EN Manual

BENDER
The Power in Electrical Safety©

ISOMETER® isoES425

AC/DC

Insulation monitoring device for
unearthed AC, AC/DC and DC systems (IT systems) for
energy storage devices
up to AC/DC 400 V
Software version: D0471 V1.xx

isoES425_D00214_00_M_XXEN/01.2019

READ THIS MANUAL AND ALL ACCOMPANYING DOCUMENTS CAREFULLY
AND RETAIN FOR FUTURE REFERENCE.

Bender GmbH & Co. KG
P.O. Box 1161 • 35301 Gruenberg • Germany
Londorfer Strasse 65 • 35305 Gruenberg • Germany

Tel.: +49 6401 807-0
Fax: +49 6401 807-259

E-mail: info@bender.de
Web: www.bender.de

Customer service
Service hotline: 0700-BenderHelp (Telephone and Fax)
Carl-Benz-Strasse 8 • 35305 Gruenberg • Germany

Tel.:+49 6401 807-760
Fax:+49 6401 807-629

E-mail:info@bender-service.com

Table of Contents

1. Important information

1.1 How to use this manual

Always keep this manual within easy reach for future reference.

To make it easier for you to understand and revisit certain sections in this manual, we have used symbols to identify important instructions and information. The meaning of these symbols is explained below:

*This signal word indicates that there is a **high risk of danger** that will result in **death** or **serious injury** if not avoided.*

*This signal word indicates a **medium risk of danger** that can lead to **death** or **serious injury** if not avoided.*

*This signal word indicates a **low-level risk** that can result in minor or **moderate injury** or **damage to property** if not avoided.*

*This symbol denotes information intended to assist the user in making **optimum use** of the product.*

*This manual is intended for **qualified personnel** working in electrical engineering and electronics!*

1.2 Technical support: Service and support

For commissioning and troubleshooting Bender offers:

1.2.1 First level support

Technical support by phone or e-mail for all Bender products

- Questions about specific customer applications
- Commissioning
- Troubleshooting

Telephone:	+49 6401 807-760*
Fax:	+49 6401 807-259
In Germany only:	0700BenderHelp (Tel. and Fax)
E-mail:	support@bender-service.com

1.2.2 Repair service

Repair, calibration, update and replacement service for Bender products

- Repair, calibration, testing and analysis of Bender products
- Hardware and software update for Bender devices
- Delivery of replacement devices for faulty or incorrectly delivered Bender devices
- Extended warranty for Bender devices with in-house repair service or replacement device at no extra cost

Telephone:	+49 6401 807-780** (technical issues)
	+49 6401 807-784**, -785** (commercial issues)
Fax:	+49 6401 807-789
E-mail:	repair@bender-service.com

1.2.3 Field service

On-site service for all Bender products

- Commissioning, parameter setting, maintenance, troubleshooting for Bender products
- Analysis of the electrical installation in the building (power quality test, EMC test, thermography)
- Practical training courses for customers

Telephone:	+49 6401 807-752**, -762** (technical issues)
	+49 6401 807-753** (commercial issues)
Fax:	+49 6401 807-759
E-mail:	fieldservice@bender-service.com
Internet:	www.bender-de.com

*Available from 7.00 a.m. to 8.00 p.m. on 365 days of the year (CET/UTC+1)

**Mo-Thu 7.00 a.m. - 8.00 p.m., Fr 7.00 a.m. - 13.00 p.m

1.3 Training courses

Bender is happy to provide training regarding the use of test equipment.

The dates of training courses and workshops can be found on the Internet at www.bender-de.com -> Know-how -> Seminars.

1.4 Delivery conditions

The conditions of sale and delivery set out by Bender apply. For software products, the "Softwareklausel zur Überlassung von Standard- Software als Teil von Lieferungen, Ergänzung und Änderung der Allgemeinen Lieferbedingungen für Erzeugnisse und Leistungen der Elektroindustrie" (software clause in respect of the licensing of standard software as part of deliveries, modifications and changes to general delivery conditions for products and services in the electrical industry) set out by the ZVEI (Zentralverband Elektrotechnik- und Elektronikindustrie e.V., (German Electrical and Electronic Manufacturers' Association) also applies.

Conditions of sale and delivery can be obtained from Bender in printed or electronic format.

Important information

1.5 Inspection, transport and storage

Inspect the dispatch and equipment packaging for damage, and compare the contents of the package with the delivery documents. In the event of damage in transit, please contact Bender immediately. The devices must only be stored in areas where it is protected from dust, humidity and spray or dripping water, and in which the specified storage temperatures can be assured.

1.6 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 device.
- Incorrect mounting, commissioning, operation and maintenance of the device.
- Failure to observe the instructions in this operating manual regarding transport, commissioning, operation and maintenance of the device.
- Unauthorised changes to the device made by parties other than the manufacturer.
- Non-observance of technical data.
- Repairs carried out incorrectly and the use of replacement parts or accessories not approved by the manufacturer.
- Catastrophes caused by external influences and force majeure.
- Mounting and installation with device combinations not recommended by the manufacturer.

This operating manual, especially the safety instructions, must be observed by all personnel working on the device. Furthermore, the rules and regulations that apply for accident prevention at the place of use must be observed.

1.7 Disposal

Abide by the national regulations and laws governing the disposal of this device. Ask your supplier if you are not sure how to dispose of the old equipment.

The directive on waste electrical and electronic equipment (WEEE directive) and the directive on the restriction of certain hazardous substances in electrical and electronic equipment (RoHS directive) apply in the European Community. In Germany, these policies are implemented through the "Electrical and Electronic Equipment Act" (ElektroG). According to this, the following applies:

- Electric and electronic equipment are not to be included in household waste.
- Batteries and accumulators are not to be included in household waste but must be disposed of in accordance with the regulations.
- Old electrical and electronic equipment from users other than private households which was introduced to the market after 13th August 2005 must be taken back by the manufacturer and disposed of properly.

For more information on the disposal of Bender devices, refer to our website at www.bender-de.com -> Service & support.

2. Safety instructions

2.1 General safety instructions

Part of the device documentation in addition to this manual is the enclosed "Safety instructions for Bender products".

2.2 Work activities on electrical installations

DANGER

Risk of electrocution due to electric shock!

Touching live parts of the system carries the risk of:

- *An electric shock ,*
- *Damage to the electrical installation,*
- *Destruction of the device.*

Before installing and connecting the device, make sure that the installation has been de-energised. The rules for working on electrical systems must be observed.

