ISOMETER® isoHV425 with AGH422 coupling device

Insulation monitoring device for unearthed AC, AC/DC and DC systems (IT systems) up to 3(N)AC, AC 1000 V

Software version: D0453 V1.xx (isoHV425-D4-4)
D0500 V1.xx (isoHV425-D4M-4)

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Manual **EN**

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1. Important information

1.1 How to use this manual

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

Always keep this manual within easy reach for future reference.
To make it easier for you to understand and revisit certain sections of text and instructions 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.*

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 (telephone and fax)

E-mail: support@bender.de

1.2.2 Repair Service

Repair, calibration, update and replacement service for Bender products

- Repair, calibration, testing and analysis
- Hardware and software update
- Delivery of replacement devices for faulty or incorrectly delivered Bender devices
- Extended warranty for Bender devices with in-house repair service or replacement devices 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.de

Please send the devices for **repair** to the following address:

Bender GmbH, Repair-Service,

Londorfer Str. 65,

35305 Grünberg

1.2.3 Field Service

On-site service for all Bender products

- Commissioning, parameter setting, maintenance, troubleshooting
- Analysis of the electrical installation in the building (power quality, EMC, 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.de

Internet: www.bender.de

*365 days 7.00 a.m. – 8.00 p.m. (CET/UTC +1)

**Mo-Thu 7.00 a.m. – 4.00 p.m., Fr 7.00 a.m. – 1.00 p.m

1.3 Training courses

Bender is happy to provide training regarding the use of test equipment. Current dates of training courses and workshops can be found on the Internet at:
www.bender.de/en –> 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.

1.5 Inspection, transport and storage

Check the shipping and device packaging for damage and compare the package contents with the shipping documents. In case of transport damage, please notify Bender immediately.

The devices must only be stored in areas where they are 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 for personal injury and property damage are excluded if they are attributable 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 spare parts or accessories not recommended 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 persons working with 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 13 August 2005 will be taken back by the manufacturer and disposed of properly.

For more information on the disposal of Bender devices, refer to our homepage at www.bender.de/en –> Service & support.

2. Safety instructions

2.1 General safety instructions

In addition to these operating manual, the "Safety instructions for Bender products", which are also included in the scope of supply, are an integral part of the device documentation.

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. Observe the rules for working on electrical installations.

If the device is being used in a location outside the Federal Republic of Germany, the applicable local standards and regulations must be complied with. 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® monitors the insulation resistance R_F of unearthed AC, AC/DC and DC systems (IT systems) with system voltages of 3(N)AC, AC/DC 0…1000 V or DC 0…1000 V. The maximum permissible system leakage capacitance C_e is 150 µF. DC components existing in AC systems do not influence the operating characteristics when a minimum load current of DC 100 mA flows. The separate supply voltage U_s allows de-energised systems to be monitored as well.

In order to meet the requirements of applicable standards, the equipment must be adjusted to local equipment and operating conditions by means of customised parameter settings. Please heed the limits of the range of application indicated in the technical data.

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

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

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

If the ISOMETER® is installed inside a control cabinet, the insulation fault message must be audible and/or visible to attract attention.

3. Function

3.1 Device features

- Monitoring the insulation resistance R_F for unearthed AC/DC systems
- Measurement of the system voltage U_n (True RMS) with undervoltage and overvoltage detection
- Measurement of the DC residual voltages system to earth (L1+/PE and L2-/PE)
- Automatic adaptation to the system leakage capacitance C_e up to 150 µF
- Selectable start-up delay, response delay and delay on release
- Two separately adjustable response value ranges from 10…500 kΩ
- Alarm signalling via LEDs (AL1, AL2), display and alarm relays (K1, K2)
- Automatic device self test with connection monitoring
- Selectable N/C or N/O relay operation
- Measured value indication via a multi-functional LC display
- Fault memory can be activated
- Password protection to prevent unauthorised parameter changes

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- RS-485 (galvanically separated) including the following protocols:
  - BMS interface (Bender measuring device interface) for data exchange with other Bender components
  - Modbus RTU
  - IsoData (for continuous data output)

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- Analogue output (galvanically separated)

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 RMS value of the system voltage U_n between L1/+ and L2/-, as well as the DC residual voltages U_{L1e} (between L1/+ and earth) and U_{L2e} (between L2/- and earth) are also measured.

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

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 %)

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

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 violate the response values activated in the "AL" menu, this will be indicated by the LEDs and relays K1 and K2 according to the signalling assignment set in the "out" menu. In addition, the operation of the relay (n.c./n.o.) can be set and the fault memory "M" can be activated.

If the values R_F or U_n do not violate their 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 go out. If the fault memory is activated, the alarm relays remain in alarm condition and the LEDs light 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 and the control buttons on the front panel; this function can be password-protected. Parameterisation is also possible via the BMS bus, for example by using a BMS Ethernet gateway (COM465IP) or Modbus RTU.

The isoHV425 determines the system leakage capacitance C_e via an impedance measurement the frequency of which is adjusted to an insulation measurement that is as accurate as possible. The measuring signal is influenced by rectifiers or inverters and phase errors may occur, resulting in a distorted measured value for the system leakage capacitance C_e.

3.2.1 Monitoring of the insulation resistance

The two parameters "R1" and "R2" for monitoring the insulation resistance R_F can be found in the response value menu "AL" (see table on Page 29). The value "R1" can only be set higher than the value "R2". If the insulation resistance R_F reaches or falls below the activated 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 29), the alarm will be cleared.

3.2.2 Undervoltage/overvoltage monitoring

In the response value menu "AL" (see Page 29), the two parameters ("U <" and "U >") for monitoring the 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 system voltage U_n is monitored. If the system voltage U_n reaches, falls below or exceeds the limit values ("U <" or "U >"), an alarm will be signalled. If the maximum permissible system voltage U_n set for the ISOMETER® is exceeded, an alarm message will be triggered even if the overvoltage limit value has been deactivated. The alarm will be deleted when the limit values plus hysteresis (see Page 29) are no longer violated.

3.2.3 Self test/error codes

The isoHV425xx contains test routines for checking that the device is functioning correctly during operation. Some test routines are performed cyclically or continuously in the background during the normal measuring function. Other test routines are triggered by the user. The following options are available to the user:

- cyclically via a timer (menu item "t" / "test")
- via the internal test button
- via the external test button
- via the communication interface (COM)

In case of a device error, all 3 LEDs on the device flash, the display shows the message "E.xx" according to the following error code table and depending on the signalling assignment, the relays switch.

