

Operating Manual



EDS460-DG

Insulation fault evaluators
Software version: D303 V1.0 / D256 V2.2



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1. How to use this operating manual effectively

1.1 How to use this manual

This operating manual describes EDS460-DG insulation fault evaluators. It is intended for skilled personnel in the areas of electronics and electrical engineering but, in particular, for planners, installers and operators of electrical systems.

Before using the equipment, please read this operating manual, the supplement entitled "Important safety instructions for BENDER products", the "BMS bus" instruction leaflet, as well as the instruction leaflets supplied with the individual system components. Please keep this documentation close at hand near the equipment.

Should you have any further questions, we would be happy to be of assistance. Please contact our technical sales team. We also offer a wide range of on-site services. Contact our Service Department for further details.

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This manual has been compiled with great care. Nevertheless, errors and omissions cannot be entirely excluded. The BENDER companies do not accept any liability for injuries to persons or material damage resulting from errors or omissions in this manual.

1.2 Explanations of symbols and notes

The following terms and symbols are used to denote hazards and instructions in BENDER documentation:

**Danger!**

This symbol indicates an immediate risk to life and limb. Failure to observe these warnings means that death, severe bodily injury or substantial material damage will occur if the corresponding precautions are not taken.

**Warning**

This symbol indicates a potential risk to life and limb. Failure to observe these warnings means that death, severe bodily injury or substantial material damage may occur if the corresponding precautions are not taken.

**Caution**

This symbol means a possibly hazardous situation. Failure to observe these warnings means that slight bodily injury or material damage may occur if the corresponding precautions are not taken.



This symbol gives important information about the correct handling of the equipment. Failure to comply with this information can result in equipment malfunctioning or in its environment.



This symbol guides you to application tips and particularly useful items of information. This type of information will help you to optimise your use of the equipment.

2. Safety information

2.1 Intended use

EDS460-DG insulation fault evaluators are used to localise insulation faults in unearthed DC power supply systems (IT systems). DC systems of DC 20...308 V can be monitored.



Using the IRDH575 or PGH... with a high test current may damage sensitive loads (e.g. in control circuits) or may accidentally activate switching operations. Therefore, it is recommended to use a PGH... with a low test current or to set a low test current at the IRDH575. In case of doubt, please contact a BENDER product manager.

An EDS system consists of EDS460-DG insulation fault evaluators and IRDH575 A-ISOMETER® or PGH insulation fault test device. Using measuring current transformers, EDS460-DG insulation fault evaluators detect test current signals generated by the IRDH575 insulation monitoring device or by the PGH... insulation fault test device and evaluate them.

Up to 12 measuring current transformers can be connected to one EDS460-DG. Up to 90 EDS460-DG evaluators can be connected via a BMS bus (RS-485 interface with BMS protocol), thereby up to 1080 measuring channels (sub-circuits) can be monitored. The scanning time for all channels is approximately 4...10 s.

Individual parameterisation, necessary to adjust the evaluator to the existing system and utilisation conditions, must be carried out at the place of utilisation in order to meet the requirements laid down in the standards.

Please take note of the limits for the application area specified in the technical data. Any other use, or use which goes beyond the foregoing, is deemed to be use other than for the intended purpose.

Intended use also implies:

- The observation of all information in this operating manual.
- Compliance with test intervals.

2.2 Skilled persons

Only skilled persons may work on BENDER products. Personnel who are familiar with the assembly, commissioning and operation of the equipment and have undergone appropriate training are considered qualified. Personnel must have read and understood the safety section and warning information in this operating manual.

2.3 General safety information

BENDER equipment is designed and built in accordance with the state of the art and accepted rules in respect of technical safety. However, the use of such devices may introduce risks to the life and limb of the user or third parties and/or result in damage to BENDER equipment or other property.

- Only use BENDER equipment:
 - for the purpose for which it is intended;
 - when it is in perfect condition as far as safety is concerned;
 - in accordance with the rules and regulations on accident prevention that are applicable for the place of utilisation.
- Any faults which may impair safety must be eliminated immediately.

- Do not make any unauthorised changes and only use replacement parts and optional accessories from or recommended by the manufacturer of the equipment. Failure to observe this requirement can result in fire, electric shock and injury.
- Reference plates must always be clearly legible. Replace damaged or illegible signs immediately.

2.4 Delivery conditions, guarantee, warranty and liability

The conditions of sale and delivery set out by BENDER shall apply. Conditions of sale and delivery can be obtained from BENDER in printed or electronic format.

3. System description

3.1 Properties

3.1.1 Typical applications

- Insulation fault location in DC IT systems
- Main and control circuits in industrial installations and ships
- Diode-decoupled DC IT systems in power stations

3.1.2 Standards

The standard DIN VDE 0100-410:2007-06; IEC 60364-4-41: 2005-12 requires for unearthed power supply systems (IT systems) that a first fault is to be eliminated with the shortest practicable delay. EDS systems allow fast localisation of insulation faults.

3.1.3 System versions

Insulation fault evaluators EDS460-DG-1 and EDS460-DG-2 differ in their supply voltage.

3.1.4 System features

- Universal system concept;
- Modular design, hence easily adaptable to the individual conditions of the system;
- Measuring current transformers in various sizes and types of construction;
- Communication between the components via BMS bus (two-wire);
- All measuring current transformers are scanned simultaneously;
- Central indication of faulty subcircuits;
- Various setting options allow individual adjustments;
- Connection to higher level control and visualisation systems can easily be established.

3.2 Function of the EDS system

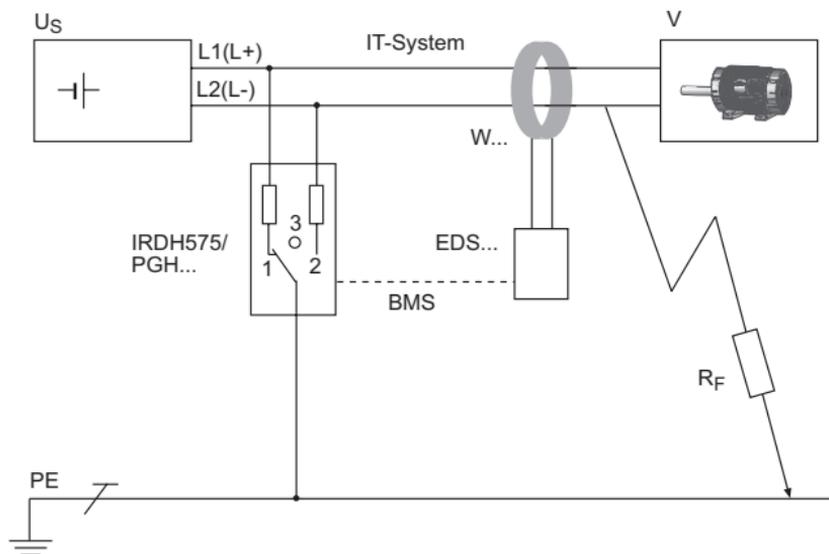
When an insulation fault is detected by the insulation monitoring device in the IT system, the insulation fault location process will be started.

On the occurrence of a first insulation fault, a fault current essentially determined by the system leakage capacitances flows in the IT system. The fundamental idea in fault location is therefore to close the fault current loop for a short period via a defined resistance. As a result of this principle, the system voltage itself drives a test current containing a signal that can be evaluated.

The test current signals are generated periodically by the IRDH575 respectively the PGH... . The test current is limited in amplitude and time. As this happens, the system conductors are connected alternately to earth via a defined resistance. The test current generated in this manner depends on the size of the present insulation fault and the system voltage. It is limited according to the setting of the IRDH575 respectively the PGH... . For planning purposes, it should be noted 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 parts, 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 IRDH575 respectively PGH... . This test current pulse is then detected by the measuring current transformers located in the insulation fault path, and is signalled by the connected insulation fault evaluator.

