2: AC or DC |
| AGH: AK80 | Coupling test: OFF |
| Relay test: ON | $C_{Emax}$ : 500 µF |
| Flash: OFF | Measuring principle: AMP |

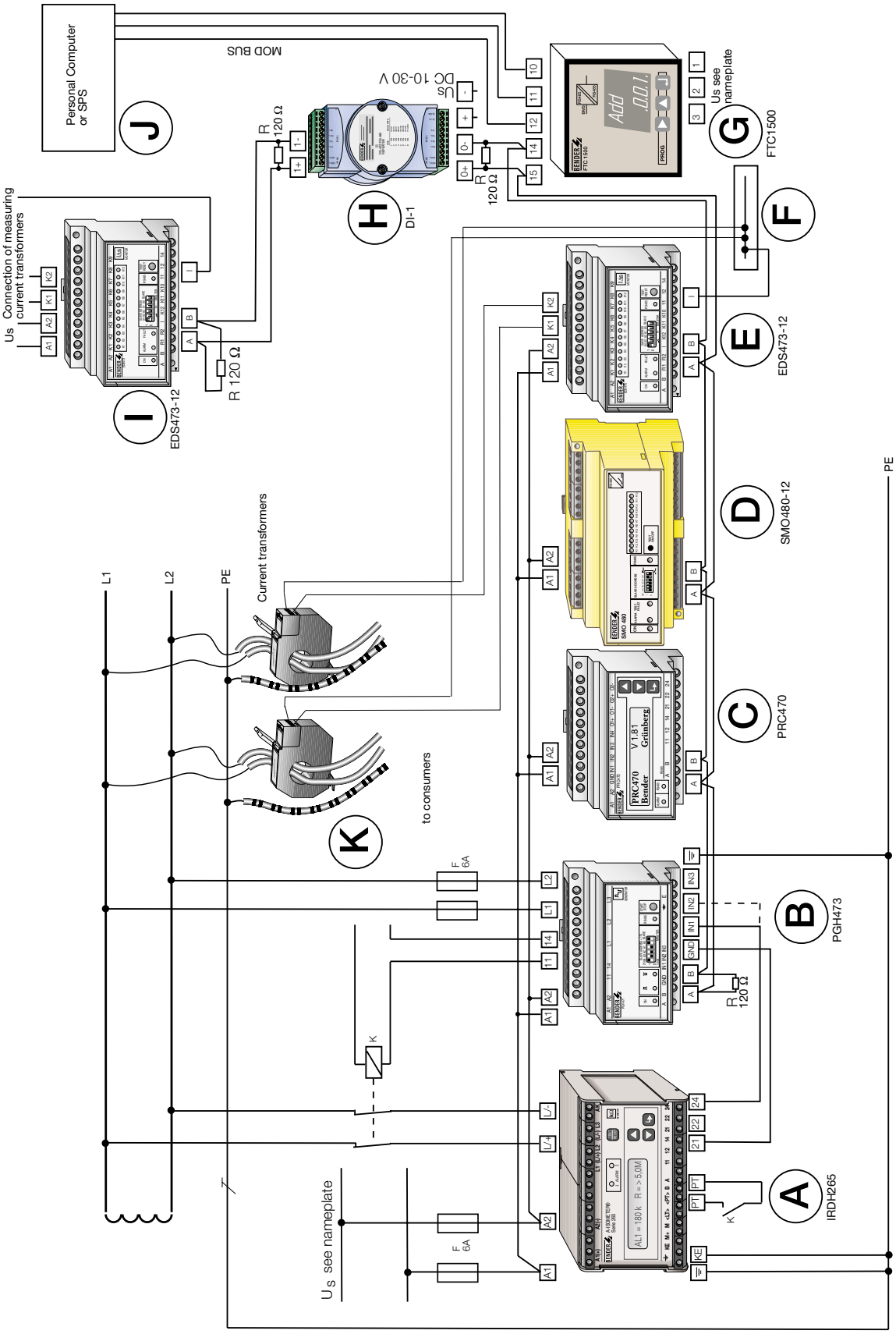
Ⓑ 
**Insulation fault test device PGH473**
Test current : 2.5 mA, address: 111, mode: SLAVE

Ⓒ **Control and indicating device PRC470**. Firmware settings:
**m6** relay: no (N/O operation) **m7**: memory: ON
**m8** set sensor: setting corresponding to the type of the measuring current transformer for each channel
**m9** address: 100 (with that MASTER) **m10** peak: n=1

Ⓓ 
**Insulation fault evaluator device EDS473-12**
Address: 1; mode: SLAVE.
Please assign further EDS473-12 devices to the next addresses (2, 3, 4, …).
**Attention**: Do not assign the same address twice!

Ⓔ **Terminal block for l-connections** of the measuring current transformers.
Connection to the EDS473-12 with single wire 2.5 mm² and max. length of 25 cm.

Ⓕ **Measuring current transformers** W1-35/8000, W08/8000 or WS50x80/8000.
Do not pass the PE conductor through the measuring current transformer!




*Example of a complete circuit 2:*
*EDS473 with PRC470 and insulation monitoring device IRDH265 and optional extensions SMO480-12, DI-1 and FTC1500.*

**Legend for the example of a complete circuit 2:**
EDS473 system in an AC system 20-265 V, the supply voltage of all system components is the same except of DI-1 (always observe the nameplate of the device)

Ⓐ **Insulation monitoring device IRDH265-3, Ri = 28 kΩ**
Menu settings:
AL1: 100 Ω/V — AL2: e.g. 10 kΩ
Operating principle of the alarm relay K1: 12-11 14
Operating principle of the alarm relay K2: 22-21 24
Fault memory: OFF (remove wire jumper LT/LT)
Alarm 1: AC or DC — Alarm 2: AC or DC
AGH: AK80 — Coupling test: OFF
Relay test: ON — $C_{Emax}$ : 500 µF
Flash: OFF — Measuring principle: AMP

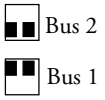
Ⓑ 
**Insulation fault test device PGH473**
Test current : 2.5 mA, address: 111, mode: SLAVE

Ⓒ **Control and indicating device PRC470**. Factory settings:
**m6** relay: no (N/O operation) — **m7**: memory: ON
**m8** set sensor: setting corresponding to the type of the measuring current transformer for each channel
**m9** address: 100 (with that MASTER) — **m10** peak: n=1

Ⓓ 
**OPTION: signal converter SMO480-12**. It converts serial signals of the EDS473-12 into relay contact messages. There is a relay available for each channel of a connected EDS473-12.
Address: (30+) 1; operating principle of the alarm relay: N/O operation

Ⓔ 
**Insulation fault evaluator device EDS473-12**
Address: 1; mode: SLAVE.
Please assign further EDS473-12 devices to the next addresses (2, 3, 4, …).
**Attention**: Do not assign the same address twice!

Ⓕ **Terminal block for l-connections** of the measuring current transformers. Connection to the EDS473-12 with single phase 2.5 mm² and max. length of 25 cm.

Ⓖ 

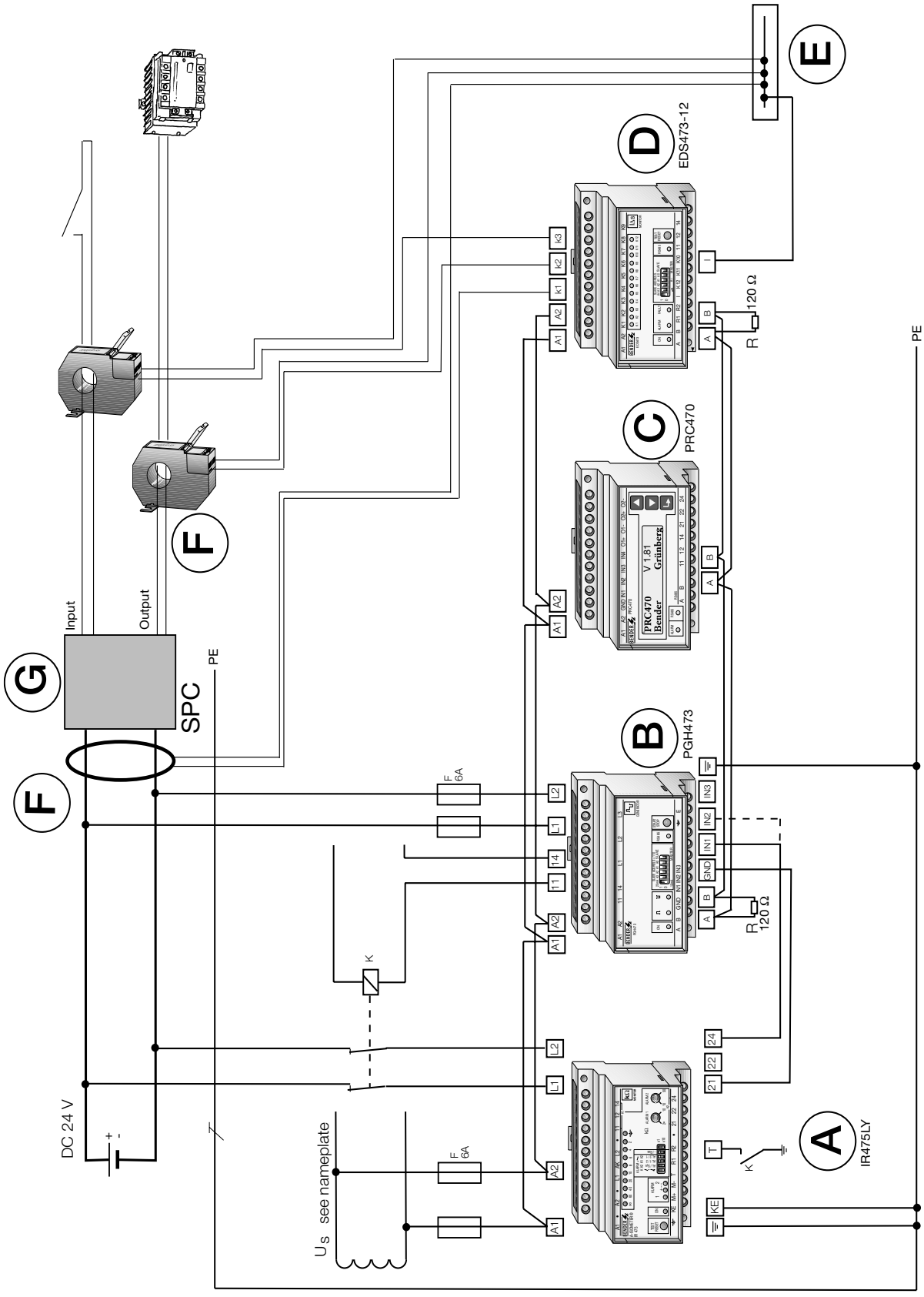
G **OPTION: protocol converter FTC1500**. It converts a BMS protocol of the RS485 bus into the MOD-BUS protocol. This is how communication with MOD-BUS nodes like stored-program controller or PCs (J) is made possible. Observe the termination: in this example the termination of bus 2 (BMS) is deactivated and the termination of bus 1 (MOD-BUS) is activated.

Ⓗ **OPTION: RS485 repeater DI-1**. It amplifies the signals of the RS485 bus and isolates the input and output circuit. It is useful in an EDS473 system, if the length of the bus exceeds 1200 m. **Attention:** do not change the factory setting of the DI-1!

Ⓘ **OPTION: insulation fault evaluator device EDS473-12**. It is used in this example to demonstrate the use of the DI-1 (H). Here the maximum length of the bus of 1200 m is exceeded. Address: free address, see (E); mode: SLAVE.

Ⓙ JBUS/MOBUS- Nodes (e.g. PC, SPS), see (G)

Ⓚ **Measuring current transformers** W1-35/8000, W08/8000 or WS50x80/8000. Do not pass the PE conductor through the measuring current transformer!




*Example of a complete circuit 3:*
*EDS473 system with PRC470 and insulation monitoring device IR475LY for monitoring the SPS.*

**Legend for the example of a complete circuit 3:**
EDS473 system in a DC system 24 V for monitoring the inputs and outputs of a stored-program controller (SPS).

Ⓐ **Insulation monitoring device IR475LY, Ri = 200 kΩ**
AL1: depends on the plant AL2: depends on the plant
Operating principle of the alarm relay: N/O operation
Fault memory: OFF

Ⓑ 
**Insulation fault test device PGH473**
Test current : 1 mA, address: 111, mode: SLAVE

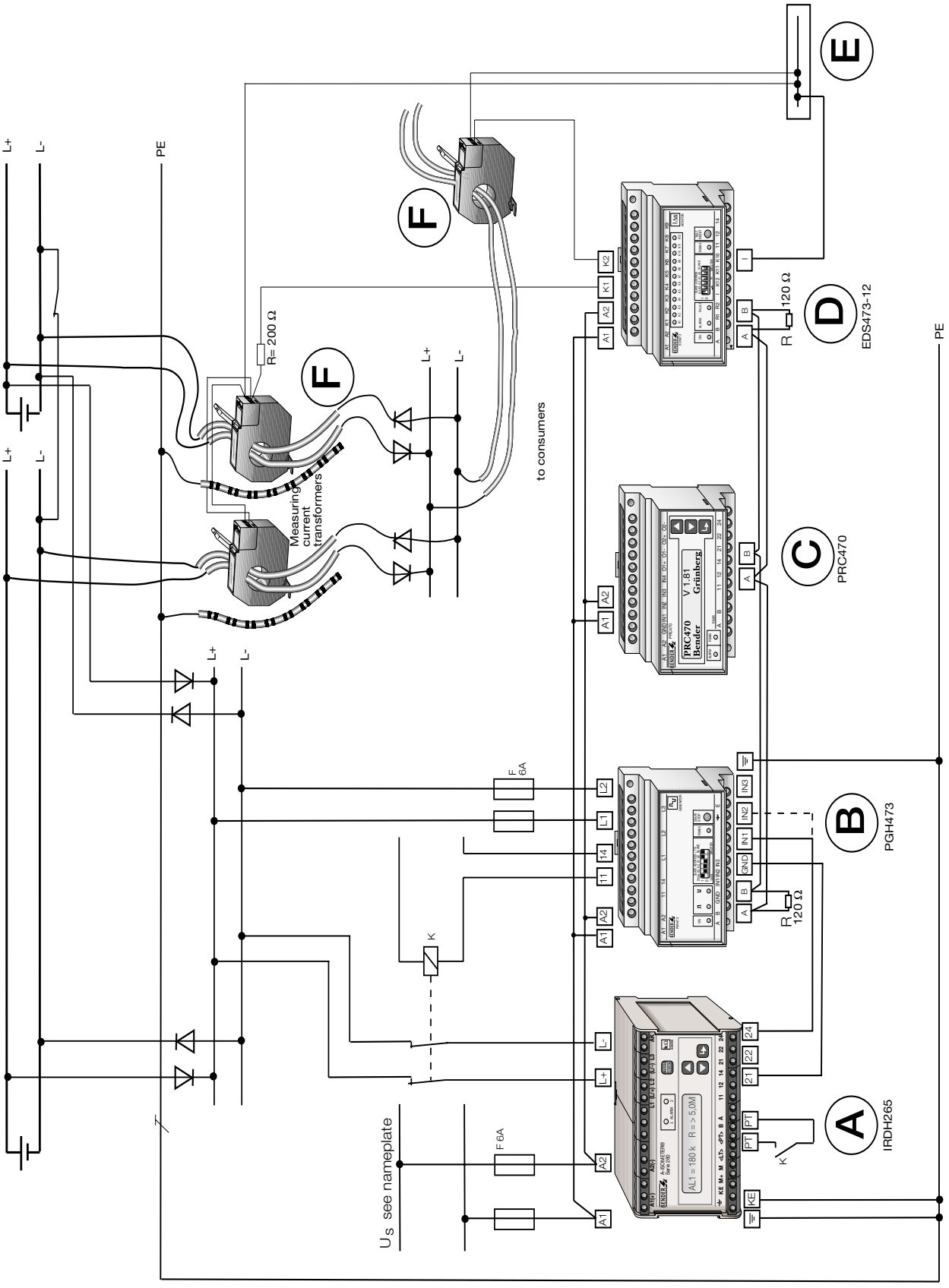
Ⓒ **Control and indicating device PRC470**. Factory settings:
**m6** relay: no (N/O operation) **m7**: memory: ON
**m8** set sensor: setting corresponding to the type of the measuring current transformer for each channel
**m9** address: 100 (with that MASTER) **m10** peak: n=1

Ⓓ 
**Insulation fault evaluator device EDS473-12**
Address: 1; mode: SLAVE.
Please assign further EDS473-12 devices to the next addresses (2, 3, 4, …).
**Attention**: Do not assign the same address twice!

