



ISOMETER® isoCHA425HV with AGH420-1

Insulation monitoring device with coupling device for unearthed DC systems (IT systems) DC 0 V to 1000 V

Suitable for DC charging stations according to CCS or CHAdeMO

Software version: D0624 V4.02



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1 General instructions

1.1 How to use this manual



This manual is intended for qualified personnel working in electrical engineering and electronics! Part of the device documentation, in addition to this manual, is the enclosed "Safety instructions for Bender products".



Read the manual before mounting, connecting and commissioning the device. Always keep the manual within easy reach for future reference.

1.2 Indication of important instructions and information



DANGER! Indicates a high risk of danger that will result in death or serious injury if not avoided.



WARNING! Indicates a medium risk of danger that can lead to death or serious injury if not avoided.









CAUTION! Indicates a low-level risk that can result in minor or moderate injury or damage to property if not avoided.



Information can help to optimise the use of the product.

1.2.1 Signs and symbols

	Disposal		Temperature range		Protect from dust
	Protect from moisture		Recycling		RoHS directives

1.3 Training courses and seminars

[www.bender.de/en-> Know-how-> Seminars](http://www.bender.de/en->Know-how->Seminars).

1.4 Delivery conditions

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

The following applies to software products:



"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)

1.5 Inspection, transport and storage

Check the shipping and device packaging for transport damage and scope of delivery. The following must be observed when storing the devices:



1.6 Warranty and liability

Warranty and liability claims in the event of injury to persons or damage to property are excluded in case of:

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.
- Use of accessories and spare parts not recommended by Bender.
- Catastrophes caused by external influences and force majeure.
- Mounting and installation with device combinations not recommended by the manufacturer.

This operating manual and the enclosed 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 of Bender devices

Abide by the national regulations and laws governing the disposal of this device.



For more information on the disposal of Bender devices, refer to

[www.bender.de/en -> Service & support](http://www.bender.de/en->Service%20%26%20support).

1.8 Safety

If the device is used outside the Federal Republic of Germany, the applicable local standards and regulations must be complied with. In Europe, the European standard EN 50110 applies.



! DANGER! Risk of electrocution due to electric shock!

Touching live parts of the system carries the risk of:

- A fatal 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.

2 Function

2.1 Intended use

The ISOMETER® isoCHA425HV in combination with the coupling device AGH420-1 monitors the insulation resistance R_F for DC fast charging stations according to CHAdeMO standard or according to Combined Charging System (CCS) for nominal system voltage ranges between DC 0 V and 1000 V.

In order to meet the requirements of applicable standards, customised parameter settings must be made on the equipment to adapt it to local equipment and operating conditions.

Please heed the limits of the area of application indicated in the technical data. Any use other than that described in this manual is regarded as improper.

i To ensure that the ISOMETER® functions correctly, an internal system resistance of $\leq 1 \text{ k}\Omega$ must exist between L1/+ and L2/- via the source or the load.

2.2 Device features

- Monitoring of the insulation resistance R_F of DC charging stations according to CHAdeMO standard or Combined Charging System (CCS).
- CHAdeMO (Mode CHd and CHA):**

CHAdeMO	Mode	
	CHd	CHA
Maximum system leakage capacitance $1.6 \text{ }\mu\text{F}$ per conductor	✓	✓
Detection of insulation faults in the system voltage range 50 V to 1000 V	✓	✓
One-pole insulation faults R_{F1} $R_{F1} \leq 100 \text{ k}\Omega$: Response time $\leq 1 \text{ s}$ $100 \text{ k}\Omega < R_{F1} \leq 2 \text{ M}\Omega$: Response time $\leq 10 \text{ s}$	✓	✓
Two-pole insulation faults R_{F5} $R_{F5} \leq 160 \text{ k}\Omega$: Response time $\leq 10 \text{ s}$ $R_{F5} > 160 \text{ k}\Omega$ (200 kΩ): no detection (Deactivation)	✓	--

- CCS (dc mode):**

Detection of insulation faults up to $2 \text{ M}\Omega$
Maximum system leakage capacitance y_e : $20 \text{ }\mu\text{F}$
Response time t_{an} at $C_e \leq 5 \text{ }\mu\text{F}$ or $R_F \leq 100 \text{ k}\Omega$: $\leq 10 \text{ s}$

- Measurement of the system leakage capacitance C_e
- Measurement of the system voltage U_n (True RMS) with undervoltage/overvoltage detection
- Measurement of the DC residual voltages U_{L1e} (between L1/+ and earth) and U_{L2e} (between L2/- and earth)
- Selectable start-up delay, response delay and delay on release
- Two separately adjustable response value ranges of 5...600 kΩ (Alarm 1, Alarm 2)
- Alarm output via LEDs ("AL1", "AL2"), a 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 multifunctional LC display
- Fault memory can be activated

- 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)
- Password protection to prevent unauthorised parameter changes
- Stop mode to deactivate the measuring pulse generator

2.3 Functional description

The ISOMETER® is designed for use in DC charging stations according to CHAdeMo standard or Combined Charging System (CCS) and can be set to the respective mode in the "Set" menu via the Mode parameter. It measures the total insulation resistance R_{FS} as well as the one-sided insulation resistance R_{FU} , the system leakage capacitance C_e , the system voltage U_n (True RMS) between L1/+ and L2/- and the DC system voltages (residual voltages) U_{L1e} and U_{L2e} between L1/+ as well as L2/- and earth.

Depending on the selected mode, the values R_{FS} and R_{FU} are combined to form the measured value R_F . In the "AL" menu, a prewarning and a main alarm limit value can be set for the measured value R_F . The prewarning limit value can only be set higher than the main alarm limit value. If the measured value reaches or falls below the limit values, an alarm is signalled. For the measured value U_n an overvoltage and undervoltage limit value can be enabled and adjusted, the violation of which triggers an alarm. The limit value alarms are only deleted when the respective measured value no longer violates the limit value including the corresponding hysteresis.