3.2.1 Block diagram EDS system

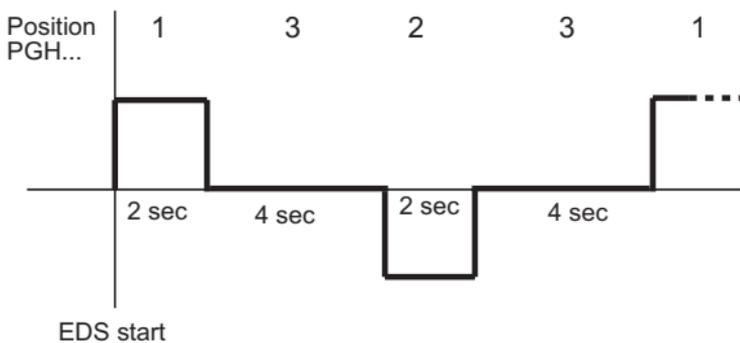


Key:

EDS...	Insulation fault evaluator
PGH...	Insulation fault test device
IRDH575	A-ISOMETER® IRDH575 with integrated test current generator
U_s	Current source IT system
W	Measuring current transformers
V	Electrical load
R_F	Insulation fault
PE	Protective conductor resp. equipotential bonding conductor
BMS	BMS bus

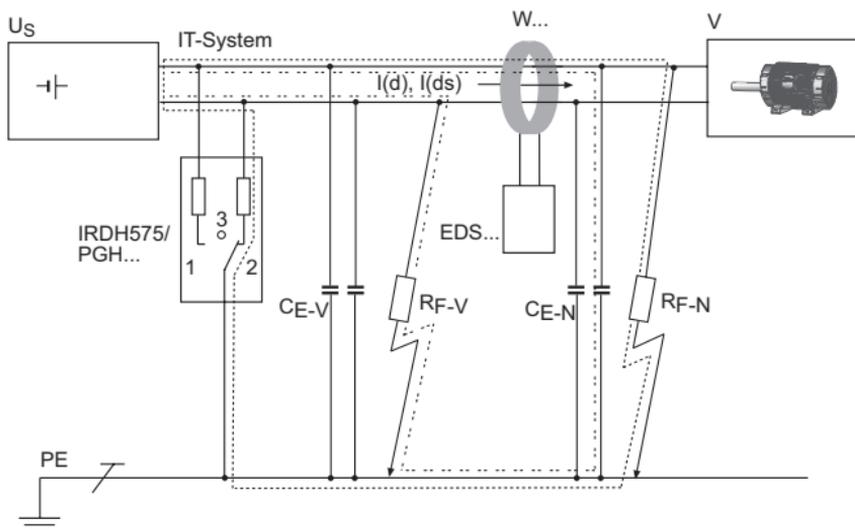
3.2.2 Test cycle

The duration of a test current pulse cycle is 6 seconds. The IRDH575 or PGH... alternatively sends positive or negative test current pulses. The test cycle of the IRDH575 or PGH... is shown in different switch positions (1,2,3) in the block diagram below, ("Block diagram EDS system" on page 15).



3.2.3 Currents in the EDS system

In addition to the block diagram on page 15, the path of the residual currents and the test current is shown in the diagram below:



Key:

.....	Test current loop $I(ds)$
.. . . .	Residual currents $I(d)$ (example) may be caused by converters.
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.

The following residual currents flow through the measuring current transformer of the EDS...:

- the test current $I(ds)$ caused by the insulation fault R_{F-N} ,
- residual currents $I(d)$ flowing through the system leakage capacitances C_{E-V} , C_{E-N} , R_{F-V} and R_{F-N} ,
- transient leakage currents caused by switching and control activities in the system,
- Low-frequency leakage currents generated by the use of converters.

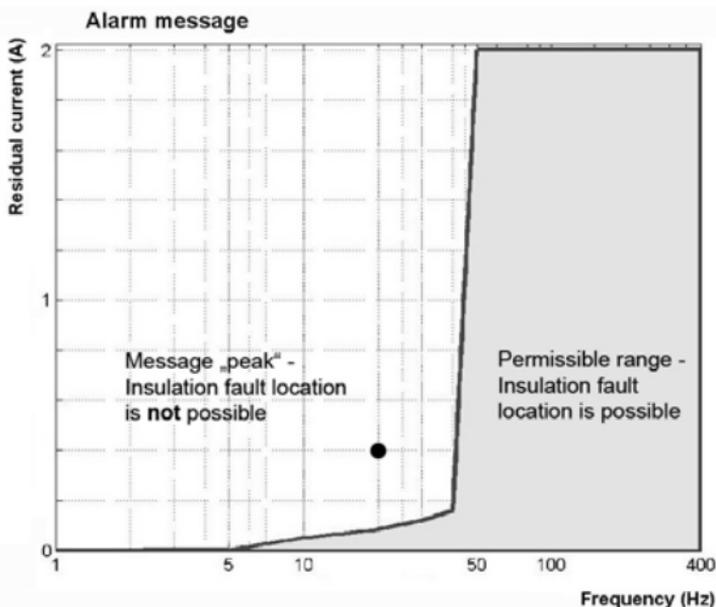
3.2.4 Requirements for reliable insulation fault location

The EDS... is intended to detect insulation faults downstream of the measuring current transformer R_{F-N} . For this purpose, the test current caused by the insulation fault has to be detected reliably. Preconditions are:

- The test current $I(ds)$ exceeds 1.5 mA and is less than 50 mA.
- The upstream capacitances C_{E-V} must be at least as large as the downstream capacitances C_{E-N} .
- The system leakage capacitance must not be too large (see "Response sensitivity characteristics" on page 65).
- The total residual current through the measuring current transformer (test current and residual currents etc.) must not exceed 2 A.
- Not only does the amplitude influence the reliable detection of the test current but also the residual current frequency. This effect is illustrated in the following fault curve.

Fault curve

Safe insulation fault location is only possible in the grey-shaded area.



A measuring channel where insulation fault location is not possible is marked with "peak" in the "Alarm/meas. values" menu.
Example: A residual current of 0.4 A / 20 Hz (marked with a point (•) in the diagram) would be outside the permissible range.



Symmetrical insulation faults downstream of the measuring current transformer are not recognised under certain circumstances. Low-frequency residual currents (caused by converters, for example) may have the effect that insulation faults cannot be found when their frequency is equal or approximately equal to the text cycle frequency of the IRDH575 respectively PGH...

4. Installation and connection

4.1 Unpacking

- Unpack all the parts of the delivered system. Avoid sharp-edged tools that may damage the contents of the packaging.
- Compare your order with our delivery note to check that you have received all products in full. The article numbers printed on the nameplates simplifies the identification of the devices.
- Check all parts supplied for any evidence of damage in transit. Equipment damaged in transit must not be used. If a device has sustained damage, please contact BENDER. Details of who to contact are indicated on the delivery documents.
- When storing the devices in a cold environment as it is in winter the following is to be considered: Leave the devices to stand for 3 to 4 hours at room temperature before connecting the power supply. When the devices are moved from a cold to a warm environment, condensation will be evident on all parts. Putting damp devices into operation risks damaging electrical components and there is a danger of electric shock on contact.

4.2 Fuses, max. voltage, cable lengths

- Equip the supply voltage of all system components with fuses so that they are protected in the event of a short circuit. We recommend the use of 6 A fuses.
- Please note: The maximum voltage of the monitored system must not exceed the rated insulation voltage of the measuring current transformer used in the EDS system and the IRDH575 or PGH...
- Select the cables and cable lengths in accordance with the technical data on page 62. If you use cables that are longer than those specified here, BENDER cannot guarantee that the equipment will function safely.

4.3 Notes on mounting



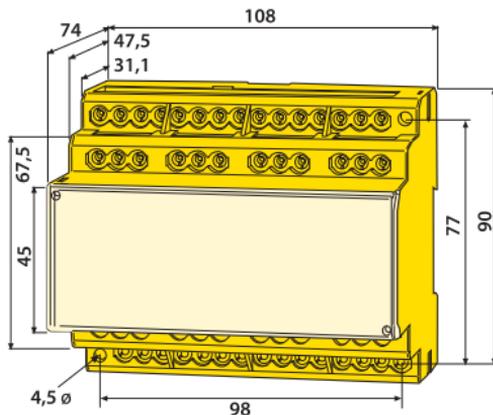
Before mounting the device and working on the device connections, make sure that the power supply voltage has been disconnected. Failure to comply with this safety information may cause electric shock to personnel. Furthermore, the electrical installation may sustain damage and the device may be destroyed beyond repair.

The devices are suitable for the following types of installation:

- standard distribution panels according to DIN 43 871 or
- DIN rail mounting according to IEC 60715 or
- screw mounting using M4 screws.

Mount the measuring current transformers in accordance with the notes in the "Transformer installation" technical information. When connecting the measuring current transformers, it is essential that you observe the maximum cable lengths.

