# 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 V1.xx

## Service and support for Bender products

**First-level support**
*Technical support*
Carl-Benz-Strasse 8 • 35305 Grünberg • Germany
Telephone: +49 6401 807-760
0700BenderHelp *
Fax: +49 6401 807-629
E-mail: support@bender-service.de
Available on 365 days from 7.00 a.m. to 8.00 p.m. (MEZ/UTC +1)
* Landline German Telekom: Mon-Fri from 9.00 a.m. to 6 p.m.: 6.3 cents/30 sec.; remaining time: 6.3 cents/min.
Mobile phone: higher, depending on mobile phone tariff

**Repair**
*Repair, calibration and replacement service*
Londorfer Strasse 65 • 35305 Grünberg • Germany
Telephone: +49 6401 807-780 (technical issues) or
+49 6401 807-784, -785 (commercial issues)
Fax: +49 6401 807-789
E-mail: repair@bender-service.de

**Field service**
*On-site service*
Telephone: +49 6401 807-752, -762 (technical issues) or
+49 6401 807-753 (commercial issues)
Fax: +49 6401 807-759
E-mail: fieldservice@bender-service.de
Mon-Thu 7.00 a.m. to 4.00 p.m., Fri 7.00 a.m. to 1 p.m. (MEZ/UTC +1)

# Table of content

# 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 | RoHS directives |

## 1.3 Training courses and seminars

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.

## 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 ≤ 1 kΩ 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 µF per conductor | ✓ | ✓ |
| Detection of insulation faults in the system voltage range 50 V to 1000 V | ✓ | ✓ |
| One-pole insulation faults $R_{FU}$<br>$R_{FU}$ ≤ 100 kΩ: Response time ≤ 1 s<br>100 kΩ < $R_{FU}$ ≤ 2 MΩ: Response time ≤ 10 s | ✓ | ✓ |
| Two-pole insulation faults $R_{FS}$<br>$R_{FS}$ ≤ 160 kΩ: Response time ≤ 10 s<br>$R_{FS}$ > 160 kΩ (200 kΩ): no detection (Deactivation) | ✓ | -- |

- ***CCS (dc mode):***

| |
|---|
| Detection of insulation faults up to 2 MΩ with a response time of 10 s |
| Maximum system leakage capacitance 5 µF |

- 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 LEDs 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 and the LEDs light 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 µF 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 MΩ. $R_{FS}$ is the two-pole insulation fault and is only determined up to a maximum of 160 kΩ. If $R_{FS}$ is below the value of 160 kΩ, it is thereafter evaluated up to max. 200 kΩ.

The response time of the one-pole insulation fault $R_{FU}$ is 1 s for limit values up to 100 kΩ and $U_n$ >= 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 MΩ and the system leakage capacitance $C_e$ are determined independently of the system voltage. The maximum permissible system leakage capacitance in this mode is 5 µF. 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 kΩ ("CHd" mode 150 kΩ). 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+ -> $R_{F+}$ = (200 % * $R_F$)/(100 % + R%)

Fault at conductor DC- -> $R_{F-}$ = (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 kΩ up to a value of 17 µF. Above 12 µF, the message Device error "E.07" is displayed.

### 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 kΩ the false alarm can be prevented by a resistor of 200 kΩ 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); the measuring function of the device is stopped during the test 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 µC 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 kΩ) internal resistance. The "on" setting is used in systems where $U_n$ < DC 100 V. When "on U" is set, the system voltage must be $U_n$ > DC 100 V during the test. 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 DC -30 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**<br>The connection of terminals E or KE to earth is interrupted.<br>**Action:**<br>Check connection, eliminate error. The error code will be erased automatically once the error has been eliminated. |
| E.02 | **System connection error**<br>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.<br>**Action:**<br>Check connection, eliminate error. The error code will be erased automatically once the error has been eliminated. |
| E.03 | **System connection error reverse polarity**<br>Terminals L1/+ and L2/- are connected with reverse polarity to the monitored DC system.<br>Detection from $U_n$ < DC -30 V. |
| E.05 | **Measurement technology error:**<br>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.<br>**Calibration invalid after software update:**<br>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 12 µF has been exceeded. |
| E.08 | A calibration error was detected during the device test.<br>**Action:**<br>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 Ω 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.