Ⓔ **Terminal block for l-connections** of the measuring current transformers. Connection to the EDS473-12 with single phase 2.5 $mm^2$ and max. length of 25 cm.

Ⓕ **Measuring current transformers** W1-35/8000, W08/8000 or WS50x80/8000. In the example the measuring current transformer is placed in the power supply DC 24 V of the SPS and monitors the entire SPS. This measuring current transformer is ordered directly before the SPS i.e. behind the coupling of the PGH473 test device. Additionally each input and output have their own measuring current transformer and are specifically monitored in this way. Do not pass the PE conductor through the measuring current transformer!

Ⓖ **Stored-program controller.** Note: not every SPS can be monitored this way. In particular there must be a electrical connection between the power supply and the inputs and outputs. Please make an arrangement with a BENDER product manager concerning the use.




*Example of a complete circuit 4:*
*EDS473 system with PRC470 and insulation monitoring device IRDH265-3 for monitoring a DC system with diode-decoupled incoming supply of consumers.*

**Legend for the example of a complete circuit 4:**
EDS473 system in an DC system with diode-decoupled incoming supply of consumers.

Ⓐ **Insulation monitoring device IRDH265-3, Ri = 28 kΩ**
Menu settings:

| | |
|---|---|
| AL1: 100 Ω/V | AL2: e.g. 10 kΩ |
| Operating principle of the alarm relay K1: | 12-11 14 |
| Operating principle of the alarm relay K2: | 22-21 24 |
| Fault memory: | OFF (remove wire jumper LT/LT) |
| Alarm 1: AC or DC | Alarm 2: AC or DC |
| AGH: AK80 | Coupling test: OFF |
| Relay test: ON | $C_{Emax}$ : 500 µF |
| Flash: OFF | Measuring principle: AMP |

Ⓑ 
**Insulation fault test device PGH473**
Test current : 2.5 mA, address: 111, mode: SLAVE

Ⓒ **Control and indicating device PRC470**. Firmware settings:
**m6** relay: no (N/O operation) **m7**: memory: ON
**m8** set sensor: setting corresponding to the type of the measuring current transformer for each channel
**m9** address: 100 (with that MASTER) **m10** peak: n=1

Ⓓ 
**Insulation fault evaluator device EDS473-12**
Address: 1; mode: SLAVE.
Please assign further EDS473-12 devices to the next addresses (2, 3, 4, …).
**Attention**: Do not assign the same address twice!

Ⓔ **Terminal block for l-connections** of the measuring current transformers.
Connection to the EDS473-12 with single phase 2.5 mm² and max. length of 25 cm.

Ⓕ **Measuring current transformers** W1-35/8000, W08/8000 or WS50x80/8000.
Do not pass the PE conductor through the measuring current transformer!

## Notes on wiring diagrams

**Supply voltage $U_s$:**
The example shows all components supplied from a common supply voltage $U_s$. For this, all the devices must be designed for the same supply voltage. Check the details on the nameplate and in the data sheet.

**Fuse F for supply voltage:**
The fuses for the supply voltage are to be regarded as line protection. According to IEC 60364-4-473, these are protective devices to guard against short-circuit. For this purpose 6 A fuses are recommended. If the devices are supplied from an IT system, all poles must be protected against short-circuit.

**System coupling – insulation monitoring device:**
For the system coupling of the insulation monitoring device, protective devices in case of short-circuits as described in IEC 60364-4-473 can be omitted, provided that the wires or the cable are laid so as to limit the danger of a short-circuit to a minimum. In this instance, it is advisable to install at least the wiring short-circuit-proof and earth-fault-proof.
In most cases, it is very difficult to minimize the possibility of short circuits, and to decide whether this objective has been achieved. In cases of doubt, it is appropriate to install protective devices in the event of short-circuits at these points as well (6 A fuse).

**System coupling insulation fault test device PGH473:**
For the system coupling of the insulation fault test device, it is advisable to install protective devices for short-circuit protection. For this purpose 6A fuses are recommended.

**Terminal block X:**
The common I connection from the device terminal of the EDS473-12 to the measuring current transformer W is limited to a maximum length of 25 cm for a cross section of 2.5 $mm^2$ or 15 cm for a cross section of 1.5 $mm^2$. Terminal blocks X are recommended, so that the wiring can be done from these out to the I terminals of the measuring current transformers W.

**Terminating resistors R:**
The interface cable must have a 120 Ω terminating resistor R (0.4 W) fitted at the beginning and end of the RS485 bus. There are two terminating resistors for every PRC470 and PGH473.
Note: stub-feeder cables are not fitted with terminating resistors.
A shielded cable is recommended for the interface connection.

**Starting up the system:**
In this case, the insulation fault location system EDS473 is started via the NO contact (21/24) of the alarm relay of the insulation monitoring device. If the NO contacts are connected to terminals GND/IN1 of the test device PGH473, the system runs as long as the contact is closed. In the event of connection to terminals GND/IN2 the system is started only for one pass.

**Address assignments:**
In general pay attention to a clear assignment of the addresses of all components which are connected via the RS485 bus. If the same address is assigned twice, the EDS system cannot recognize the corresponding device.

**Decoupling contactor K:**
As a basic rule the existing insulation monitoring device has to be disconnected from the system at the start. This happens by means of a decoupling contactor K. A contactor relay of K short-circuits the terminals of the test button. This is how a response of the connection monitoring is prevented and the device is set to a test mode.

- Check for correct nominal voltage.
- Check for correct supply voltage.
- Only one insulation monitoring device may be used in each conductively connected system.
- During insulation and voltage tests in the system, the insulation monitoring device and the PGH473 must be disconnected from the system.
- Electrical devices must be assembled and installed only by qualified electricians. The applicable safety regulations must be observed.
- Attention: the test and reset buttons of the different devices must **not** be connected in parallel for collective testing or collective resetting.

## Cables, cable length

The following recommendations concerning the cables and the permissible cable length must be observed:

| Connection | Cable | Cable length |
|---|---|---|
| RS485 | JY(ST)Y 0.6Δ<br>Shield on I | 1200 m |
| Supply voltage (all devices) | 0.8 … 1.5 mm² | any |
| Control cables | 0.8 … 1.5 mm² | any |
| System couplings (ISOMETER, PGH470) | 0.8 … 1.5 mm² short-circuit and earth-fault proof wiring (e.g. NSGAFöu) | any |
| EDS473-12 to I-terminals | Single phase 5 mm² | 25 cm |
| Connection EDS473-12 to measuring current transformers | Min. 0.75 mm², shielded lead, shield on I | 40 m |

## Factory settings

All devices are delivered with certain factory settings which are suitable for many standard uses. However, some installationsneed specific settings that differ from the factory settings. First the factory settings of the individual devices are listed below.

Insulation monitoring device
Factory settings depend on the type of device. Refer to the data sheet of the respective insulation monitoring device.

Insulation fault test device PGH473

| | |
|---|---|
| Operating mode of the alarm relay: | N/O operation |
| Address: | 111 |
| Operating mode: | SLAVE |
| Max. test current: | 2.5 mA |

Insulation fault evaluator EDS473-12

| | |
|---|---|
| Operating mode of the alarm relay: | N/O operation |
| Operating mode: | SLAVE (with PRC470 or PGH473) |
| Fault memory: | ON |
| Transformer type: | Standard transformers W1-35/8000 |
| Address: | 001 |
| Peak: | n = 1 |

**Control and indicating device PRC470** (from Firmware Version 1.81 up)

| | |
|---|---|
| Operating mode of the alarm relay: | N/O operation |
| Fault memory: | ON |
| Address: | 100 |
| Operating mode: | MASTER |
| Peak: | n = 1 |

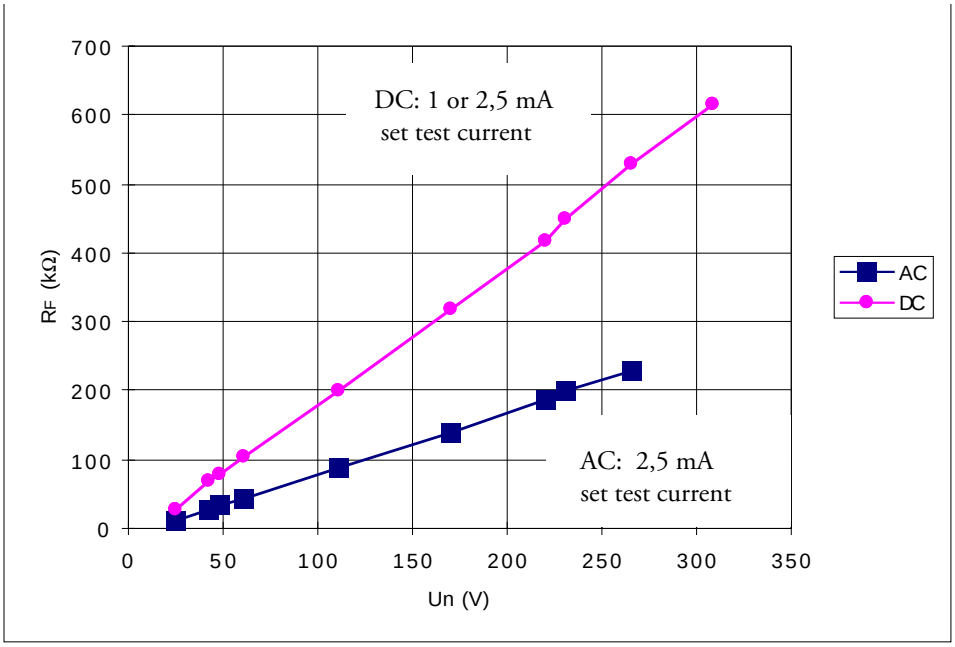
## Information concerning the insulation monitoring device

The following are to be considered when choosing the insulation monitoring device.

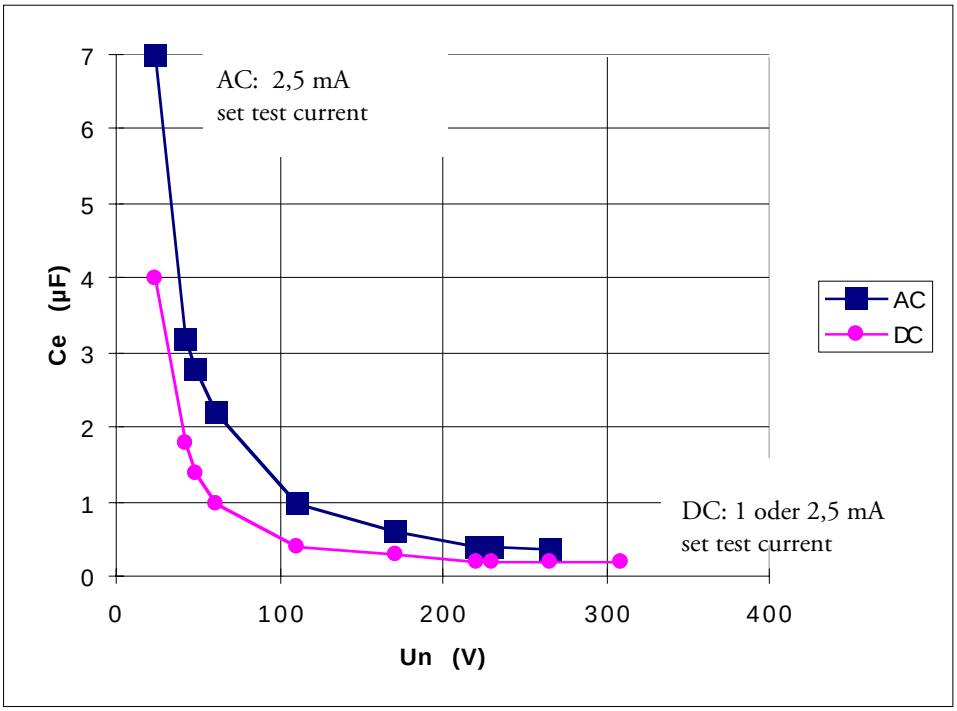
Device with two adjustable response values.
In this case, response value 1 can for example be set to the value recommended in IEC60364 (100 Ω/V) or even more sensitive. This will then be considered as pre-warning.
Response value 2 must start the EDS system. It should be set to a practicable and useful value which depends on the nominal voltage of the system.

The setting of a practicable response value depends on some system parameters. The curves on the following pages can be used for determining this value.

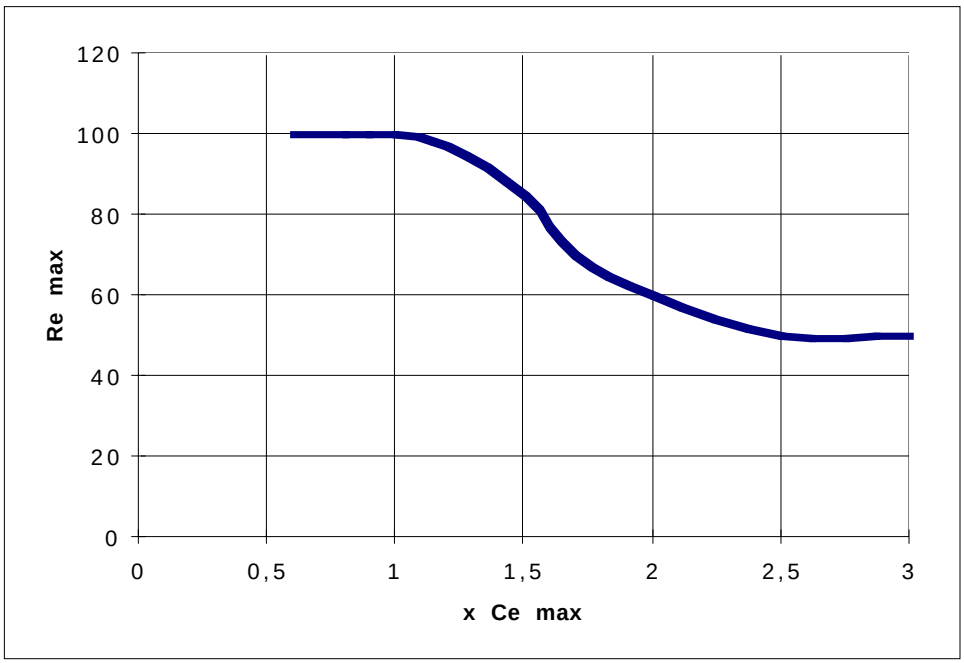
## Characteristic curves




***Curve 1:*** *limits of the response value dependent on the system voltage (AC 20-265 V and DC 20-308V) for a maximum system leakage capacitance $C_e$ according to curve 2.*




***Curve 2:*** *max. permissible system leakage capacitance dependent on the nominal voltage (AC 20-265 V and DC 20-308 V).*

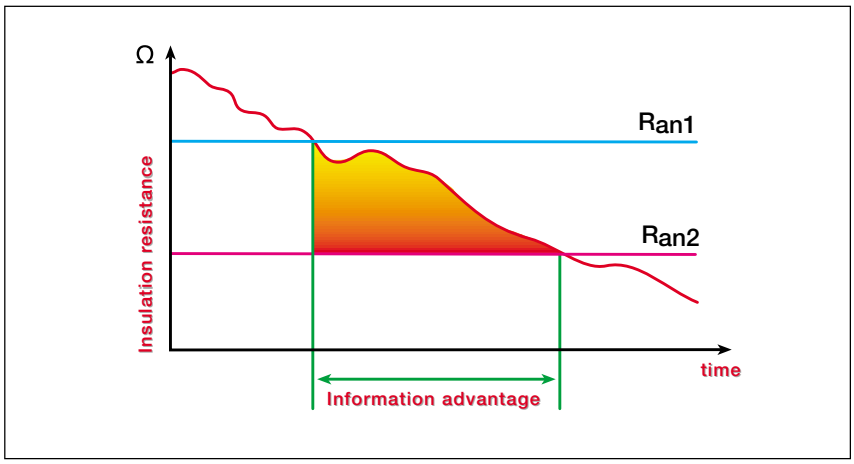



***Curve 3:*** *reduced response sensitivity in case of system leakage capacitances higher than the max. permissible value of $C_e$ of curve 2. The test current displayed on the PRC470 also differs in case of high system leakage capacitances.*

Looking at the curves it must be considered that the sum of the capacitances downstream the measuring current transformers must be at least 50% of the total capacity. Otherwise, false fault alarm may be signalled.