All alarms generated by the ISOMETER® are signalled via the LEDs "AL1" and "AL2". In the "out" menu, the alarms can be assigned to the alarm relays ("K1, K2"). In addition, the operation of the alarm relays (n.o./n.c.) can be configured and the fault memory "M" can be activated or deactivated. If the fault memory is activated, the alarm relays remain in alarm condition until the reset button "R" is pressed or the supply voltage U_s is interrupted.

In the "t" menu, the start-up delay at device start, the response delay and the delay on release of the alarms as well as the repetition time of the automatic device self test can be set.

For the RS-485 interface, the protocols BMS, Modbus RTU or isoData are selected in the "out" menu. The measured values can be read and the parameters of the ISOMETER® can be set via the BMS protocols, e.g. using the BMS Ethernet gateway (COM465IP) and Modbus RTU. If the isoData protocol is selected, the ISOMETER® only sends the measured values, once per second.

The device function can be tested using the test button "T". The device parameters are set via the LC display and via the control buttons on the front panel. This function can be password-protected.

The ISOMETER® can be set to stop mode to deactivate the measuring pulse generator.

2.3.1 R_F and C_e in "CHd" and "CHA" mode (CHAdeMO)

The insulation fault R_F and the system leakage capacitance C_e are only determined for DC system voltages ≥ 50 V. The maximum permissible system leakage capacitance C_e is 1.6 μ F per conductor. In mode "CHd" the value R_F is determined by the smaller of the values R_{FU} and R_{FS} . R_{FU} is the one-pole total insulation fault determined based on the voltages U_{L1e} and U_{L2e} up to a maximum of 2 M Ω . R_{FS} is the two-pole insulation fault and is only determined up to a maximum of 160 k Ω . If R_{FS} is below the value of 160 k Ω , it is thereafter evaluated up to max. 200 k Ω .

The response time of the one-pole insulation fault R_{FU} is 1 s for limit values up to 100 k Ω and $U_n \geq 100$ V. For values outside these ranges, the response time of R_F is ≤ 10 s.

In "CHA" mode, only the one-pole insulation fault R_{FU} is evaluated and not the two-pole isolation fault R_{FS} .

2.3.2 R_F and C_e in "dc" mode (CCS)

In "dc" mode, the insulation fault R_F up to 2 M Ω and the system leakage capacitance C_e are determined independently of the system voltage. The maximum permissible system leakage capacitance in this mode is 20 μ F. The response time for R_F is 10 s.

2.3.3 Fault location R%

From $U_n > DC\ 20\ V$ the fault location R% is calculated for insulation faults R_F up to 500 k Ω ("CHd" mode 150 k Ω). The value -100 % indicates a one-pole insulation fault at L2/-, 0 % indicates a symmetrical insulation fault and +100 % indicates a one-pole insulation fault at L1/+. For values of 30 % and more, the alarm assignment of the relays distinguishes between insulation faults at L1/+ and L2/-.

From the values R% and R_F the partial resistances R_{F+} and R_{F-} can be calculated using the following formulas:

Fault at conductor DC+ $\rightarrow R_{F+} = (200\ \% * R_F) / (100\ \% + R\%)$

Fault at conductor DC- $\rightarrow R_{F-} = (200\ \% * R_F) / (100\ \% - R\%)$

2.3.4 System leakage capacitance C_e

The system leakage capacitance C_e is determined for insulation faults $R_F > 10\ k\Omega$ up to a value of 35 μ F. Above 30 μ F, the message Device error "E.07" is displayed. For applications according to UL2231-1/-2, the system leakage capacitance C_e is limited to 5 μ F.

2.3.5 System voltages U_n , U_{L1e} and U_{L2e}

The system voltage U_n between terminals L1/+ and L2/- is measured as RMS value (True RMS). Limit values for overvoltage and undervoltage are available in the "AL" menu ([see chapter "AL' menu"](#)). Above 1200 V, the message "Overvoltage" is displayed regardless of the set overvoltage limit value.

The DC system voltages U_{L1e} and U_{L2e} are respectively measured between terminals L1/+ as well as L2/- and earth. No limit value is assigned to them.

2.3.6 Functional tests of contactors in the charging station and the vehicle

If the ISOMETER® is disconnected on one pole from the monitored voltage source during a functional test of the charging station or vehicle contactors, a false alarm may occur depending on the location of an existing insulation fault. For insulation faults above 600 k Ω the false alarm can be prevented by a resistor of 200 k Ω connected directly between terminals L1/+ and L2/-.

2.3.7 Monitoring of the insulation resistance

The two parameters "R1" and "R2" for monitoring the insulation resistance can be found in the response value menu "AL" ([see chapter "AL' menu"](#)). 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, the alarm will be cleared.

2.3.8 Undervoltage/overvoltage monitoring

In the response value menu "AL" ([see chapter "AL' menu"](#)), 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 RMS 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 the hysteresis are no longer violated.

2.3.9 Stop mode

For applications where the ISOMETER® is not needed and the measuring pulse interferes with other measuring functions, it can be set to stop mode via the Modbus protocol or by pressing and holding the external test/reset button ("T/R"). The measuring pulse generator is turned off and the measuring function is deactivated. The message "StP" appears on the display. It sends the identifiers "warning" and "external test" via the communication interface.

2.3.10 Self test functions (device errors)

The ISOMETER® provides test routines to check the correct function of the device. Some test routines are performed cyclically or continuously in the background during the normal measuring function. Other test routines are triggered by the user either cyclically via a timer (menu item "t" / "test"), the internal test button, the external test button or the communication interface (COM) and stop the measuring function of the device during this period.

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

2.3.11 Cyclic background test

The cyclic background test to check the μ C is not visible to the user and does not influence the measuring function. In case of malfunction, the messages device error with error codes "E.09" to "E.16" is displayed.

2.3.12 Continuous PE connection monitoring

The connection of terminal "E" of the AGH420-1 to the PE protective conductor is monitored continuously and in parallel with the measuring function of the device via the input "KE" of the ISOMETER®, which is also connected to the PE protective conductor. In case of a connection interruption, the message Device error with the error code "E.01" is displayed.