Error codes

If a device error occurs, the following error codes appear on the display:

Error code	Description
E.01	**PE connection error** The connection of terminals E or KE to earth is interrupted. Action: Check connection, eliminate error. The error code will be erased automatically once the error has been eliminated.
E.02	**System connection error** The internal resistance of the system is too high, the connection of terminals L1/+ or L2/- to the system is interrupted or L1/+ and L2/- are connected with reversed polarity to the monitored DC system (U_n < – 100 V). Action: Check connection, eliminate error. The error code will be erased automatically once the error has been eliminated.
E.05	**Measurement technology error/calibration invalid** For the current software version
E.07	**The maximum permissible system leakage capacitance C_e according to the technical data 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 error, 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 U_s.

Cyclic background test

The cyclic background test to check the functionality of the µC is not visible to the user and does not influence the measuring function. In case of malfunction, the respective device error messages "E.09" to "E.16" appear.

If the error occurs again after restarting the device or after a reset to factory settings, contact Bender Service.

Continuous PE connection monitoring

The connection of terminal E of the AGH to the PE protective conductor is monitored continuously and in parallel with the measuring function of the device via the input KE of the isoCHA425HV, which is also connected to the PE protective conductor. In case of a connection interruption, the device error message "E.01" is displayed.

User-controlled test functions

The user-controlled test functions interrupt the measuring function of the device. They always include a test of the measurement technology (device error "E.05") and additionally a test of the connection between the terminals L1/+ and L2/- via the system to be monitored (device error system connection "E.02") which can be activated by the user (menu "SEt" / "nEt"). If during the system connection check a system voltage U_n negative DC -100 VDC is applied to the ISOMETER®, the message "E.02" for a system connection with reversed polarity is also displayed.

If these test functions are started via a test button or the communication interface, this can be indicated not only by the LEDs AL1 and AL2 lighting up but also by the message "test" via the relays (menu "out"/"Signalling assignment").

3.2.4 Signalling assignment of the alarm relays K1/K2

The messages "Device error", "Insulation fault", "Undervoltage/overvoltage fault, "Device test" or "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". The messages "+R1" and "+R2" indicate an insulation fault assigned to conductor L1/+, and the 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 to "S.AL = on", the ISOMETER® starts with the insulation measured value $R_F = 0\,\Omega$ and sets all activated alarms. The alarms are only cleared when the measured values are up-to-date and no thresholds are violated. With the factory setting "S.AL = off", the ISOMETER® starts without an alarm. It is recommended to set the parameter value "S.AL" identically for both relays.

3.2.5 Measuring and response times

The measuring time is the time required to detect a measured value. The measuring time is reflected in the operating time t_{ae}. The measuring time for the measured insulation resistance value is mainly determined by the required 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 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 measured value. For the measured insulation resistance 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 signalling assignment has 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 measured 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 listed in the signalling assignment hast 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 of t_{off} without interruption. Each time the threshold value is not violated for the period of t_{off}, the delay on release "toff" restarts.

Start-up delay *t*

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

3.2.6 Password protection (on, OFF)

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

3.2.7 Factory setting FAC

Activating the factory settings will reset all modified settings ? with the exception of the interface parameters ? to the default values upon delivery.

3.2.8 External, combined test or reset button T/R

Reset= press the external button < 1.5 s

Reset followed by a test = press the external button > 1.5 s

Stop measuring function = press and hold the external button

When the measuring function is stopped, the display shows „STP“.

The stop function 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. A galvanic parallel connection of several test or reset inputs for testing multiple insulation monitoring devices is not allowed.

3.2.9 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.

3.2.10 History memory HiS

When the first error occurs after clearing the history memory, all measured values (that are marked in the table on Page 33) are saved in the history memory. This data can be read out using the menu item "HiS". In order to be able to record a new data record, the history memory must first be cleared via the menu using "Clr".

3.2.11 Digital interfaces (isoHV425-D4-4)

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). Data is transferred using ASCII characters.

- **Modbus RTU**

Modbus RTU is an application layer messaging protocol and it provides master/slave communication between devices that are connected altogether via bus systems and networks. Modbus RTU messages have a 16-bit CRC (Cyclic Redundant Checksum), which guarantees reliability.

- **IsoData**

The ISOMETER® continously sends an ASCII data string with a cycle of approximately 1 s. Communication with the ISOMETER® within this mode is not possible and no additional transmitter may be connected to the RS-485 bus cable. The ASCII data string for the ISOMETER® is described on Page 45.

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

With "Adr = 0", the menu entries "Baud rate" and "Parity" are not shown in the menu and the IsoData protocol is activated.
With a valid bus address (i.e. not equal to 0), the menu item "Baud rate" is displayed in the menu. The parameter value "---" for the baud rate indicates the activated BMS protocol. In this event, the baud rate for the BMS protocol is set to 9,600 baud. If the baud rate is set unequal to "---", the modbus protocol is activated with a configurable baud rate.

3.2.12 Analogue interface (isoHV425-D4M-4)

The following functions can be selected at the potential-free analogue signal output:

- Voltage output DC 0…10 V
- Current output DC 4…20 mA
- Current output DC 0…20 mA
- Current output DC 0…400 µA

4. Mounting, connection and commissioning

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:

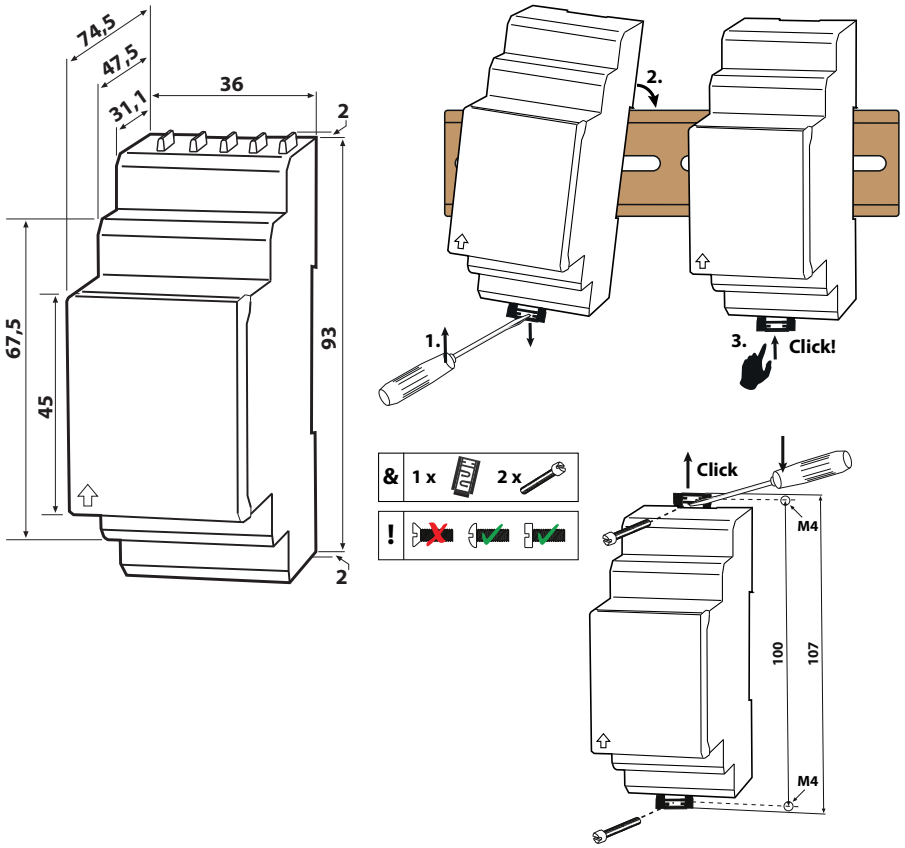
- *An electric shock*
- *Damage to the electrical installation*
- *Destruction of the device*