If the device is used outside the Federal Republic of Germany, the applicable local standards and regulations must be complied with. The European standard EN 50110 can be used as a guide.

2.3 Intended use

Only qualified personnel are permitted to carry out the work necessary to install, commission and run a device or system.

The ISOMETER® isoES425 monitors the insulation resistance R_F of unearthed AC, AC/DC and DC systems (IT systems) for energy storage devices up to AC/DC 400 V. DC components existing in AC systems do not influence the operating characteristics when a minimum load current of DC 10 mA flows. A separate supply voltage U_s allows de-energised systems to be monitored too. By using the isoES425 in network operation, the connection to earth is monitored for interruptions, which are indicated as faults. When operated as an island network, the isoES425 takes over the monitoring of the island network (IT system).

In order to meet the requirements of applicable standards, customised parameter settings must be made on the equipment in order to adapt it to local equipment and operating conditions. Please heed the limits of the area of application indicated in the technical specifications.

Any other use than that described in this manual is regarded as improper.

To ensure that the ISOMETER® functions correctly, an internal resistance of ≤1 kΩ must exist between L1/+ and L2/- via the source (e.g. the transformer) or the load.

In case the ISOMETER® issues an alarm message, the insulation fault should be eliminated as quickly as possible.

The alarm message of the ISOMETER® must be audible and/or visible even when the device is installed inside a control cabinet.

3. Function

3.1 Device features

- Monitoring the insulation resistance R_F for unearthed AC, DC systems
- Measuring the nominal system voltage U_n (True RMS) with undervoltage/overvoltage detection
- Measuring the offset voltages system to earth (L1+/PE and L2-/PE)
- Automatic adaptation to the system leakage capacitance C_e up to 100 µF
- Selectable start-up delay, response delay and delay on release
- Two separately adjustable response value ranges of 1…990 kΩ (Alarm 1, Alarm 2)
- Alarms are indicated via LEDs ("AL1", "AL2"), a display and alarm relays ("K1", "K2")
- Automatic device self test with connection monitoring
- N/C or N/O operation selectable
- Measured value indication via multi-functional LCD
- Fault memory can be activated
- RS-485 (galvanically isolated) including the following protocols:
  - BMS interface (Bender measuring device interface) for data exchange with other Bender components
  - IsoData (for continuous data output)
- Password protection to prevent unauthorised parameter changes

3.2 Functional description

The ISOMETER® measures the insulation resistance R_F and the system leakage capacitance C_e between the system to be monitored (L1/+, L2/-) and earth (PE). The r.m.s. value of the nominal system voltage U_n between L1/+ and L2/-, as well as the offset voltages U_{L1e} (between L1/+ and earth) and U_{L2e} (between L2/- and earth) are also measured.

In the DC system, from a minimum nominal system voltage, the ISOMETER® determines the faulty conductor L1/+/L2/-, i.e. the distribution of the insulation resistance R_F between conductors L1/+ and L2/- and indicates this by means of a positive or negative sign preceding the insulation resistance measured value. The value range of the faulty conductor is +/-100 %:

Display	Meaning
-100 %	One-sided fault on conductor L2/-
0 %	Symmetrical fault
+100 %	One-sided fault on conductor L1/+

The partial resistances can be calculated from the total insulation resistance R_F and the faulty conductor (R %) using the following formula:

Fault on conductor L1/+ R_{L1F} = (200 % * R_F)/(100 % + R%)

Fault on conductor L2/- R_{L2F} = (200 % * R_F)/(100 % – R%)

In the AC system, the location of the fault in the DC link is indicated by a positive or negative sign preceding the insulation resistance measured value in the AC system from a minimum nominal system voltage between the AC system and earth, caused by a fault in a connected DC circuit. A percentage distribution to the location of the fault is not possible. The faulty conductor "R%" is only represented as a one-sided fault on L1/+ (+100 %) or L2/- (-100 %).

Also from a minimum nominal system voltage, the ISOMETER® determines the insulation resistance R_{UGF} from the offset voltages U_{L1e} and U_{L2e}. It is an approximate value for one-sided insulation faults and can be used as a trend indicator in cases where the ISOMETER® has to adapt to an R_F and C_e relation that varies considerably.

It is possible to assign the detected fault or the faulty conductor to an alarm relay via the menu. If the values R_F or U_n exceed the response values activated in the "AL" menu, this will be indicated by the LEDs and relays "K1" and "K2" according to the alarm assignment set in the "out" menu. In addition, the operating mode of the relay (n.c./n.o.) can be set and the fault memory "M" can be activated in this menu.

If the values R_F or U_n do not violate their respective release value (response value plus hysteresis) for the period t_{off} without interruption, the alarm relays will switch back to their initial position and the alarm LEDs "AL1"/"AL2" will go out. If the fault memory is activated, the alarm relays remain in alarm state and the LEDs stay lit until the reset button "R" is pressed or the supply voltage U_s is interrupted.

The device function can be tested using the test button "T". Parameters are assigned to the device via the LCD as well as the control buttons on the front panel; this function can be password-protected. Parameterisation is also possible via the BMS bus, e.g. by using the BMS Ethernet gateway (COM465IP).

Function

3.2.1 Monitoring of the insulation resistance

The two parameters "R1" and "R2", which monitor the insulation resistance R_F, can be found in the response value menu "AL" (see table on Page 16). The value R1 can only be set higher than the value R2. If the insulation resistance R_F reaches or falls below the values R1 or R2, this leads to an alarm message. If R_F exceeds the values R1 or R2 plus the hysteresis value (see table on Page 16), the alarm is be cleared.

3.2.2 Undervoltage/overvoltage monitoring

In the response value menu "AL" (refer to Page 16), the two parameters ("U <" and "U >") for monitoring the nominal system voltage U_n can be activated or deactivated. The maximum undervoltage value is limited by the overvoltage value.

The R.M.S. value of the nominal system voltage U_n is monitored. If the nominal system voltage U_n reaches, falls below or exceeds the limit values ("U <" or "U >"), an alarm will be signalled. If the maximum permissible nominal system voltage U_n set for the ISOMETER® is exceeded, an alarm will be triggered even if the overvoltage limit value has been deactivated. The alarm will be deleted when the threshold values plus hysteresis (refer to Page 16) are no longer violated.