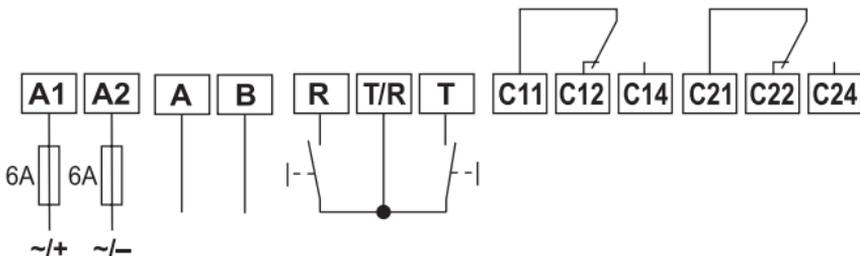
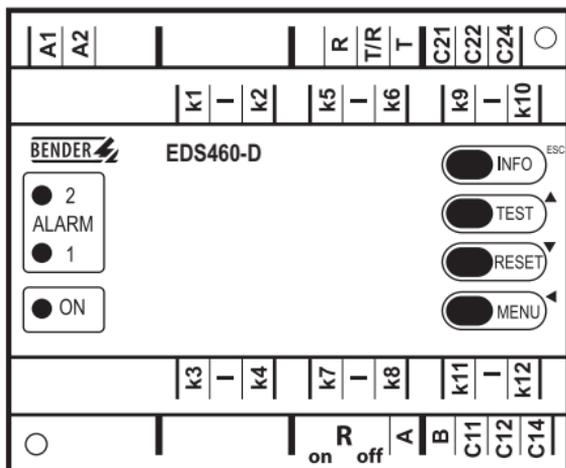
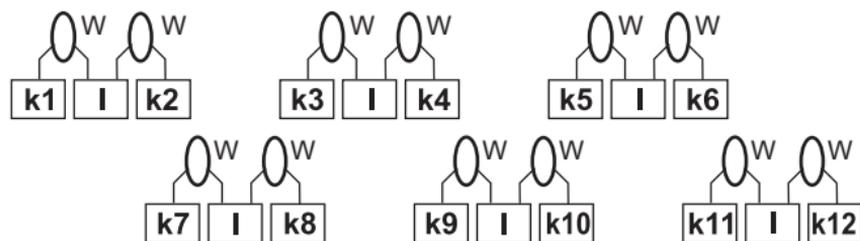
4.3.1 Dimension diagram EDS460-DG



Dimensions in mm

4.4 Connection

4.4.1 Wiring diagram EDS460-DG

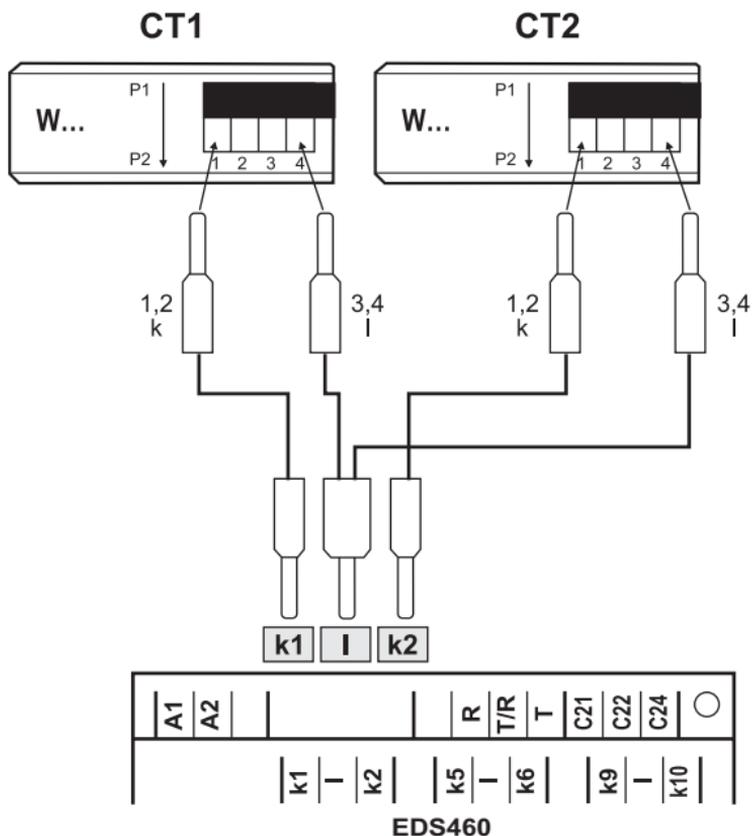


Legend to wiring diagram

A1, A2	Supply voltage U_S (see ordering information), 6 A fuse recommended; two-pole fuses should be used on IT systems.
k1, l ... k12, l	Connection of measuring current transformers 1...12.
A, B	BMS bus (RS-485 interface with BMS protocol)
R, R/T	External RESET button (N/O contact)*
T, R/T	External TEST button (N/O contact)*
C11, C12, C14	Common alarm relay K1: Alarm 1, common alarm for alarm or device error.
C21, C22, C24	Common alarm relay K2: Alarm 2, common alarm for alarm or device error.
$R_{on/off}$	Activate or deactivate the BMS bus terminating resistor (120 Ω).
W	Measuring current transformers

* *The external TEST/RESET buttons of several devices must not be connected to one another.*

4.4.2 Connection of W..., WR..., WS...series measuring current transformers



The terminals 1 and 2 as well as the terminals 3 and 4 are bridged internally.

The connections k and I at the EDS460-DG must not be interchanged.



You must ensure that all live conductors are routed through the measuring current transformer. Do not route any PE conductors or shields of shielded conductors through the measuring current transformer! Commercial measuring current transformers are not suitable for EDS460-DG and must not be used.

Only if these notes are observed will you obtain a true measurement result.

Additional information is available in our "Transformer installation" technical information.

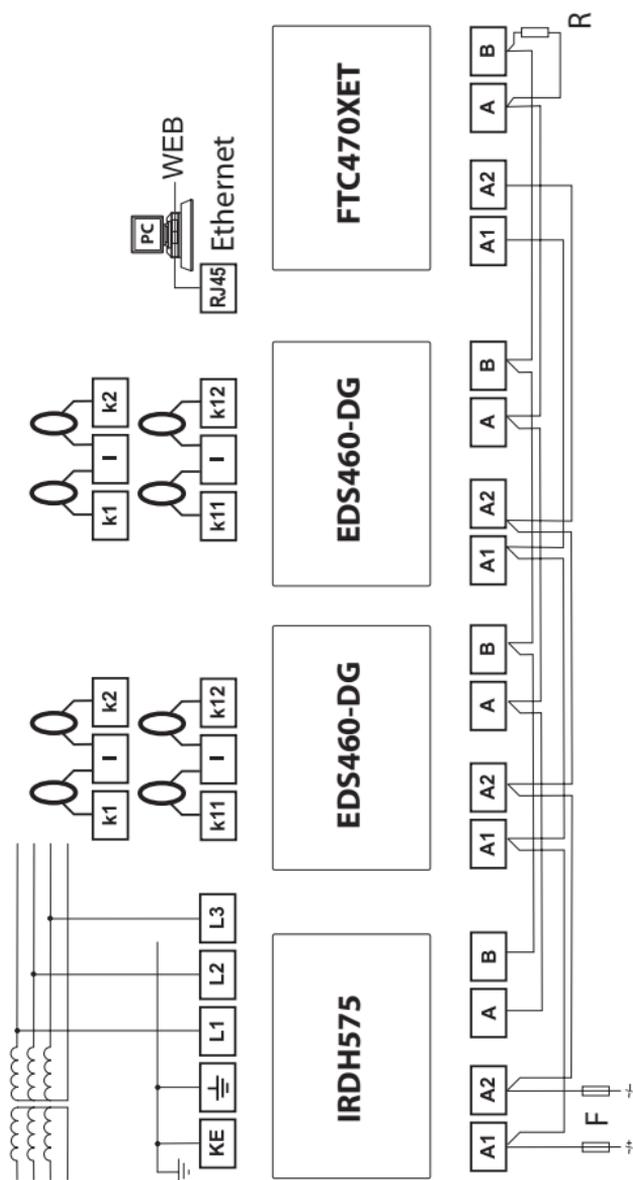
4.4.3 Connection example EDS standard system with FTC470XET

See the next page for this example.

Key for connection example:

IRDH575	Insulation monitoring device with integrated test current generator.
EDS460-DG	Insulation fault evaluators
FTC470XET	Protocol converter for connecting the BMS (BMS = Bender-Messgeräte-Schnittstelle or Bender measuring device interface in English) bus with a TCP/IP (Transmission Control Protocol / Internet Protocol) network via Ethernet.

Connection example



5. Commissioning



*Note on opening the transparent front panel cover:
Take hold of the cover at the bottom edge and swivel it upwards. The cover can also be removed completely. Once the adjustments have been completed, the front panel cover must be refitted.*

5.1 Before switching on

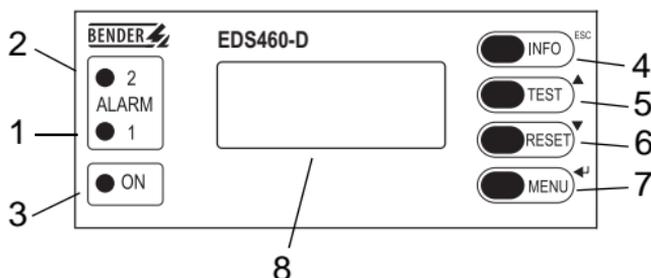
1. Does the connected supply voltage U_S match the information on the device nameplates?
2. Has the maximum permissible rated insulation voltage of the measuring current transformers and IRDH575 or PGH... been observed?
3. Are you sure that the PE conductor has not been routed through the measuring current transformer at any point?
4. In mounting the measuring current transformers, have any magnetic fields that are nearby and could cause interference been taken into account?
5. Has the maximum permissible cable length for the measuring current transformers been observed?
6. Is a 120 Ω resistor connected at the beginning and end of the BMS bus?
7. Have the maximum permissible interface cable length (1200 m) and number of BMS bus nodes (32) been observed?
8. In respect of the BMS bus node address settings, has each address only been assigned once? Is address 001 and therefore the master function, assigned?