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

### 2.3.19 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 $C_e$.

*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 hast 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 supressed for the preset time (0…10 s) specified for parameter "t".

### 2.3.20 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).

### 2.3.21 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.

### 2.3.22 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.

### 2.3.23 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.

### 2.3.24 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".

### 2.3.25 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")

*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.

*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.*

# 3 Dimensions and mounting

## 3.1 Dimensions

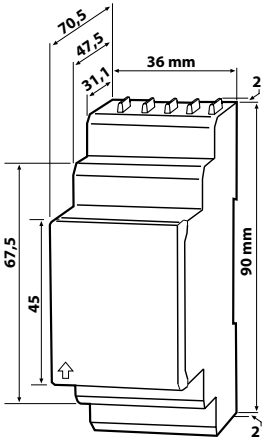
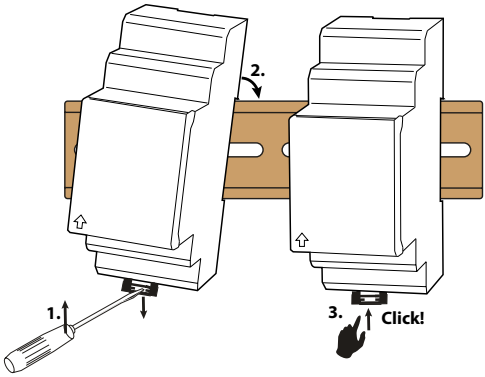
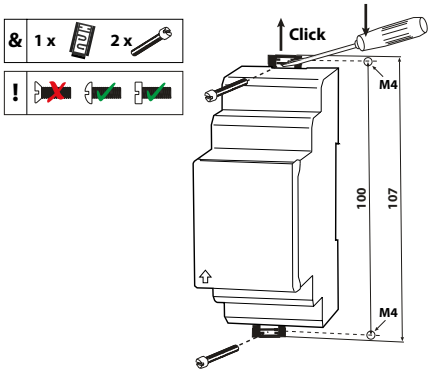



*Abb. 3–1 Dimensions in mm*

## 3.2 Mounting



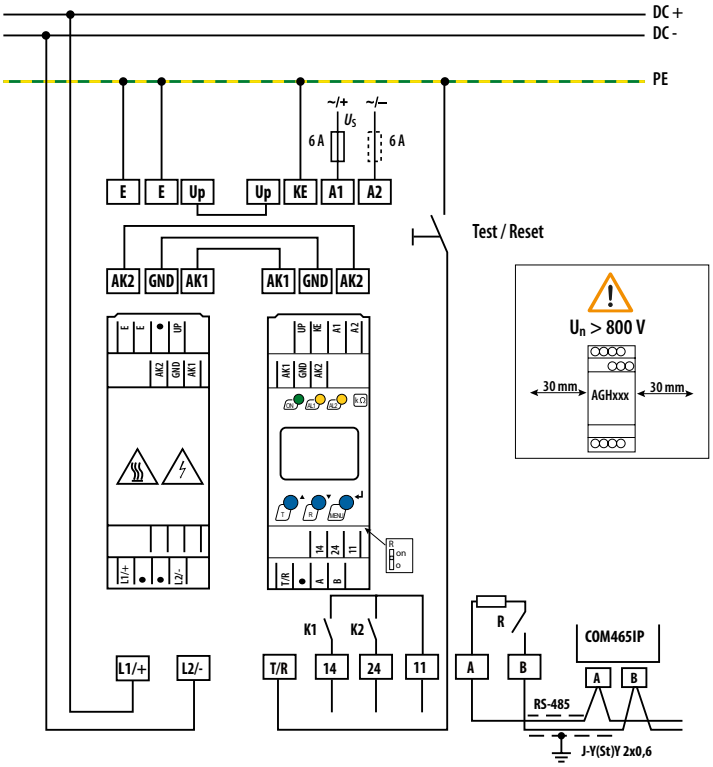




Variant A: DIN rail mounting

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".*

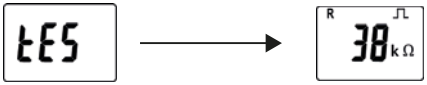
**Legend**

| Terminal | Connections |
|---|---|
| A1, A2 | Connection to the supply voltage $U_s$ via fuse:<br>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 |