2.3.13 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 system connection test which can be activated by the user ("SEt"/"nEt" menu) to test the connection between terminals L1/+ and L2/-. 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"/"Alarm assignment").

2.3.14 Internal and external test button

Pressing the external test/reset button or the test button "T" on the device (> 1.5 s) starts the user-controlled test functions. When pressing the test button "T" on the device, all display elements available for this device are additionally shown.

2.3.15 Timer for test functions

At menu item "t"/"test" the user-controlled test can be activated in a cycle of one or 24 hours. The timer restarts after each completed test, regardless of whether it was triggered by the timer or manually.

2.3.16 Device test at device start

At menu item "SEt"/"S.Ct" the execution of the user-controlled test functions can be activated for the time of the device start.

2.3.17 System connection test L1/+ and L2/-

The system connection test configurable in the "SEt"/"nEt" menu checks the connection between terminals L1/+ and L2/- via the monitored system. For correct operation of the ISOMETER® the monitored system must have a low-ohmic ($< 1 \text{ k}\Omega$) internal resistance. The "on" setting is used in systems where $U_n < \text{DC } 100 \text{ V}$. When "on U" is set, the system voltage must be $U_n > \text{DC } 100 \text{ V}$ during the test. The response time of "on U" is shorter than that of "on". If an error is detected during this test, the message Device error system connection "E.02" is displayed. If the system voltage U_n is lower than $\text{DC } -30 \text{ V}$ during the system connection test, the message Device error reverse polarity "E.03" is also displayed.

Overview of some error codes:

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 or the connection of terminals L1/+ or L2/- to the system is interrupted. Terminals L1/+ and L2/- are connected incorrectly. Action: Check connection, eliminate error. The error code will be erased automatically once the error has been eliminated.
E.03	System connection error reverse polarity Terminals L1/+ and L2/- are connected with reverse polarity to the monitored DC system. Detection from $U_n < \text{DC } -30 \text{ V}$.
E.05	Measurement technology error: The measured insulation value is no longer updated due to system disturbances or a device error. At the same time, the prewarning and main alarm for the measured insulation value are set. Calibration invalid after software update: In case of a software update, E.05 appears together with E.08 if the new software is no longer compatible with the calibration of the device. Either the previous software version must be installed again or the device must be recalibrated at the factory.
E.07	The system leakage capacitance C_e of $30 \mu\text{F}$ has been exceeded.
E.08	A calibration error was detected during the 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.

2.3.18 Alarm 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/-. If the insulation fault cannot be assigned to any conductor, "+Rx" and "-Rx" are set together.

The message "test" refers to a self test manually triggered via a test button or the communication interface.

The message "S.AL" indicates a so-called "device start with alarm". After connecting the supply voltage U_s and setting the parameter to "S.AL = on", the ISOMETER® starts with the measured insulation 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 limit values are violated. With the factory setting "S.AL = off", the ISOMETER® starts without an alarm.

i *It is recommended to set the parameter value "S.AL" identically for both relays.*

2.3.19 Fault memory

The fault memory can be activated or deactivated via 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 via the reset button (internal/external) or the supply voltage U_s is switched off.

2.3.20 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). 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® continuously 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. (See [chapter "IsoData data string"](#))

i *The IsoData protocol can be terminated by sending the command "Adr3" during a transmission pause of the ISOMETER®.*

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

i *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 case, 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.*

2.3.21 Measuring and response times

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 value R_F , the system leakage capacitance C_e , the residual voltages U_{L1e} and U_{L2e} as well as the faulty conductor "R%" it depends on the insulation resistance R_F and the system leakage capacitance C_e .

i *System disturbances may lead to extended measuring times. The time for the system voltage measurement U_n is independent of this and is considerably shorter.*

Response delay time t_{on}

The response delay time t_{on} is set uniformly for all messages in the "t" menu using the parameter " t_{on} ", whereby each alarm message specified in the alarm assignment has its own timer for t_{on} . This response delay time can be used for interference suppression in the case of short measuring times. An alarm will only be signalled if there is a limit value violation of the respective measured value for the period of t_{on} without interruption. Every time the limit value is violated within the time t_{on} , the response delay time " t_{on} " restarts once again.

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} .

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 " t_{off} ", whereby each alarm message listed in the alarm assignment has its own timer for t_{off} . An alarm will continuously be signalled until the limit value of the respective measured value is not violated (including hysteresis) for the period of t_{off} without interruption. Each time the limit value is not violated for the duration of the delay on release t_{off} the delay on release " t_{off} " restarts.

Start-up delay time t

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

2.3.22 Password protection (on, OFF)

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

2.3.23 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.

2.3.24 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

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. It is not allowed to use a parallel connection of several test or reset inputs for combined testing of ISOMETER®s.

2.3.25 History memory HiS

When the first error occurs after clearing the history memory, all measured values ([see chapter "Measured value display and history memory"](#)) 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 Dimensions and mounting