The max. system leakage capacitance is **300 µFV**. For a 230 V system, this is 300 µFV/ 230V = 1.3 µF. If the limit value is exceeded, false trippings may occur.

## Determination of the response value




Ran1 Response value of pre-warning on the insulation monitoring device. Setting, e.g. 100 Ω/V system voltage. Signal on contacts 11/12 /14.

Ran2 The response value of the main signal on the insulation monitoring device. Signal on contacts 21/22/24, which starts the EDS system.

**Example of how to determine a practical response value:**

This refers to the response value for the main alarm of the insulation monitoring device. This signal initiates the start of the EDS473 system via contacts 21/22/24. Any response value which may be available can be used for pre-warning purposes, and it may be set higher as appropriate.

The system voltage is assumed to be AC 230 V. In this example, the system leakage capacitance remains within the permissible range according to curve 2, so < 0.5 µF.

According to curve 1, a response sensitivity of 180 kΩ is obtained. It must be assumed that the total insulation resistance of the system consists of the parallel connection of several insulation faults. It is not known which individual faults are included.
As standard value, it is recommended to remain at least 40% below the value $R_{an2}$ of the insulation monitoring device in this case: 108 kΩ.

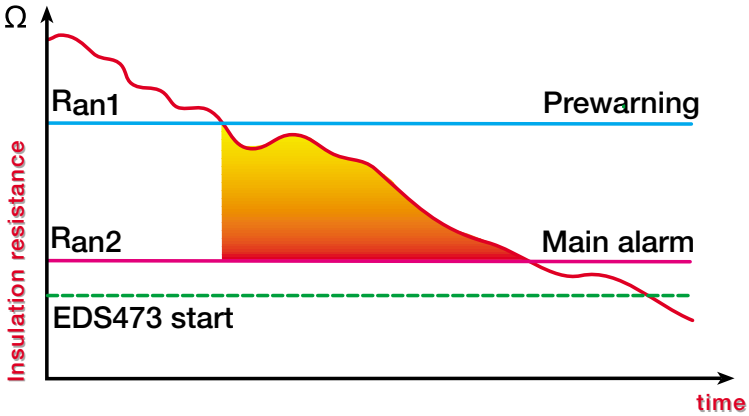
This example does not apply generally. The total insulation resistance consists of the sum of many low resistive faults. In this case a lower response value must be set to be able to find an insulation fault.

**How to determine a practical response value:**

- use curves 1, 2, 3 to determine the insulation fault $R_F$, which is the maximum value to be located.
- Note the guidance value for $R_{an2}$: **$R_{an2}$ = 0.6 x max. $R_F$**
  Factor 0.6 is based on the knowledge that as a general rule, the total insulation resistance is the result of several faults connected in parallel.
- Install a test resistance with the value of $R_{an2}$ at a circuit monitored by one measuring current transformer.
- Select this circuit on the PRC, using the POSITION function (menu 5).
  Determine whether the installed fault is located.
- Read out the test current for this output in the POSITION function on the PRC.
  **The test current must be at least 0.5 mA, so that a fault signal will be given.**
- If the displayed test current is substantionally greater than 0.5 mA, it will be possible to locate an insulation fault which has a higher resistance than the installed test resistance.
  Increase the resistance of the installed test resistor until the test current displayed on the PRC470 is approximately **0.7 mA.**
  The resistance value which has been determined in this way must now be set as the $R_{an2}$ on the insulation monitoring device.
- It is therefore necessary to select an insulation monitoring device whose response range includes the $R_{an2}$ which has just been determined.

## Critical test current


**Important**: it should be ensured that no control malfunctions are caused in the system by the test current (maximum 2.5 mA resp. 1 mA). If control malfunctions cannot be excluded, then an automatic fault location is not advisable.
In such cases, the EDS473 system should only be started manually.
**Attention**: a manual start must only be undertaken by skilled technical personnel.
They must be able to foresee the possible consequences of the test current, and they must also be capable of instituting any action which may be required.




$R_{an1}$ The response value for the prewarning on the insulation monitoring device. For example, setting 100 Ω/V system voltage. Signal on contacts 11/12/14.

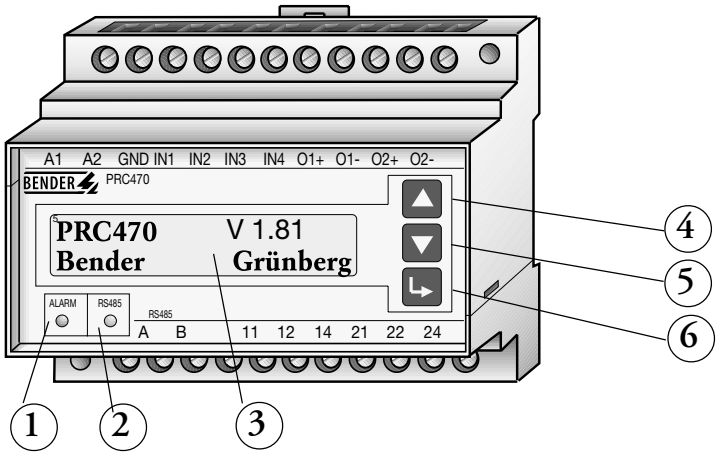
$R_{an2}$ The response value of the main signal on the insulation monitoring device. Signal on contacts 21/22/24. In the case of this insulation fault, control malfunctions cannot be excluded.

**EDS473-Start:** Manual start of the EDS473 system.


If $R_{an2}$ is above the value of the EDS473 start (as shown in the diagram above), the EDS473 system must only be started manually.

## PRC470

All settings at the control and indicating device PRC470 are carried out by means of the menu control. The LC display and 3 keys are available for this purpose.




Information about the device:

1 LED <Alarm>. Lights up when the response value in one channel of the EDS473-12 is exceeded.
2 Alarm LED "RS485". Lights up when the RS485 interface is active.
3 LC display 2x16 characters.
4 <UP> key
5 <DOWN> key } press the soft key for at least 1 second
6 <ENTER> key

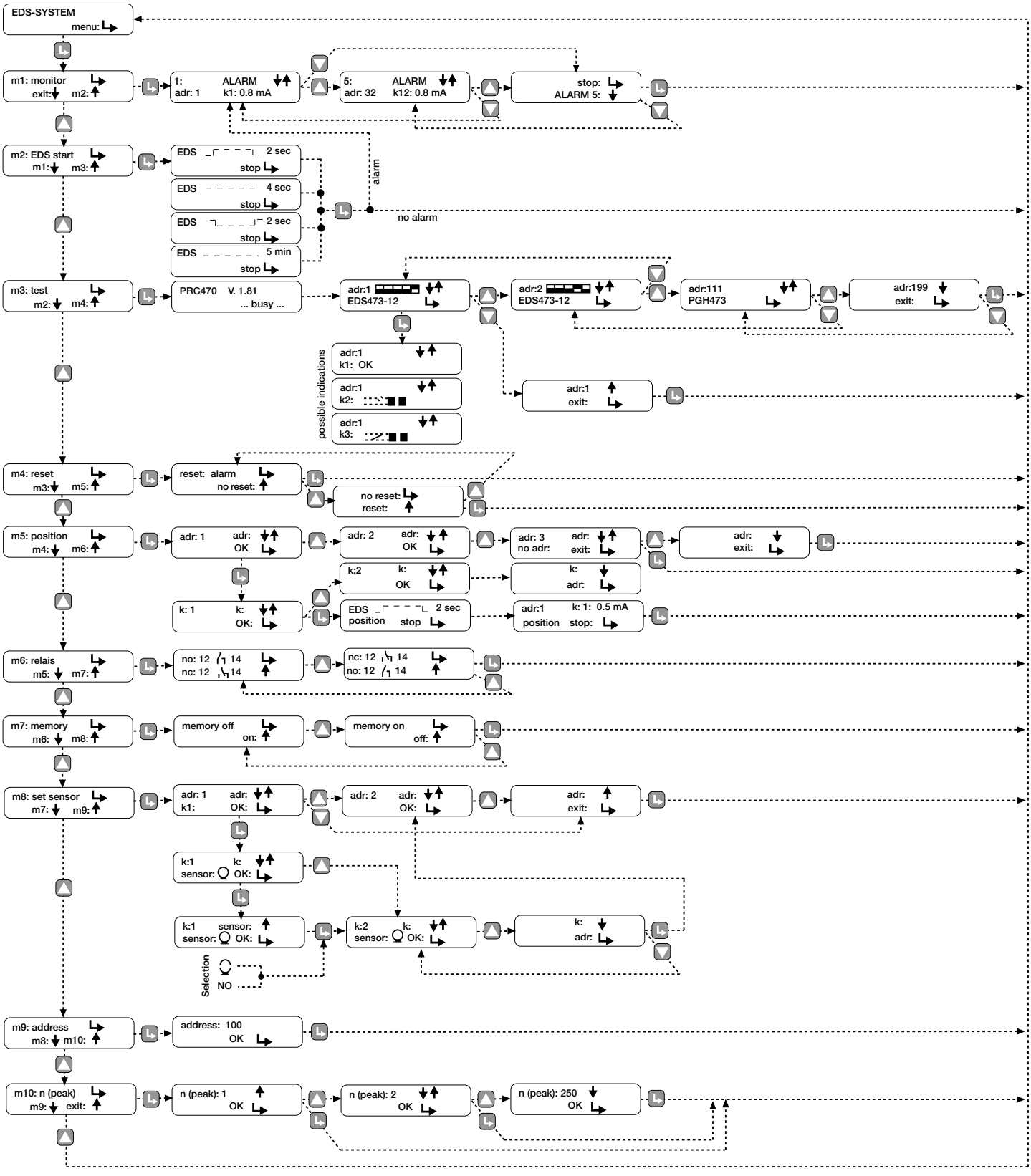
## 10 Menus

In order to parameterize and for the display, the PRC470 offers 10 menus with following functions:

**Menu 1 (m1 monitor)**
Displays all located insulation faults, the address of the respective EDS473-12, the corresponding channel, and the measured test current at this channel.
**Menu 2 (m2 EDS start)**
Starts the scanning and continuously displays the test cycle.
**Menu 3 (m3 test)**
Starts a test program in which all the connected devices with their addresses are displayed. The respective measuring current transformer subcircuits are checked for short-circuits and interruptions and possible faults are displayed as well.
**Menu 4 (m4 reset)**
Resets the alarm relays and the alarm LEDs of the PRC470 and of all connected EDS473-12 and SMO480-12 devices as well as all alarm messages.
**Menu 5 (m5 position)**
Enables the user to choose specifically a certain measuring current transformer for testing.
**Menu 6 (m6 relays)**
For the general changeover of the operating mode of the alarm relays between N/O and N/C operation of all devices which are connected with the bus.
**Menu 7 (m7 memory)**
For the general changeover of the memory behaviour of the alarm relays of all devices which are connected with the bus (exception: SMO480-12).
**Menu 8 (m8 set sensor)**
For setting the right measuring current transformer for each channel of the EDS473-12. If no measuring current transformer is connected, please choose NO setting.
**Menu 9 (m9 address)**
For displaying the own address of the PRC470.
**Menu 10 (m10 peak)**
For setting of the number of the scanning cycles per measuring current transformer when interferences occur in the system.

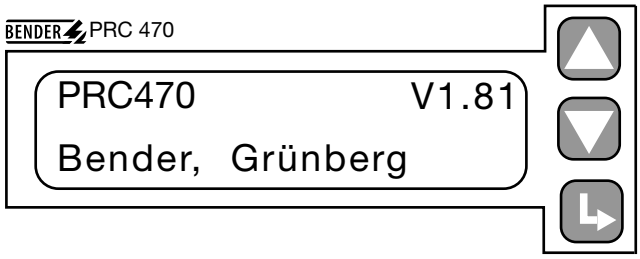
**Attention:** Do not carry out any settings during a pass of the EDS system.

## Menu overview PRC470



## Software Menus PRC470

When switching on the EDS473 system, the control and indicating device PRC470 shows a ”Welcome menu” for approx. 5 seconds. In this menu, the type of device, the software version and the manufacturer's name are displayed. Afterwards, the basic menu is displayed.



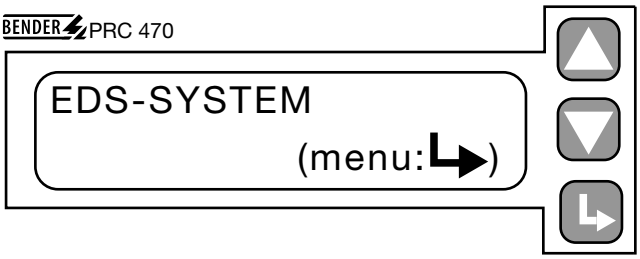

Welcome menu

## Software-Reset

In case of technical questions, the engineer of BENDER will at first ask you for the software version which is displayed in the welcome menu. This menu is also displayed when a software reset is carried out. The software is reset by pressing the keys <UP> and <ENTER> simultaneously for 1 second.
The software version is also printed on the nameplate of the device.

## PRC470 basic menu

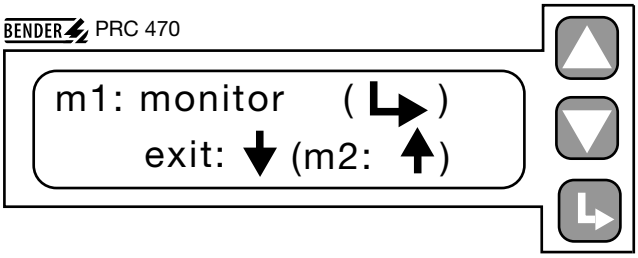
When no insulation fault location is being carried out and no stored fault is displayed, the basic menu will be displayed.



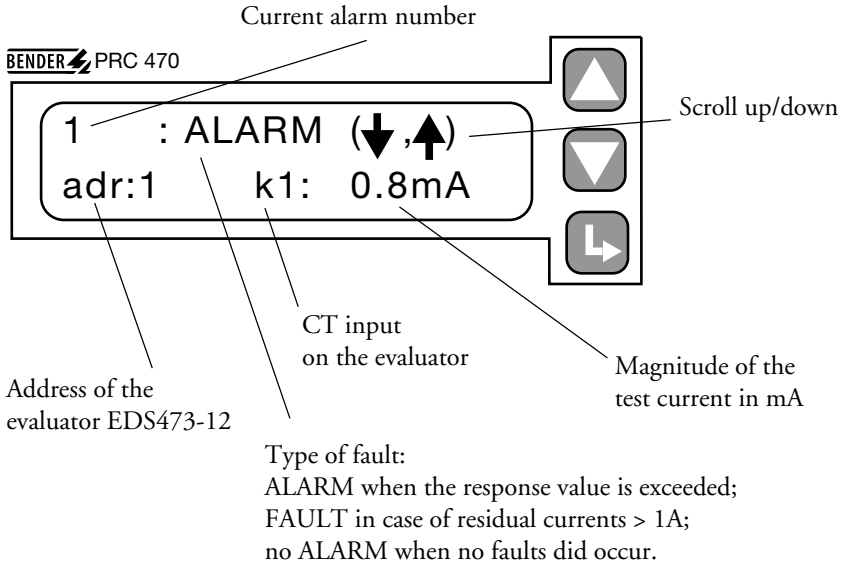

The basic menu indicates that the submenus can be entered by pressing the <ENTER> key.

The PRC470 has 10 submenus in which the respective settings can be made. If the <ENTER> key is pressed while the basic menu is activated, the mask of menu 1 is displayed.

## Menu 1: Monitor

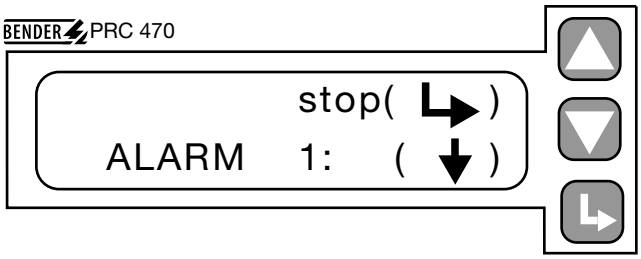



The <ENTER> key starts the monitor program, the <UP> key switches to menu 2 (m2), <DOWN> leads back to the basic menu. After starting the monitor program, all detected insulation faults, the address of the respective evaluator as well as the test current measured by the evaluator are displayed. Additionally, all transformer inputs in which a residual current of more than 1 A was measured are indicated.
The display starts with the lowest address. By means of the keys <UP> and <DOWN> all the faulty subcircuits can be called up one after the other.

