EN Manual

BENDER
The Power in Electrical Safety©

# ISOMETER® iso1685...

AC/DC


**Insulation monitoring device for unearthed AC, AC/DC and DC power supplies (IT systems) up to AC 1000 V / DC 1500 V**

**Software version D408 v1.0x**

iso1685P_D00003_01_M_XXEN / 12.2016

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Table of contents

# 1. Important information

## 1.1 How to use this manual

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

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


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


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


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

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

## 1.2 Technical support

For commissioning and troubleshooting Bender offers you:

### 1.2.1 First level support

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

- Questions concerning specific customer applications
- Commissioning
- Troubleshooting

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

### 1.2.2 Repair service

Repair, calibration, update and replacement service for Bender products

- Repairing, calibrating, testing and analysing Bender products
- Hardware and software update for Bender devices
- Delivery of replacement devices in the event of faulty or incorrectly delivered Bender devices
- Extended guarantee for Bender devices, which includes an in-house repair service or replacement devices at no extra cost

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

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

Bender GmbH, Repair-Service,
Londorfer Strasse 65,
35305 Grünberg

### 1.2.3 Field service

On-site service for all Bender products

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

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

*Available from 7.00 a.m. to 8.00 p.m. 365 days a year (CET/UTC+1)
**Mo-Thu 7.00 a.m. - 8.00 p.m., Fr 7.00 a.m. - 13.00 p.m.

## 1.3 Training courses

Bender is happy to provide training regarding the use of test equipment.
The dates of training courses and workshops can be found on the Internet at www.bender-de.com -> Know-how -> Seminars.

## 1.4 Delivery conditions

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

## 1.5 Storage

The devices must only be stored in areas where they are protected from dust, damp, and spray and dripping water, and in which the specified storage temperatures can be ensured.



## 1.6 Disposal

Abide by the national regulations and laws governing the disposal of this device. Ask your supplier if you are not sure how to dispose of the old equipment.
The directive on waste electrical and electronic equipment (WEEE directive) and the directive on the restriction of certain hazardous substances in electrical and electronic equipment (RoHS directive) apply in the European Community. In Germany, these policies are implemented through the "Electrical and Electronic Equipment Act" (ElektroG). According to this, the following applies:

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

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

# 2. Safety instructions

## 2.1 General safety instructions

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

## 2.2 Work activities on electrical installations

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

**DANGER**

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

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

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

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

## 2.3 Device-specific safety information

**DANGER**

***Hazard due to excessively high locating current or excessively high locating voltage!***
*An excessively high locating current may damage sensitive loads (e.g. in control circuits) or trigger unintended switching processes. For this reason select a lower locating current for these systems. In case of doubt, please contact our service department.*

**WARNING**

*Make sure that the basic settings meet the requirements of the IT system. Children and unauthorised persons must not have access to or contact with the ISOMETER®.*

**CAUTION**

***Make sure that the operating voltage is correct!***
*Prior to insulation and voltage tests, the ISOMETER® must be disconnected from the IT system for the duration of the test. In order to check the correct connection of the device, a functional test has to be carried out before starting the system.*

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

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

*When using ISOMETER®s in IT systems, make sure that only one active ISOMETER® is connected in each interconnected system. If IT systems are interconnected via coupling switches, make sure that ISOMETER®s not currently used are disconnected from the IT system and deactivated. IT systems coupled via diodes or capacitances may also influence the insulation monitoring process so that a central control of the different ISOMETER®s is required.*

***Prevent measurement errors!***
*When a monitored IT system contains galvanically coupled DC circuits, an insulation fault can only be detected correctly if the rectifier valves (e.g. rectifier diode, thyristors, IGBTs, frequency inverters, …) carry a minimum current of > 10 mA.*

Safety instructions

***Unspecified frequency range***
*When connecting to an IT system with frequency components below the specified frequency range, the response times and response values may differ from the indicated technical data. However, depending on the application and the selected measurement method, continuous insulation monitoring is also possible in this frequency range.*
*There is no influence on the insulation monitoring for IT systems with frequency components above the specified frequency range, e.g. within the range of typical switching frequencies of frequency inverters (2…20 kHz).*

## 2.4 Intended use

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

The device is used for monitoring the insulation resistance of extensive systems which are designed as IT systems. The specific measurement technique monitors the insulation resistance also in extensive installations where extremely high system leakage capacitances against earth exist due to interference suppression methods. Also, the adaptation to high system leakage capacitances occurs automatically.
The device generates locating current pulses required for insulation fault location. That allows the detection of the insulation fault using permanently installed or mobile insulation fault locators.