Before installing and connecting the device, make sure that the installation has been de-energised. Observe the rules for working on electrical installations.

4.1 Mounting

- **DIN rail mounting:**
  Snap the mounting clip at the rear of the device onto the DIN rail so that it sits securely.
- **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, push-wire terminal connection:



All dimensions in mm

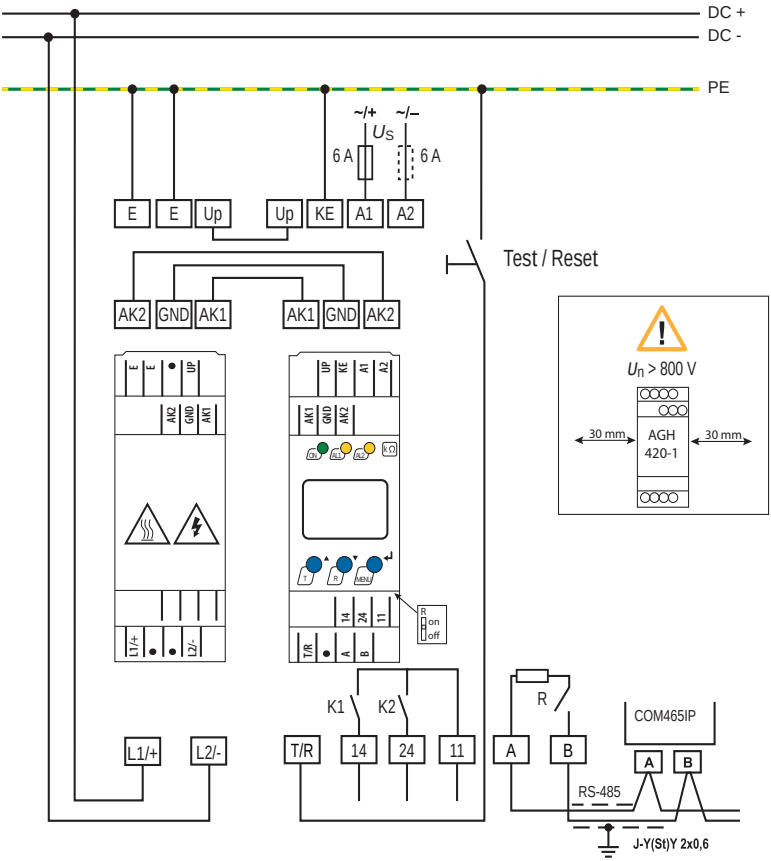
The front plate cover can be opened at the lower part marked with an arrow.

Application in rail vehicles/DIN EN 45545-2:2016

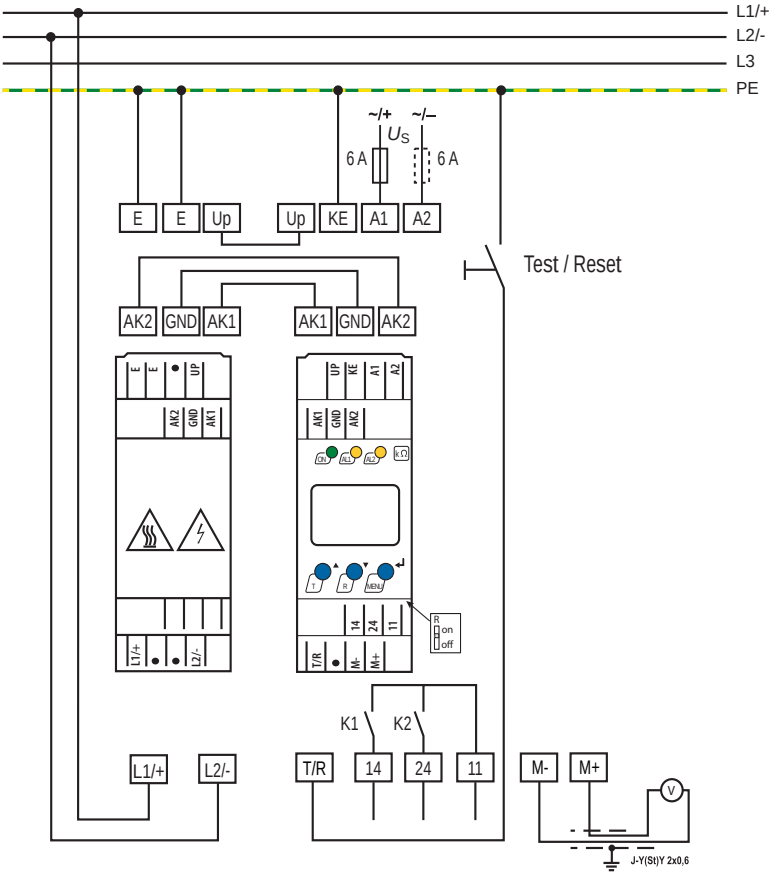
If the distance to neighbouring components that do not meet the requirements of the DIN EN 45545-2 Table 2 standard is < 20 mm horizontally or < 200 mm vertically, these are to be regarded as grouped. See DIN EN 45545-2 Chapter 4.3 Grouping rules. Standards, approvals and certifications

4.2 Wiring diagram

4.2.1 Connection isoHV425-D4-4



4.2.2 Connection isoHV425W-D4M-4 with analogue interface:



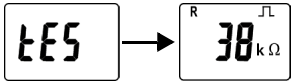
For details about the conductor cross sections required for wiring, refer to the technical data from Page 46 .