Switching on

1. Connect the supply voltage of all devices connected to the BMS bus. Initially, the "ON" LED flashes on the EDS460-DG and the EDS460-D graphic display shows the (BENDER) welcome screen. The "ON" LED then lights up permanently.
2. Eliminate insulation and device errors. If a response value is exceeded or device error messages occur, this is indicated by means of the alarm LED lighting up and an associated message appearing on the graphic display.
 - You can find information about the alarms in the "Alarm/Meas. values" menu.
 - Eliminate the insulation faults detected by the EDS460-DG.
 - The EDS460-DG displays any device errors that have occurred.
 - Device errors may be caused by measuring current transformers not being connected. Check the measuring current transformer connections. Disable transformer monitoring for measuring channels that are not required (refer to chapter "6.4.3.2 Settings menu 2: Channel", submenu "2.CT" on page 46).

6. Operation

6.1 Operating and display elements EDS460-DG

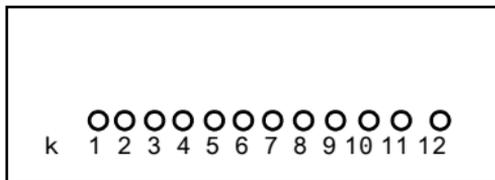


1	Alarm LED 1 lights up in the event of the following types of device errors: - when the residual current is exceeded > 2 A (RCM function) - when there is a loss of power or short circuit in a measuring current transformer circuit (this function can be deactivated).
2	Alarm LED 2 lights up if an insulation fault is detected on a measuring channel (EDS function).
3	The "ON" LED lights up when the device is switched on and flashes during power on until the device is ready for operation.
4	INFO key: to query standard information ESC key: to exit the menu function without changing parameters.
5	TEST button: to start the self test UP key: Parameter change, scroll
6	RESET button: to acknowledges alarm and fault messages DOWN key: Parameter change, scroll
7	MENU key: Toggles between the standard display, MENU and alarm display. ENTER key: to confirm parameter change
8	Backlit graphical display (refresh every 20 seconds)

6.2 Working in operating mode

6.2.1 Standard display

In operating mode, the EDS460-DG waits for insulation fault location to begin. The schematic representation shows that no alarm message exist on all of the 12 channels (⇒).



6.2.2 Alarm messages and their effects

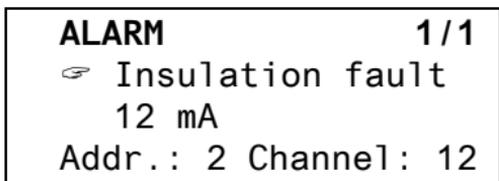
Possible causes of alarm messages include:

- Insulation faults or when the residual current is > 2 A.
- A measuring current transformer fault or measuring current transformer connection fault.
- Device error

The EDS460-DG signals alarm or device error:

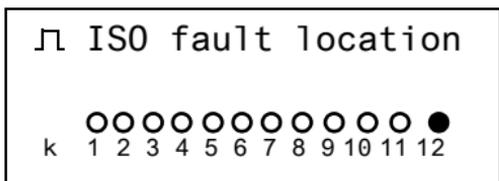
- LED "ALARM 1" lights up when the residual current is > 2 A or in case of a CT connection fault.
- "ALARM 2" LED lights up when an insulation fault is located.
- Assigned common alarm relays switch.
- An alarm message is being sent to the BMS bus.
- An alarm message is shown on the display. An entry is made in the history memory.

- An alarm message is shown on the display.



- Line 1: ALARM,
Alarm 1 of 1 pending alarm
- Line 2: Alarm status and alarm text
 ☞ No alarm
 ☞ ALARM
- Line 3: Currently measured mean value of the residual current.
- Line 4: BMS bus address of the EDS460-DG and measuring channel on which the alarm has occurred.

Press the "INFO" key to display the schematic representation for this alarm message. Channels where an alarm exists are marked with the ☞ symbol.



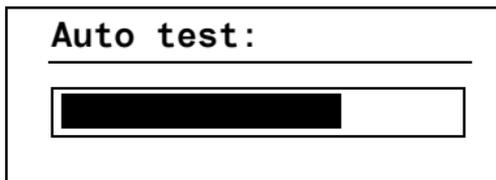
6.2.3 Carrying out a test

A test serves to check the device function (hardware components) of the EDS. A test can be called in the following ways:

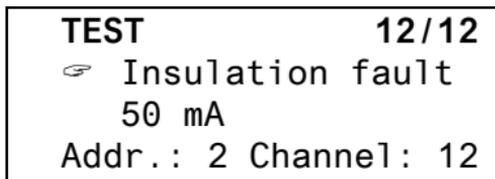
- press the "TEST" button on the front panel of the EDS460-DG,
- press an external test button connected to the EDS460-DG,
- send a TEST command via the BMS bus,
- call up the "TEST" function in the Control menu.

The EDS460-DG responds as follows:

- LED "ALARM 1" and LED "ALARM 2" light.
- All alarm relays switch (function can be deactivated, see page 48).
- An alarm message is being sent to the BMS bus.
- An entry is made in the history memory with the suffix "TEST".
- The progress of the test is shown on the display.



The EDS460-DG will now display the maximum measured value that can be detected for channel 12 (provided that the measuring channel is functioning correctly). Press the "▼" arrow key several times to show that the other channels are functioning correctly.



6.2.4 Resetting saved alarm messages (RESET)

If the fault memory is enabled, the alarm status will remain, even after the cause of the fault has been eliminated, until a "RESET" is carried out. Press the "ESC" key to exit the display of the current alarm message. A reset is carried out by:

- pressing the "RESET" button on the front panel of the EDS460-DG,
- pressing an external reset button connected to the EDS460-DG,
- sending a reset command via the BMS bus.
- calling up the "RESET" function in the Control menu.

Stored alarm messages that are no longer pending are reset, the alarm relay drops out, the ALARM LEDs go out and there are no longer any alarm messages on the BMS bus. The EDS460-DG shows the progress of the reset operation.

6.2.5 Displaying standard information

Press the "INFO" key. You will now see information relating to the device and software on the EDS460-DG display. Press the "▼" arrow key several times to display all the information. Please have this information to hand if you should need to contact us for assistance by telephone.

```
■ EDS460 - DG
  20.08.08 14:59
  Address : 2
  Software: D303V1.0x
```

- Line 1: Device type
- Line 2: Date, time
- Line 3: Address set on the BMS bus
- Line 4: Measuring technology software version
- Line 5: Date of the measuring technology software version
- Line 6: Communication software version
- Line 7: Date of communication software version
- Line 8...10: Bender address, homepage
- Line 11: Exit. Exit standard information.

6.3 Operation and setting of the EDS460-DG

This chapter describes the EDS460-DG menu mode.

6.3.1 Opening the main menu

Press the "MENU" key to open the main menu.

- Exit

 1. Alarm/meas. values
 2. History
 3. Settings

The following keys are used in the main menu:

- ESC Exit function or go up one menu level.
▲, ↓ Select menu items.
↵ Confirm selected menu item (Enter).



Menu mode is exited if no key is pressed for longer than five minutes. Exceptions: The "Test" and "Test communication" functions.



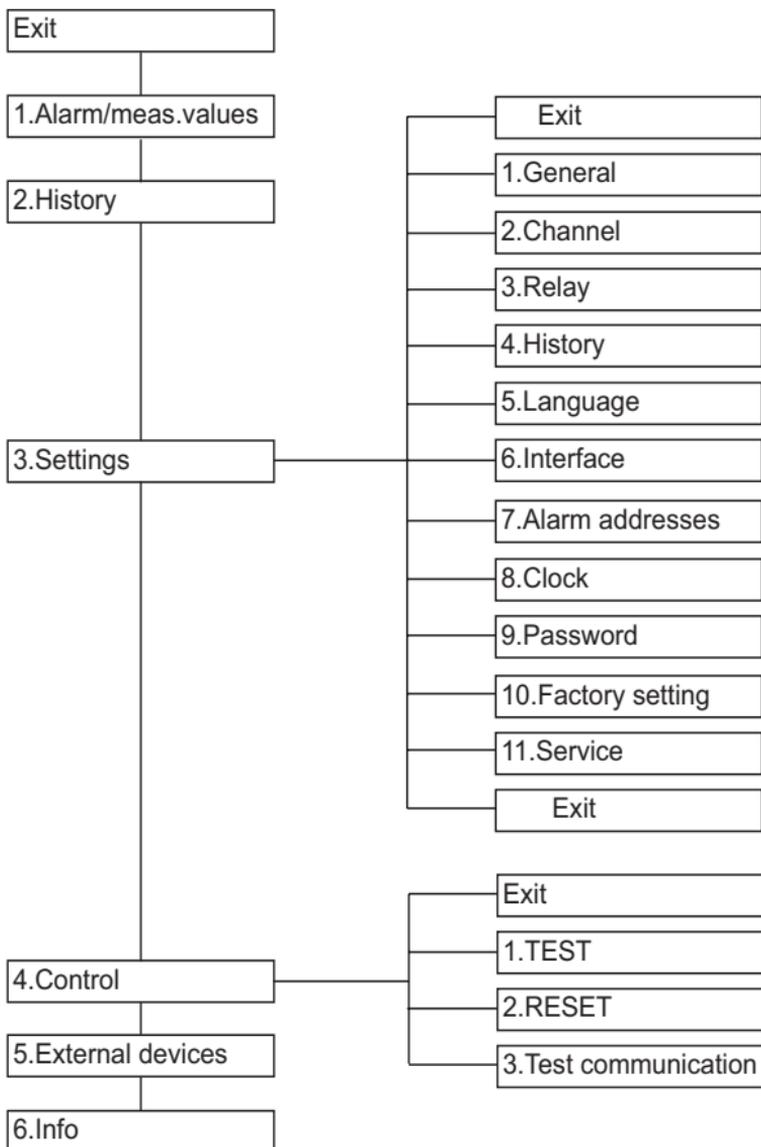
Settings can be password protected. When an attempt is made to change settings, the password entry screen appears automatically:

Enter password:

0 0 0

For details refer to see "Settings menu 9: password" on page 52. If you can't remember your password, contact the BENDER Service.