** 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 device carries out a calibration, a self test and adjusts itself to the IT system to be monitored. This procedure may take up to 40 s; afterwards, the standard display appears showing the present insulation resistance, e.g.:

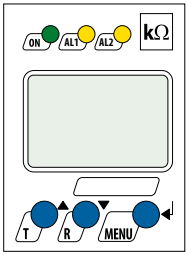


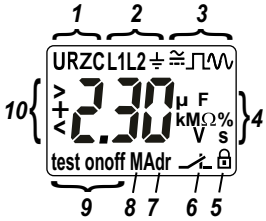

   The pulse symbol signals an error-free update of the measured resistance value. If the measured value cannot be updated due to malfunctions, the pulse symbol will be hidden.

3. **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.
4. **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")
5. **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

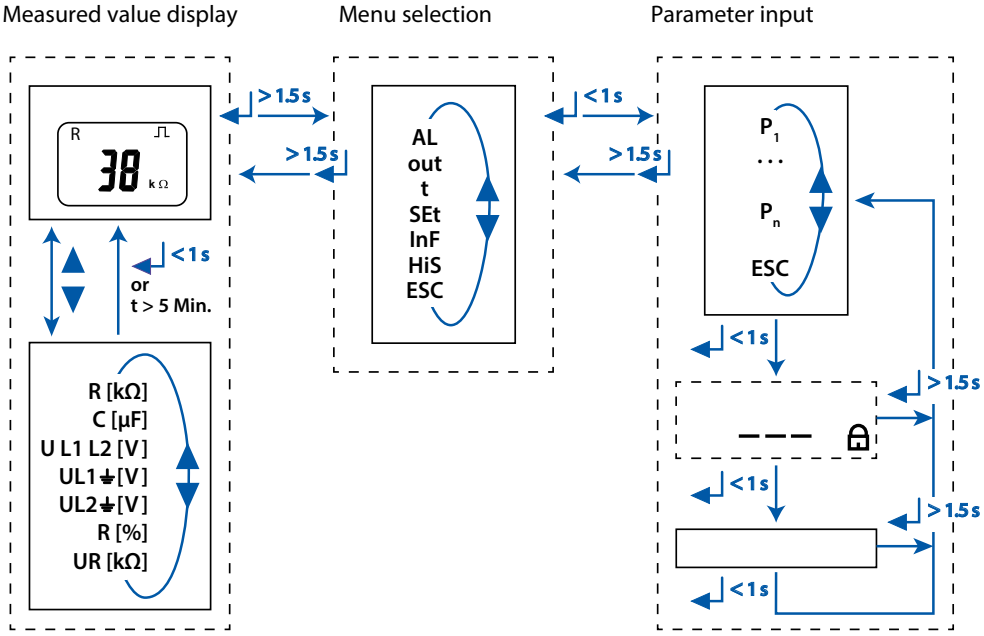
## 4.1 Displays and buttons

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

| Function | | Display |
|---|---|---|
| 1 | U : System voltage $U_n$<br>R : Insulation resistance $R_F$<br>C : System leakage capacitance $C_e$ |  |
| 2 | Monitored conductor | |
| 3 | ⎓ : Voltage type DC<br>⎍: Error-free measured value update<br>~ : 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 | |

*The areas of the display that can be configured flash.*

## 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 deactivated in the response value menu "AL". The maximum undervoltage value is limited by the overvoltage value.