3.1 Dimensions

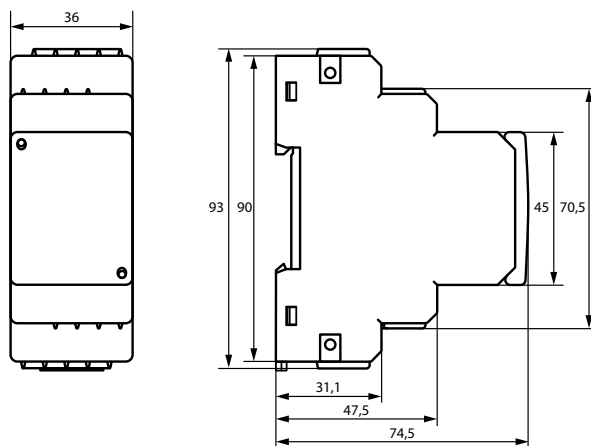
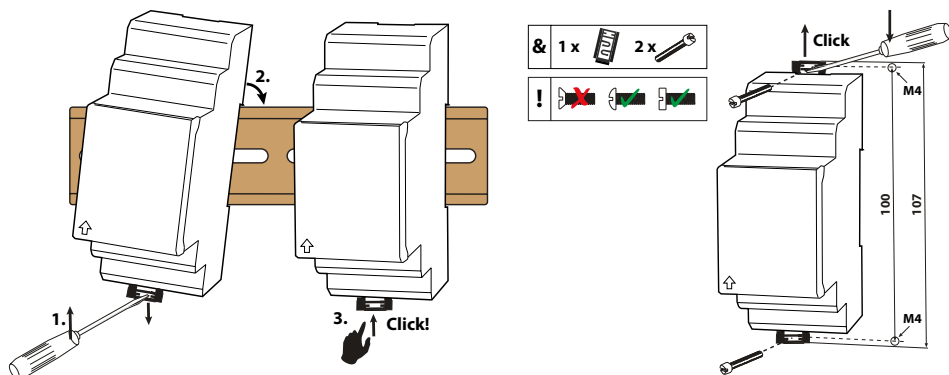


Abb. 3-1 Dimensions in mm

3.2 Mounting

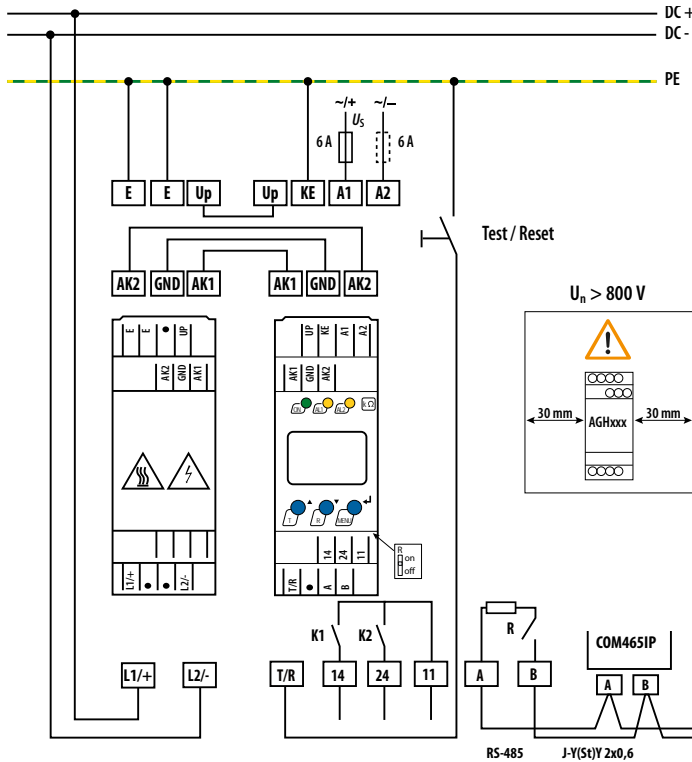


Variant A: DIN rail mounting

Variant B: screw mounting

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

3.3 Wiring diagram



For conductor cross sections for wiring, refer to "Technical data".

Legend

Terminal	Connections
A1, A2	Connection to the supply voltage U_s via fuse: 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 AGH420-1 to the corresponding terminals of the ISOMETER® isoCHA425HV.
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

i * For UL applications: Use 60/75 °C copper lines only! UL and CSA applications require the supply voltage U_s to be protected via 5 A fuses.

3.4 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 start routine can take up to 30 s. Afterwards, the current insulation resistance is shown as the standard display.



The pulse symbol ┐ signals an error-free update of the measured resistance value. If the measured value cannot be updated due to malfunctions, the pulse symbol will be hidden.

3. **Setting the insulation monitoring mode**

Set the correct insulation monitoring mode in the "SEt" menu. The factory setting is "dc".

4. **Starting a manual self test**

Press test button "T". While pressing and holding the test button (> 1.5 s), all display elements available for this device are shown. After releasing the button, the test starts and "tES" flashes for the duration of the test. Detected malfunctions are displayed as error codes ([see "Overview of some error codes"](#)). 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.

5. **Check factory setting for suitability.**

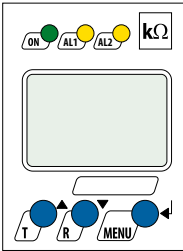
Are the settings suitable for the installation to be monitored? ([For lists of factory settings, see from chapter "AL' menu"](#)) For networks with a leakage capacitance $> 5\mu\text{F}$, the response value R_{an1} should be set to a maximum of $200\text{ k}\Omega$ due to the increased measurement tolerance.

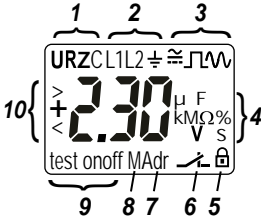
6. **Check the function using a genuine insulation fault.**

The ISOMETER® on the monitored system must be tested with a suitable resistance to earth.