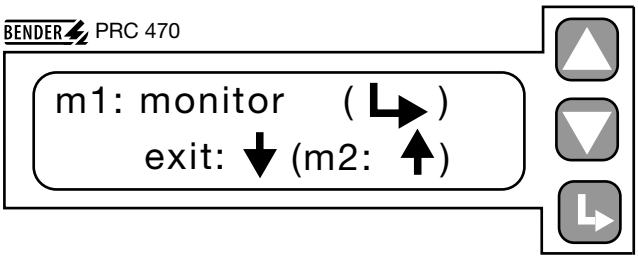



**Note:** a maximum of 50 alarm messages can be saved.

When the last faulty subcircuit is reached when scrolling by means of the keys <UP> resp. <DOWN>, the following is displayed.

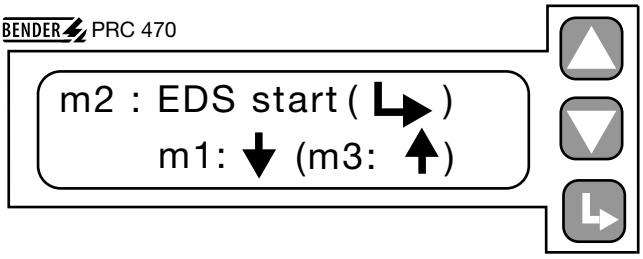



By pressing the <ENTER> key, the basic menu will be displayed, by pressing the <DOWN> key, the last ALARM display will be called again.
While ALARM or FAULT are displayed, the menu can be quit at any time by pressing the <ENTER> key to get back into the basic menu.




The menus can only be opened one after the other. If, for example, menu 2 is to be selected, the menu must be chosen by means of <ENTER> while the basic menu is opened. Then, menu 1 (m1) must be run through by means of the key <UP> to get to menu 2 (m2) or further, if required.
If menu 2 (m2) is reached, the sub-routine is started with <ENTER>.

### Menu 2: EDS start



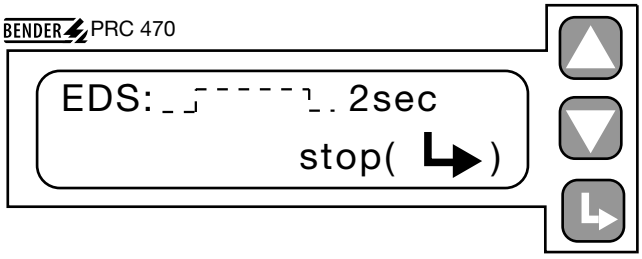

In sub-routine EDS start, the scanning is started directly. The test device is selected and switches the test impulses to the system. During the interpulse period, the evaluators are scanned for detected insulation faults. If this is the case, the alarm relay switches and the alarm LED <ALARM> lights up.

During scanning, the positive and negative testing impulses as well as the interpulse periods are graphically displayed. By means of the <ENTER> key, the program can be quit at any time. Afterwards, menu 2 (m2: monitor) with the results is automatically displayed provided that insulation faults were detected during scanning. Otherwise, the system will return to the basic menu.

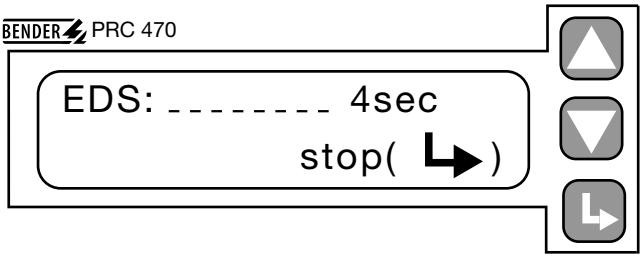
The scanning continues until it is stopped manually.

**Important:** this internal start/stop function of the PRC470 menu takes precedence over the external inputs.

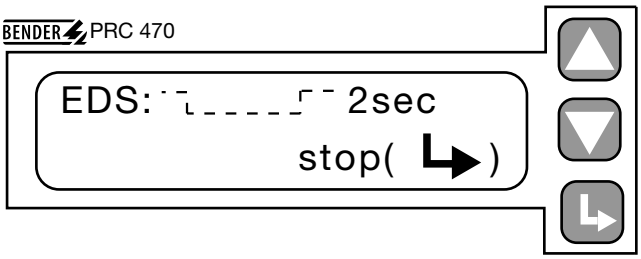
**Displays in Menu 2**




For 2 seconds, a positive current impulse is superimposed on the system.

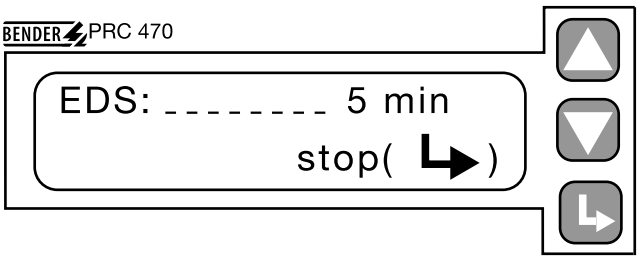



During an interpulse period of 4 seconds, the evaluators EDS473-12 are detected and scanned for insulation faults.




For 2 seconds, a negative current pulse is superimposed on the system.

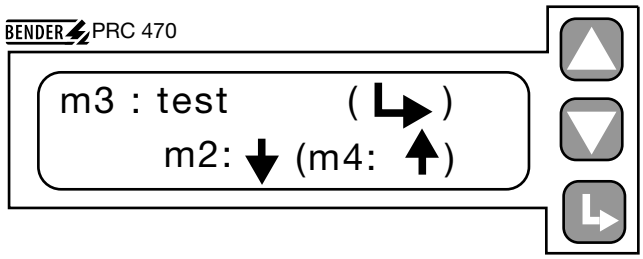
When the EDS473 system is started via the control inputs GND/IN1 there is a pause for 5 minutes after each pass. This is displayed in the following picture:

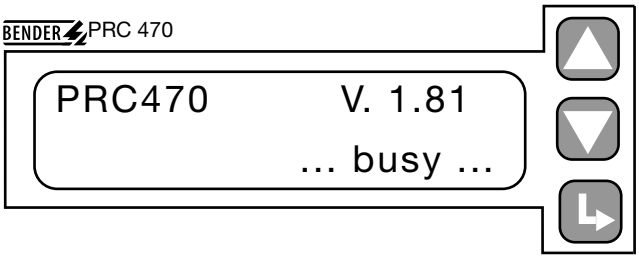



If insulation faults were detected, they are displayed in menu 2 (m2: monitor).
The insulation fault location runs as long as the ENTER key (stop) is activated.

## Menu 3: test

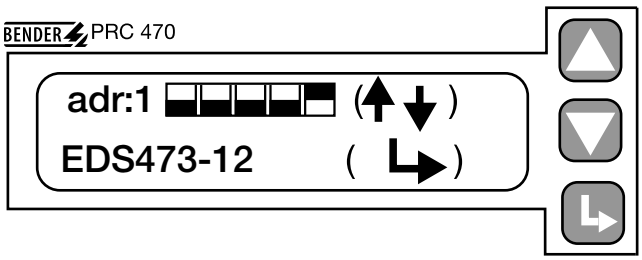
In menu 3 (m3: test), a test program is started. It displays all devices connected to RS485 interface with their addresses in binary representation. The current transformer inputs are checked for short-circuits and interruptions. This check also reveals whether a measuring current transformer is connected or the connection to the measuring current transformer is interrupted or short-circuited.



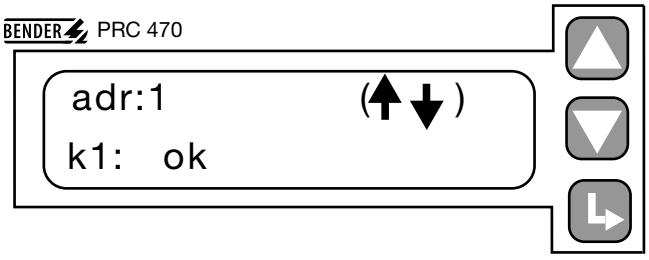

When the test program is started, the message that the tests are running is displayed briefly.

All evaluators EDS473-12 which are connected to the PRC470 are subjected to self-test. The measuring current transformer inputs and their wiring are checked.
Furthermore, their functionings are partially tested.
After approx. 30 seconds the type and the address of the first evaluator EDS473-12 is displayed.

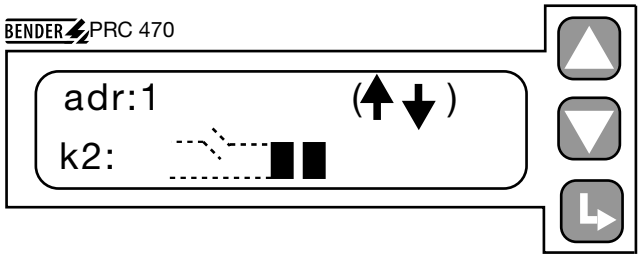



The available addresses can be scrolled by means of the keys <UP> or <DOWN>. If the last of these available addresses is reached this information is displayed on the monitor.

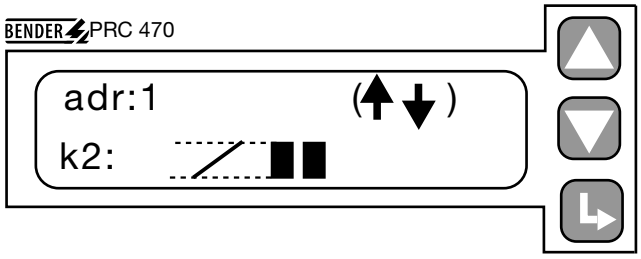
The <ENTER> key starts the test of the respective address. The wiring of each measuring current transformer input of the evaluator is displayed successively for 2 seconds. The following displays are possible:




Measuring current transformer input k1 is connected to a functionally-serviceable measuring current transformer.

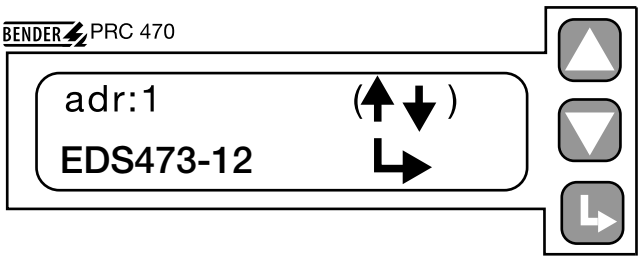



No measuring current transformer is connected to measuring current transformer input k2 or the measuring current transformer wire is interrupted.

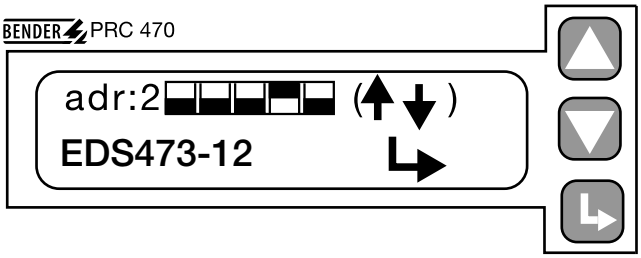



Short-circuit in measuring current transformer input k2.

According to the condition of the measuring current transformer connection, one of these displays is then displayed for each measuring current transformer. Afterwards, a screen mask indicating the relay setting, the set memory behaviour and the software version of the EDS473-12 which was checked is displayed.

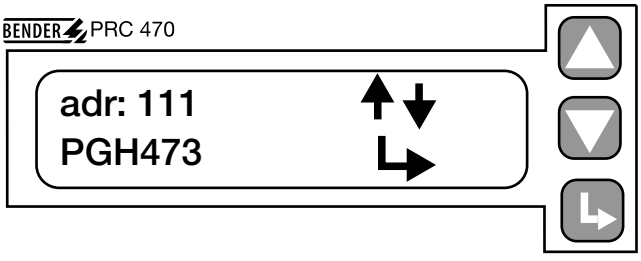



From this mask, a second test of address 1 is started by means of <ENTER> or another address is selected with the keys <UP> or <DOWN>.




The address range of 1-30 is reserved for EDS473-12, the range of 111-119 for the PGH473.

Example: EDS473-12 with address 2.

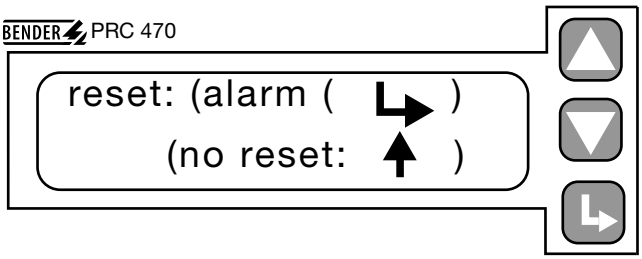



Example: PGH473 with address 111.

If one of the arrow keys is pressed, the mask with the following address is displayed. The address is displayed by symbols of the DIP switches which were set at the EDS473-12. If the program does not find an address, it tries to find a connected device by running through all addresses up to address No. 199. The mask shown above which indicates the respective address number is displayed briefly. The search can be stopped by means of the <ENTER> key, afterwards the system returns to the basic menu.

### Menu 4: reset

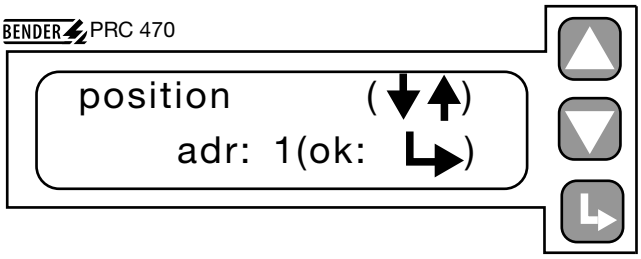
In the reset menu (m4), the alarm relay and the alarm LEDs of the control and indicating device PRC470 as well as the evaluator EDS473-12 and the signal converter SMO480-12 are reset. All alarm messages of the devices connected to the interface are reset. The reset function corresponds to a restart of the EDS473 system.



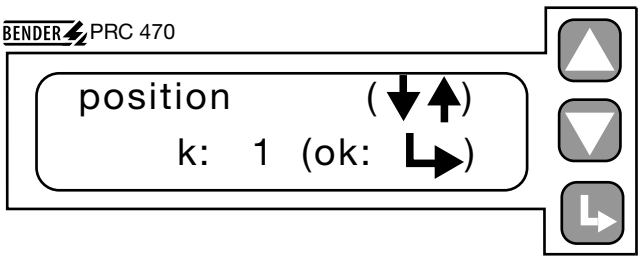

Pressing the <ENTER> key, activates the reset function and returns to the basic menu. Pressing the <UP> key, prevents reset.

### Menu 5: position

In menu 5 (m5) a certain measuring current transformer can be selected for the test.

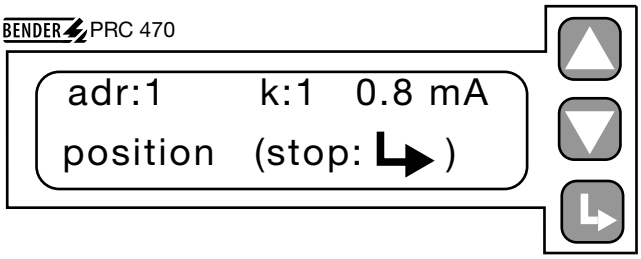



In this mask, the desired address can be selected by means of the arrow keys (<UP>,<DOWN>). By pressing the <ENTER> key, this address is called up.




Afterwards, the desired channel of the selected address can be determined. The arrow keys call the next or the previous channel, the <ENTER> key starts the test of the selected channel.

During the test, the positive and the negative test impulses are displayed (see menu 2 EDS start). The measured test current is displayed between the display of the positive and the negative testing cycle provided that a fault in the channel was detected.




**Note:** selecting <memory on> in menu 7, displays the maximum measured test current. Selecting <memory off>, displays the current measured value.

Pressing the <ENTER> key quits the <position> program and returns to the basic menu.