6.3.2 Menu overview diagram



6.3.3 Main menu functions

Menu item	Function	Page
Exit	Exit menu mode	-
1.Alarm/ meas.values	Displays the following for each measuring channel: Alarm status, test current I(ds), residual current I(d)	40
2.History	Displays the history (300 data records) with information about messages, acknowledgements and associated times. Displays the minimum and maximum I(ds) measured value, with address and channel.	42
3.Settings	Carry out settings for EDS460-DG	43
4.Control	This menu offers various control options, such as TEST, RESET, etc.	53
5.External devices	Settings on devices externally connected to the BMS bus (e.g. EDS460-D/-L, EDS490-D/-L).	55
6.Info	Information on the device. The same display is obtained by pressing the INFO key in the operating mode (refer to "Displaying standard information" on page 36).	56

6.4 The main menu

6.4.1 Menu 1: Alarm/meas. values

EDS460-DG displays the following for each measuring channel: Alarm status, test current I(ds), residual current I(d).

	I (ds)	I (d)
1.	☞ 6mA	120mA
2.	☞ --	<20mA
3.	☞ Channel disabled	

Column 1: Channel number 1...12

Column 2: Alarm status:

☞ No alarm

☞ Alarm

Column 3: I(ds): Currently measured test current.

Column 4: I(d): Currently measured residual current.



The accuracy of the displayed test current depends on the system leakage capacitances.

The IRDH575/PGH... test current is limited. Consequently, the insulation fault resistance may in fact be lower than the displayed test current suggests.

Residual current

The residual current flowing through the measuring current transformer is continually measured and displayed.

- If the residual current exceeds 100 mA, it will be indicated on the display.
- If the residual current exceeds 2 A, an alarm message will be signalled. Once the residual current reaches values of this magnitude, reliable insulation fault location becomes impossible.

ALARM	1 / 1
 Residual current	
> 2 A	
Addr.: 2 Channel: 1	

6.4.2 Menu 2: History

The non-volatile history memory saves up to 300 data records (alarms, device errors). If the history memory is full, the oldest entry will be deleted in the event of an alarm to create space for the new entry. For details about erasing the entire history memory refer to chapter "6.4.3.4 Settings menu 4: History".

```

History no. 297
Start:21.11.2005 / 15:57:00
Quit:
End: 21.11.2005 / 16:07:03
    
```

Line 1: Event number (if applicable): TEST.

Line 2: Event start: Date/time

Line 3: Event acknowledgement (e.g. alarm deleted at IRDH575, MK800, MK2430, FTC470...):

Date / time

Line 4: Event end: Date/time

1. If you are searching for an event that occurred at a specific time, use the arrow keys to scroll to the required entry.
2. Use the "↵" key to call up details about the current history memory entry.

```

History no. 297
☞ Insulation fault
Min. 2mA/Max.50mA
Addr.:2 Channel:1
    
```

Line 1: Data record number

Line 2: Alarm/device error designation.

Line 3: Minimum and maximum measured value

Line 4: Address and measuring channel of device sending the message

6.4.3 Menu 3: settings

The following menu items are available for configuring the EDS...:

Menu item	Function	Page
Exit	Exit settings	-
1.General	Configure the fault memory, trigger, rated frequency and type of system.	44
2.Channel	Configure the following in respect of each measuring channel: Response value, measuring transformer type, response delay, delay on release, measuring transformer monitoring, filters for systems with converters, and alarm when the residual current has been exceeded.	45
3.Relay	Set the mode of operation and type of fault that you wish to cause a switching operation for common alarm relay.	48
4.History	Erasing the history memory	50
5.Language	Select the language for menu and alarm texts.	50
6.Interface	Set the BMS bus address of the EDS460-DG.	50
7.Alarm-addresses	Setting of bus addresses for devices whose alarm messages are to be displayed on this EDS460-DG.	50
8.Clock	Configure the time, date, date format and summer time changeover.	51
9.Password	Changing and activating the password.	52
10.Factory setting	Resets every setting to its factory setting.	52
11.Service	For Bender service staff only.	52

6.4.3.1 Settings menu 1: General

Use this menu to make settings that apply to the whole device and therefore to all channels.

1. Fault memory

Faults that only occur temporarily can be saved.

- ON After the cause of fault has been eliminated, all alarm messages remain saved until a RESET is carried out. This function relates to alarm and device error messages.
- off EDS460-DG exits the alarm status as soon as the cause of the error is eliminated.

2. Trigger

The IRDH575 / PGH... test current pulse is synchronised with the EDS460-DG measurement technique. The EDS460-DG is told when to expect a test current pulse. This means that test current pulses can still be reliably detected in the event of interference. Sources for interference include, for example, variable-speed drives, power converters, actuators, suppressor filters, PLCs or control electronics.

Choose:

- Com Synchronisation via BMS bus. The EDS460-DG will only begin searching for insulation faults when insulation fault location has been started. It knows when to expect the test current pulse. Insulation fault location is performed more quickly than with the "auto" setting.
- auto No synchronisation (e.g. if there is no BMS bus). The EDS searches continually for insulation faults.

3. Rated frequency

Set the rated frequency of the system being monitored. The EDS460-DG must always be set to "DC" (factory setting). This must be set correctly, otherwise the EDS460-DG will not be able to evaluate the test current pulse accurately.

4.Type of system

Select the type of distribution system for the system being monitored. The EDS460-DG must always be set to "DC" (factory setting).

6.4.3.2 Settings menu 2: Channel

You make the measuring channel settings in this menu (either individually or for all channels simultaneously). Selecting a measuring channel:

1. Use the "▲" key to go to the measuring channel setting. Press the "↵" key
2. Use the UP/DOWN keys to select a single measuring channel or all measuring channels (1...12). Press "↵" to confirm your selection.

Set
a single channel:

Channel:	1
<input type="checkbox"/> Exit	
1. Resp. value:	4mA
2. CT:	W/WR

Set
all channels:

Channel:	1..12
<input type="checkbox"/> Exit	
1. Resp. value:	4mA
2. CT:	W/WR



If the measuring channel settings only differ slightly, we recommend to proceed as follows:

- First set all the channels (1...12) to the same value.
- Then modify the settings of individual channels.

1. Response value

An alarm is output when the measured value reaches the response value. Response ranges: 2...10 mA (factory setting 2 mA).

Please also heed the characteristics for a reliable response on page 65.

2. CT

Set the transformer type.

W/WR	Bender standard measuring current transformers, circular and rectangular W... and WR... series designs.
WS	Split-core type WS... series measuring current transformers.
off	Measuring channel is deactivated

The following measuring current transformer types can be used: W..., WR..., WS...

3. Response delay T(on)

This is the response delay before the alarm is activated. This time delay is necessary in cases where the monitored system is subject to interference.

The duration of a test current pulse cycle is 6 seconds. Consequently, the response delay can only be adjusted in increments of 6 seconds.

0s	An alarm is triggered when the first test current pulse is detected.
6s	Two test current pulses must be detected before an alarm is triggered.
12s	Three test current pulses must be detected before an alarm is triggered.

Configurable values: 0s, 6s, 12s, 18s, 24s

4. Release delay T(off)

This function is only effective when the fault memory is deactivated (see "1. Fault memory" on page 44).

If the status that triggered the alarm is no longer present, the EDS460-DG terminates its alarm once the release delay has expired.