3.2.3 Self test/error codes

The integrated self test function checks the function of the insulation monitoring device and the connection to earth. The alarm relays are not switched during an automatically started self test. For a manually started self test, the switching of the alarm relays can be set via the parameter "test" in the alarm assignment ("out" menu, Page 17). During the test, the display indicates "tES".

When malfunctions are detected or connections are missing, the LEDs "ON"/"AL1"/"AL2" flash. The respective error codes ("E.xx") are indicated on the display and when factory settings has been selected, relay "K2" switches.

The relays can be assigned to a device error with the parameter "Err" in the "out" menu in the alarm assignment.

Error codes

If, contrary to expectations, a device error should occur, error codes will appear on the display. Some of these are described below:

Error code	Meaning
E.01	**PE connection fault** The connections of "E" or "KE" to earth are interrupted. **Action**: Check connection, eliminate error. The error code will be erased automatically once the error has been eliminated.
E.02	**System connection fault** The internal resistance of the system is too high, the connection "L1/+" or "L2/-" to the system is interrupted or the DC system being monitored has the wrong polarity at U_n > 50 V. **Action**: Check connection, eliminate error. The error code will be erased automatically once the error has been eliminated.
E.05	**Measurement technique error/calibration invalid** for the current software version
E.07	**The maximum permissible system leakage capacitance C_e according to the technical data sheet is exceeded** **Action:** Device not suitable for the existing system leakage capacitance C_e: Uninstall device.
E.08	**Calibration error during device test** **Action**: If the error continues to exist after checking the device connections, there is an error inside the device.

Internal device errors "E.xx" can be caused by external disturbances or internal hardware errors. If the error message occurs again after restarting the device or after a reset to factory settings (menu item "FAC") , the device must be repaired.

After eliminating the fault, the alarm relays switch back automatically or by pressing the reset button. The self test can take a few minutes.

It can be suppressed for the duration of the device start by setting the parameter in the menu "SEt" to "S.Ct = off". This allows the ISOMETER® to enter measurement mode quickly after connecting the supply voltage.

Function

Automatic self test

The device runs a self test after connecting the supply voltage U_s and afterwards every 24 hours (selectable at ""t" menu" auf Seite 18 : off, 1 h, 24 h).

Manual self test

A self test is initiated by pressing the test button for more than 1.5 s. While pressing the internal test button "T", all display elements available for this device are shown.

3.2.4 Connection monitoring

The connection monitoring activated by the self test checks the connections of the terminals "E" and "KE" to the protective earth conductor PE. When an error is detected, the message device error (Err) will be signalled and the error code "E.01" appears on the display.

The system connection monitoring is used to check the connections of terminals "L1/+" and "L2/-" to the system to be monitored. When an interruption or a high-resistance connection between L1/+ and L2/- is detected via the internal resistance of the system, the device error ("Err") is signalled and the error code "E.02" appears on the display. Since a test of the system connection may take considerable time due to system disturbances or may even provide incorrect results, the system connection monitoring can be disconnected using the parameter "nEt" in the "SEt" menu.

3.2.5 Malfunction

In addition to the described self test, several functions in the insulation monitoring device are continuously checked during operation. If a fault is detected, the device error (Err) will be signalled. The error code E.xx appears on the display as an identifier for the error type xx and the LEDs "ON"/"AL1"/"AL2" flash.

If the error occurs again after restarting the device or after restoring the factory settings, please contact Bender service.

3.2.6 Alarm assignment of the alarm relays "K1"/"K2"

The messages "device error", "insulation fault", "undervoltage/overvoltage fault", "device test" and "device start with alarm" can be assigned to the alarm relays via the "out" menu. An insulation fault is indicated by the messages "+R1", "-R1", "+R2" and "-R2". Messages "+R1" and "+R2" indicate an insulation fault assigned to conductor L1/+, and messages "-R1" and "-R2" indicate an insulation fault assigned to conductor L2/-.

The message "test" indicates a self test.

The message "S.AL" indicates a so-called "device start with alarm". After connecting to the supply voltage U_s and setting the parameter value to "S.AL = on", the ISOMETER® starts with the insulation measured value R_F = 0 Ω and sets all activated alarms. The alarms will only be cleared when the measured values are up-to-date and no thresholds are exceeded. When set to "S.AL = off" (factory setting), the ISOMETER® starts without an alarm. It is recommended that the "S.AL" parameter value is set identically for both relays.

3.2.7 Measuring and response times

The measuring time is the period essential for the detection of the measuring value. The measuring time is reflected in the operating time t_{ae} . For the insulation resistance measured value, it is mainly determined by the necessary measuring pulse duration, which depends on the insulation resistance R_F and the system leakage capacitance C_e of the system to be monitored. The measuring pulse is produced by the measuring pulse generator integrated in the ISOMETER®. The measuring times for C_e, U_{L1e}, U_{L2e} and R% are synchronous. System disturbances may lead to extended measuring times. In contrast, the time for the nominal system voltage measurement U_n is independent and considerably shorter.

Total response time t_{an}

The total response time t_{an} is the sum of the operating time t_{ae} and the response delay time t_{on}.

Operating time t_{ae}

The operating time t_{ae} is the time required by the ISOMETER® to determine the insulation resistance measured value. It depends on the insulation resistance R_F and the system leakage capacitance C_e.

Response delay t_{on}

The response delay t_{on} is set uniformly for all messages in the "t" menu using the parameter "ton", whereby each alarm message specified in the alarm assignment hast its own timer for t_{on}. This delay time can be used for interference suppression in the case of short measuring times.

An alarm will only be signalled when a threshold value of the respective measuring value is violated for the period of t_{on} without interruption. Every time the threshold value is violated within the time t_{on}, the response delay "ton" restarts once again.

Delay on release t_{off}

The delay on release t_{off} can be set uniformly for all messages in the "t" menu using the parameter "toff", whereby each alarm message specified in the alarm assignment has its own timer for t_{off}. An alarm will continuously be signalled until the threshold value of the respective measured value is not violated (including hysteresis) for the period t_{off} without interruption. Each time the threshold value is not violated for the period t_{off}, the delay on release "toff" restarts once again.

Function

Start-up delay *t*

After connection to the supply voltage U_s the alarm indication for the preset time (0…10 s) in the parameter "t" is suppressed.

3.2.8 Password protection (on, OFF)

If password protection has been activated (on), settings can only be made after the correct password has been entered (0...999).

3.2.9 Factory settings FAC

Activating the factory settings will reset all modified settings, except interface parameters, to the default upon delivery.