Legend of the wiring diagrams:

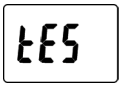
Terminal	Connections
A1, A2	Connection to the supply voltage U_s via fuse (line protection): If being supplied from an IT system, both lines have to be protected by a fuse.
E, E, KE	Connect each terminal separately to PE: The same wire cross section as for A1, A2 is to be used.
L1/+, L2/-	Connection to the IT system to be monitored
Up, AK1, GND, AK2	Connect the terminals of the AGH422 to the corresponding terminals of the ISOMETER®.
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 COM460IP
M-, M+	Analogue output

4.3 Commissioning

1. **Check that** the ISOMETER® is **properly connected** to the system to be monitored.
2. **Connect the supply voltage U_s for 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, e.g.:

   The pulse symbol signals an error-free update of the measured resistance value. If the measured value cannot be updated due to disturbances, the pulse symbol will be hidden.
3. **Start a manual self test** by pressing the test button "T". Whilst the test button is pressed and held down (> 1.5 s), all display elements available for this device are shown. During the test, the "tES" symbol flashes. Any internal malfunctions detected are displayed as error codes (see Page 14). 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 factory setting for suitability.**
   Are the settings suitable for the installation to be monitored?
   List of factory settings (see table from Page 29).
5. **Check the function using a genuine insulation fault**.
   Check the ISOMETER® in the system being monitored, e.g. via a suitable resistance to earth.

5. Operation

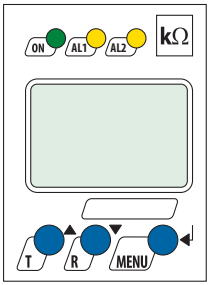
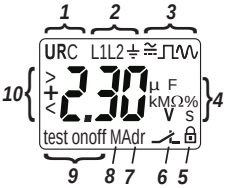
The menu structure is illustrated schematically on the following pages.

If the "MENU" button is pressed for more than 1.5 s, the first menu item "AL" appears. Use ▼▲ and ↵ (enter) buttons for navigation and settings.

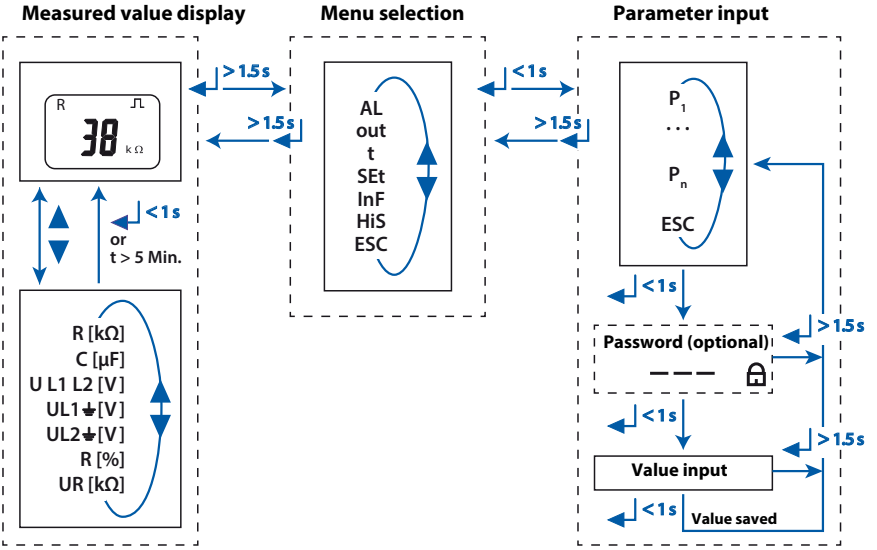
▼▲	Up and down button: - Navigate up or down in the menu settings - Increase or decrease values
MENU ↵	Pressing the MENU/enter button for **more** than 1.5 s: - Start menu mode or - If the device is already in menu mode: Exit menu item (Esc). Any recent changes will not be stored. Pressing the MENU/enter 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

Device front/display		Function
	**ON** **AL1** **AL2**	green - on yellow - alarm yellow - alarm
	▲ **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** : 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 enabled.
	6	In the menu mode, the operating mode of the respective alarm relay is displayed.
	7	Communication interface With measured value: isoData operation
	8	The fault memory is enabled.
	9	Condition symbols
	10	Identifier for response values and response value violation

5.2 Menu overview



Menu item	Parameter
AL	Query and set response values
out	Configure fault memory, alarm relays and interface
t	Set delay times and self test cycles
SEt	Set device control parameters
InF	Query software version
HiS	Query and clear the history memory
ESC	Go to the next higher menu level

5.3 "AL" menu – response value setting

The two parameters "R1" and "R2" for monitoring the insulation resistance R_F 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.

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

Display	Activation		Setting value			Description
	FAC	Cs	Value range	FAC	Cs	
R1 <	on		R2 … 500	50	kΩ	Prewarning value R_{an1} Hys. = 25 %/min. 1 kΩ
R2 <	on		10… R1	25	kΩ	Alarm value R_{an2} Hys. = 25 %/min. 1 kΩ
U <	off		30 … U>	30	V	Alarm value undervoltage RMS Hys . = 5 %/min. 5 V
U >	off		U< … 1.10k	1100	V	Alarm value overvoltage RMS Hys. = 5 %/min. 5 V

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

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 setting; **Cs** = Customer settings

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

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

In the event of an unsymmetrical insulation fault, only the alarm corresponding to the assigned conductor (L1/+ or L2/-) will be displayed. .

K1 "r1"			K2 "r2"			LEDs			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		●	●	○	Prewarning R1 Fault R_F at L1/+
r1 -R1 < Ω	on		**r2 -R1 < Ω**	off		●	●	○	Prewarning 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	off		**r2 S.AL**	off		●	●	●	Device start with alarm

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

5.4.4 Interface configuration (isoHV425-D4-4)

Display	Setting value			Description	
	Value range	FAC	Cs		
Adr	0 / 3 … 90	3	( )	BusAdr.	Adr = 0 deactivates BMS as well as Modbus and activates isoData with continuous data output (115k2, 8E1)
Adr 1	--- / 1.2k … 115k	"–––"	( )	Baud rate	"–––" –––> BMS bus (9k6, 7E1) "1.2k" … "115k" –––> Modbus (variable, variable)
Adr 2	8E1 8o1 8n1	8E1	( )	Modbus	**8E1** – 8 data bits, even parity, 1 stop bit **8o1** – 8 data bits, odd parity, 1 stop bit **8n1** – 8 data bits, no parity, 1 stop bit

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

( ) = Customer setting that is not modified by FAC.