Configurable values: 0s, 6s, 12s, 18s, 24s

- | | |
|-----|--|
| 0s | The alarm is terminated when the EDS460-DG has not recognised an insulation fault for the duration of a test current pulse. |
| 6s | The alarm is terminated when the EDS460-DG has not recognised an insulation fault for the duration of two test current pulses. |
| 12s | The alarm is terminated when the EDS460-DG has not recognised an insulation fault for the duration of two test current pulses. |



In the case of DC systems, a release delay of at least 6 seconds must be set in order for a pending fault to be permanently signalled. IRDH575 / PGH... sends alternate positive and negative test current pulses. However, in a DC system, test current pulses must either be all positive or all negative. As only every second test current pulse counts, the system must wait for a further test current pulse to be sent (6 seconds) before it can be certain that this measuring channel is free from insulation faults.

5. CT monitoring

Enable or disable the measuring current transformer connection monitoring.

- | | |
|-----|--|
| on | Measuring current transformers are monitored.
Open circuit, short circuit or missing measuring current transformers generate an alarm message. The "ALARM 1" LED lights up. |
| off | Measuring current transformers are not monitored. |

6.Converters

Converters are a major source of interference for the monitored system.

- | | |
|-----|---|
| on | Channel is optimised for converters. Insulation fault location takes longer in this subcircuit. |
| off | Channel is not optimised for converters. Insulation faults cannot be reliably detected in circuits containing converters. |

7.Alarm I(d)

If the residual current exceeds 2 A , an alarm message will be signalled (Alarm 1). This alarm message can be deactivated.

- | | |
|-----|---|
| on | Alarm when the residual current response value is exceeded. |
| off | No alarm when the residual current response value is exceeded (for specific applications only). |

6.4.3.3 Settings menu 3: Relays

You make the settings for the common alarm relays K1 and K2 in this menu (either individually or common to all alarm relays).

Selecting a relay

1. Use the "▲" key to go to the relay channel setting. Press the "↵" key
2. Use the UP/DOWN keys to select one relay (1, 2) or both relays (1...2). Press "↵" to confirm your selection.

Set
a single relay:

Relay:	1
<input type="checkbox"/> Exit	
1. Relay mode:	N/0-T
2. Alarm:	on

Set
both relays:

Relay:	1...2
<input type="checkbox"/> Exit	
1. Relay mode:	N/O-T
2. Alarm:	on

1. Relay mode

Set the relay mode of operation:

N/O-T	N/O operation. Relay switches in the event of an alarm or a test.
N/C-T	N/C operation. Relay switches in the event of an alarm or a test.
N/O	N/O operation. Relay only switches in the event of an alarm.
N/C	N/C operation. Relay only switches in the event of an alarm.

2. Alarm

on	Relay switches in the event of an alarm.
off	Relay does not switch in the event of an alarm.

3. Device error

on	Relay switches in the event of a device error.
off	Relay does not switch in the event of a device error.

4. Ext. alarm

on	Relay switches in the event of an external alarm.*
off	Relay does not switch in the event of an external alarm.*

* *Alarm on an external device the address of which has been set to "on" in the "Alarm addresses" menu. (see "Settings menu 7: Alarm addresses" on page 50).*

6.4.3.4 Settings menu 4: History

Here the entire history memory can be deleted. Press the "↵" key to confirm that the memory is to be cleared.

6.4.3.5 Settings menu 5: language

Select the language for menu and alarm texts.
Setting options: English, Deutsch or Français.

6.4.3.6 Settings menu 6: Interface

Set the BMS bus address of the EDS460-DG.
Setting range: Address 1...90

6.4.3.7 Settings menu 7: Alarm addresses

Setting of the bus addresses (1...150) externally connected to the BMS bus, the alarm messages of which are to be displayed on this EDS460-DG. Set the addresses of devices whose messages are to be displayed to "on". Addresses set to "on" are monitored for presence on the BMS bus; if a device cannot be found on the bus, a corresponding message will appear. The EDS460-DG own address is automatically set to "on".

<input type="checkbox"/>	Exit	
1.Address:		on
2.Address:		off
3.Address:		off

on Messages of this device will be displayed.
off Messages of this device will not be displayed.

6.4.3.8 Settings menu 8: Clock

Set the date format, date, time, and summer time changeover.



Set the time and date on the BMS bus master. All slaves adopt this setting. The setting is synchronised every hour. The "Clock" menu setting remains stored for approx. 2 h after power supply failure.

1.Format

Select the German or American format.

d.m.y German format (day.month.year)

m-d-y American format (month-day-year)

2.Date

Set the date (e.g. 20.07.2006).

3.Time

Set the time (e.g. 16:44).

4.Summer time

Setting for automatic switchover to central European summer time.

auto Automatic switchover

off No switchover (winter time is retained).

6.4.3.9 Settings menu 9: password

Change password, activate/deactivate password.

1.Password

Change password. Factory setting: 000

2.Status

Enable or disable password protection.



Settings can be password protected. If the password is activated (enabled), all settings can be displayed. When an attempt is made to change settings, the password entry screen appears automatically:

Enter password:

0 0 0

Once a valid password has been entered, access will be granted to settings in all menus (except the Service menu) until menu mode is exited. If you can't remember your password, contact the BENDER Service.

6.4.3.10 Settings menu 10: Factory settings

Resets every setting to its factory setting. Factory settings are given in parentheses "()*" in the technical data.

6.4.3.11 Settings menu 11: Service

This menu is intended for Bender service employees only.

6.4.4 Menu 4: Control

This menu offers various options for controlling the EDS:

Exit	Exit settings
1.TEST	Call up a test
2.RESET	Initiate a reset (see "Resetting saved alarm messages (RESET)" on page 35")
3.Test communication	Test communication between the EDS460-DG and other BMS equipment.

6.4.4.1 Control menu 1: TEST

Call up a test (see also "Carrying out a test" on page 34). To prevent this function being carried out inadvertently, the operator must once again confirm this entry.

6.4.4.2 Control menu 2: RESET

Call up a reset (see also "Resetting saved alarm messages (RESET)" on page 35). To prevent this function being carried out inadvertently, the operator must once again confirm this entry.

6.4.4.3 Control menu 3: Test communication

This function enables you to test communication between the EDS460-DG and other BMS equipment. To do this, the EDS460-DG sends an alarm message via the BMS bus until the "Test communication" function is exited. A connected evaluation device (IRDH575, MK800, MK2430, FTC470...) must process this alarm. Select a channel for this alarm message.

Example: Alarm "insulation fault" on channel 1.

1. Select channel 1.

☞ Channel disabled
Exit
1.Chan.: 1

2. Once the "↵" key is pressed, the alarm is transmitted on the BMS bus. This is represented by the alarm indication ☞.

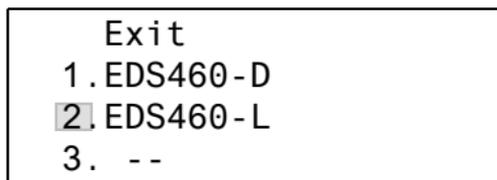
☞ Insulation fault
Exit
1.Chan.: 1

6.4.5 Menu 5: External devices

This menu can be used for setting and operating external devices connected via the BMS bus to this EDS460-DG. In this way, settings at other EDS460-DG can be carried out, for example.

The menu items of the external devices available via this function are displayed on the EDS460-DG. Modifications of the external device settings are stored automatically in the external device.

After calling up this menu, the address and type of devices already stored will be displayed. The display will be updated every five minutes.

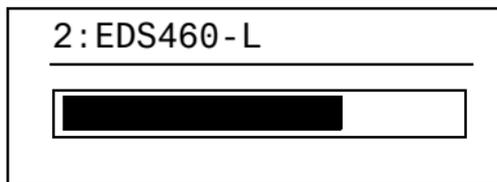


Use the UP/DOWN keys to set the address of the external device and confirm with the ↵ key.



External devices connected to the BMS bus or switched on for the first time are displayed by the EDS460-DG not until a few minutes later in the external devices list. You don't need to wait for the list to appear. You can select and set the external device immediately via the address.

The device is being searched:



If "no access to the menu" appears, press the "ESC" key to exit the display. Possible causes are:

- No device with this address available.
- Connected device does not support this programming function.
- Access not possible at the moment.



The "External devices" menu is not suitable for programming this EDS... If you otherwise try to program it, the error message "Own address" will appear.

When the device has been recognised, the EDS460-DG reads the current settings of the connected device. The address and the device type will be displayed in the first line.

2:EDS460-DG

Exit

1.Alarm/meas.values

2.Settings

6.4.6 Menu 6: Info

This menu displays standard information on the EDS460-DG (for details, see "Displaying standard information" on page 36).

7. Tests and service

7.1 Periodic verification

The EDS system monitors itself during operation.

We recommend that the test function is called on each connected EDS460-DG at regular intervals. You call a test by:

- pressing the "TEST" button on the front panel of the EDS460-DG,
- pressing an external test button or
- calling the "TEST" function in the Control menu.

Observe the applicable national and international standards which require regular testing of electrical equipment.

7.2 Maintenance

The EDS system does not contain any parts that require maintenance.

7.3 Service

BENDER is happy to provide on-site service in respect of commissioning and periodic testing.