4 Operation of the device

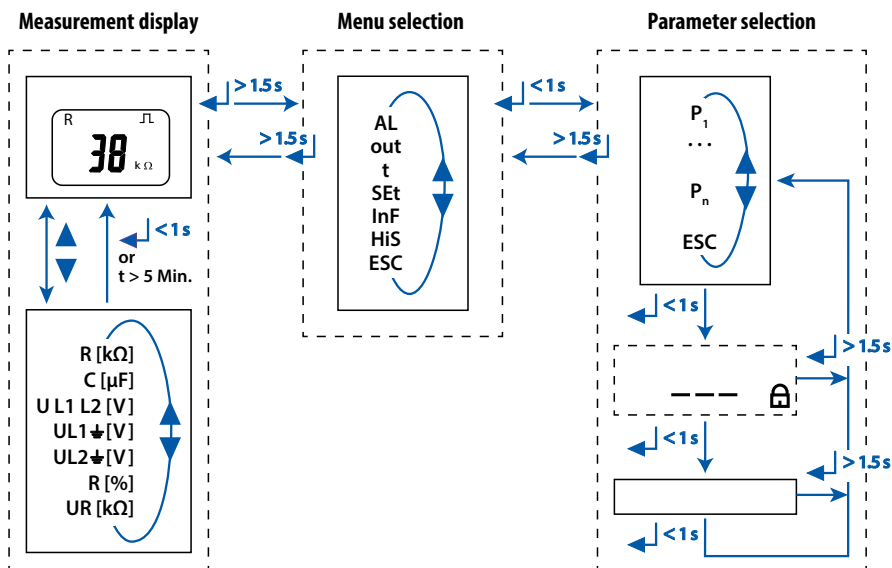
4.1 Displays and buttons

Function		Device front
ON	green - on	
AL1	yellow - alarm	
AL2	yellow - alarm	
▲	Arrow-up button: navigate up in the menu. Test button (press > 1.5 s) By pressing and holding the test button, the display elements are shown.	
▼	Arrow-down button: navigate down in the menu. Reset button (press > 1.5 s)	
↵	ENTER	
MENU	MENU button: Press > 1.5 s: start menu (menu item "AL" appears) or exit menu item (Esc). Any recent changes will not be stored. Press < 1.5 s: confirm menu selection or confirm modified value.	

Function		Display
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 activated	
6	In the menu mode, the operating mode of the respective alarm relay is displayed.	
7	Communication interface with measured value: isoData operation	
8	Fault memory activated	
9	Condition symbols	
10	Identifier for response values and response value violation	

i The areas of the display that can be configured flash. The readability below the temperature of -25 °C is limited.

4.2 Menu overview



Menu	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 history memory
ESC	Go to the next higher menu level

4.3 "AL" menu

Legend of the tables below:

FAC= factory settings, CS: customer settings, () = customer settings that are not affected by FAC, ●: LED on, ◎: LED flashes, ○: LED off

4.3.1 Setting response value



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, the alarm will be cleared.

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

Display	Activation		Setting value			Description
	FAC	CS	Value range	FAC	CS	
R1 <	on		R2 ... 600	600	kΩ	Prewarning value Ran1 Hys. = 25 %/min. 1 kΩ
R2 <	on		5 ... R1	120	kΩ	Alarm value Ran2 Hys. = 25 %/min. 1 kΩ
U <	off		10 ... U>	10	V	Alarm value Undervoltage RMS Hys. = 5 %/min. 5 V
U >	off		U< ... 1.10k	1.10k	V	Alarm value Overvoltage RMS Hys. = 5 %/min. 5 V



4.4 "out" menu

4.4.1 Relay mode configuration

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.

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

In the alarm 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			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		●	●	○	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/-

K1 "r1"			K2 "r2"			LEDs			Alarm description
Display	FAC	CS	Display	FAC	CS	ON	AL1	AL2	
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

4.4.3 Fault memory configuration

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

4.4.4 Interface configuration

Display	Setting value			Description	
	Value range	FAC	CS		
Adr	0/3...90	3	()	BusAdr.	Adr = 0 activated isoData with continuous data output (115k2, 8E1)
Adr 1	---/ 1.2k...115k	19.2k	()	Baud rate	"---" → BMS bus (9k6, 7E1) "1.2k" ... "115k2" → Modbus (variable, variable)
Adr 2	8E1 8o1 8n1 8n2	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 8n2 - 8 data bits, no parity, 2 stop bits

4.5 "t" menu

4.5.1 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 relays K1 and K2
toff	0...99	0	s	Delay on release relays K1 and K2
test	OFF/1/24	OFF	h	Repetition time device test



To comply with the standard UL2231, the parameter „test“ must be switched off „OFF“.

4.6 "SEt" menu

4.6.1 Function configuration

Display	Activation		Setting value			Description
	FAC	CS	Value range	FAC	CS	
	off		0...999	0		Password for parameter setting
dc CHd CHA			dc CHd CHA	dc		Selection of the insulation monitoring mode in the DC system dc: CCS $t_{an} \leq 10\text{ s}$ CHd: CHAdEMO Values R_{FU} , R_{FS} and C_e if $U_n > 50\text{ V}_{DC}$ $t_{an} \leq 1,0\text{ s}$ if $R_{FU} \leq 100\text{ k}\Omega$ and $U_n > 100\text{ V}_{DC}$ $t_{an} \leq 10\text{ s}$ if $R_{FS} \leq 160\text{ k}\Omega$ CHA: CHAdEMO Values R_{FU} and C_e if $U_n > 50\text{ V}_{DC}$ $t_{an} \leq 1,0\text{ s}$ if $R_{FU} \leq 100\text{ k}\Omega$ and $U_n > 100\text{ V}_D$
nEt			off on on U	on U		System connection test on : if $U_n \leq DC\ 100\text{ V}$ on U: if $U_n > DC\ 100\text{ V}$
S.Ct			off on	off		Device test at device start
FAC						Restore factory settings
SYS						For Bender Service only

4.7 Measured value display and history memory

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
✓	$\pm R \quad k\Omega \quad \square$	Insulation resistance R_F^* 1 k Ω ... 2 M Ω resolution 1 k Ω The "+" or "-" sign appears if a fault $R_F < 500 \text{ k}\Omega$ is predominantly detected at L1/+ or L2/- if $ R\% \geq 30 \%$.
✓	$C \quad \mu F \quad \square$	System leakage capacitance C_e 0 ... 35 μF resolution 1 nF
✓	$\sim \pm U_{L1 L2} \quad V$	System voltage L1/+ - L2/- U_n 0 V _{trueRMS} ... 1200 V _{trueRMS} resolution 1 V _{trueRMS} The "+" or "-" sign indicates the polarity at terminals L1/+ and L2/- in the case of a DC system at $U_{RMS} > 20 \text{ V}$. The "~" sign indicates an AC system.
✓	$\pm U_{L1} \quad \equiv \quad V$	Residual voltage L1/+ - PE U_{L1e} DC 0 V ... \pm DC 1200 V resolution DC 1 V
✓	$\pm U_{L2} \quad \equiv \quad V$	Residual voltage L2/- - PE U_{L2e} DC 0 V ... \pm DC 1200 V resolution DC 1 V
-	$\pm R \quad \%$	Fault location in % -100 % ... +100 %
✓	$U_R = k\Omega \quad \square$	One-side insulation resistance R_{FIJ} 1 k Ω ... 2 M Ω resolution 1 k Ω One-side insulation resistance calculated from U_{L1e} and U_{L2e} if $U_n > \text{DC } 40 \text{ V}$.