| Display | Activation | | Setting value | | | Description |
|---|---|---|---|---|---|---|
| | FAC | CS | Value range | FAC | CS | |
| R1 < | on | | R2 … 600 | 600 | kΩ | Prewarning value Ran1<br>Hys. = 25 %/min. 1 kΩ |
| R2 < | on | | 5 … R1 | 120 | kΩ | Alarm value Ran2<br>Hys. = 25 %/min. 1 kΩ |
| U < | off | | 10 … U> | 10 | V | Alarm value<br>Undervoltage RMS<br>Hys. = 5 %/min. 5 V |
| U > | off | | U< … 1.10 | 1.10 | kV | Alarm value<br>Overvoltage RMS<br>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<br>+R1 < Ω | on | | r2<br>+R1 < Ω | off | | ● | ● | ○ | Prewarning R1<br>Fault $R_F$ at L1/+ |
| r1<br>-R1 < Ω | on | | r2<br>-R1 < Ω | off | | ● | ● | ○ | Prewarning R1<br>Fault $R_F$ at L2/- |
| r1<br>+R2 < Ω | off | | r2<br>+R2 < Ω | on | | ● | ○ | ● | Alarm R2<br>Fault $R_F$ at L1/+ |
| r1<br>-R2 < Ω | off | | r2<br>-R2 < Ω | on | | ● | ○ | ● | Alarm R2<br>Fault $R_F$ at L2/- |
| r1<br>U < V | off | | r2<br>U < V | on | | ● | ○ | ◎ | Alarm $U_n$<br>Undervoltage |
| r1<br>U > V | off | | r2<br>U > V | on | | ● | ◎ | ○ | Alarm $U_n$<br>Overvoltage |
| r1<br>test | off | | r2<br>test | off | | ● | ● | ● | Manually started<br>device test |
| r1<br>S.AL | off | | r2<br>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 | ---/<br>1.2k…115k | **19.2k** | ( ) | Baud rate | "---" → BMS bus (9k6, 7E1)<br>"1.2k" … "115k2" → Modbus (variable, variable) |
| Adr 2 | 8E1<br>8o1<br>8n1<br>8n2 | **8E1** | ( ) | Modbus | 8E1 - 8 data bits, even parity, 1 stop bit<br>8o1 - 8 data bits, odd parity, 1 stop bit<br>8n1 - 8 data bits, no parity, 1 stop bit<br>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 |

## 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<br>CHd<br>CHA | | | dc<br>CHd<br>CHA | CHd | | Selection of the insulation monitoring mode in the DC system<br>dc: CCS $t_{an} \leq 10$ s<br>CHd: CHAdeM0 Values $R_{FU}$, $R_{FS}$ and $C_e$ if $U_n > 50\ V_{DC}$<br>$t_{an} \leq 1{,}0$s if $R_{FU} \leq 100$ kΩ and $U_n > 100\ V_{DC}$<br>$t_{an} \leq 10$ s if $R_{Fs} \leq 160$ kΩ<br>CHA: ChaDemo Values $R_{FU}$ and $C_e$ if $U_n > 50\ V_{DC}$<br>$t_{an} \leq 1{,}0$s if $R_{FU} \leq 100$ kΩ and $U_n > 100\ V_D$ |
| nEt | | | off<br>on<br>on U | on U | | System connection test<br>on : if $U_n \leq$ DC 100 V<br>on U: if $U_n >$ DC 100 V |
| S.Ct | | | off<br>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 |
|---|---|---|
| ✓ | ± R kΩ ⎍ | Insulation resistance $R_F$*<br>1 kΩ…2 MΩ resolution 1 kΩ<br>The "+" or "-" sign appears if a fault $R_F$ < 500 kΩ is predominantly detected at L1/+ or L2/- if \|R%\| ≥ 30 %. |
| ✓ | C µF ⎍ | System leakage capacitance $C_e$<br>0…17 µF resolution 1 nF |
| ✓ | ~ ± U L1 L2 V | System voltage L1/+ - L2/- $U_n$<br>0 $V_{trueRMS}$…1200 $V_{trueRMS}$ resolution 1 $V_{trueRMS}$<br>The "+" or "-" sign indicates the polarity at terminals L1/+ and L2/- in the case of a DC system at $U_{RMS}$ > 20 V. The "~" sign indicates an AC system. |
| ✓ | ± U L1 ⏚ = V | Residual voltage L1/+ - PE $U_{L1e}$<br>DC 0 V … ± DC 1200 V resolution DC 1 V |
| ✓ | ± U L2 ⏚ = V | Residual voltage L2/- - PE $U_{L2e}$<br>DC 0 V … ± DC 1200 V resolution DC 1 V |
| - | ± R % | Fault location in %<br>-100 % …+100 % |
| ✓ | U R = kΩ ⎍ | One-side insulation resistance $R_{FU}$<br>1 kΩ…2 MΩ resolution 1 kΩ<br>One-side insulation resistance calculated from $U_{L1e}$ and $U_{L2e}$ if $U_n$ > DC 40 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 | $U_{L1e}$ voltage (76) [no alarm] | --- | --- | --- |
| 1020 to 1023 | $U_{L2e}$ 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<br>1 = on |
| 3009 | RW | Alarm value undervoltage "U<" | UINT 16 | V | 10 … U> |
| 3010 | RW | Activation alarm value overvoltage "U>" | UINT 16 | --- | 0 = off<br>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<br>1 = on |
| 3013 | RW | Operating mode of relay 1 "r1" | UINT 16 | --- | 0 = n.o.<br>1 = n.c. |
| 3014 | RW | Operating mode of relay 2 "r2" | UINT 16 | --- | 0 = n.o.<br>1 = n.c. |
| 3015 | RW | Bus address "Adr" | UINT 16 | --- | 0/3 … 90 |
| 3016 | RW | Baud rate "Adr 1" | UINT 16 | --- | 0 = BMS<br>1 = 1.2k<br>2 = 2.4k<br>3 = 4.8k<br>4 = 9.6k<br>5 = 19.2k<br>6 = 38.4k<br>7 = 57.6k<br>8 = 115.2k |
| 3017 | RW | Parity "Adr 2" | UINT 16 | --- | 0 = 8N1<br>1 = 8O1<br>2 = 8E1<br>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<br>1 = 1 h<br>2 = 24 h |
| 3022 | RW | Reserved | --- | --- | --- |
| 3023 | RW | Insulation monitoring mode | UINT 16 | --- | 0 = dc<br>1 = CHd<br>2= CHA |