7.4 Trouble shooting

7.4.1 Display device error

An "error code" is displayed if a fault occurs. Display in the event of a fault: Device error: xx (xx = Error code).

Please have this device information to hand if you should need to contact us for assistance by telephone.

Error code	Description
1	Measurement technique: Fault parameter memory (EEP-ROM/FLASH)
2	Measurement technique: Fault data memory (RAM)
4	Measurement technique: No boot loader available.
11	Measurement technique: Device not calibrated.
12	Measurement technique: Wrong measurement p.c.b., incorrect mounting
13	Measurement technique: Hardware error after performing a self test
71	BMS interface: No master available resp. has not been queried by a master for five minutes
72	BMS interface: Fault RS-485 interface

7.4.2 Device error display (channel-related)

LED "ALARM 1" lights up. The common alarm relay switches. The EDS460-DG displays:

```
Fault          1/1
☞ Device error
   11
Addr.: 2 Channel: 4
```

- Line 1: FAULT,
Alarm 1 of 1 pending alarm
- Line 2: Alarm status and alarm text
☞ No alarm
☞ Alarm
- Line 3: Error code (refer to "Display device error" on page 58)
- Line 4: BMS bus address of the EDS460-DG and measuring
channel on which the alarm has occurred.

Possible causes:

- Incorrect basic programming of the EDS460-DG.
- Wrong p.c.b. assembly at four consecutive channels.
- Internal memory fault.
- Faulty channels after test.

7.4.3 CT connection fault display (channel-related)

LED "ALARM 1" lights up. The common alarm relay switches. The EDS460-DG displays:

Fault	1/1
☞ CT fault	
Addr.: 2	Channel: 4

The "CT fault" is displayed in the same way as "Display device error" on page 58.

Possible causes:

- Measuring current transformer defective
- Power supply cable interrupted
- Power supply cable short-circuited

7.4.4 Display "peak"

System-related faults may impair the insulation fault location process. The EDS460-DG marks the faulty channels in the "Alarm/meas.values" menu with "peak".

I (ds)	I (d)
1. ☞ peak	<100mA

7.4.5 External alarm

LED "ALARM 2" lights up. The common alarm relay switches.

Possible causes:

- Alarm message from an external device
- Device failure

8. Data

8.1 Standards

Observe the applicable national and international standards. The EDS460-DG type range complies with the standards:

- IEC 60364-4-41:2005, modified: Selection and erection of electrical equipment; Protection against electric shock; DIN VDE 0100-410; VDE 0100-410:2007-06
Errichten von Niederspannungsanlagen - Teil 4-41: Schutzmaßnahmen - Schutz gegen elektrischen Schlag; German implementation of HD 60364-4-41:2007
- IEC 61557-9:1999; Electrical safety in low voltage distribution systems up to AC 1 kV and DC 1.5 kV - Equipment for testing, measuring or monitoring of protective measures -Part 9; DIN EN 61557-9, edition: 2000-08
Elektrische Sicherheit in Niederspannungsnetzen bis AC 1 kV und DC 1,5 kV - Geräte zum Prüfen, Messen oder Überwachen von Schutzmaßnahmen - Teil 9: Einrichtungen zur Isolationsfehlersuche in IT-Systemen; German version EN 61557-9:1999.

The operating manuals for the individual system components provide you with information about the standards that apply to that particular device.

8.2 Certifications



8.3 Technical data EDS460-DG

Insulation coordination acc. to IEC 60664-1 / IEC 60664-3

Rated insulation voltage	AC 250 V
Rated impulse voltage/pollution degree	4 kV / III
Protective separation (reinforced insulation) between:	
..... (A1, A2) - (K1, L...K12, R / RT / T, AB) - (11, 12, 14) - (21, 22, 24)	
Voltage test according to IEC 61010-1	2.21 kV

Supply voltage

Supply voltage U_S	see ordering information
Power consumption	≤ 10 VA

Measuring circuit

Nominal system voltage U_n	DC 20...308 V
External measuring current transformer	W..., WR..., WS... series
CT monitoring	on/off (on)*
Burden	68 Ω
Rated insulation voltage (measuring current transformer)	800 V
Response sensitivity	2...10 mA (2 mA)*
Rated frequency	50 / 60 / 400 Hz
Measuring range EDS function	2 mA...50 A
Measuring range RCM function	100 mA...2 A
Number of measuring channels (per device/system)	12 / 1080

Specified time

Response delay t_{on}	0...24s
Release delay t_{off}	0...24s
Scanning time for all channels	approx. 4...10 s

Displays, memory

LEDs	ON/ALARM
LC display	backlit graphics LC display
History memory	300 data records
Password	off / 0...999 (off)*
Language	D, GB, F (GB)*
Fault memory alarm relay	on / off (off)*

Inputs/outputs

Test/reset button	internal / external
Cable length for external test/reset button	0 ... 10 m

Interface

Interface/protocol	RS-485 / BMS
Baud rate	9.6 kbit / s
Cable length	0 ... 1200 m
Recommended cable (shielded, shield connected to PE on one side) min. J-Y(St)Y	2 x 0.8
Terminating resistor	120 Ω (0.25 W) can be connected via DIP switch
Device address, BMS bus	1 ... 90 (2)*

EDS - measuring current transformer connection

Single wire $\geq 0.75 \text{ mm}^2$	0 ... 1 m
Single wire, twisted $\geq 0.75 \text{ mm}^2$	1 ... 10 m
Shielded cable $\geq 0.5 \text{ mm}^2$	10 ... 40 m
Recommended cable (shielded, shield connected to I conductor at one end, not earthed)	J-Y(ST)Y min. 2x0.8J-Y(ST)Y min. 2x0.8

Switching elements

Number	2 relays, each with 1 changeover contact				
Operating principle	N/C / N/O operation (N/O operation)*				
Electrical service life, number of cycles	10.000				
Contact data acc. to IEC 60947-5-1					
Utilisation category	AC-13	AC-14	DC-12	DC-12	DC-12
Rated operational voltage	230 V	230 V	24 V	110 V	220 V
Rated operational current	5 A	3 A	1 A	0.2 A	0.1 A
Minimum contact rating	1 mA at AC/DC $\geq 10 \text{ V}$				

Environment / EMC

EMC	IEC 61326
Operating temperature	-25 $^{\circ}\text{C}$... +55 $^{\circ}\text{C}$
Climatic class acc. to IEC 60721	
Stationary use (IEC 60721-3-3)	3K5 (except condensation and formation of ice)
Transport (IEC 60721-3-2)	2K3 (except condensation and formation of ice)
Storage (IEC 60721-3-1)	1K4 (except condensation and formation of ice)

Classification of mechanical conditions acc. to IEC 60721

Stationary use (IEC 60721-3-3).....	3M4
Transport (IEC 60721-3-2).....	2M2
Storage (IEC 60721-3-1).....	1M3

Connection

Connection type.....	screw-type terminals
Connection properties:	
rigid / flexible.....	0.2 . . . 2.5 mm ² / AWG 24 . . . 14
Flexible with ferrules.....	0.2 . . . 1.5 mm ² (AWG 24 . . . 16)
Stripping length.....	10 mm
Opening force.....	50 N
Test opening, diameter.....	2.1 mm

General data

Operating mode.....	continuous operation
Position of normal use.....	any
Degree of protection, terminals (IEC 60529).....	IP 20
Enclosure material.....	polycarbonate
Flammability class.....	UL94V-0
Screw mounting.....	2 x M4
DIN rail mounting acc. to.....	IEC 60715
Weight.....	< 360 g

() * Factory setting

8.4 Response sensitivity characteristics

The type of distribution system, system voltage, leakage capacitance and test current all affect the EDS system's response sensitivity.



The value of the test current can be set at the IRDH575 insulation monitoring device and at the PGH... insulation fault test device.