3.2.10 External, combined test or reset button T/R

Reset = Press the external button < 1.5 s

Reset with subsequent test= Press the external button > 1.5 s

Stop mode = Press and hold the external button

Stop mode can also be triggered via an interface command and in this case it can only be reset via the interface.

Only one ISOMETER® may be controlled via an external test/reset button. Galvanic parallel connection of several test or reset inputs for combined testing of insulation monitoring devices is not permitted.

3.2.11 Fault memory

The fault memory can be activated or deactivated with the parameter "M" in the "out" menu. When the fault memory is activated, all pending alarm messages of the LEDs and relays remain available until they are deleted by using the reset button (internal/external) or the supply voltage U_s is turned off.

3.2.12 History memory HiS

When the first fault occurs after clearing the history memory, all measured values (that are marked in the table on Page 18) are saved in the history memory. This data can be read out using the "HiS" menu item. In order to be able to record a new data record, the history memory must first be cleared via the menu using "Clr".

3.2.13 Interface/protocols

The ISOMETER® uses the serial hardware interface RS-485 with the following protocols:

- **BMS**

The BMS protocol is an essential component of the Bender measuring device interface (BMS bus protocol). ASCII characters are used for data transfer.

- **IsoData**

The ISOMETER® continuously sends an ASCII data string with a cycle of approximately 1 s. Communication with the ISOMETER® in this mode is not possible and no additional sender may be connected via the RS-485 bus cable. The ASCII data string for the ISOMETER® is described on Page 20.

The parameter address, baud rate and parity for the interface protocols are configured in the "out" menu.

The IsoData protocol is activated by setting "Adr = 0".
With a valid bus address (i.e. not equal to 0), the BMS protocol is activated.
In this case, the baud rate for the BMS protocol is set to 9,600 baud.

Only qualified personnel are permitted to carry out the work necessary to install, commission and run a device or system.

DANGER

Risk of electrocution due to electric shock!
Touching live parts of the system carries the risk of:

- *An electric shock,*
- *Damage to the electrical installation,*
- *Destruction of the device.*

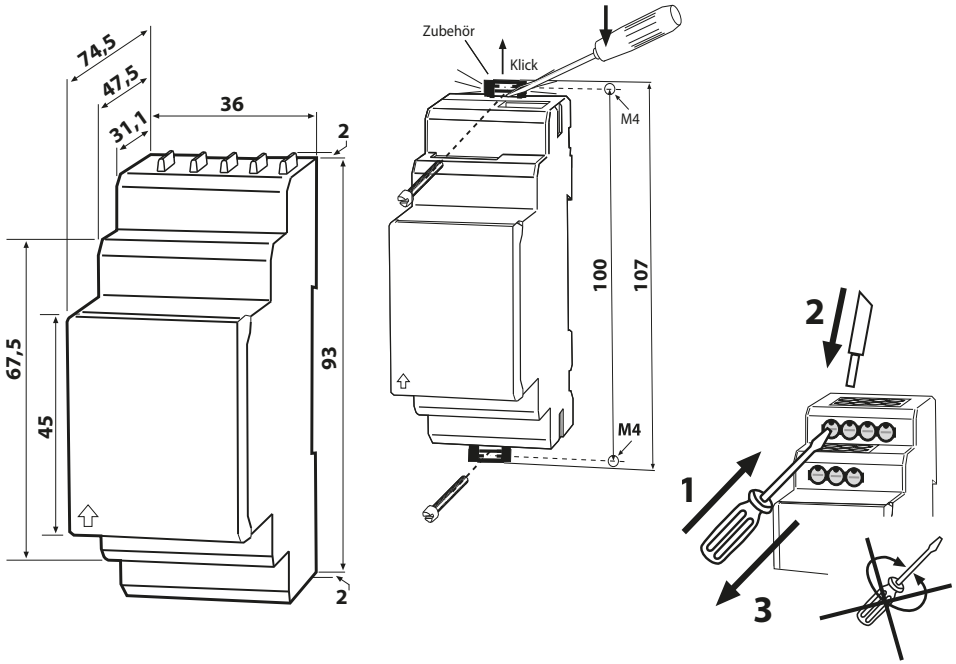
Before installing and connecting the device, make sure that the installation has been de-energised. The rules for working on electrical systems must be observed.

If the ISOMETER® is used in rail vehicles, it must be ensured that the ISOMETER® is installed within a control cabinet that complies with the fire protection requirements of DIN EN 45545-2.

4.1 Mounting

- **DIN rail mounting:**
  Snap the rear mounting clip of the device into place in such a way that a safe and tight fit is ensured.
- **Screw mounting:**
  Use a tool to position the rear mounting clips so that they project beyond the enclosure (a second mounting clip is required, see ordering information). Fix the device with two M4 screws, see the following sketch.

Dimension diagram, sketch for screw mounting and push-wire terminal connection:



All dimensions in mm

The front plate cover can be opened at the lower part marked with an arrow.

4.2 Wiring diagram

Terminals "A1" and "A2" are to be connected to the supply voltage U_s according to IEC 60364-4-43, i.e. the connections are to be protected against short circuit by means of a protective device (a 6 A fuse is recommended).

Devices for protection against short circuit in conformity with IEC 60364-4-43 for the coupling of terminals "L1/+" and "L2/-" to the IT system to be monitored can be omitted if the wiring is carried out in such a manner as to reduce the risk of a short circuit to a minimum.

Only one ISOMETER® may be controlled via a test/reset button. It is not allowed to use a parallel connection of several test or reset inputs for combined testing of ISOMETER®s.