| Register | Property | Description | Format | Unit | Value range |
|---|---|---|---|---|---|
| 3024 | RW | Test of the system connection during device test "nEt" | UINT 16 | --- | 0 = off<br>1 = on<br>2 = on U |
| 3025 | RW | Device test at device start "S. Ct" | UINT 16 | --- | 0 = off<br>1 = on |
| 3026 | RW | Request stop mode<br>(0 = deactivate device) | UINT 16 | --- | 0 = Stop<br>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<br>to 9809 | RO | Device names | UINT 16<br>(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<br>0x00 | 0x01 | 0x02 | 0x03 | ---------- | 0x08 | 0x09 |
| 10 words in total<br>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 |
| 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<br>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<br>When writing, any value. |
| 11 | Reserved | When reading, always 0<br>When writing, any value. |
| 12 | Reserved | When reading, always 0<br>When writing, any value. |
| 13 | Reserved | When reading, always 0<br>When writing, any value. |
| 14 | Reserved | When reading, always 0<br>When writing, any value. |
| 15 | Reserved | When reading, always 0<br>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.<br>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 |

| Value | Description of parameters |
|---|---|
| 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 $U_n$ [$V_{trueRMS}$]<br>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")<br><br>The alarms are included in this value with the OR function.<br>Assignment of the alarms:<br>0x0002 Device error<br>0x0004 Prewarning insulation resistance $R_F$ at L1/+<br>0x0008 Prewarning insulation resistance $R_F$ at L2/-<br>0x000C Prewarning insulation resistance $R_F$ symmetrical<br>0x0010 Alarm insulation resistance $R_F$ at L1/+<br>0x0020 Alarm insulation resistance $R_F$ at L2/-<br>0x0030 Alarm insulation resistance $R_F$ symmetrical<br>0x0040 Alarm undervoltage $U_n$<br>0x0080 Alarm overvoltage $U_n$<br>0x0100 Message system test<br>0x0200 Device start with alarm |
| 12 | Update counter, consecutively counts from 0 to 99.<br>It increases with the update of the insulation resistance value. |
| <CR><LF> | String end |