5.4.5 Analogue output (isoHV425-D4M-4)

Display			Setting value			Description
		FAC	Value range	FAC	Cs	
U 0.10 V			I 4.20 mA I 0.20 mA I 0.400 µA U 0.10 V	U 0.10 V		"I 4.20 mA"; 4…20 mA; load ≤ 130 Ω "I 0.20 mA"; 0…20 mA; load ≤ 130 Ω "I 0.400 µA"; 0…400 µA; load ≤ 3 kΩ "U 0.10 V"; 0…10 V; load ≥ 20 kΩ
AnA	**R xxx kΩ**	on	120 kΩ	120	kΩ	Scaled value for the displayed non-linear resistance at 50 % of interface control R [kΩ] = SR [kΩ] * 100 % / analogue value [%] - SR [kΩ]
	U L1 L2 xxx V	off	20…1.5 k	1.5 k	V	Scaled value for the displayed linear system voltage at 100 % of interface control
	U L1 L2 > AL V	off			V	The overvoltage alarm value is the scaled value for the displayed linear system voltage at 100 % of interface control.

5.5 "t" menu – time configuration

Display	Setting value			Description
	Value range	FAC	Cs	
t	0 … 10	0	s	Start-up delay at 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 setting; **Cs** = Customer settings

5.6 "SEt" menu – function configuration

Display	Activation		Setting value			Description
	FAC	Cs	Value range	FAC	Cs	
🔒	off		0 . . . 999	**0**		Password for parameter setting
nEt	on					Test of the system connection L1/+, L2/- during device test
S.Ct	on					Device test during device start
FAC						Restore factory settings
SYS						For Bender Service only

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

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 minutes. The pulse symbol indicates a present 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 above 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 1 µF ... 200 µF Resolution 1 µF
✓	**~ ± U L1 L2 = V**	**System voltage L1 – L2** U_n 0 V_{RMS} … 1.15 kV_{RMS} Resolution 1 V_{RMS}
✓	**± U L1** ⏚ **= V**	**Residual voltage L1/+ – PE** U_{L1e} 0 V_{DC} … ±1.15 kV_{DC} Resolution 1 V_{DC}
✓	**± U L2** ⏚ **= V**	**Residual voltage L2/- – PE** U_{L2e} 0 V_{DC} … ±1.15 kV_{DC} Resolution 1 V_{DC}
✓	**± R %**	**Fault location in %** -100 % …+100 %
	U R = kΩ ⎍	**Insulation resistance** R_{FU} 1 kΩ …4 MΩ Resolution 1 kΩ R_{FU} is an approximate value for unsymmetrical insulation faults and can be used as a trend indicator with short measuring times. It is determined by the DC system voltage (> 50 V) and is only correct in the event of one-sided insulation faults. If there are simultaneous insulation faults at L1/+ and L2/- the value is indicated as a too high resistance.

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

6. BMS protocol (isoHV425-D4-4)

The BMS protocol is a component of the Bender measuring device interface (BMS bus protocol). Data is transferred using ASCII characters.

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

7. Modbus RTU protocol (isoHV425-D4-4)

Requests to the ISOMETER® can be made using the function code 0x03 (Read Holding Registers) or the function code 0x10 (Write Multiple Registers). The ISOMETER® generates a function-related answer and sends it back.

7.1 Reading out the Modbus register from the ISOMETER®

The required words of the process image can be read out from the "Holding Registers" of the ISOMETER® using the function code 0x03. For this purpose, the start address and the number of registers to be read out have to be entered. Up to 125 words (0x7D) can be read with one single request.

7.1.1 The master sends a command to the ISOMETER®

In the following example, the master addresses the ISOMETER® with address 3 and requests the contents of register 1003. The register contains the channel description of measuring channel 1.

Byte	Name	Example
Byte 0	ISOMETER® Modbus address	0x03
Byte 1	‚Function code	0x03
Byte 2, 3	Start address	0x03EB
Byte 4, 5	Number of registers	0x0001
Byte 6, 7	CRC16 Checksum	0xF598

7.1.2 The ISOMETER® answers the master

Byte	Name	Example
Byte 0	ISOMETER® Modbus address	0x03
Byte 1	Function code	0x03
Byte 2	Number of data bytes	0x02
Byte 3, 4	Data	0x0047
Byte 7, 8	CRC16 Checksum	0x81B6

7.2 Writing to Modbus registers (parameter setting)

Registers in the device can be modified with the function code 0x10 (Write Multiple Registers). Parameter registers are available from address 3000. The content of the registers can be found in the table on Page 37.

7.2.1 The master sends a command to the ISOMETER®

In this example, the master addresses the ISOMETER® with address 3 and requests that the content of the register with address 3003 is set to 2.

Byte	Name	Example
Byte 0	ISOMETER® Modbus address	0x03
Byte 1	Function code	0x10
Byte 2, 3	Start register	0x0BBB
Byte 4, 5	Number of registers	0x0001
Byte 6	Number of data bytes	0x02
Byte 7, 8	Data	0x0002
Byte 9, 10	CRC16 Checksum	0x9F7A

7.2.2 The ISOMETER® answers the master

Byte	Name	Example
Byte 0	ISOMETER® Modbus address	0x03
Byte 1	Function code	0x10
Byte 2, 3	Start register	0x0BBB
Byte 4, 5	Number of registers	0x0001
Byte 6, 7	CRC16 Checksum	0x722A

7.3 Exception code

If a request cannot be answered, the ISOMETER® will send a so-called exception code with which possible faults can be narrowed down.

Exception code	Description
0x01	Impermissible function
0x02	Impermissible data access
0x03	Impermissible data value
0x04	Internal fault
0x05	Acknowledgement of receipt (answer will be time-delayed)
0x06	Request not accepted (repeat request if necessary)

Structure of the exception code

Byte	Name	Example
Byte 0	ISOMETER® Modbus address	0x03
Byte 1	Function code (0x03) + 0x80	0x83
Byte 2	Data (exception code)	0x04
Byte 3, 4	CRC16 Checksum	0xE133

7.4 Modbus register assignment

Depending on the device state, the information in the registers is either the measured value without alarm, the measured value with alarm 1, the measured value with alarm 2 or only the device error.