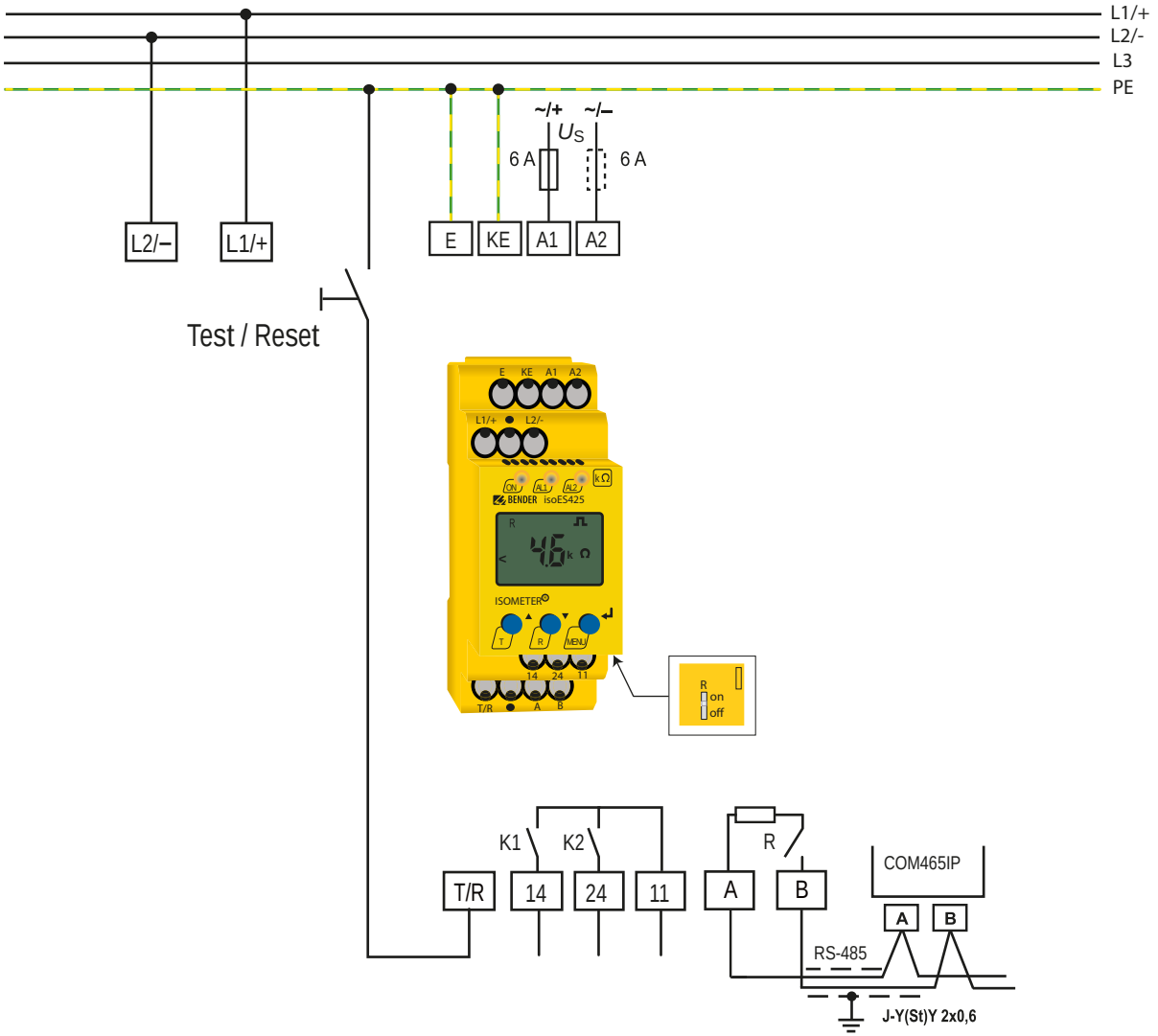


Fig. 4.1: Wiring diagram of the isoES425

For details about the conductor cross sections required for wiring, refer to the technical data from Page 21.

Wiring diagram legend:

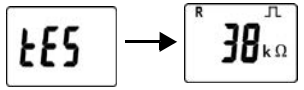
Terminal	Connections
A1, A2	Connection to the supply voltage U_s via fuse (line protection): If being supplied from an IT system, both lines have to be protected by a fuse.*
E, KE	Connect each terminal separately to PE: The same wire cross section as for "A1", "A2" is to be used.
L1/+, L2/–	Connection to the AC or DC system to be monitored
T/R	Connection for the external combined test and reset button
11, 14	Connection to alarm relay "K1"
11, 24	Connection to alarm relay "K2"
A, B	RS-485 communication interface with connectable terminating resistor Example: Connection of a BMS Ethernet gateway COM465IP

**** For UL applications:***
Use 60/75 °C copper lines only!
For UL and CSA applications, the supply voltage U_s must be protected via 5 A fuses.
Connect the device according to the wiring diagram.

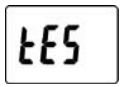
Installation, connection and commissioning

4.3 Commissioning

1. Check that the ISOMETER® **is properly connected** to the system to be monitored.
2. **Connect the supply voltage U_s to the ISOMETER®**.
   The device carries out a calibration, a self test and adjusts itself to the IT system to be monitored. When high system leakage capacitances are involved, this procedure may take up to 4 min. The standard display then appears showing the present insulation resistance R_F, e.g.:



   The pulse symbol signals an error-free update of the resistance measured value. If the measuring value cannot be updated due to disturbances, the pulse symbol will be blanked.
3. **Start a manual self test** by pressing the test button "T". Whilst the test button is pressed and held down, all display elements available for this device are shown. During the test, the "tES" symbol flashes. Any internal malfunctions detected are shown on the display as error codes (refer to Page 9). The alarm relays are not checked during the test (factory setting). The setting can be changed in the "out" menu so that the relays switch to the alarm state during the manual self test.



4. **Check the factory settings for suitability.**
   Are the settings suitable for the installation to be monitored?
   The list of factory settings are shown in the tables from Page 16.
5. **Check the function using a genuine insulation fault**.
   Check the ISOMETER® in the system being monitored against earth, e.g. via a suitable resistance.

5. Operating the device

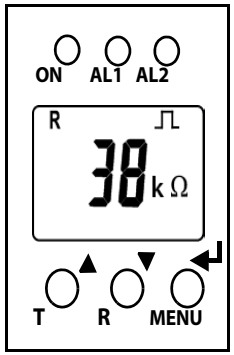
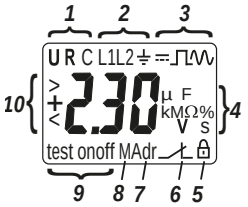
The menu structure is illustrated schematically on the following pages.

After pressing the "MENU" button for > 1.5 s, the first menu item "AL" appears. Use ▲▼ and ↵ (Enter) buttons for navigation and settings.