# 9 Technical data

( )* = 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…1 000 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…1.09 kV (off)*
Overvoltage detection $U>$ ... 11…1.10 kV (off)*
Overload detection $U>$ ... 1.20 kV (cannot be deactivated)
Hysteresis $U$ ... 5 %, > 5 V

### System voltage

Nominal voltage $U_n$ ... DC 0 V …DC 1000 V +10%
Measuring range ... ±1200 $V_{PEAK}$
Display range ... 0 V…1.2 kV (measurement True RMS)
Measurement and relative uncertainty ... ±5 %, > ±5 V

### Mode CCS (dc)

Permissible system leakage capacitance $C_e$ ..... ≤ 5 µF
Measuring and display range $R_F$ ..... 1 kΩ ... 2 MΩ
Measurement uncertainty $R_F$/relative uncertainty $R_{an}$ ..... ±15 %, ±2 kΩ
Measuring and display range $C_e$ ..... 0 ... 17 µF

**Measurement uncertainty $C_e$:**
$R_F$ < 10 kΩ ..... no measurement
$R_F$ ≥ 10 kΩ ..... ±15 %, ±0.1 µF

**Response time $t_{an}$:**
$R_{an}$ = 2.0 x $R_F$ and $C_e$ = 1 µF acc. to IEC 61557-8 ..... ≤ 10 s
$R_{an}$ = 1.2 x $R_F$ and $C_e$ ≤ 5 µF ..... ≤ 10 s

### *Mode CHAdeMO (CHd an CHA)*

System voltage $U_n$ ..... **measurement only from $U_n$ ≥ DC 50 V**
Permissible system leakage capacitance $C_e$ ..... per conductor ≤ 1.6 µF

**One-pole fault $R_{FU}$**
Measuring and display range $R_{FU}$ ..... 1 kΩ ... 2 MΩ

**Measurement uncertainty $R_{FU}$/relative uncertainty $R_{an}$:**
≤ 200 kΩ and $U_n$ ≥ 100 V ..... ±15 %, ±2 kΩ
$U_n$ > 200 V ..... ±15 %, ±2 kΩ

**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 kΩ ..... ±15 %, ±2 kΩ
Measuring and display range $C_e$ ..... 0 ... 17 µF

**Measurement uncertainty $C_e$:**
$R_F$ < 10 kΩ ..... no measurement
$R_F$ ≥ 10 kΩ ..... ±15 %, ±0.1 µF

**Response time $t_{an}$:**
$R_{an}$ = 1.2 x $R_{FU}$ and $R_{FU}$ ≤ 100 kΩ and $U_n$ > 100 V ..... ≤ 1.0 s
$R_{an}$ = 1.2 x $R_F$ ..... ≤ 10 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, shield connected to PE on one side ..... 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/O operation)*
Electrical endurance under rated operating conditions, 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 load ..... 10 mA/5 V DC

## Environment/EMC

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

**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) ..... 3K24 (except condensation and formation of ice)
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
Transport (IEC 60721-3-2) ..... 2M4
Long-term storage (IEC 60721-3-1) ..... 1M12

## Connection (for isoCHA425HV und AGH420-1)

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

**Screw terminals:**

Nominal current ..... ≤ 10 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 ..... ≤ 10 A
Cross section ..... AWG 24-14
Stripping length ..... 10 mm
Rigid ..... 0.2…2.5 mm²
Flexible without ferrules ..... 0.75…2.5 mm²
Flexible with ferrules with/without plastic sleeve ..... 0.25…2.5 mm²
Multi-conductor flexible with TWIN ferrules with plastic sleeve ..... 0.5…1.5 mm²
Opening force ..... 50 N
Test opening ..... Ø 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 mounting ..... 2 x M4 with mounting clip
Weight ..... ≤ 150 g

## 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 ..... 1 000 V
Overvoltage category ..... III

**Rated impulse voltage:**

IC1/IC2 ..... 8 kV

**Rated insulation voltage:**

IC1/IC2 ..... 1 000 V
Pollution degree ..... 3

**Protective separation (protective impedance) between:**

IC1/IC2 ..... overvoltage category III, 1 000 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 µA
Internal DC resistance $R_i$ ..... ≥ 120 kΩ