## Menu 6: relays

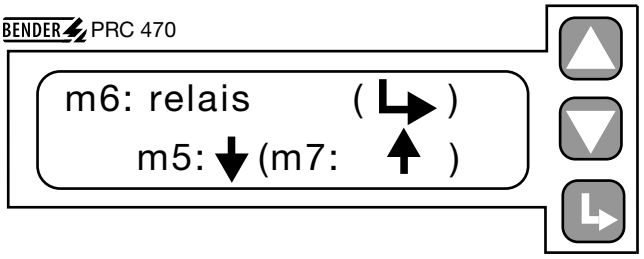
Menu 6 (m6) allows to set the operating mode of the alarm relays for all devices which are connected to the interface RS485. Optionally, N/O or N/C operation can be selected.

## N/O / N/C operation

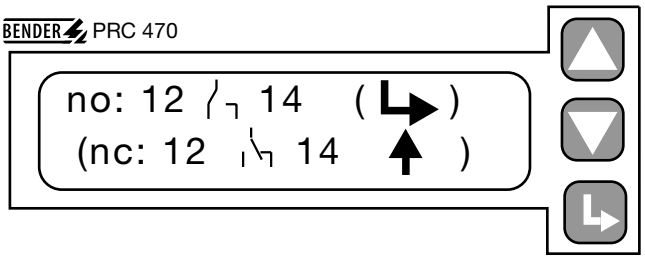
Explanation of the operating modes:

N/O operation: the alarm relay is de-energized in normal condition and energized in fault condition.

N/C operation: the alarm relay is energized in normal condition and de-energized in fault condition.



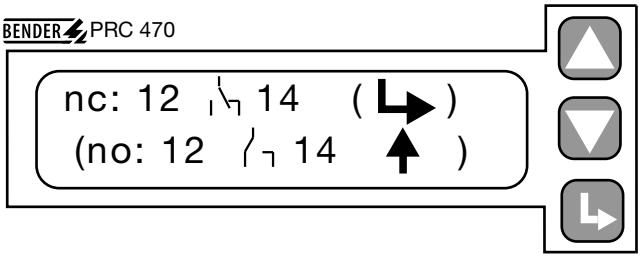

The <ENTER> key opens the program for setting the relays, the <UP> key opens the next menu (m7).




The upper line shows the current setting of the alarm relay. The condition of the contacts is displayed graphically.

| | | | | |
|---|---|---|---|---|
| no | => | normally open | => | N/O operation |
| nc | => | normally closed | => | N/C operation |

By pressing the <ENTER> key, the current setting is kept and the program returns to the basic menu. The <UP> key changes the current setting and the screen mask shows the changed setting.




When changing the operation mode of the alarm relays, the new operational characteristics of the contacts must be considered. If, for example, the contacts are used for turning on warning lights or horns or even for starting switching operations, the contact wiring must be changed.

**Important:** do not change the operating mode of the relay if an alarm is being indicated.

## Menu 7: memory

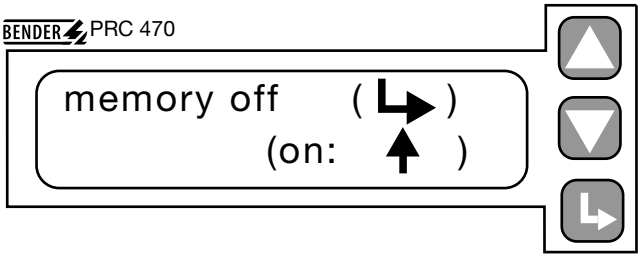
In menu 7 (m7), the fault memory behaviour is determined for all devices connected to the RS485 interface.

## Fault memory behaviour

Explanation:

memory on — Fault memory on:
Detected fault messages (alarm relay and alarm LEDs) and the maximum measured test current are stored and kept stored until they are deleted by means of the reset menu or can be deleted by a reset key, if available. Fault messages are kept stored even in case of power failure.

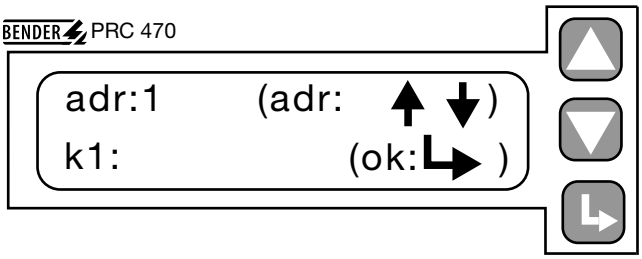
memory off — Fault memory off:
Alarm relays and alarm LEDs are reset automatically as soon as no insulation fault is detected during a new measurement. The current measured value will be displayed.



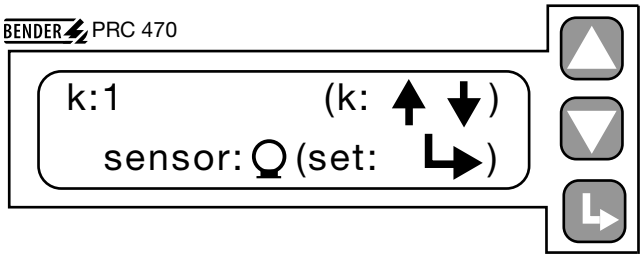

The upper line shows the current setting of the fault memory, which in this case is set to OFF. Pressing the <UP> key changes this setting to ON. Pressing the <ENTER> key accepts the current setting and returns to the basic menu.

## Menu 8: set sensor

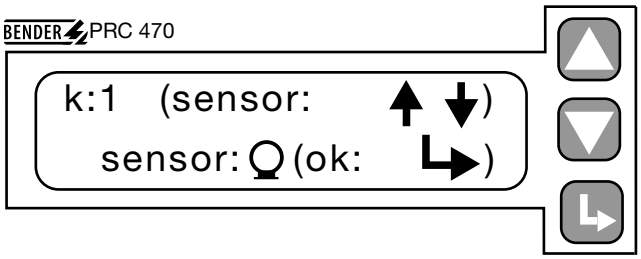
The evaluators EDS473-12 are pre-set by factory to the standard measuring current transformers W1-35/8000. If other types of measuring current transformers are to be used, for example split-core transformers, the evaluators EDS473-12 must be informed about that. Select menu 8 (m8) of the PRC470 for changing the setting.




Choose the address of the EDS473-12 which is to be changed by scrolling the arrow keys (<UP>, <DOWN>). After selecting the right address, call up the next menu for setting the channel by pressing the <ENTER> key.



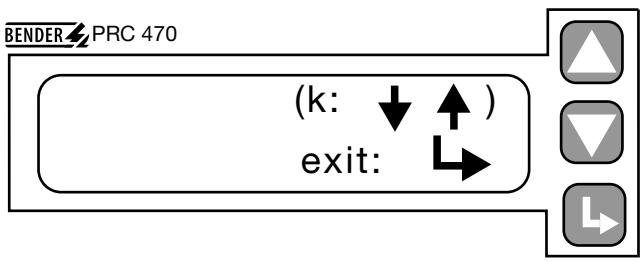

Use the arrow keys to select the desired channel (1-12) and confirm with <ENTER> to open the next menu for selecting the measuring current transformer.




The arrow keys (<UP>, <DOWN>) allow to select the desired type of measuring current transformer (sensor). The following three settings are possible:

| | |
|---|---|
| | Standard measuring current transformers: W1-35/8000 or W08/8000 |
| | Split-core measuring current transformers WS50x80/8000 |
| NO | This NO can be indicated for subcircuits which are not used. These subcircuits will then be skipped which shortens the scanning time. |

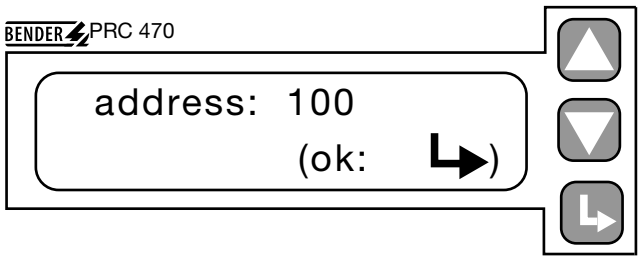
By pressing <ENTER>, the selected measuring current transformer will be accepted for this channel. Afterwards, there is either the possibility to select the next channel and to set the desired type of measuring current transformer or to go back by scrolling the <DOWN> key until the following mask appears. From there return to the basic menu by pressing <ENTER>.




The sign for *current transformer not connected* will be displayed in case of selecting a channel which is set to "no sensor" in the position menu.

### Menu 9: address

In menu 9 (m9), the address of the control and indicating devices PRC470 is displayed. The address cannot be changed.

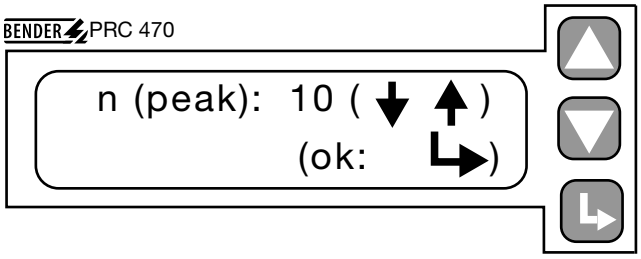



The address is selected by means of the arrow keys. The selected address is confirmed with <ENTER> and jumps back to the basic mask.

### Menu 10: peak

In the peak menu 10 (m10), the EDS system is adjusted to systems in which special interferences occur. Please note the explanations concerning this subject in chapter LIMITS OF THE INSULATION FAULT LOCATION.
The statistic probability of detecting an insulation fault despite interferences is increased by the number of the set scanning cycles per measuring current transformer (= peaks). The measuring time certainly increases with the number of the set peaks. In the worst case, the measuring time is increased by 6 seconds x n per subcircuit.
Example:
Setting n: 250 (maximum value)
Number of subcircuits: 12
means
6 sec x 250 x 12 subcircuits = 18000 sec = 5 hours
Thus, in this case, a complete pass would take 5 hours. This maximum time will only be effective when all the subcircuits are disturbed in a way that the maximum value (setting n) is required.

The factory setting is n = 1. If system interferences repeatedly cause fault messages (PEAK-FAULT) at the FAULT LED of an EDS473-12, n should be increased by steps of 10 until insulation faults can be detected. For further information, see chapter INITIAL OPERATION.

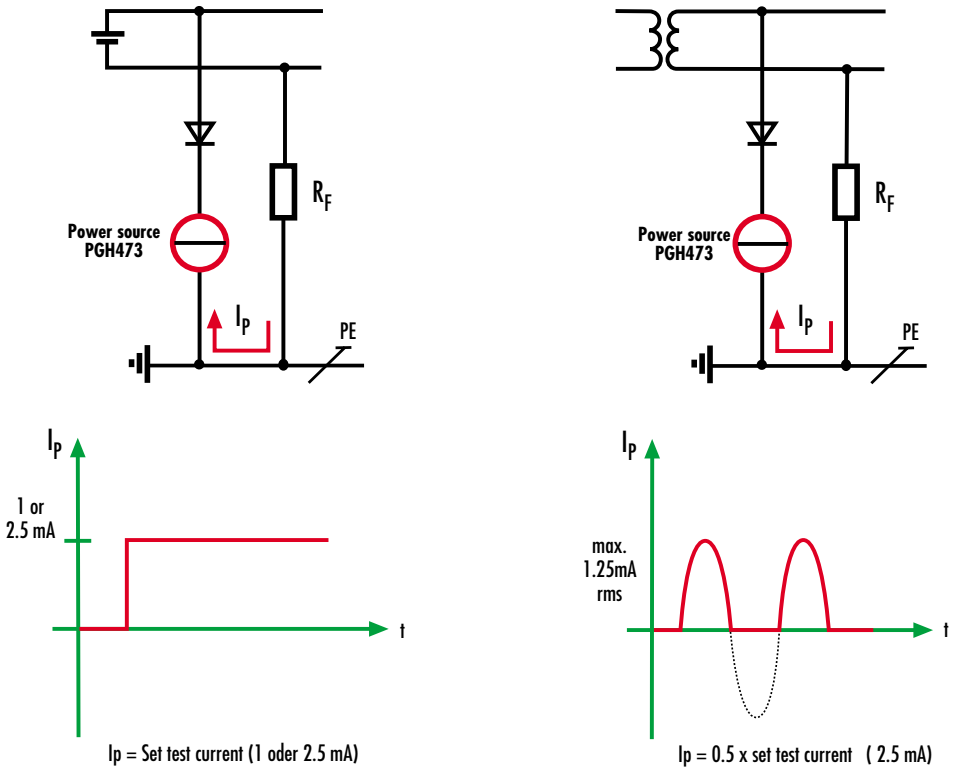



**n (peak)** can be changed between 1 and 250 by means of the arrow keys. <ENTER> confirms the input and returns the program to the basic menu.

## Display test current

Apart from the identification of the faulty subcircuit, the test current which passes through this measuring current transformer is also displayed in menu 2 (MONITOR) (m2). This display can be used to determine the rough value of the insulation resistance behind this measuring current transformer.

In DC systems, the insulation resistance in kΩ directly results from dividing the nominal voltage by the displayed test current.
In AC systems, a pulsating test current of the PGH473 is produced. Therefore a correction factor of 0.5 has to be taken into consideration in the calculation.
The following diagram clearly shows this.




**Therefore set the test current at the PGH473 in DC systems either to 1 or 2.5 mA corresponding to the conditions of the plant.**
**In AC systems set the test current always to 2.5 mA.**

**Note:** the displayed measuring value may be falsified by the influence of system leakage capacitances.
The test current of the PGH473 is limited to 2.5 mA resp. 1 mA maximum. Due to this limitation, the insulation fault may have lower impedance than signalled by the displayed test current.

## Check list

After installing and wiring the EDS473 system, it is recommended to carry out the initial operation by means of the following check list.

Before switching on the system for the first time

- check the supply voltage on all devices.
- Check the system coupling of the PGH473 and insulation monitoring device.
- Wire lengths, wire cross sections of all device connections (on this point, compare the section on LINE LENGTHS).
- Correct termination of the serial bus.
- Check the DIP switches for the address settings of all connected devices. Addresses must never be doubly assigned!
- Check the setting for the maximum test current (2.5/1 mA) on the PGH473. Note: setting 1 or 2.5 mA in DC systems, as a basic rule 2.5 mA in AC systems.
- Check the MASTER-SLAVE concept and the MASTER-SLAVE settings for all connected devices. Here is a little help with this, in the form of the following table:

| | SETTING | | |
|---|---|---|---|
| **System concept** | **EDS473-12** | **PGH473** | **PRC470** |
| EDS473 without PRC470, connectionEDS473-12 to PGH473 via RS485 | SLAVE | MASTER | ---------- |
| EDS473 with PRC470, connection of all decices via RS485 | SLAVE | SLAVE | MASTER |
| EDS473 without PRC470, no RS485 connection between EDS473-12 and PGH473 | MASTER | MASTER | ---------- |

**Note:** the setting ”EDS473-12” applies to all EDS473-12 devices within an EDS system.

**Switching on the system**

Insulation monitoring device

- Switch on the supply voltage, check the response values, especially the response value for activating the EDS system. Observe the instructions in chapter SETTINGS AND ADJUSTMENTS.

Test device PGH473

- Switch on the device, the green power ON LED must light up. Measure the voltage at terminals L1, L2, L3.
- Check the contact function of the insulation monitoring device at terminals GND/ IN1 resp. IN2. For this purpose, this simulation of an insulation fault lower than the response value of the insulation monitoring device is recommended.

Insulation fault evaluator EDS473-12

- switch on the supply voltage, the green power ON LED must light up.
- Press the test button to test all channels. After testing, all LEDs apart from the power On LED must extinguish again.

Control and indicating device PRC470

- Switch on the device, observe the LC display. After switching on the device, the welcome menu with display of the software version must be displayed for approx. 5 seconds. Afterwards, the basic menu is displayed.

**Functional test**

- Activate menu 3 (TEST) at the PRC470 control and indicating device. Check whether all connected devices are displayed and whether all measuring current transformers are displayed.
- Press the test button on the evaluator EDS473-12. Check whether all measuring current transformers are displayed.
- Cause an insulation fault in the system by means of an appropriate resistor (consider the capacity!). The resistance must be lower than the response value of the insulation monitoring device and must be connected between a phase of the system and earth. **Attention: this work may only be carried out by an electrician while observing the safety regulations and relevant standards.**
  Possible effects on the system must be observed.
- Connect a measuring instrument (setting mA DC) between the PE conductor and the ⏚ terminal of the test device PGH473, if required. This instrument allows to check the test current.
- Observe the LEDs at the PGH473. The LEDs for the positive and negative test cycle must light up alternately for approx. 2 seconds.
  There is a pause for 4 seconds between the positive and the negative test cycle.
- Observe the LEDs at the EDS473-12. The LEDs for each subcircuit must light up subsequently and extinguish again if no insulation fault is present.
- The insulation fault must be displayed in the respective subcircuit at the PRC470.
- Carry out a reset at the PRC470 and insulation monitoring device after the test.