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

*: Only these measured values are displayed permanently (standard display). All other measured value displays switch to the standard display after a maximum of 5 minutes.

5 **Data access using the BMS protocol**

The BMS protocol is an essential 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	----	----
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	C_e	---
11	---	---
12	Update counter	---
13	U_{L1e}	---
14	U_{L2e}	---
15	R_{FU}	---

6 Data access using the Modbus RTU protocol

Requests to the ISOMETER® can be made using the function code 0x03 (read multiple registers) or the command 0x10 (write multiple registers). It generates a function-related answer and sends it back.

6.1 Reading out Modbus registers 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.

6.2 Command of the master 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

6.2.1 Response of the ISOMETER® to 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

6.3 Writing to Modbus registers (parameter setting)

Registers in the device can be modified with the Modbus command 0x10 (set multiple registers). Parameter registers are available from address 3000.

6.3.1 The master sends a command to the ISOMETER®

In this example, address 3 is used to set the content of register address 3003 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

6.3.2 Response of the ISOMETER® to 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

6.4 Exception code

If a request cannot be answered for whatever reason, 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)

6.4.1 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 Modbus register assignment of the ISOMETER®

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 to 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 to 1007	---	---	---	---
1008 to 1011	U_n voltage (76) [no alarm]	U_n undervoltage (77) [alarm]	U_n overvoltage (78) [alarm]	--- System connection (101) [device error]
1012 to 1015	C_e capacitance (82) [no alarm]	---	---	---
1016 to 1019	U_{11e} voltage (76) [no alarm]	---	---	---
1020 to 1023	U_{12e} voltage (76) [no alarm]	---	---	---
1024 to 1027	Fault location in % --- (1022) [no alarm]	---	---	---
1028 to 1031	R_{fU} insulation fault (71) [no alarm]	---	---	---
1032 to 1035	Measured value update counter --- (1022) [no alarm]	---	---	--- Device error (115) [device error]

() = [Channel description code](#); [] = [Alarm type](#)

Register	Property	Description	Format	Unit	Value range
999	RO	Number of Modbus measured value channels with active alarm	UINT 16	---	0 ... 9
3000	RW	Reserved	---	---	---
3001	RW	Reserved	---	---	---
3002	RW	Reserved	---	---	---
3003	RW	Reserved	---	---	---
3004	RW	Reserved	---	---	---
3005	RW	Prewarning value resistance measurement "R1"	UINT 16	kΩ	R2 ... 600

Register	Property	Description	Format	Unit	Value range
3006	RW	Reserved	---	---	---
3007	RW	Alarm value resistance measurement "R2"	UINT 16	kΩ	5 ... R1
3008	RW	Activation alarm value undervoltage "U<"	UINT 16	---	0 = off 1 = on
3009	RW	Alarm value undervoltage "U<"	UINT 16	V	10 ... U>
3010	RW	Activation alarm value overvoltage "U>"	UINT 16	---	0 = off 1 = on
3011	RW	Alarm value overvoltage "U>"	UINT 16	V	U< ... 1100
3012	RW	Memory function for alarm messages (Fault memory) "M"	UINT 16	---	0 = off 1 = on
3013	RW	Operating mode of relay 1 "r1"	UINT 16	---	0 = n.o. 1 = n.c.
3014	RW	Operating mode of relay 2 "r2"	UINT 16	---	0 = n.o. 1 = n.c.
3015	RW	Bus address "Adr"	UINT 16	---	0/3 ... 90
3016	RW	Baud rate "Adr 1"	UINT 16	---	0 = BMS 1 = 1.2k 2 = 2.4k 3 = 4.8k 4 = 9.6k 5 = 19.2k 6 = 38.4k 7 = 57.6k 8 = 115.2k
3017	RW	Parity "Adr 2"	UINT 16	---	0 = 8N1 1 = 8O1 2 = 8E1 3 = 8N2
3018	RW	Start-up delay "t" at device start	UINT 16	s	0 ... 10
3019	RW	Response delay "ton" for relays K1 and K2	UINT 16	s	0 ... 99
3020	RW	Delay on release "toff" for relays K1 and K2	UINT 16	s	0 ... 99
3021	RW	Repetition time "test" for automatic device test	UINT 16	---	0 = OFF 1 = 1 h 2 = 24 h
3022	RW	Reserved	---	---	---
3023	RW	Insulation monitoring mode	UINT 16	---	0 = dc 1 = CHd 2 = CHA

Register	Property	Description	Format	Unit	Value range
3024	RW	Test of the system connection during device test "nEt"	UINT 16	---	0 = off 1 = on 2 = on U
3025	RW	Device test at device start "S. Ct"	UINT 16	---	0 = off 1 = on
3026	RW	Request stop mode (0 = deactivate device)	UINT 16	---	0 = Stop 1 = ---
3027	RW	Alarm assignment of relay 1 "r1"	UINT 16	---	Bit 9 ... Bit 1
3028	RW	Alarm assignment of relay 2 "r2"	UINT 16	---	Bit 9 ... Bit 1

8003	WO	Factory settings for all parameters	UINT 16	---	0x6661 "fa"
8004	WO	Factory settings only for parameters resettable by FAC	UINT 16	---	0x4653 "FS"
8005	WO	Start device test	UINT 16	---	0x5445 "TE"
8006	WO	Clear fault memory	UINT 16	---	0x434C "CL"

9800 to 9809	RO	Device names	UINT 16 (ASCII)	---	---
9820	RO	Software ID number	UINT 16	---	---
9821	RO	Software version number	UINT 16	---	---
9822	RO	Software version: Year	UINT 16	---	---
9823	RO	Software version: Month	UINT 16	---	---
9824	RO	Software version: Day	UINT 16	---	---
9825	RO	Modbus driver version	UINT 16	---	---

RW = Read/Write; **RO** = Read Only; **WO** = Write Only

7.1 Device-specific data type of the ISOMETER®

7.1.1 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						

7.1.2 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	

7.1.2.1 Float = Floating point value of the channels

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

Word	0x01															
Byte	HiByte								LoByte							
Bit	15							8	7							0
	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

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

Bit	7	6	5	4	3	2	1	0	Description
	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.