### Environment/EMC

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

**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) ..... 3K24 (except condensation and formation of ice)
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 → isoCHA425HV) ..... ≤ 0.5 m
Cross section ..... ≥ 0.75 mm²

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

## 9.1 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

## 9.2 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*

## 9.3 Declaration of Conformity

**Bender GmbH & Co. KG**
Postfach 1161 • 35301 Grünberg/Germany
Londorfer Straße 65 • 35305 Grünberg/Germany
Phone: +49 6401 807-0 • Fax: +49 6401 807-259
E-Mail: info@bender.de • www.bender.de

BENDER
The Power in Electrical Safety®

CE

# EU-Konformitätserklärung
# *EU-Declaration of Conformity*

**Hersteller:** **Bender GmbH & Co. KG**
*Manufacturer:*

erklärt in alleiniger Verantwortung, dass das Produkt
*declare under our sole responsibility that the product*

**Produktbezeichnung:** **Isolationsüberwachungsgerät isoXX425 (siehe Anlage)**
*Product name:* *Insulation monitoring device isoXX425 (see annex)*

auf das sich diese Erklärung bezieht, mit den Vorschriften folgender Europäischen Richtlinien übereinstimmt.
*to which this declaration relates, is in conformity with the following European directives.*

**Richtlinien:** *Directives:*

| | | |
|---|---|---|
| 2011/65/EU | RoHS-Richtlinie | *RoHS directive* |
| 2014/35/EU | Niederspannungsrichtlinie | *Low voltage directive* |
| 2014/30/EU | EMV-Richtlinie | *EMC directive* |

Zur Beurteilung der Konformität wurden folgende Normen herangezogen:
*The assessment of this product has been based on the following standards:*

Angewandte Normen / *Applied standards:*

| | |
|---|---|
| EN 45545-2 | :2013 + A1:2015* |
| EN 50121-3-2 | :2016* |
| EN 50121-4 | :2016* |
| EN 50155 | :2017* |
| EN 50581 | :2012 |
| EN 61010-1 | :2010* |
| EN 61326-2-4 | :2013 |
| EN 61557-1 | :2007 |
| EN 61557-8 | :2015 |

Grünberg, den 07.10.2020

(H. Nowicki, CSO) (i.V. J. Schäfer, Quality Manager)

Anmerkung: Die Anlagen sind Bestandteil dieser EU-Konformitätserklärung.
*Evtl. Normen Einschränkungen sind gerätespezifisch in der Typenliste gekennzeichnet.

*Remark:* *The annexes are part of this EU declaration.*
*Limitation of standards are marked with a sign in the attached type list.

## 9.4 Document revision history

| Date | Document version | Valid from software version | State/Changes |
|---|---|---|---|
| 11/2021 | 01 | D624 V1.00 | Added:<br>Data about Mode CHA in chapter<br>2.2 Device features<br>2.3.1 $R_F$ and $C_e$ in Mode „CHd“ and „CHA“ (CHAdeMO)<br>4.6 Menu „SEt“<br>7 Modbus register assignment of the ISOMETER® (at register 3032)<br>Info about screw terminal in chapter<br>9 Technical Data (at AGH420-1)<br>9.2 Ordering information<br>Changes:<br>Chapter 4.3 Menu „AL“ Description LED on / off |
| | | | |
| | | | |



**Bender GmbH & Co. KG**
Postfach 1161 • 35301 Grünberg • Deutschland
Londorfer Str. 65 • 35305 Grünberg • Deutschland
Tel.: +49 6401 807-0 • Fax: +49 6401 807-259
E-mail: info@bender.de • www.bender.de

**Bender GmbH & Co. KG**
PO Box 1161 • 35301 Grünberg • Germany
Londorfer Str. 65 • 35305 Grünberg • Germany
Tel.: +49 6401 807-0 • Fax: +49 6401 807-259
E-mail: info@bender.de • www.bender.de

isoCHA425HV_D00404_02_M_XXEN / 11.2021 / pdf / © Bender GmbH & Co. KG, Germany – Subject to change! The specified standards take into account the edition valid until 11/2021 unless otherwise indicated.