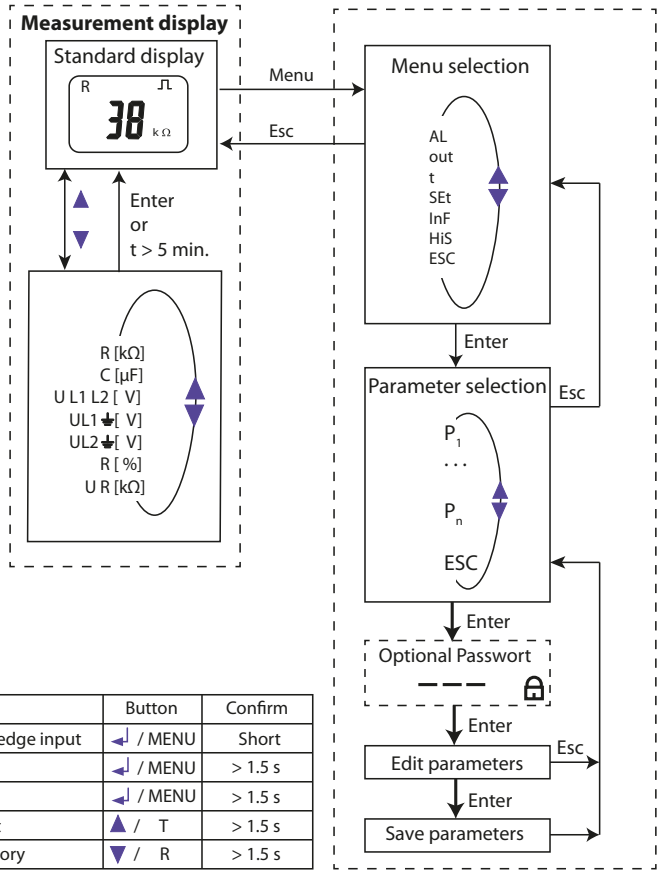
▲▼	Up and down button: - Navigate up or down in the menu settings - Increase or decrease values
MENU ↵	Pressing the MENU/Enter button for **more** than 1.5 s: - Start menu mode **or** - When the device already is in menu mode: Exit menu item (Esc). Any recent changes won't be stored. Pressing the MENU/Enter button for **less** than 1.5 s: - Confirm menu selection **or** - Confirm modified value

The areas of the display that can be configured flash!

5.1 Display elements in use

Device front/display		Function
	**ON** **AL1** **AL2**	green - on yellow - alarm yellow - alarm *Assignment according to table on Page 17*
	▲ **T**	Up button Test button (press > 1.5 s) By pressing and holding the test button, the display elements are indicated
	▼ **R**	Down button Reset button (press > 1.5 s)
	↵ **MENU**	ENTER MENU button (press > 1.5 s)
	**1**	**U** : Nominal system voltage U_n **R** : Insulation resistance R_F **C** : System leakage capacitance C_e
	2	Monitored conductor
	3	= : Voltage type DC ⎍ : Error-free measured value update ~ : Voltage type AC
	4	Measured values and units
	5	Password protection is activated.
	6	In the menu mode, the operating mode of the respective alarm relay is displayed.
	7	Communication interface sends in IsoData mode.
	8	The fault memory is activated.
	9	Condition symbols
	10	Identification for response values and response value violation

5.2 Menu overview



Funktion		Button	Confirm
Enter	Select, acknowledge input	↵ / MENU	Short
Menu	Call menu	↵ / MENU	> 1.5 s
Esc	Exit menu item	↵ / MENU	> 1.5 s
Test	Start device test	▲ / T	> 1.5 s
Reset	Clear fault memory	▼ / R	> 1.5 s

Menu item	Parameter
AL	Querying and setting response values
out	Configuring fault memory, alarm relays and interface
t	Setting delay times and self-test cycles
SEt	Setting device control parameters
InF	Querying software version
HiS	Querying and clearing the history memory
ESC	Going to the next higher menu level

5.3 "AL" menu

5.3.1 Response value setting

The two parameters that monitor the insulation resistance R_F, "R1" and "R2", can be found in the response value menu "AL". The value R1 can only be set higher than the value R2. If the insulation resistance R_F reaches or falls below the values R1 or R2, this leads to an alarm message. If R_F exceeds the values R1 or R2 plus the hysteresis value (see table below), the alarm will be cleared.

The two parameters ("U <" and "U >") for monitoring the nominal system voltage U_n can also be activated or deactivated in the response value menu "AL". The maximum undervoltage value is limited by the overvoltage value.

Display	Activation		Setting value			Description
	FAC	Cs	Range	FAC	Cs	
R1 <			R2 … 990	69	kΩ	Pre-alarm value R_{an1} Hys. = 25 %/min. 1 kΩ
R2 <			1… R1	23	kΩ	Alarm value R_{an2} Hys. = 25 %/min. 1 kΩ
U <	**off**		10 … U>	30	V	Alarm value undervoltage RMS Hys. = 5 %/min. 5 V
U >	**off**		U< … 500	500	V	Alarm value overvoltage RMS Hys. = 5 %/min. 5 V

FAC = Factory settings; **Cs** = Customer settings

Operating the device

5.4 "out" menu

5.4.1 Configuration of the relay operating mode

Relay K1			Relay K2			Description
Display	FAC	Cs	Display	FAC	Cs	
1	n.c.		2	n.c.		Operating mode of the relay n.c./n.o.

FAC = Factory settings; **Cs** = Customer settings

5.4.2 Relay alarm assignment "r1" and "r2" and LED assignment

In the alarm assignment, each alarm is assigned to the corresponding relay with the setting "on". The LED indication is directly assigned to the alarms and is not related to the relays.

If the device can assign an asymmetrical insulation fault to the corresponding conductor (L1/+ or L2/-), it will only signal the respective alarm.

K1 „r1“			K2 „r2“			LEDs			Alarm description
Display	FAC	Cs	Display	FAC	Cs	ON	AL1	AL2	
1 Err	off		2 Err	on		◎	◎	◎	Device error E.xx
r1 +R1 < Ω	on		r2 +R1 < Ω	off		●	●	○	Pre-alarm R1 Fault R_F at L1/+
r1 -R1 < Ω	on		r2 -R1 < Ω	off		●	●	○	Pre-alarm R1 Fault R_F at L2/-
r1 +R2 < Ω	off		r2 +R2 < Ω	on		●	○	●	Alarm R2 Fault R_F at L1/+
r1 -R2 < Ω	off		r2 -R2 < Ω	on		●	○	●	Alarm R2 Fault R_F at L2/-
r1 U < V	off		r2 U < V	on		●	○	◎	Alarm U_n undervoltage
r1 U > V	off		r2 U > V	on		●	◎	○	Alarm U_n Overvoltage
r1 test	off		r2 test	off		●	●	●	Manually started device test
r1 S.AL	on		r2 S.AL	on		●	●	●	Device start with alarm

FAC = Factory settings; **Cs** = Customer settings

○: LED off ◎: LED flashes ●: LED on

5.4.3 Fault memory configuration

Display	FAC	Cs	Description
M	**off**		Memory function for alarm messages (fault memory)

FAC = Factory settings; **Cs** = Customer settings

5.4.4 Interface configuration

Display	Setting value			Description	
	Range	FAC	Cs		
Adr	0 / 3 … 90	**3**	( )	Bus addr.	Adr = 0 deactivates BMS and activates the isoData data logger with continuous data output (115k2, 8E1)

FAC = Factory settings; **Cs** = Customer settings;
( ) = User setting that is not modified by FAC.