Register	Measured value			Device error
	Without alarm	Alarm 1	Alarm 2	
1000…1003	R_F Insulation fault (71) [no alarm]	R_F Insulation fault (1) [prewarning]	R_F Insulation fault (1) [alarm]	--- Connection earth (102) [device error]
1004 …1007	---	---	---	---
1008 …1011	U_n Voltage (76) [no alarm]	U_n Undervoltage (77) [alarm]	U_n Overvoltage (78) [alarm]	--- System connection (101) [device error]
1012 …1015	C_e Capacitance (82) [no alarm]	---	---	---
1016 …1019	U_{L1e} Voltage (76) [no alarm]	---	---	---
1020 …1023	U_{L2e} Voltage (76) [no alarm]	---	---	---
1024 …1027	Fault location in % --- (1022) [no alarm]	---	---	---
1028 …1031	R_{FU} Insulation fault (71) [no alarm]	---	---	---
1032 …1035	Measured value update counter --- (1022) [no alarm]	---	---	--- Device error (115) [device error]

( ) = Channel description code (refer to Chapter 7.5.4)

[ ] = Alarm type (refer to Chapter 7.5.2.2)

Register	Mode	Description	Format	Unit	Value range
3000	RW	Reserved	–––	–––	–––
3001	RW	Reserved	–––	–––	–––
3002	RW	Reserved	–––	–––	–––
3003	RW	Reserved	–––	–––	–––
3004	RW	Reserved	–––	–––	–––
3005	RW	Prewarning value resistance measurement "R1"	Uint16	kΩ	R2 … 500
3006	RW	Reserved	–––	–––	–––
3007	RW	Alarm value resistance measurement "R2"	Uint16	kΩ	10 … R1
3008	RW	Activation alarm value undervoltage "U<"	Uint16	–––	0 = Inactive 1 = Active
3009	RW	Alarm value undervoltage "U<"	Uint16	V	30 … U>
3010	RW	Activation alarm value overvoltage "U>"	Uint16	–––	0 = Inactive 1 = Active
3011	RW	Alarm value Overvoltage "U >"	Uint16	V	U< … 1100
3012	RW	Memory function for alarm messages (fault memory) "M"	Uint16	–––	0 = Inactive 1 = Active
3013	RW	Operating mode of relay 1 "r1"	Uint16	–––	0 = n.o. 1 = n.c.
3014	RW	Operating mode of relay 2 "r2"	Uint16	–––	0 = n.o. 1 = n.c.
3015	RW	Bus address "Adr"	Uint16	–––	0/3 … 90
3016	RW	Baud rate "Adr 1"	Uint16	–––	0 = BMS 1 = 1.2 k 2 = 2.4 k 3 = 4.8 k 4 = 9.6 k 5 = 19.2 k 6 = 38.4 k 7 = 57.6 k 8 = 115.2 k
3017	RW	Parity "Adr 2"	Uint16	–––	0 = 8N1 1 = 8O1 2 = 8E1
3018	RW	Start-up delay "t" during device start	Uint16	s	0 …10
3019	RW	Response delay "ton" for relays K1 and K2	Uint16	s	0 … 99

Register	Mode	Description	Format	Unit	Value range
3020	RW	Delay on release "toff" for relays K1 and K2	Uint16	s	0 … 99
3021	RW	Repetition time "test" for automatic device test	Uint16	–––	0 = OFF 1 = 1 h 2 = 24 h
3022	RW	Reserved	–––	–––	–––
3023	RW	Reserved	–––	–––	–––
3024	RW	Check system connection during device test 'nEt'	Uint16	–––	0 = Inactive 1 = Active
3025	RW	Device test during device start "S. Ct"	Uint16	–––	0 = Inactive 1 = Active
3026	RW	Request stop mode (0 = deactivate device)	Uint16	–––	0 = Stop 1 = ---
3027	RW	Signalling assignment of relay 1 "r1"	Uint16	–––	Bit 9 … Bit 1 Chapter 7.5.3
3028	RW	Signalling assignment of relay 2 "r2"	Uint16	–––	Bit 9 … Bit 1 Chapter 7.5.3
8003	WO	Factory settings for all parameters	Uint16	–––	0x6661 "fa"
8004	WO	Factory settings only for parameters resettable by FAC	Uint16	–––	0x4653 "FS"
8005	WO	Start device test	Uint16	–––	0x5445 "TE"
8006	WO	Clear fault memory	Uint16	–––	0x434C "CL"
9800 …9809	RO	Device names	Uint16(ASCII) Chapter 7.5.1	–––	–––
9820	RO	Software ID number	Uint16	–––	Software ID
9821	RO	Software version number	Uint16	–––	Software version
9822	RO	Software version: Year	Uint16		
9823	RO	Software version: Month	Uint16		
9824	RO	Software version: Day	Uint16		
9825	RO	Modbus driver version	Uint16		

RW = Read/Write; RO = Read only; WO = Write only

7.5 Device-specific data types

7.5.1 Device name

The data format of the device name is specified below.

Word 0x00	0x01	0x02	0x03	––––––––––––––––––	0x08	0x09
10 words in total Each word contains two ASCII characters						

7.5.2 Measured values

Each measured value is available as a channel and consists of 8 bytes (4 registers). The first measured value register address is 1000. The structure of a channel is always identical. Content and number depend on the device. The structure of a channel is shown with the example of channel 1:

1000		1001		1002		1003	
HiByte	LoByte	HiByte	LoByte	HiByte	LoByte	HiByte	LoByte
Floating point value (Float)				Alarm type and test type (AT&T)	Range and unit (R&U)	Channel description	

7.5.2.1 Float = Floating point value of the channels

Word	0x00								0x01																			
Byte	HiByte								LoByte								HiByte								LoByte			
Bit	31	30						24	23	22						16	15							8	7							0
	S	E	E	E	E	E	E	E	E	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M

Representation of the bit order for processing analogue measured values according to IEEE 754

S = Sign

E = Exponent

M = Mantissa

7.5.2.2 AT&T = Alarm type and test type (internal/external)

Bit	7	6	5	4	3	2	1	0	Meaning
	External test	Internal test	Reserved	Reserved	Reserved	Alarm	Error		
Alarm type	X	X	X	X	X	0	0	0	No alarm
	X	X	X	X	X	0	0	1	Prewarning
	0	0	X	X	X	0	1	0	Device error
	X	X	X	X	X	0	1	1	Reserved
	X	X	X	X	X	1	0	0	Warning
	X	X	X	X	X	1	0	1	Alarm
	X	X	X	X	X	1	1	0	Reserved
	X	X	X	X	X	…	…	…	Reserved
	X	X	X	X	X	1	1	1	Reserved
Test	0	0	X	X	X	X	X	X	No test
	0	1	X	X	X	X	X	X	Internal test
	1	0	X	X	X	X	X	X	External test

The alarm type is coded by the bits 0 to 2. Bits 3, 4 and 5 are reserved and always have the value 0. Bit 6 or 7 is usually set when an internal or external test has been completed. Other values are reserved. The complete byte is calculated from the sum of the alarm type and the test type.