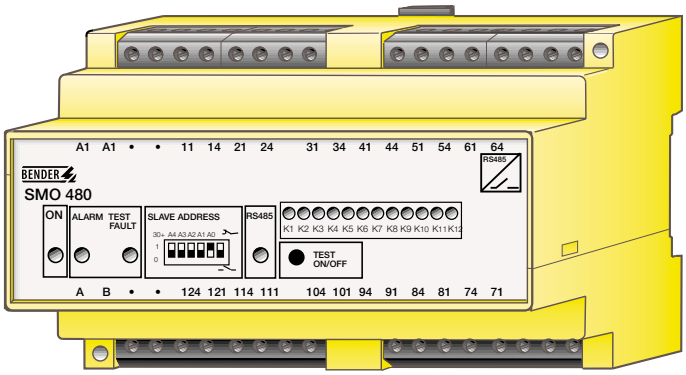
## Maintenance, test

The components of the insulation fault location system EDS473 contain no parts requiring servicing.
Operation of the test keys of the insulation monitoring device and the PRC 470 at regular intervals to start a scanning pass is recommended. Also a test run should be carried out from the menu of the PRC470. The plant operator is to specify the periodicities of these checks.

Several additional modules are available for extending the EDS473 system.

## SMO480-12 signal converter

The SMO480-12 signal converter converts serial signals of BENDER evaluators (e.g. EDS473-12) into relay contact messages. There is a relay available for each assigned EDS473-12. The relay contacts are also suitable for small currents (from 5 mA up).




The assignment between the evaluator EDS473-12 and the SMO480-12 is carried out by the setting of the device addresses. The evaluator and the signal converter have to be set to the same address. The SMO480-12 has an internal address extension (+30) so that conflicts concerning the addresses can be prevented.

If the assigned EDS473-12 signals an alarm message, it is tranferred via the RS485 interface. As a result the signal converter SMO480-12 switches to the alarm relay of the corresponding channel.
The operation mode of the alarm relays can be switched per DIP switch from N/O operation to N/C operation. The setting is independend of the PRC470.

Setting of the SLAVE address:

| Adr. | A4 | A3 | A2 | A1 | A0 |
|---|---|---|---|---|---|
| (30+) 1 | 0 | 0 | 0 | 0 | 1 * |
| (30+) 2 | 0 | 0 | 0 | 1 | 0 |
| (30+) 3 | 0 | 0 | 0 | 1 | 1 |
| (30+) 4 | 0 | 0 | 1 | 0 | 0 |
| (30+) 5 | 0 | 0 | 1 | 0 | 1 |
| (30+) 6 | 0 | 0 | 1 | 1 | 0 |
| (30+) 7 | 0 | 0 | 1 | 1 | 1 |
| (30+) 8 | 0 | 1 | 0 | 0 | 0 |
| (30+) 9 | 0 | 1 | 0 | 0 | 1 |
| (30+) 10 | 0 | 1 | 0 | 1 | 0 |
| (30+) 11 | 0 | 1 | 0 | 1 | 1 |
| (30+) 12 | 0 | 1 | 1 | 0 | 0 |
| (30+) 13 | 0 | 1 | 1 | 0 | 1 |
| (30+) 14 | 0 | 1 | 1 | 1 | 0 |
| (30+) 15 | 0 | 1 | 1 | 1 | 1 |
| (30+) 16 | 1 | 0 | 0 | 0 | 0 |
| (30+) 17 | 1 | 0 | 0 | 0 | 1 |
| (30+) 18 | 1 | 0 | 0 | 1 | 0 |
| (30+) 19 | 1 | 0 | 0 | 1 | 1 |
| (30+) 20 | 1 | 0 | 1 | 0 | 0 |
| (30+) 21 | 1 | 0 | 1 | 0 | 1 |
| (30+) 22 | 1 | 0 | 1 | 1 | 0 |
| (30+) 23 | 1 | 0 | 1 | 1 | 1 |
| (30+) 24 | 1 | 1 | 0 | 0 | 0 |
| (30+) 25 | 1 | 1 | 0 | 0 | 1 |
| (30+) 26 | 1 | 1 | 0 | 1 | 0 |
| (30+) 27 | 1 | 1 | 0 | 1 | 1 |
| (30+) 28 | 1 | 1 | 1 | 0 | 0 |
| (30+) 29 | 1 | 1 | 1 | 0 | 1 |
| (30+) 30 | 1 | 1 | 1 | 1 | 0 |

* Factory setting

The SLAVE address must be identical to the address of the assigned EDS473-12.

DIP switch

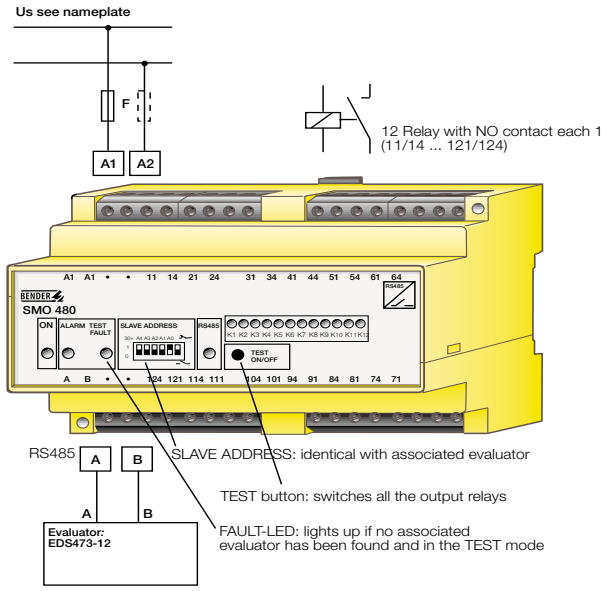
A0 .. A4: address setting (assignment to EDS473-12)
: operation mode N/O (= factory setting)
: operation mode N/C

In case of an invalid address setting the FAULT LED will light up.
Note: all the output relays will be switched over when pressing the TEST button. For the reset from the TEST mode into the normal mode the TEST button has to be pressed again.
ALARM LED: lights up as soon as one (or several) relays have responded and are in the TEST mode.
RS485 LED: indicates activity on the RS485 bus.

**Output relay (NO contact)**

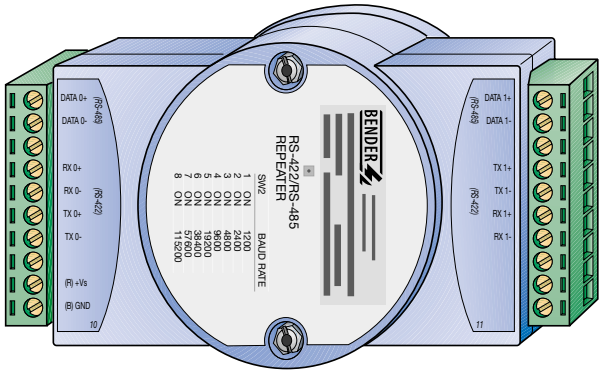
| | |
|---|---|
| Channel 1: | 11-14 |
| ……: | ……. |
| ……: | ……. |
| Channel 12: | 121-124 |

## SMO480-12 connection




## RS485 repeater DI-1

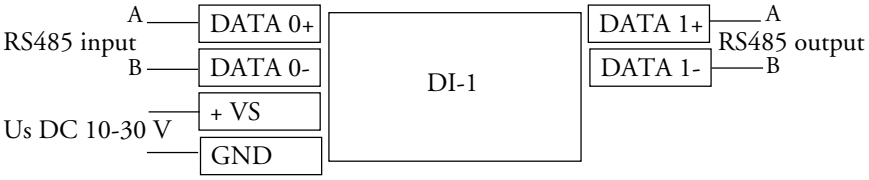
The RS485 repeater DI-1 amplifies the signals of the RS485 interfaces. It causes a isolation between the input and output circuit.




The specification of the RS485 interface limits the maximum length of the bus to 1200 m. The repeater DI-1 ensures a signal amplification. An extension of the bus to additional 1200 m behind a DI-1 is possible with that. As a side effect the number of the maximum of possible bus-nodes is increased by 32.
The connected devices are protected against spikes on the bus by electrical disconnection between the input and output circuit (DC 3000 V).

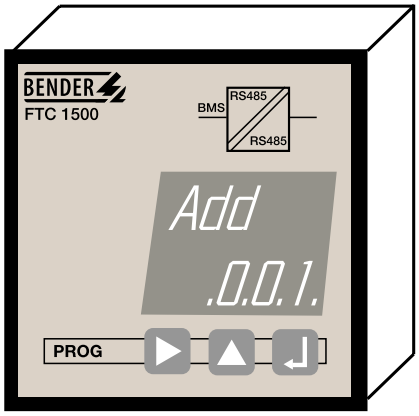
In an insulation fault location system EDS473 it is possible that the permissible bus length of 1200 m is not sufficient when the system has a lot of monitored subcircuits. Here the use of a DI-1 can extend the RS485 bus to additional 1200 m.

## DI-1 Anschluß

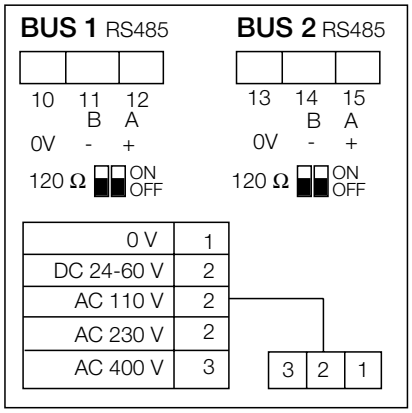



**Note:** do not change the factory settings of the DI-1!

## FTC1500 protocol converter




The FTC1500 protocol converter converts the BMS protocol (BMS = BENDER Meßgeräte Schnittstelle) of the RS485 bus into the JBUS/ MODBUS protocol. This is how a communication with MODBUS-nodes like SPC or PCs is possible. The FTC1500 is operating bidirectional so that the BMS data are transferred to the MODBUS as well as MODBUS data are transferred to the BMS bus.

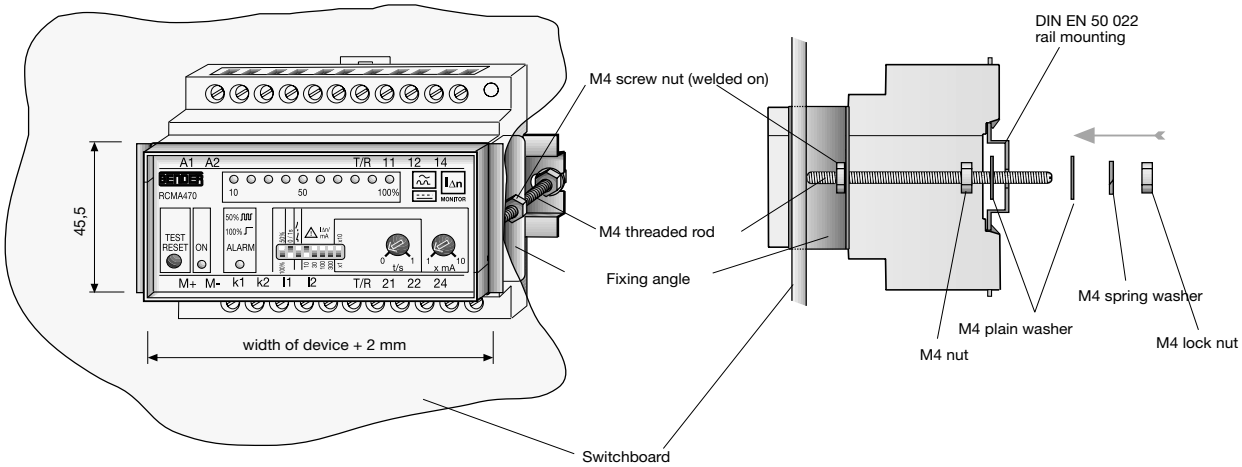



**Connection:**
BUS1: JBUS/MODBUS
BUS2: BMS-BUS

Observe the terminations of both busses!

## Switchboard kit

All devices in casing X470 (PGH473, EDS473-12, PRC470, IR475LY-4) can also be installed in switchboards by means of a switchboard kit.

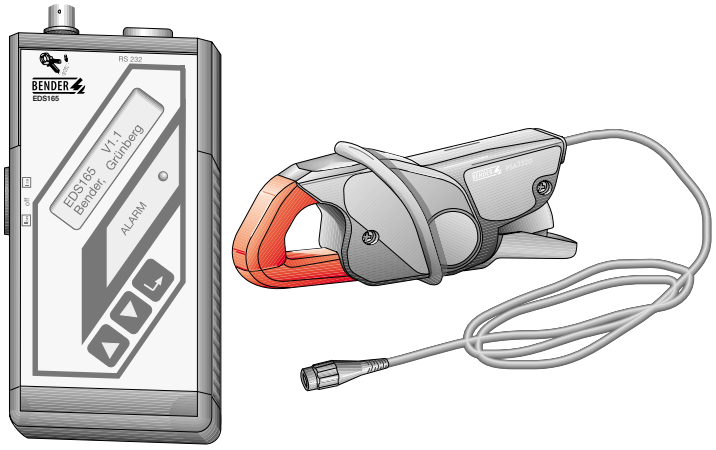


## EDS165-3

The portable evaluator EDS165-3 carries out two measuring tasks:

1. It is an ideal supplement to the fixed installed insulation fault scanning systems EDS473.
2. It represents an adequate device for measuring the residual current together with the current clamps PSA3320 and PSA3352.

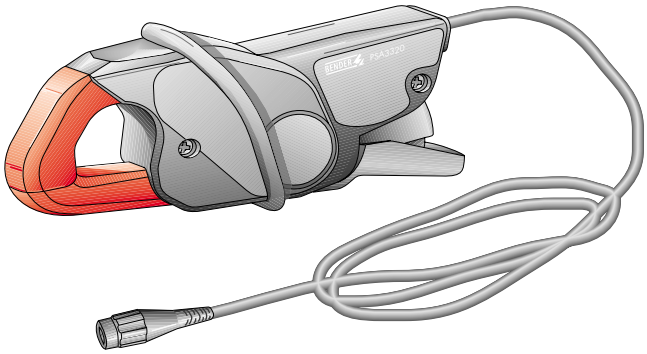
Fixed installed insulation fault location systems like EDS473 enable the operator to maintain the systems on a constantly high insulation level and thus to guarantee highest availability of the systems. Occuring faults are signalled selectively and it is not necessary to disconnect the system for fault location.
For this purpose, the portable insulation fault location evaluator EDS165-3 represents an ideal completion.



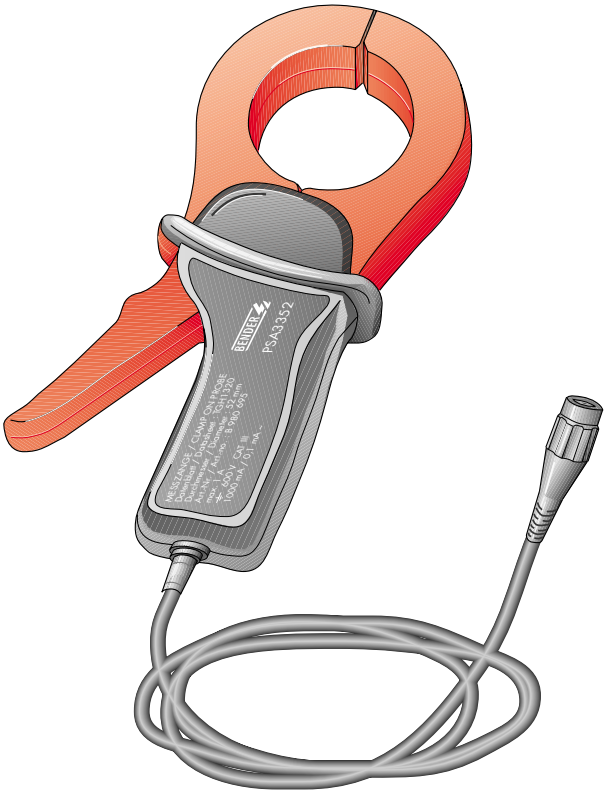

Subcircuits which have not been provided with a built-in measuring current transformer for cost reasons can easily be checked by means of the EDS165-3. The EDS165-3 detects the test pulses of the insulation fault test device PGH473 which is already installed.