5.5 "t" menu

5.5.1 Time configuration

Display	Setting value			Description
	Range	FAC	Cs	
t	0 … 10	0	**s**	Start-up delay during device start
ton	0 … 99	0	**s**	Response delay K1 and K2
toff	0 … 99	0	**s**	Delay on release K1 and K2
test	OFF / 1 / 24	24	**h**	Repetition time device test

FAC = Factory settings; **Cs** = Customer settings

5.6 "SEt" menu

5.6.1 Function configuration

Display	Activation		Setting value			Description
	FAC	Cs	Range	FAC	Cs	
🔒	**off**		0 . . . 999	**0**		Password for parameter setting
nEt	**on**					Test of the system connection during device test
S.Ct	**on**					Device test during device start
FAC						Restore factory settings
SYS						For Bender service only

FAC = Factory settings; **Cs** = Customer settings

Operating the device

5.7 Measured value display and history memory

R_F is continuously indicated on the display (standard display). All other measured value displays switch to the standard display after a maximum of 5 min. The pulse symbol indicates a current measured value. If this symbol does not appear, the measurement is still running and the latest valid measured value will be displayed. The symbols "<" or ">" will be displayed additionally to the measured value when a response value has been reached or violated, or the measured value is below or exceeds the measuring range.

HiS	Display	Description
✓	±R kΩ ⎍	**Insulation resistance** R_F 1 kΩ ... 4 MΩ Resolution 1 kΩ
✓	C µF ⎍	**System leakage capacitance** C_e 0 µF ... 105 µF Resolution 1 µF No update when R_F is < 10 kΩ.
✓	~ ± U L1 L2 = V	**Nominal system voltage L1 - L2** U_n 0 V_{RMS} … 500 V_{RMS} Resolution 1 V_{RMS}
✓	±U L1 ⏚ = V	**Residual voltage L1/+ - PE** U_{L1e} 0 V_{DC} … ±500 V_{DC} Resolution 1 V_{DC}
✓	±U L2 ⏚ = V	**Residual voltage L2/- - PE** U_{L2e} 0 V_{DC} … ±500 V_{DC} Resolution 1 V_{DC}
✓	±R %	**Fault location in %** -100 % …+100 %
	U R = kΩ ⎍	**Insulation resistance** R_{UGF} 1 kΩ … 4 MΩ Resolution 1 kΩ R_{UGF} is an approximate value for asymmetrical insulation faults and can be used as a trend indicator with short measuring times.

✓ : The measured value is indicated in the history memory.

6. Data access using the BMS protocol

The BMS protocol is an essential component of the Bender measuring device interface (BMS bus protocol). ASCII characters are used for the data transfer.

BMS channel no.	Operation value	Alarm
1	R_F	Pre-alarm R1
2	R_F	Alarm R2
3	C_e	----
4	U_n	Undervoltage
5	U_n	Overvoltage
6	---	Connection fault earth (E.01)
7	---	Connection fault system (E.02)
8	---	All other device faults (E.xx)
9	Fault location [%]	---
10	U_{L1e}	---
11	U_{L2e}	---
12	Update counter	---
13	R_{UGF}	---
14	---	---
15	---	---

7. IsoData data string

In IsoData mode, the ISOMETER® continuously sends the whole data string with a cycle time of approximately 1 s. Communication with the ISOMETER® in this mode is not possible and no additional sender may be connected via the RS-485 bus cable.

IsoData is activated in the "out" menu**,** menu item "Adr" when it has been set to Adr = 0. In this case, the symbol "Adr" flashes on the measured value display.

String	Description
!;	Start sign
v;	Insulation fault location ' ' / '+' / '-'
1234, 5;	Insulation resistance R_F [kΩ]
1234;	System leakage capacitance C_e [µF]
1234, 5;	reserved
+1234;	Nominal system voltage U_n [V_{RMS}] Nominal system voltage type: AC or unknown: ' ' DC: '+'/'-'
+1234;	Offset voltage U_{L1e} [V_{DC}]
+1234;	Offset voltage U_{L2e} [V_{DC}]
+123;	Insulation fault location -100 … +100 [%]
1234, 5;	Approximate asymmetrical insulation resistance R_{UGF} [kΩ]
1234;	Alarm message [hexadecimal] (without leading "0x") The alarms are included in this value with the OR function. Assignment of the alarms: 0x0002 Device error 0x0004 Prewarning insulation resistance R_F at L1/+ 0x0008 Prewarning insulation resistance R_F at L2/- 0x000C Prewarning insulation resistance R_F symmetrical 0x0010 Alarm insulation resistance R_F at L1/+ 0x0020 Alarm insulation resistance R_F at L2/- 0x0030 Alarm insulation resistance R_F symmetrical 0x0040 Reserved 0x0080 Reserved 0x0100 Alarm undervoltage U_n 0x0200 Alarm overvoltage U_n 0x0400 Message system test 0x0800 Device start with alarm
1	Update counter, counts consecutively from 0 to 9. It increases with the update of the insulation resistance value.
<CR><LF>	String end

8. Technical data

8.1 Tabular presentation

( )* = Factory settings

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

Definitions:

- Measuring circuit (IC1) ..... L1/+, L2/-
- Supply circuit (IC2) A1, A2
- Output circuit (IC3) 11, 14, 24
- Control circuit (IC4) ..... E, KE, T/R, A, B

Rated voltage ..... 400 V
Overvoltage category III

Rated impulse voltage:

- IC1/(IC2-4) ..... 6 kV
- IC2/(IC3-4) ..... 4 kV
- IC 3 / IC4 ..... 4 kV

Rated insulation voltage:

- IC1/(IC2-4) ..... 400 V
- IC2/(IC3-4) ..... 250 V
- IC3/IC4 ..... 250 V

Pollution degree 3

Safe isolation (reinforced insulation) between:

- IC1/(IC2-4) ..... Overvoltage category III, 600 V
- IC2/(IC3-4) ..... Overvoltage category III, 300 V
- IC 3/(IC4) ..... Overvoltage category III, 300 V

Voltage tests (routine test) acc. to IEC 61010-1:

- IC2/(IC3-4) ..... AC 2.2 kV
- IC3/(IC4) ..... AC 2.2 kV

Supply voltage

Supply voltage U_s ..... AC 100...240 V/DC 24...240 V
Tolerance of U_s ..... -30...+15 %
Frequency range U_s ..... 47...63 Hz
Power consumption ..... ≤ 3 W, ≤ 9 VA

Monitored IT system

Nominal system voltage U_n ..... 3 (N)AC, AC 0...400 V/DC 0...400 V
Tolerance of U_n ..... +25 %
Frequency range of U_n ..... DC, 15...460 Hz

Measuring circuit

Measuring voltage U_m ..... ±12 V
Measuring current I_m at $R_F = 0\ \Omega$ ..... ≤ 110 µA
Internal resistance R_i ..... ≥ 115 kΩ
Permissible system leakage capacitance C_e ..... ≤ 100 µF
Permissible extraneous DC voltage U_{fg} ..... ≤ 700 V

Response values

Response value R_{an1} ..... 2...990 kΩ (69 kΩ)*
Response value R_{an2} ..... 1...980 kΩ (23 kΩ)*
Relative uncertainty R_{an} ..... ±15 %, at least ±1 kΩ
Hysteresis R_{an} ..... 25 %, at least 1 kΩ
Undervoltage detection U< ..... 10...499 V (off)*
Overvoltage detection U> ..... 11...500 V (off)*
Relative uncertainty U ..... ±5 %, at least ±5 V
Relative uncertainty depending on the frequency ≥ 400 Hz ..... -0.015 %/Hz
Hysteresis U ..... 5 %, at least 5 V

Time response

Response time t_{an} at $R_F = 0.5 \times R_{an}$ and C_e=1 µF acc. to IEC 61557-8 ..... ≤ 10 s
Start-up delay t ..... 0...10 s (0 s)*
Response delay t_{on} ..... 0...99 s (0 s)*
Delay on release t_{off} ..... 0...99 s (0 s)*

Displays, memory

Display ..... LC display, multi-functional, not illuminated
Display range measured value insulation resistance (R_F) ..... 1 kΩ...4 MΩ
Operating uncertainty R_F ..... ±15 %, at least ±1 kΩ
Display range measured value nominal system voltage (U_n) ..... 0...500 V_{RMS}
Operating uncertainty (U) ..... ±5 %, at least ±5 V
Display range measured value system leakage capacitance at R_F > 10 kΩ ..... 0...105 µF
Operating uncertainty ..... ±15 %, at least ±2 µF
Password ..... off/0...999 (0, off)*
Fault memory alarm messages ..... on/(off)*

Interface

Interface/protocol ..... RS-485/BMS, isoData
Baud rate ..... BMS (9.6 kbit/s), isoData (115.2 kbits/s)
Cable length (9.6 kbits/s) ..... ≤ 1200 m
Cable: twisted pairs, shield connected to PE on one side ..... min. J-Y(St)Y 2x0.6
Terminating resistor ..... 120 Ω (0.25 W), internal, can be connected
Device address, BMS bus ..... 3...90 (3)*

Switching elements

Switching elements ..... 2 x 1 N/O contacts, common terminal 11
Operating principle ..... N/C operation/N/O operation (N/C operation)*
Electrical endurance, number of cycles 10 000

Contact data acc. to IEC 60947-5-1:

Utilisation category ..... AC-12 ..... 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 ..... 2 A ..... 1 A ..... 0.2 A ..... 0.1 A
Minimum contact rating ..... 1 mA at AC/DC ≥10 V

Environment/EMC

EMC ..... IEC 61326-2-4

Ambient temperatures:

Operation ..... -25 . . . +70 °C
Transport ..... -40 . . . +85 °C
Storage ..... -25 . . . +70 °C

Classification of climatic conditions 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)
Long-term 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
Long-term storage (IEC 60721-3-1) 1M3

Connection

Connection type ..... push-wire terminal
Nominal current ..... ≤ 10 A
Conductor sizes ..... AWG 24 -14
Stripping length ..... 10 mm
rigid ..... 0.2 . . . 2.5 mm^2
Flexible without ferrules ..... 0.75 . . . 2.5 mm^2
Flexible with ferrules with/without plastic sleeve ..... 0.25 . . . 2.5 mm^2
Multi-conductor flexible with TWIN ferrules with plastic sleeve ..... 0.5 . . . 1.5 mm^2
Opening force ..... 50 N
Test opening, diameter ..... 2.1 mm

Other

Operating mode ..... continuous operation
Mounting ..... cooling slots must be ventilated vertically
Degree of protection, built-in components (DIN EN 60529) IP30

Technical data

Degree of protection, terminals (DIN EN 60529) IP20
Enclosure material ..... polycarbonate
DIN rail mounting acc. to ..... IEC 60715
Screw fixing ..... 2 x M4 with mounting clip
Weight ..... ≤ 150 g

8.2 Standards, approvals and certifications

The ISOMETER® has been developed in compliance with the following standards:

- DIN EN 61557-8 (VDE 0413-8): 2015-12/Ber1: 2016-12
- IEC 61557-8: 2014/Cor1: 2016

Subject to change! The specified standards take into account the edition valid until 01.2019 unless otherwise indicated.

8.3 Ordering details

Type	Version	Art. No.
isoES425-D4-4	Push-wire terminal	B71037020
Mounting clip for screw fixing (1 piece per device)		B98060008

Bender GmbH & Co. KG
P.O. Box 1161 • 35301 Gruenberg • Germany
Londorfer Strasse 65 • 35305 Gruenberg • Germany

Tel.: +49 6401 807-0
Fax: +49 6401 807-259

E-mail: info@bender.de
Web: www.bender.de

Customer service
Service hotline: 0700-BenderHelp (Telephone and Fax)
Carl-Benz-Strasse 8 • 35305 Gruenberg • Germany

Tel.: +49 6401 807-760
Fax: +49 6401 807-629

E-mail: info@bender-service.com
Web: http://www.bender.de

BENDER Group

Fotos: Bender Archiv.