7.5.2.3 R&U = Range and unit

Bit	7	6	5	4	3	2	1	0	Meaning
Unit	–	–	–	0	0	0	0	0	Invalid (init)
	–	–	–	0	0	0	0	1	No unit
	–	–	–	0	0	0	1	0	Ω
	–	–	–	0	0	0	1	1	A
	–	–	–	0	0	1	0	0	V
	–	–	–	0	0	1	0	1	%
	–	–	–	0	0	1	1	0	Hz
	–	–	–	0	0	1	1	1	Baud
	–	–	–	0	1	0	0	0	F
	–	–	–	0	1	0	0	1	H
	–	–	–	0	1	0	1	0	°C
	–	–	–	0	1	0	1	1	°F
	–	–	–	0	1	1	0	0	Second
	–	–	–	0	1	1	0	1	Minute
	–	–	–	0	1	1	1	0	Hour
	–	–	–	0	1	1	1	1	Day
	–	–	–	1	0	0	0	0	Month
Range of validity	0	0	X	X	X	X	X	X	Actual value
	0	1	X	X	X	X	X	X	The actual value is lower
	1	0	X	X	X	X	X	X	The actual value is higher
	1	1	X	X	X	X	X	X	Invalid value

- The units of the bits 0 to 4 are coded.
- Bits 6 and 7 describe the validity range of a value.
- Bit 5 is reserved.

The complete byte is calculated from the sum of the unit and the range of validity.

7.5.3 Alarm assignment of the relays

Several alarms can be assigned to each relay. For the assignment of each relay, a 16-bit register is used with the bits described below. The following table applies to relay 1 and relay 2, in which "x" stands for the relay number. A set bit activates the specified function. A set bit activates the specified function.

Bit	Display indication	Description
0	Reserved	When reading, always 0 When writing, any value
1	x Err	Device error E.xx
2	rx; +R1 < Ω	Prewarning R1, fault R_F at L1/+
3	rx; -R1 < Ω	Prewarning R1, fault R_F at L2/-
4	rx; +R2 < Ω	Alarm R2, fault R_F at L1/+
5	rx; -R2 < Ω	Alarm R2, fault R_F at L2/-
6	rx; U < V	Alarm message U_n - undervoltage
7	rx; U > V	Alarm message U_n - overvoltage
8	rx; test	Manually started self test
9	rx; S.AL	Device start with alarm
10	Reserved	When reading, always 0 When writing, any value
11	Reserved	When reading, always 0 When writing, any value
12	Reserved	When reading, always 0 When writing, any value
13	Reserved	When reading, always 0 When writing, any value
14	Reserved	When reading, always 0 When writing, any value
15	Reserved	When reading, always 0 When writing, any value

7.5.4 Channel descriptions

Value	Measured value description/ alarm and operating message	Note
0		
1 (0x01)	Insulation fault	
71 (0x47)	Insulation fault	Insulation resistance R_F in Ω
76 (0x4C)	Voltage	Measured value in V
77 (0x4D)	Undervoltage	
78 (0x4E)	Overvoltage	
82 (0x52)	Capacitance	Measured value in F
86 (0x56)	Insulation fault	Impedance Z_i
101 (0x65)	Connection system	
102 (0x66)	Connection earth	
115 (0x73)	Device error	Malfunction ISOMETER®
129 (0x81)	Device error	
145 (0x91)	Own address	

To convert parameter data, data type descriptions are required. Text representation is not necessary in this case.

Value	Description of parameters
1023 (0x3FF)	Parameter/measured value invalid. The menu item of this parameter is not displayed.
1022 (0x3FE)	No measured value/no message
1021 (0x3FD)	Measured value/parameter inactive
1020 (0x3FC)	Measured value/parameter only temporarily inactive (e.g. while transmitting a new parameter). Indication in the menu "…".
1019 (0x3FB)	Parameter/measured value (value) unit not displayed
1018 (0x3FA)	Parameter (code selection menu) unit not displayed
1017 (0x3F9)	String max. 18 characters (e.g. device type, device variant, …)
1016 (0x3F8)	
1015 (0x3F7)	Time
1014 (0x3F6)	Date: Day
1013 (0x3F5)	Date: Month
1012 (0x3F4)	Date: Year
1011 (0x3F3)	Register address (unit not displayed)
1010 (0x3F2)	Time
1009 (0x3F1)	Factor multiplication [*]
1008 (0x3F0)	Factor division [/]
1007 (0x3EF)	Baud rate
1022 (0x3FE)	
1023 (0x3FF)	Invalid

8. IsoData data string (isoHV425-D4-4)

In IsoData mode, the ISOMETER® continuosly sends the entire data string with a cycle time of approximately 1 s. Communication with the ISOMETER® within 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 "Adr" symbol flashes on the measured value display.

String	Description
!;	Start symbol
v;	Insulation fault location ' ' / '+' / '-'
1234, 5;	Insulation resistance R_F [kΩ]
1234;	System leakage capacitance C_e [µF]
1234, 5;	Reserved
+1234;	System voltage U_n [V_{RMS}] System voltage type: AC or unknown: ' '; DC: '+' / '-'
+1234;	Residual voltage U_{L1e} [V_{DC}]
+1234;	Residual voltage U_{L2e} [V_{DC}]
+123;	Insulation fault location -100 … +100 [%]
1234, 5;	Approximate unsymmetrical insulation resistance R_{FU} [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 Alarm undervoltage U_n 0x0080 Alarm overvoltage U_n 0x0100 Message system test 0x0200 Device start with alarm
1	Update counter, consecutively counts from 0 to 9. It increases with the update of the insulation resistance value.
<CR><LF>	String end

9. Technical data

9.1 Tabular presentation

( )* = Factory settings

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

Definitions:

- Supply circuit (IC2) A1, A2
- Output circuit (IC3) 11, 14, 24
- Control circuit (IC4) ..... Up, KE, T/R, A, B, AK1, GND, AK2; M+, M-
- Rated voltage ..... 240 V
- Overvoltage category III

Rated impulse voltage:

- IC2/(IC3–4) ..... 4 kV
- IC3/IC4 ..... 4 kV

Rated insulation voltage:

- IC2/(IC3–4) ..... 250 V
- IC3/IC4 ..... 250 V
- Pollution degree 3

Protective separation (reinforced insulation) between:

- IC2/(IC3–4) ..... overvoltage category III, 300 V
- IC3/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

IT system being monitored

Nominal system voltage U_n with AGH422 ..... AC 0…1000 V, DC 0…1000 V
Tolerance of U_n ..... AC +10 %, DC +10 %
Nominal system voltage range U_n (UL508) ..... AC/DC 0…600 V
Frequency range of U_n ..... DC, 15…460 Hz