As a residual current monitor, the EDS165 is used for detecting fault currents to earth in AC TT and TN systems or, if certain system conditions are met, even in AC IT systems. The detection of defective consumers or cables is carried out during operation and does not require to disconnect the entire system. Thus, faults are detected quickly and safely and can be cleared as soon as possible. Under the aspect of preventive maintenance, this is an important step to increase the availability of the system. This measuring function allows to measure the leakage current which causes FAULT messages in EDS473 systems, if the value exceeds 1 A.

## Current clamps for EDS 165-3



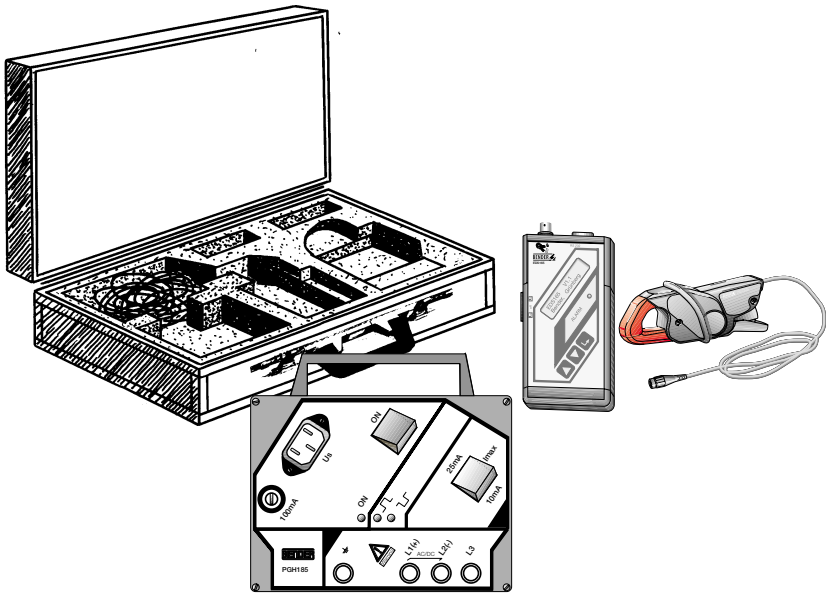
*Current clamp PSA3320 with an internal diameter of 20 mm*




*Current clamp PSA3352 with an internal diameter of 52 mm*

## Insulation fault location system EDS3365

The EDS3365 is a portable insulation fault location system. This enables insulation fault location to be conducted in IT systems while operation is in progress. Insulation faults can be located in IT systems, AC 20 … 265 V and DC 20 … 308 V.




**The insulation fault location system consists of the following components:**

EDS3365

| | |
|---|---|
| 1 | Aluminium case with a carrying belt |
| 1 | Test device PGH183 |
| 1 | Insulation fault evaluator EDS165 incl. accumulators |
| 1 | Current clamp PSA3320 (20 mm ø) |
| 1 | Current clamp PSA3352 (52 mm ø) |
| 1 | Mains cable |
| 3 | Safety measuring lead, black |
| 1 | Safety measuring lead, green/yellow |
| 4 | Safety claw grip (3 x black, 1 x green/yellow) |
| 1 | Adaptor BNC/4 mm plug -> current transformer |
| 2 | 4 mm plug |
| 1 | Accumulator charger AC 230 V |
| 1 | Operating manual |

**Ordering details :**

| Type | Designation | Art. No. |
|---|---|---|
| EDS3365 | Insulation fault location system<br>Supply voltage AC 230 V | 91 082 011 |
| EDS3365-13 | Insulation fault location system<br>Supply voltage AC 90-132 V<br>No accumulator charger | 91 082 012 |

You can obtain information about the EDS3365 on request.

# 9 Limits of the insulation fault location

## Interferences

As it is known, there is a limit to everything in the world. Of course this also applies to the measuring technology of the EDS473 system. Today´s sophisticated power systems contain a large number of components which can cause influences and interferences.

Interferences for the EDS473 system are for example:

- high system leakage capacitances
- too high leakage currents
- transient leakage currents
- low-frequency leakage currents

The limit conditions of the EDS473 system are given in this operating manual. Clear statements of every kind of interference compatibility as well as functional limits cannot be made because of the large number of possibilities. In case of doubt, the suitability of the EDS473 system for the respective application must be clarified with a consultant from BENDER.

Here, the conditions and reactions of the EDS473 system in case of the non-observance of the conditions shall be explained:

- response sensitivity: consider curve 3 in chapter SETTINGS AND ADJUSTMENTS.

- Influence of the system leakage capacitances: curve 2 in chapter SETTINGS AND ADJUSTMENTS shows the response sensitivity dependent on the leakage capacitance of the entire system. If the leakage capacitance exceeds the permissible value in a subcircuit downstream of the measuring current transformer, fault messages from the evaluators EDS473-12 may occur (FAULT LED).

- Maximum leakage currents: the maximum permissible system-related leakage current which allows for a proper evaluation is restricted to 1 A. If the leakage current exceeds 1 A, a selective fault location can no longer be carried out. Leakage currents > 1 A are displayed by the LED ”FAULT” on the EDS473-12. On this point, the FAULT curve has to be considered.

- Transient leakage currents: switching and controlling activities in the system may cause transient leakage currents which influence the evaluation of the EDS test signal. These transient leakage currents can only partially be filtered out. Yet, the EDS473 system detects most of these interferences and signals them via the ”Fault” LED of the EDS473-12. It cannot be excluded that periodic interferences which accidentally have the same periodic duration, amplitude and frequency as the internal signal scanning may cause false measurements and thus results in false trippings. Yet, the probability is relatively small. A precise definition of these limits and conditions is not possible since they depend on the system features.

- Low-frequency leakage currents: They may be caused by the use of converters. If the frequency of the converters is identical or approximately identical with the test cycle frequency of the PGH473, they may cause FAULT messages and insulation faults may not be detected. By adjustments in menu 10 (PEAK) of the PRC470, the statistic probability of detecting an insulation fault can be increased.

# 11 Increasing the sensitivity

The total insulation resistance of a system may consist of the parallel connection of several insulation faults. If the test current of the PGH473 is distributed among too many insulation faults, the result may be that certain insulation faults are not recorded during insulation fault location. In this case, the current which is caused by the insulation fault is below the response value (approx. 0.5 mA).

In cases such as these, it may be sensible to increase the test current. This can be done by connecting two PGH473 insulation fault test devices. **Important:** this is only possible in systems **with** a PRC470. Different addresses must be set for the two PGH473.

At first, only one PGH473 is activated during insulation fault location. If no insulation fault is detected or the value of the detected insulation fault is very close to the response value (0.5 mA), a second insulation fault location is started – this time the detection is carried out by means of two PGH473 in parallel.

The second PGH473 insulation fault test device should be switched on when the value has fallen below the response value of the insulation monitoring device (EDS473 system started), and no insulation faults have been detected after the first complete pass.
After the insulation fault location, the second PGH473 must be disconnected from the system again, since test currents of up to 5 mA (2 x 2.5 mA)may occur on parallel connection.

If only one insulation fault occurs, the additional PGH473 does not improve the sensitivity since the current is limited by the insulation fault. It only supplies additional current if the test current is divided due to the occurrence of several insulation faults.


**Note:** normally, the test current which now flows via the insulation fault cannot be higher than 1 mA since the current measured during the first measurement was below 0.5 mA and the test current can at most be doubled by the second PGH473.

However, if a new insulation fault occurs during the measurement, a current of 5 mA may flow through under extreme conditions. This possibility must be considered when using two PGH473. It must be checked whether there are parts of the installation in which this test current in combination with a real insulation fault may cause wrong operations.

# 11 Means for fault location

**Memory behaviour**

Frequently, an alarm contact of the insulation monitoring device is used for automatic start of the EDS473 system. This contact must be closed during insulation fault location (GND/IN1). When the system is started via GND/IN2 of the PGH473, a pulse of approximately 6 seconds is sufficient in order to start a pass.

**Interfaces**

For insulation monitoring devices with integrated interface it must be checked whether the insulation fault message caused by the test cycle of the PGH473 causes an undesired message on the higher-order PC. If necessary, the interface must be disconnected.

**IRDH265/365 and IR475LY series**

If the EDS473 system is operated with an insulation monitoring device of the BENDER series IRDH265/365 resp. IR475, the EDS473 system must be started via alarm relay 2. Depending on its setting, alarm relay 1 can also indicate system faults and thus start the EDS473 system even if no insulation fault is present.

**Internal resistance of the A-ISOMETERS**

The used insulation monitoring device should have a minimum internal resistance $R_i$ of 28 kΩ.

**Two response values**

It is recommended to use an insulation monitoring device with two adjustable response values. In this case, one response value is set in a way that it meets the requirements of the relevant standards (e.g. 100 Ω/V), while the second response value is used for starting the EDS473 system. The second response value is set in a way that the system can find an insulation fault (see chapter SETTINGS AND ADJUSTMENTS).

**"no system" display**

If ”no system” appears on the display of the control and indicating device PRC470 please check the settings of all devices connected to the RS485 bus.

**Upstream capacitance, downstream capacitance**

The response sensitivity of the EDS473 system depends among other things on the existing leakage capacitance of the monitored IT system (see also chapter SETTINGS AND ADJUSTMENTS, characteristic curve 3). When considering the system leakage capacitance it must be taken into consideration that the division of the capacities upstream and downstream of the individual measuring current transformers is not arbitrary. The upstream capacitance of the entire system must amount to at least 50% of the total capacitance. Otherwise, a reduced response sensitivity is to be expected.

**FAULT LED**

If the LED FAULT on the evaluator EDS473-12 lights up, the following reasons are possible:

- interruption or short-circuit in the transformer connection.
- A residual current > 1 A flows through a measuring current transformer.
- Occurrence of high interferences in the system.
- The capacitances in the system are very high.

FAULT messages are only transmitted as > 1 A message to the PRC470.

**RS485 LED**

During insulation fault location, the RS485 LEDs on the PRC470, the EDS473-12 and the PGH473 must be active in irregular intervals. Every sending and receiving operation is indicated via the LEDs. If no activities of the LEDs can be observed, it is recommended to check the interface cables. The connections A and B must not be changed.

**Different time behaviour**

If several EDS473 systems are operated, the test cycles may take different time even if the systems are started simultaneously.
For example, EDS473 system1 has already reached transformer subcircuit No. 7 whereas EDS473 system 2 has only reached transformer subcircuit No. 5. Different time behaviour of similar systems can be caused by the following:

- Current transformer inputs which are not assigned reduce the measuring time.
- Detection of an insulation fault before the end of the maximum measuring time.
- Residual currents > 1 A.

**Balanced faults**

Under certain conditions, balanced faults cannot be detected with the EDS473 system.

**BENDER service**

For problem solutions concerning system protection, consult the BENDER service department. Please contact your responsible Technical Bureau if you have any queries regarding possible solutions and costs.

## Technical Data EDS473-12

| Technical data EDS473-12 insulation fault evaluator | |
|---|---|
| **Insulation coordination acc. to DIN IEC 60664-1** | |
| Rated insulation voltage | AC 250 V |
| Rated impulse withstand voltage / contamination level | 4 kV / 3 |
| **System being monitored:** | |
| Nominal voltage of the system $U_n$ | see PGH473 |
| **Supply voltage:** | |
| Supply voltage $U_S$ | see ordering details and nameplate |
| Max. power consumption | 3VA |
| **Measuring channels:** | |
| Number of measuring channels | 12 |
| Response value DC, AC u. 3AC | 0.5 mA |
| Scanning time for 12 channels (PEAK=1) | ca. 5 min. |
| System leakage capacitances | see SETTINGS AND ADJUSTMENTS |
| **Inputs:** | |
| Interface | RS485 |
| Connecting lead | shielded cable 0.75 mm² max. 1200 m |
| Measuring current transformer | max. 12 |
| Connection to measuring current transformer: | |
| Single wire 0.75 mm² | up to 1 m |
| Single wire, twistedverdrillt 0.75 mm² | >1 ... 10 m |
| Shielded cable 0.75 mm² (shield to L) | >10 ... 25 m |
| **Contact circuits:** | |
| Switching components | 1 change-over contact |
| Contact class acc. DIN IEC 60255 Part 0-20 | IIB |
| Rated contact voltage | AC 250 V / DC 300 V |
| Admissible number of operations | 12000 cycles |
| Making capacity | UC 5 A |
| Breaking capacity for: | |
| AC 230 V, cos phi = 0.4 | AC 2 A |
| DC 220 V, L/R = 0.04s | DC 0.2 A |
| Operating principle, selectable | N/O / N/C operation |
| Pre-set by factory | N/O operation |
| **Type tests:** | |
| Test of the Electromagnetic Compatibility (EMC) | |
| Immunity against electromagnetic interferences acc. to EN 50082-2 | |
| Emission acc. to EN 50081: | |
| Emission acc. to EN 55011/CISPR11 | class B*) |
| Mechanical tests | |
| Shock resistance acc. to IEC 6068-2-27 | 15 g / 11 ms |
| Bumping acc. to IEC 6068-2-29 | 40 g / 6 ms |
| Vibration strength acc. to IEC 6068-2-6 | 10...150 Hz / 0,15 mm - 2 g |
| **Environmental conditions:** | |
| Ambient temperature, during operation | -10...+55°C |
| Storage temperature range | -40...+70°C |
| Climatic class acc. to IEC 60721 | 3K5, except condensation and formation of ice |
| **General data:** | |
| Connection/line: | modular terminals / aluminium or copper |
| Temperature range/line | 60°C (18...16 AWG) / 75°C (14...12 AWG) |
| Wire cross section | |
| Single wire/flexible | 0.2...4 mm²/0.2...2.5 mm² (24...12 AWG) |
| Protection class acc. to EN 60529 | |
| Internal components/terminals | IP 30 / IP 20 |
| Weigth approx. | 350 g |

| **Factory setting:** | |
|---|---|
| Operating principle alarm relay: | N/O operation |
| Operation mode: | SLAVE |
| Fault memory: | ON |
| Type of measuring current transformer: | |
| | Standard measuring current transformers(W1-35/8000) |
| Address: | 001 |
| Peak: | n=1 |

*) Class B devices are suitable for household and industrial use

## Technical data PGH473

| Technical data PGH473 test device | |
|---|---|
| **Insulation coordination acc. to IEC 60664-1** | |
| Rated insulation voltage | AC 500 V |
| Rated impulse withstand voltage/contamination level | 4 kV / 3 |
| **System being monitored** | |
| Nominal voltage of the system $U_n$ DC | 20 ... 308 V |
| Nominal voltage of the system $U_n$ AC | 45-65 Hz / 20 ... 265 V |
| **Supply voltage** | |
| Supply voltage $U_S$ | see ordering details resp. nameplate |
| Max. power consumption | 3 VA |
| **Test cycle** | |
| Max. test current | 2.5 mA oder 1 mA |
| Test cycle/test pause | 2 s/4 s |
| **Inputs** | |
| Number (IN1 ... IN3) | 3 digital |
| Max. voltage | DC 5V |
| Interface(A - B) | RS485 |
| Contact circuit | |
| Switching components | 1 N/O contact |
| Rated contact voltage | AC 250 V/DC 300 V |
| Admissible number of operations | 12 000 cycles |
| Making capacity | UC 5 A |
| Breaking capacity AC/DC | 2 / 0.2 A |
| **Type tests** | |
| Test of the Electromagnetic Compatibility (EMC) | |
| Immunity against electromagnetic interferences acc. to EN 50082-2 | |
| Emissions acc. to EN 50081: | |
| Emissions acc. to EN 55011/CISPR11 | class B *) |
| Mechanical tests | |
| Shock resistance acc. to IEC 6068-2-27 | 15 g / 11 ms |
| Bumping acc. to IEC 6068-2-29 | 40 g / 6 ms |
| Vibration strength acc. to IEC 6068-2-6 | 10...150 Hz / 0.15 mm - 2 g |
| **Environmental conditions** | |
| Ambient temperature, during operation | -10...+55°C |
| Storage temperature range | -40...+70°C |
| Climatic class acc. IEC 60721 | 3K5, except condensation and formation of ice |
| **General data** | |
| Connection/line : | modular terminals/aluminium or copper |
| Temperature range/line | 60°C (18...16 AWG) / 75°C (14...12 AWG) |
| Wire cross section | |
| Single wire/flexible | 0.2...4 mm²/0.2...2.5 mm²(24...12 AWG) |
| Protection class acc. to EN 60529 | |
| Internal components/terminals | IP 30 / IP 20 |
| Weight approx. | 350 g |

| **Factory setting:** | |
|---|---|
| Operating principle, alarm relay: | N/O operation |
| Operation: | SLAVE |
| Address: | 111 |
| Test current: | 2.5 mA |

*) Class B devices are suitable for household and industrial use.