7.1.2.3 R&U = Range and unit

Bit	7	6	5	4	3	2	1	0	Description
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


Bit	7	6	5	4	3	2	1	0	Description
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.

7.1.3 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.

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.

7.2 Channel descriptions

Value	Measured value description/alarm message 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). Display 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

In IsoData mode, the ISOMETER® continuously sends the entire data string with a cycle time of approximately 1 s. Communication with the ISOMETER® within this mode is not possible. No additional transmitters may be connected to 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 ' ' / ' + ' / ' - '
123456;	Insulation resistance R_f [kΩ]
12345;	System leakage capacitance C_e [nF]
123456;	Reserved
+1234;	System voltage U_n [V _{trueRMS}] System voltage type: DC, +, -, -'
+1234;	Residual voltage U_{L1e} [V _{DC}]
+1234;	Residual voltage U_{L2e} [V _{DC}]
+123;	Insulation fault location -100...+100 [%]
123456;	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
12	Update counter, consecutively counts from 0 to 99. It increases with the update of the insulation resistance value.
<CR><LF>	String end

9 Technical data isoCHA425HV

() * = 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
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)	DC ±3.1 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 AGH420-1	DC 0...1000 V
Tolerance of U_n	DC +10 %
Nominal system voltage range U_n with AGH420-1 (UL508).....	DC 0...600 V

Response values

Response value R_{an1}	R_{an2} ...600 kΩ (600 kΩ)*
Response value R_{an2}	5 kΩ... R_{an1} (120 kΩ)*
Hysteresis R_{an}	25 %, > 1 kΩ
Undervoltage detection $U <$	10 V...1.09 kV (off)*
Overvoltage detection $U >$	11 V...1.10 kV (off)*
Overload detection $U >$	1.20 kV (cannot be deactivated)
Hysteresis U	5 %, > 5 V

System voltage

Measuring range.....	DC ±1200 V
Display range	0 V...1.2 kV (measurement True RMS)
Measurement and relative uncertainty.....	±5 %, > ±5 V

Mode CCS (dc)

Permissible system leakage capacitance C_e	$\leq 20 \mu\text{F}$
Permissible system leakage capacitance C_e (acc. to UL2231-1/-2)	$\leq 5 \mu\text{F}$
Measuring and display range R_F	1 kΩ ... 2 MΩ
Measurement uncertainty R_{an} :	
$C_e \leq 5 \mu\text{F}$	$\pm 15 \%, \pm 2 \text{ k}\Omega$
$C_e > 5 \mu\text{F}$ and $R_F > 100 \text{ k}\Omega$	$\pm (5 \% * R_{an}/100 \text{ k}\Omega + 10\%)$
Measuring and display range C_e	0 ... 35 μF
Measurement uncertainty C_e :	
$R_F < 10 \text{ k}\Omega$	no measurement
$R_F \geq 10 \text{ k}\Omega$	$\pm 15 \%, \pm 0.1 \mu\text{F}$
Response time t_{an} :	
$R_{an} = 2.0 \times R_F$ and $C_e = 1 \mu\text{F}$ acc. to IEC 61557-8	$\leq 10 \text{ s}$
$R_{an} = 2.0 \times R_F$ and $C_e \leq 5 \mu\text{F}$ or $R_F \leq 100 \text{ k}\Omega$	$\leq 10 \text{ s}$

Mode CHAdemo (CHd an CHA)

System voltage U_n	measurement only from $U_n \geq \text{DC } 50 \text{ V}$
Permissible system leakage capacitance C_e	per conductor $\leq 1.6 \mu\text{F}$

One-pole fault R_{FU}

Measuring and display range R_{FU}	1 kΩ ... 2 MΩ
Measurement uncertainty R_{FU} / relative uncertainty R_{an} :	
$U_n \geq 100 \text{ V}$ and $R_{FU} \leq 200 \text{ k}\Omega$	$\pm 15 \%, \pm 2 \text{ k}\Omega$
$U_n > 200 \text{ V}$	$\pm 15 \%, \pm 2 \text{ k}\Omega$

Two-pole fault R_{FS} (only CHd Mode)

Measuring and display range R_{FS}	1 kΩ ... 160 kΩ
Measurement uncertainty R_{FS} / Relative uncertainty R_{an} :	
$< 160 \text{ k}\Omega$	$\pm 15 \%, \pm 2 \text{ k}\Omega$
Measuring and display range C_e	0 ... 35 μF
Measurement uncertainty C_e :	
$R_F < 10 \text{ k}\Omega$	no measurement
$R_F \geq 10 \text{ k}\Omega$	$\pm 15 \%, \pm 0.1 \mu\text{F}$
Response time t_{an} :	
$R_{an} = 1.2 \times R_{FU}$ and $R_{FU} \leq 100 \text{ k}\Omega$ and $U_n > 100 \text{ V}$	$\leq 1.0 \text{ s}$
$R_{an} = 1.2 \times R_F$	$\leq 10 \text{ s}$

Displays, memory

Password	off/0 ... 999 (off/0)*
Fault memory alarm messages	on/(off)*
Display	LC display, multifunctional, not illuminated

Time response

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)*

Interface

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)	≤ 1 200 m
Cable: twisted pairs	min. J-Y(St)Y 2 x 0.6
Terminating resistor.....	120 Ω (0.25 W), internal, can be connected
Device address, BMS bus, Modbus RTU	3...90 (3)*

Switching elements

Switching elements	2 x 1 N/O contact, common terminal 11
Operating principle	N/C operation, N/O operation (N/C operation)*
Electrical endurance under rated operating conditions, number of cycles	10000

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 load	1 mA at DC ≥ 5 V

Contact data acc. to UL508

Rated operational voltage	AC 250 V
Rated operational current.....	2 A

Environment/EMC

EMC	IEC 61326-2-4, IEC 61851-21-2:2018-04 Ed. 1.0
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Ambient temperatures:

Operation	-40...+70 °C ¹⁾
Transport	-40...+85 °C
Storage	-40...+70 °C

¹⁾ The readability of the display below the temperature of -25 °C is limited.