Measuring circuit

Permissible system leakage capacitance C_e ..... ≤ 150 µF
Permissible extraneous DC voltage U_{fg} ..... ≤ 1600 V

Response values

Response value R_{an1} ..... 11…500 kΩ (50 kΩ)*
Response value R_{an2} ..... 10…490 kΩ (25 kΩ)*
Relative uncertainty R_{an} ..... ±15 %, at least ±3 kΩ
Hysteresis R_{an} ..... 25 %, at least 1 kΩ
Undervoltage detection ..... 30…1.09 kV (off)*
Overvoltage detection ..... 31…1.10 kV (off)*
Relative uncertainty U ..... ±5 %, at least ±5 V
Relative uncertainty depending on the frequency ≥ 200 Hz ..... -0.075 %/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 ..... ≤ 20 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 ..... ±15 %, at least ±3 kΩ
Display range measured value system voltage (U_n) ..... 30…1.15 kV_{RMS}
Operating uncertainty ..... ±5 %, at least ±5 V
Display range measured value system leakage capacitance at R_F > 20 kΩ ..... 0…200 µF
Operating uncertainty ..... ±15 %, at least ±2 µF
Password ..... off/0…999 (0, off)*
Fault memory alarm messages ..... on/(off)*

Interface (isoHV425-D4-4 only)

Interface/protocol ..... RS-485/(BMS)*, Modbus RTU, isoData
Baud rate ..... BMS (9.6 kbit/s), Modbus RTU (selectable), 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, Modbus RTU ..... 3…90 (3)*

Analogue output (isoHV425-D4M-4 only)

Operating mode ..... mid-scale U (R = 120 kΩ)*
Functions ..... (insulation value R_F)*
Max. no load voltage (open terminals) ..... DC 12 V
Max. short-circuit current ..... 25 mA, short-circuit-proof
Voltage output ..... DC 0…10 V, load ≥ 20 kΩ *
Current output ..... DC 0/4…20 mA, load ≤ 130 Ω
Current output ..... DC 4…400 µA, load ≤ 3 kΩ
Tolerance ..... ±10 %, +2 % of the full scale value

Switching elements

Switching elements ..... 2 x 1 N/O contacts, common terminal 11
Operating principle ..... N/C operation/N/O operation (N/O 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, EN 50121-3-2
Ambient temperatures:
- Operation ..... -40…+70 °C
- Transport ..... -40…+85 °C
- Storage ..... -40…+70 °C

Classification of climatic conditions acc. to IEC 60721:
- Stationary use (IEC 60721-3-3) ..... 3K23 (except condensation and formation of ice)
- W variant 3K24
- Transport (IEC 60721---2) ..... 2K11 (except condensation and formation of ice)
- Long-term storage (IEC 60721-3-1) ..... 1K22 (except condensation and formation of ice)

Classification of mechanical conditions acc. to IEC 60721:
- Stationary use (IEC 60721-3-3) 3M11
- W variant 3M12
- Transport (IEC 60721-3-2) 2M4
- Long-term storage (IEC 60721-3-1) 1M12

Connection

Connection type ..... push-wire terminal
Nominal current ..... ≤10 A
Cross section ..... 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
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

Technical data AGH422

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

Definitions:
- Measuring circuit (IC1) ..... L1/+, L2/-
- Control circuit (IC2) ..... AK1, GND, AK2, Up, E
- Rated voltage ..... 1000 V
- Overvoltage category III

Rated impulse voltage:
- IC1/IC2 ..... 8 kV

Rated insulation voltage:
- IC1/IC2 ..... 1000 V
- Pollution degree 3

Protective separation (reinforced insulation) between:
- IC1/IC2 ..... Overvoltage category III, 1000 V

IT system being monitored

- System voltage range U_n ..... AC0…1000 V, DC 0…1000 V
- Tolerance of U_n ..... AC +10 %/DC +10 %

Measuring circuit

Measuring voltage U_m ..... ±45 V
Measuring current I_m at R_F ..... ≤ 120 µA
Internal resistance R_i ..... ≥ 390 kΩ

Environment/EMC

EMC ..... IEC 61326-2-4, EN 50121-3-2
Ambient temperatures AGH422:
- Operation U_n < 700 V ..... -40…+70 °C
- Operation U_n > 700 V ..... -40…+55 °C
- Transport ..... -40…+85 °C
- Storage ..... -40…+70 °C

Classification of climatic conditions acc. to IEC 60721:
- Stationary use (IEC 60721-3-3) ... 3K23 (except condensation and formation of ice)
- W variant ... 3K24
- Transport (IEC 60721-3-2) ... 2K11 (except condensation and formation of ice)
- Long-term storage (IEC 60721-3-1) ... 1K22 (except condensation and formation of ice)

Classification of mechanical conditions acc. to IEC 60721:
- Stationary use (IEC 60721-3-3) ... 3M11
- W variant ... 3M12
- Transport (IEC 60721-3-2) ... 2M4
- Long-term storage (IEC 60721-3-1) ... 1M12

Connection

Connection type ... push-wire terminal

Push-wire terminals:
- Nominal current ... ≤10 A
- Cross section ... 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

Single cables for terminals Up, AK1, GND, AK2 – requirement for connecting cables between isoHV425xx and AGH422
- Cable lengths ... ≤ 0.5 m
- Wire cross-section ... ≥ 0.75 mm^2

Other

Operating mode ... continuous operation
Mounting ... cooling slots must be ventilated vertically
Distance to adjacent devices from U_n > 800 V ... ≥ 30 mm
Degree of protection, built-in components (DIN EN 60529) ... IP30
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

9.2 Standards

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

- DIN EN 61557-8 (VDE 0413-8): 2015-12/Ber1: 2016-12
- DIN EN 50155: 2018-05
- DIN EN 45545-2:2016
- IEC 61557-8: 2014/COR1: 2016
- EN61373 cat I class B

Subject to change! The specified standards take into account the edition valid until 08.2021 unless otherwise indicated.

9.3 Ordering information

Type	Version	Art. No.
isoHV425-D4-4 with AGH422	Push-wire terminal	B71036501
isoHV425W-D4-4 with AGH422W	Push-wire terminal	B71036501W
isoHV425W-D4M-4 with AGH422	Push-wire terminal	B71036503
isoHV425W-D4M-4 with AGH422W	Push-wire terminal	B71036503W
Mounting clip for screw fixing (1 piece per device)		B98060008

9.4 Change log

Date	Document version	Software	State/Changes
09.2021	04	-	*Editorial revision* p. 21 Information rail vehicles p. 51 Standards, Change log

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