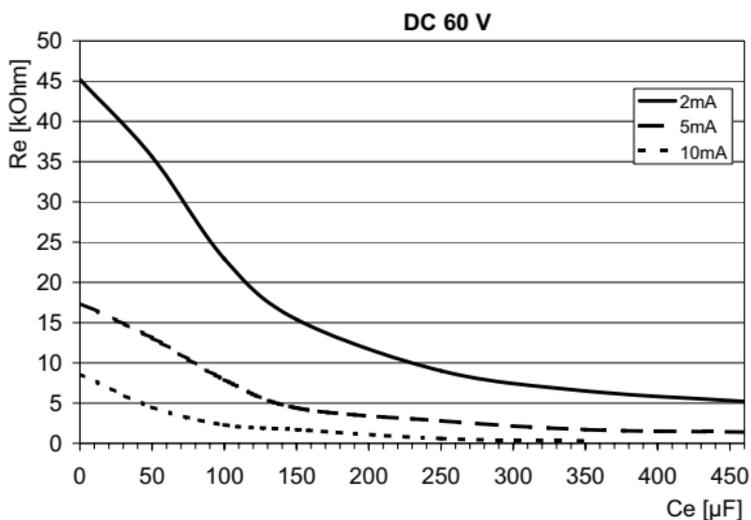
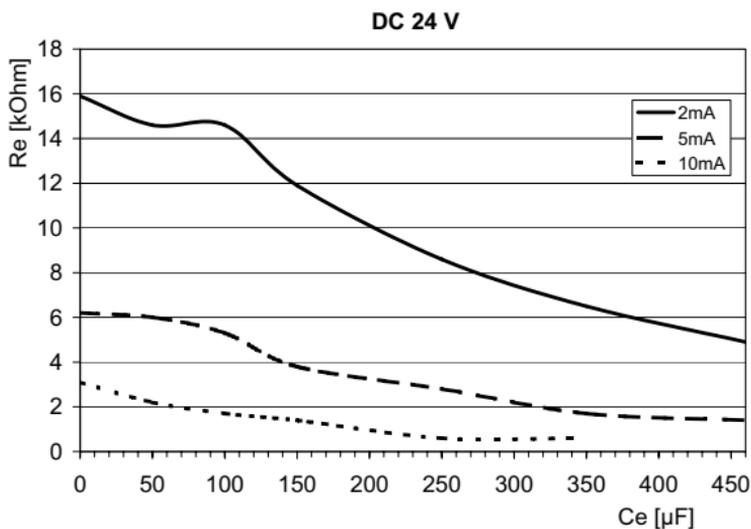
The response values are displayed as characteristic curves. The maximum deviation can be +/- 30 %, including the tolerances of the measuring current transformers. The characteristic curves apply to the respective nominal voltage indicated in the diagram. If the nominal voltage of the system being monitored is different from the nominal voltage shown in the diagram, the response values may change proportionally.

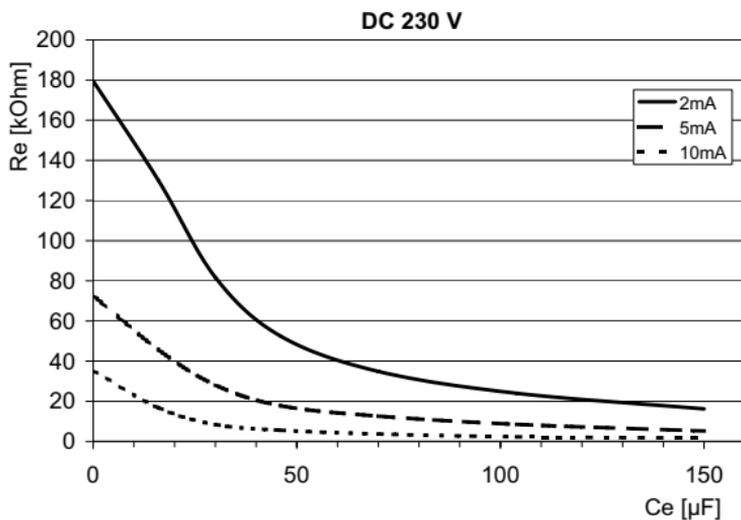
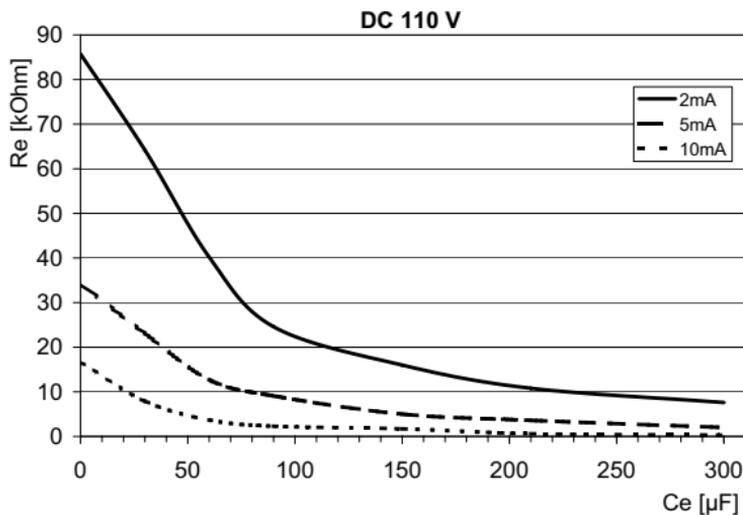
Nominal voltages changing dynamically during operation or in case of superimposed alternating currents that deviate from the system frequency (e.g. caused by frequency converters or inverters) or superimposed direct currents may result in response value that are outside the range displayed in the diagram.

The following characteristics are an easy way of determining a suitable response value for the insulation monitoring device and the EDS460-DG. Proceed as follows:

1. Select the characteristics that are appropriate for your system voltage.
2. Calculate the anticipated leakage capacitance of the system being monitored. The IRDH575 displays the system leakage capacitance (press the INFO key). Apply this value to the diagram in the form of a vertical line.
3. The characteristics provided indicate the EDS system's response sensitivity when the EDS460-DG response value is set to 2 mA, 5 mA and 10 mA. Values above the relevant curve cannot be detected.
4. Select the upper characteristic for a EDS460-DG response value of 2 mA (factory setting). Mark the system leakage capacitance C_e on the characteristic. Read off the relevant resistance R_e from the characteristic. The resistance R_e thus calculated indicates the maximum response value that can be set on the insulation monitoring device (e.g. IRDH575). If higher response values than this are set, insulation fault detection becomes unreliable. A reliable response on the part of the insulation monitoring device must be ensured before the EDS system can be started.
5. If you wish to set a higher response value for the insulation monitoring device, you will need to calculate the resistance R_e as described under point 4 from the characteristic for 5 mA or 10 mA. Values and characteristics which are in the range between the top and bottom characteristic can be estimated by means of existing characteristics.
6. Set the calculated response values on the insulation monitoring device and the EDS460-DG.

8.4.1 EDS460-DG characteristics





8.5 Ordering information

Insulation fault evaluators

Type	Supply voltage U_s^*	Response value	Art. No.
EDS460-DG-1	DC 16...94 V AC 42...460 Hz 16...72 V	2...10 mA	B 9108 0018
EDS460-DG-2	AC/DC 70...276 V, AC 42...460 Hz	2...10 mA	B 9108 0019
EDS460-DGW-1	DC 16...94 V AC 42...460 Hz 16...72 V	2...10 mA	B 9108 0018W
EDS460-DGW-1	AC/DC 70...276 V, AC 42...460 Hz	2...10 mA	B 9108 0019W

* *Absolute values*

EDS460-DGW.. Version for increased climatic and mechanical stresses.

Accessories

Type	Supply voltage U_S	Art. No.
DI-1PSM (RS-485 repeater)	AC/DC 24 V $\pm 20\%$	B 9501 2044
DI-2USB (interface converter RS-485/USB) with USB cable	Supply from USB interface	B 9501 2045
AN471 (power supply unit for DI-1 or DI-2)	AC 230 V 50/ 60 Hz/ AC, DC 20 V	B 924 189
Snap-on mounting W20.../35...		B 9808 0501
Snap-on mounting W60...		B 9808 0502

Protocol converter

Type	Supply voltage U_S	Art. No.
FTC470XDP	AC / DC 85...276 V*	B 9506 1000
FTC470XMB	AC / DC 85...276 V*	B 9506 1002
FTC470XET	AC / DC 85...276 V*	B 9506 1001

*Absolute value

Measuring current transformer for EDS460-DG

Bender measuring current transformers

Type	Inside diameter/mm	Type of construction	Art. No.
W20	20	circular-type	B 9808 0003
W35	35	circular-type	B 9808 0010
W60	60	circular-type	B 9808 0018
W120	120	circular-type	B 9808 0028
W210	210	circular-type	B 9808 0034
WR70x175	70 x 175	rectangular	B 9808 0609
WR115x305	115 x 305	rectangular	B 9808 0610
WS20x30	20 x 30	split-core	B 9808 0601
WS50x80	50 x 80	split-core	B 9808 0603
WS80x80	80 x 80	split-core	B 9808 0605
WS80x120	80 x 120	split-core	B 9808 0606
WS80x160	80 x 160	split-core	B 9808 0608

Alternative measuring current transformers from the Bender range

Type	Inside diameter/mm	Type of construction	Art. No.
W10/600	10	circular-type	B 911 761
W0-S20	20	circular-type	B 911 787
W1-S35	35	circular-type	B 911 731
W2-S70	70	circular-type	B 911 732
W3-S105	105	circular-type	B 911 733
W4-S140	140	circular-type	B 911 734
W5-S210	210	circular-type	B 911 735
WR 70x175S	70x175	rectangular	B 911 738
WR 115x305S	115x305	rectangular	B 911 739
WR 150x350S	150x350	rectangular	B 911 740
WR 200x500S	200x500	rectangular	B 911 763
WS 50x80S	50x80	split-core	B 911 741
WS 80x80S	80x80	split-core	B 911 742
WS 80x120S	80x120	split-core	B 911 743
WS 80x160S	80x160	split-core	B 911 755

For further information about measuring current transformers, please refer to the relevant instruction leaflet supplied with the product.

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