Classification of climatic conditions acc. to IEC 60721 (related to temperature and relative humidity):

Stationary use (IEC 60721-3-3)	3K22
Transport (IEC 60721-3-2)	2K11
Long-term storage (IEC 60721-3-1).....	1K22

Classification of mechanical conditions acc. to IEC 60721:

Stationary use (IEC 60721-3-3)	3M11
Transport (IEC 60721-3-2)	2M4
Long-term storage (IEC 60721-3-1)	1M12

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 mounting	2 x M4 with mounting clip
Weight.....	≤ 150 g

9.1 Technical data AGH420-1

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
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Rated insulation voltage:

IC1/IC2	1 000 V
Pollution degree	3

Protective separation (protective impedance) between:

IC1/IC2	overvoltage category III, 1000 V
---------------	----------------------------------

IT system being monitored

Nominal system voltage range U_n	DC 0 ... 1 000 V
Tolerance of U_n	DC +10 %
Nominal system voltage range U_n (UL508)	DC 0 ... 600 V

Measuring circuit

Measuring voltage U_m	± 45 V
Measuring current I_m at R_F	≤ 400 μ A
Internal DC resistance R_i	≥ 120 k Ω

Environment/EMC

EMC	IEC 61326-2-4
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Ambient temperatures:

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

Classification of climatic conditions acc. to IEC 60721 (related to temperature and relative humidity):

Stationary use (IEC 60721-3-3)	3K22
Transport (IEC 60721-3-2)	2K11
Long-term storage (IEC 60721-3-1)	1K22

Classification of mechanical conditions acc. to IEC 60721:

Stationary use (IEC 60721-3-3)	3M11
Transport (IEC 60721-3-2)	2M4
Long-term storage (IEC 60721-3-1)	1M12

Single cables for terminals Up, AK1, GND, AK2:

Cable length (AGH420-1 \rightarrow isoCHA425HV)	≤ 0.5 m
Cross section	≥ 0.75 mm ²

Other

Operating mode	continuous operation
Mounting	cooling slots must be ventilated vertically
Distance to adjacent devices from $U_n > 800\text{ V}$	$\geq 30\text{ mm}$
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 mounting	2 x M4 with mounting clip
Weight	$\leq 150\text{ g}$

9.2 Connection (for isoCHA425HV und AGH420-1)

Connection type	Screw or push-wire terminal
-----------------------	-----------------------------

Screw terminals:

Nominal current	$\leq 10\text{ A}$
Tightening torque	0,5 ... 0,6 Nm (5 ... 7 lb-in)
Conductor sizes	AWG 24 ... 12
Stripping length	8 mm
Rigid / flexible	0.2 ... 2.5 mm ²
Flexible with ferrules with/without plastic sleeve	0.25 ... 2.5 mm ²
Multiple conductor rigid	0.2 ... 1.5 mm ²
Multiple conductor flexible	0.2 ... 1.5 mm ²
Multiple conductor with ferrules without plastic sleeve	0.25 ... 1.5 mm ²
Multiple conductor flexible with TWIN ferrules with plastic sleeve	0.25 ... 1.5 mm ²

Push-wire terminals:

Nominal current	$\leq 10\text{ A}$
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	$\varnothing 2.1\text{ mm}$

9.3 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
- IEC 61851-21-2: 2018-04 Version 1.0
- IEC 61851-23
- UL2231-1/-2

9.4 Ordering information

Type	Nominal voltage U_n	Art. No.
isoCHA425HV-D4-4 + AGH420-1 (push-wire terminal)	DC 0 (50*)...1 000 V	B71036396
isoCHA425HV-D4-4 + AGH420-1 (screw terminal)	DC 0 (50*)...1 000 V	B91036396
Mounting clip for screw fixing (1 piece per device)		B98060008

* Value for CHAdeMo

9.5 EU Declaration of Conformity

Bender GmbH & Co. KG hereby declares that the device covered by the Radio Directive complies with Directive 2014/53/EU. The full text of the EU Declaration of Conformity is available at the following Internet address:

https://www.bender.de/fileadmin/content/Products/CE/CEKO_isoXX425.pdf



9.6 Document revision history

Date	Document version	Valid from software version	State/Changes
11/2021	02	D624 V1.00	<p>Added:</p> <p>Data about Mode CHA in chapter 2.2 Device features</p> <p>2.3.1 R_f and C_e in Mode „CHd“ and „CHA“ (CHAdEMO)</p> <p>4.6 Menu „SEt“</p> <p>7 Modbus register assignment of the ISOMETER® (at register 3032)</p> <p>Info about screw terminal in chapter 9 Technical Data (at AGH420-1)</p> <p>9.2 Ordering information</p> <p>Changes:</p> <p>Chapter 4.3 Menu „AL“ Description LED on / off</p>
02/2023	03	D624 V4.02	<p>Editorial revision</p> <p>3.1 Dimension drawing new</p> <p>3.3 Connection diagram new</p> <p>3.4 Setting insulation monitoring mode incl. note</p> <p>4.1 Note „Readability ...“</p> <p>4.5.1 Note „To comply with UL2231 ...“</p> <p>9.0 TD: ModeCCS (dc), climatic classes</p> <p>9.1 Climate classes; UL2231</p> <p>9.3 EU conformity</p> <p>9.4 Modification history</p>



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