## Technical data PRC470

| Technical data PRC470 control and indicating device | |
|---|---|
| **Insulation coordination acc. to IEC 60664-1** | |
| Rated insulation voltage | AC 250 V |
| Rated impulse withstand voltage/contamination level | 4 kV / 3 |
| **Supply voltage** | |
| Supply voltage $U_S$ | see ordering details resp. nameplate |
| Max. power consumption | 3 VA |
| **Inputs** | |
| Number of inputs (IN1 ... IN4) | 4 digital |
| Max. voltage | DC 5V |
| Interface(A - B) | RS485 |
| **Outputs (01+ ... 02-)** | |
| Signal outputs (electronical switch) | 2 |
| Max. voltage/current | AC/DC 24V/100mA |
| **Note:** These outputs are not required in connection with the PGH 473 test device | |
| **Contact circuits** | |
| Switching components | 2 change-over contacts |
| Contact class | IIB acc. DIN IEC 60255 part 0-20 |
| Rated contact voltage | AC 250 V / DC 300 V |
| Admissible number of operations | 12000 cycles |
| Making capacity AC/DC | 5 A |
| Breaking capacity | |
| AC 230 V, cos phi = 0.4 | AC 2 A |
| DC 220 V, L/R = 0.04 s | DC 0.2 A |
| Operating principle | N/O / N/C operation |
| Pre-set by factory | N/O operation |
| **Type tests** | |
| Test of the Electromagnetic Compatibility (EMC) | |
| Immunity against electromagnetic interferences acc. to EN 50082-2 | |
| Emissions acc. to EN 50081: | |
| Emissions acc. to EN 55011/CISPR11 | class B *) |
| Mechanical tests: | |
| Shock resistance acc. to IEC 6068-2-27 | 15 g / 11 ms |
| Bumping acc. to IEC 6068-2-29 | 40 g / 6 ms |
| Vibration strenth acc. to IEC 6068-2-6 | 10...150 Hz/0.15 mm - 2 g |
| **Environmental conditions** | |
| Ambient temperature, during operation | -10...+55°C |
| Storage temperature range | -40...+70°C |
| Climatic class acc. IEC 60721 | 3K5, except condensation and formation of ice |
| **General data** | |
| Connection/line | modular terminals/aluminium or copper |
| Temperature range/line | 60°C (18...16 AWG)/75°C(14...12 AWG) |
| Wire cross section | |
| Single wire/flexible | 0.2 ... 4 mm²/0.2 ... 2.5 mm² (24...12 AWG) |
| Protection class acc. to EN 60 529 | |
| Internal components | IP 30 |
| Terminals | IP 20 |
| Weight approx. | 350 g |

| **Factory setting:** | |
|---|---|
| Operating principle, alarm relay: | N/O operation |
| Operation: | MASTER |
| Fault memory: | ON |
| Address: | 100 |
| Peak: | n=1 |

*) Class B devices are suitable for household and industrial use

## Technical data SMO480-12

| Technical data SMO480-12 signal converter | |
|---|---|
| Insulation coordination acc. to IEC 60664-1 | |
| Rated insulation voltage | AC 250 V |
| Rated impulse withstand voltage/contamination level | 4 kV / 3 |
| Supply voltage Us | see nameplate |
| Max. power consumption | 8 VA |
| Input | RS 485 |
| Outputs | 12 relays |
| Switching components per relay | 1 N/O contact |
| Rated contact voltage | AC 250 V / DC 300 V |
| Making capacity | AC/DC 5 A |
| Breaking capacity AC/DC | 2 / 0.2 A |
| Minimum current | 5 mA |
| Safe isolation up to 230 V | acc. to prEN 50178 |
| Operating principle, selectable | N/O / N/C operation |
| Test of the Electromagnetic Compatibility (EMC): | |
| Immunity against electromagnetic interferences acc. to EN 50082-2 | |
| Emissions acc. to EN 50081: | |
| Emissions acc. to EN 55011/CISPR11 | class B *) |
| Ambient temperature, during operation | -10°C ... +55°C |
| Storage temperature range | -40°C ... +70°C |
| Climatic class acc. IEC 60721 | 3K5, except condensation and formation of ice |
| Connection/line : | modular terminals/aluminium or copper |
| Temperature range/line | 60°C (18...16 AWG) / 75°C (14...12 AWG) |
| Wire cross section: | |
| Single wire/flexible | 0.2...4 mm²/0.2...2.5 mm²(24...12 AWG) |
| Protection class acc. to EN 60529 | |
| Internal components/terminals | IP 30 / IP 20 |
| Weight approx. | 350 g |

| Factory setting: | |
|---|---|
| Address | 031 (30+1) |
| Operating principle relays | N/O operation |

*) Class B devices are suitable for household and industrial use

## Technical data DI-1

**Technical data RS485-repeater DI-1**

| | |
|---|---|
| Insulation voltage | 3 kV DC |
| Supply voltage Us | DC 10 ... 30 V |
| Max. power consumption | 1.0 W |
| Input/Output | RS 485/RS485 |
| Baudrate (bps) | 1200 ... 115.200 selectable |
| Ambient temperature, during operation | 0°C ... +70°C |
| Storage temperature range | -25°C ... +85°C |
| Humidity | 5 .. 95 %, without condensation |
| Connection/line : | modular terminals/aluminium or copper |
| Wire cross section: | |
| Single wire/flexible | 0.5...2.5 mm²/(22...12 AWG) |
| Weight approx. | approx. 150 g |

**Factory setting:**
Baudrate: 9600 bps
Data format: 10 bit (1 start bit, 8 data bits, 1 stop bit)

Settings of the device via DIP switch (SW1 and SW2) inside the enclosure. Remove both screws of the device fixing. Afterward remove both screw recessed heads from the back and lift the cover.

Note: for the use within an EDS473 system the factory settings do not need to be changed.

## Technical data FTC1500

**Technical data Protocol converter FTC1500**

| | |
|---|---|
| Insulation voltage | 4 kV |
| Supply voltage Us | see nameplate |
| Max. power consumption | 10 VA |
| Input/Output | RS 485/RS485 |
| Protocols | BMS/ASCII to JBUS/MODBUS |
| Ambient temperature, during operation | -10°C ... +55°C |
| Storage temperature range | -20°C ... +55°C |
| Climatic class | 3K5, except condensation and formation of ice |
| Connection/line : | |
| Modular terminals/aluminium or copper | |
| Wire cross section | |
| Single wire/flexible | 0.5...2.5 mm²/(22...12 AWG) |
| Weight approx. | approx. 900 g |

## Technical data measuring current transformer

The technical data and features mentioned below apply to the following BENDER measuring current transformers:

- circular measuring current transformers W1-35/8000
- split-core rectangular measuring current transformers WS50x80/8000

All these measuring current transformers are high sensitive transformers which convert residual currents into evaluable signals. The connection to the evaluator is carried out by means of two connecting leads.
The measuring current transformers are equipped with a special suppressor circuit which is required for the EDS473 system.

When installing make sure that all wires of the respective subcircuit **except the PE** are passed through the measuring current transformer.

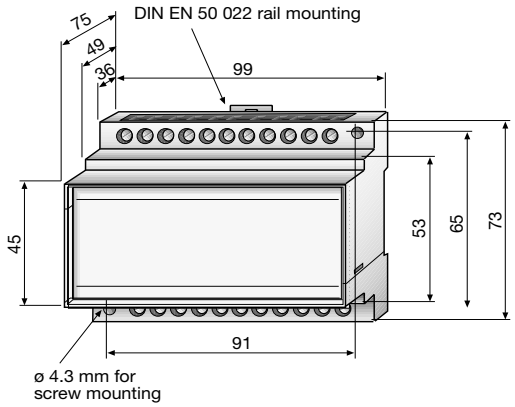
The BENDER measuring current transformers comply with IEC 60044-1.

The measuring current transformers are only suitable for the EDS473 insulation fault location system.

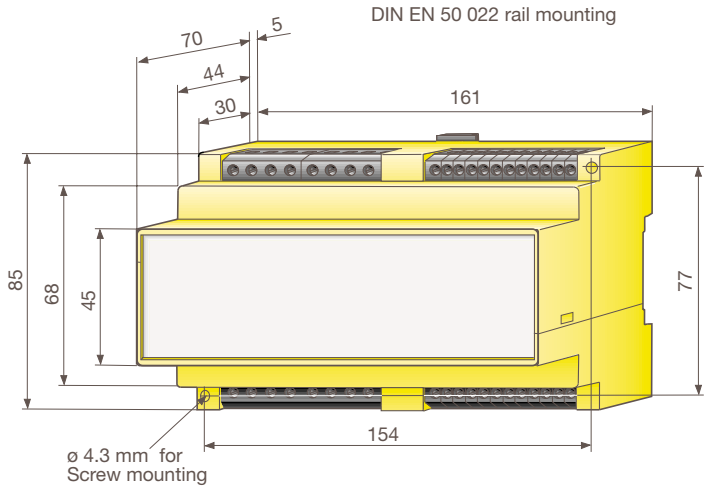
**Technical data**

| | |
|---|---|
| Rated transformation ratio: | 8000:1 |
| Rated primary current max. | 1 A |
| Rated power | 0.375 mW |
| Rated burden | 24 kΩ |
| Accuracy class: | 5 |
| | |
| Rated continuous thermal current | 6 A |
| Rated short-time thermal current | 0.75kA / 1s |
| Dynamic rated current | 4.2 kA / 30 ms |
| | |
| Ambient temperature during operation: | -10 °C … +55 °C |
| Flammability class: | UL94V-0 |
| | |
| Wire length | maximum of 25 m shielded |
| Wire cross section | minimum of 0.75 mm² |
| | |
| Screw mounting | M5 |
| Shock resistance | 15 g / 11 ms |
| Vibration strength | 1 g (10 … 150 Hz) |
| | |
| Insulation coordination acc. to IEC 664-1: | |
| Rated insulation voltage: | AC 690V |
| Rated impulse voltage: | 6 kV |
| Contamination level: 3 | |
| Voltage test acc. to IEC 255: | AC 3 kV |
| | |
| Length of connecting cables | |
| Single wire 0.75 mm² up to 1 m | |
| Single wire 0.75 mm², twisted | up to 10 m |
| Shielded cable 0.75 mm² | up to 25 m |
| (Shield to terminal I) | |

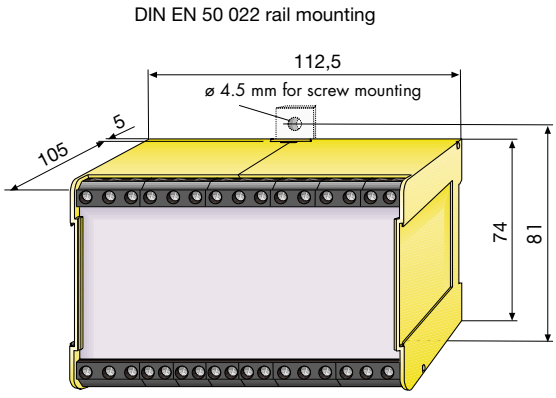
## Dimension diagrams



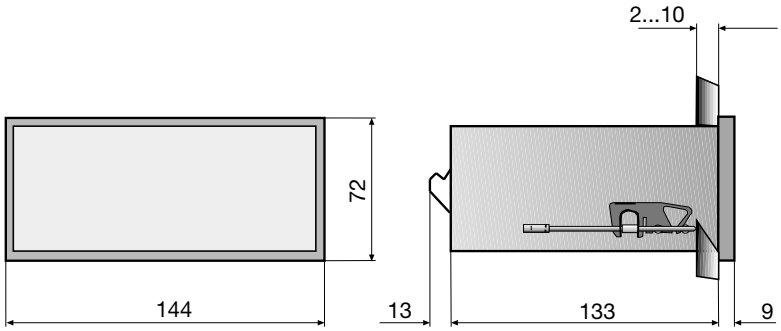

Dimension diagram EDS473-12, PGH473, PRC470 und IR475LY



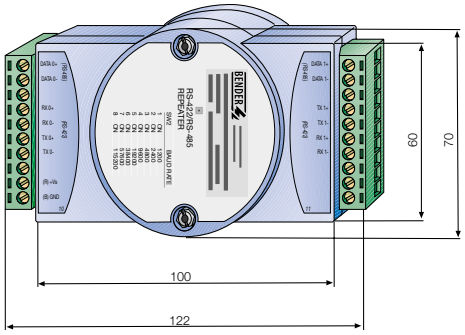

Dimension diagram SMO480-12




Dimension diagram IRDH265

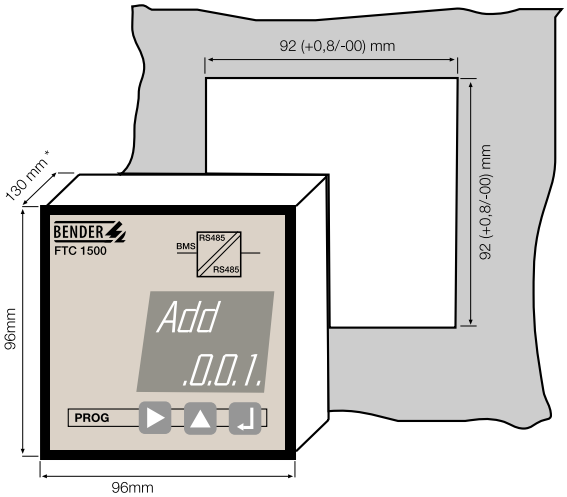



Dimension diagram IRDH365




DIN rail mounting acc. to DIN EN 50 022 or screw mounting by means of an enclosed mounting plate

Dimension diagram DI-1




Panel mounting or DIN rail mounting.

Dimension diagram FTC1500

## Ordering information

| Type | Supply voltage $U_s$ | Designation | Art. No. |
|---|---|---|---|
| PGH473 | AC 230 V | Insulation fault test device | B 950 180 09 |
| PGH473-13 | AC 90-132 V | Insulation fault test device | B 950 180 10 |
| PGH473-21 | DC 10,6-80 V | Insulation fault test device | B 950 180 11 |
| EDS473-12 | AC 230 V | Insulation fault evaluator | B 950 120 19 |
| EDS473-1213 | AC 90-132 V | Insulation fault evaluator | B 950 120 20 |
| EDS473-1221 | DC 10,5-80 V | Insulation fault evaluator | B 950 120 21 |
| PRC470 | AC 230 V | Control and indicating device | B 950 120 01 |
| PRC470-13 | AC 90-132 V | Control and indicating device | B 950 120 04 |
| PRC470-21 | DC 10,5-80 | Control and indicating device | B 950 120 07 |
| SMO480-12 | AC 230 V | Signal converter | B 950 120 11 |
| DI-1 | DC 10-30 V | Signal repeater | B 950 120 15 |
| FTC1500 | AC 110, 230, 400 V<br>DC 24-60 V | Protocol converter | B 950 120 12 |
| IRDH265-3 | AC 230 V | Insulation monitoring device | B 910 680 08 |
| IRDH365-3 | AC 230 V | Insulation monitoring device | B 910 680 13 |
| IRDH265-4 | AC 230 V | Insulation monitoring device | B 910 680 01 |
| IRDH365-4 | AC 230 V | Insulation monitoring device | B 910 680 06 |
| IR475LY | AC 230 V | Insulation monitoring device | B 910 680 38 |
| EDS3365 | AC 230 V | Insulation fault location system | B 910 820 11 |
| W1-35/8000 | ——————— | Measuring current transformer | B 911 756 |
| WS 50x80/8000 | ——————— | Measuring current transformer | B 911 757 |
| WS 08/8000 | ——————— | Measuring current transformer | B 911 759 |

Different designs on request.