Intended use also implies:

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

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

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

## 2.5 Work activities on electrical installations

- Only skilled persons are permitted to carry out the work necessary to install, commission and run a device or system.
- Follow the relevant provisions which apply to working governing on electrical installations particularly EN 50110 or the regulations which take its place.

DANGER

***Risk of electric shock!***
*Touching uninsulated live conductors can result in death or serious injury. Therefore avoid any physical contact with active conductors and ensure compliance with the regulations for working on electrical installations.*

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

## 2.6 Address setting and termination

Correct address setting and termination of the iso1685… series insulation monitoring device is essential for correct functioning.

CAUTION

***Risk of bus errors!***
*Double assignment of addresses on the respective BMS busses can cause serious malfunctions.*

Ensure correct address setting and termination of the device!

## 3.1 Device features

- Insulation monitoring in extensive unearthed power supply systems up to AC 1000 V / DC 1500 V
- Measurement of low-resistance insulation faults
- Separately adjustable response values $R_{an1}$ (Alarm 1) and $R_{an2}$ (Alarm 2) (both 200 Ω…1 MΩ) for prewarning and alarm
- Automatic adaptation to high system leakage capacitances up to 2000 µF, selectable range
- Integrated locating current injector up to 50 mA
- Device self test with automatic fault message in the event of a fault
- Alarm relays separately adjustable for insulation fault 1, insulation fault 2 and device error
- RS-485 interface (BMS bus), e.g. to control insulation fault location
- µSD card with data logger and history memory for alarms

## 3.2 Product description

### 3.2.1 General product description

The ISOMETER® is an insulation monitoring device for IT systems in accordance with IEC 61557-8 and IEC 61557-9. The device is applicable in AC/DC systems.

## 3.3 Function

Insulation monitoring is carried out using an active measuring pulse which is superimposed onto the IT system to earth via the integrated coupling.
When the insulation resistance between the IT system and earth falls below the set prewarning response value $R_{an1}$ the LED "Alarm 1" lights and the **alarm relay K1** switches. When the values fall below the alarm response value $R_{an2}$, also LED "Alarm 2" lights and the **alarm relay K2** switches.
The locating current injector integrated in the device for insulation fault location is externally activated via the BMS interface. When starting insulation fault location, the LED "PGH on" signals the locating current pulse.

The integrated µSD card is used as data logger for storing all relevant events.
The following measured values, statuses and alarms are stored during operation:

- Insulation resistances and leakage capacitances
- System voltages, partial voltages to earth, supply voltages
- Temperatures: current controller of the locating current injector, coupling L1/+, L2/–
- Insulation fault
- Connection fault
- Device error

Following each device start-up, a new file is generated. If the current file size exceeds 10 MByte during operation, a new file is generated. The file name contains the time and date of the creation time. Usually, it takes two days until the maximum file size is reached. Hence, a µSD card with a memory space of 2 GByte can record data for approx. 400 days. When the card has reached the maximum data volume, always the oldest file will be overwritten. The history memory on the µSD card contains all saved alarms in csv. format.

Function

### 3.3.1 Insulation monitoring

For insulation monitoring, a pulsating AC measuring voltage is superimposed on the IT system. The measuring pulse consists of positive and negative rectangular impulses of the same amplitude. The period depends on the system leakage capacitances in each case and the insulation resistance of the system to be monitored.

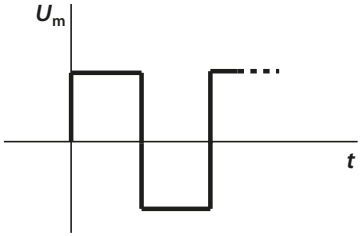



*Abb. 3.1: Pulse sequence of the measuring voltage for insulation fault monitoring*

An insulation fault between system and earth closes the measuring circuit. When the insulation resistance between the IT system and earth falls below the set response values $R_{an1}$ and $R_{an2}$ (response value $R_{an1}$ musst be set higher than $R_{an2}$), the associated alarm relay switches K1 (11, 12, 14).
Detected insulation faults are signalled to other bus devices via the BMS bus. In addition, the alarm LEDs Alarm 1 and Alarm 2 will light up.

### 3.3.2 Insulation fault location

For insulation fault location, a suitable locating current is superimposed onto the faulty IT system with which EDS… insulation fault locators can locate insulation faults. iso1685P utilises an internal locating current injector with $I_L \leq 50$ mA DC.

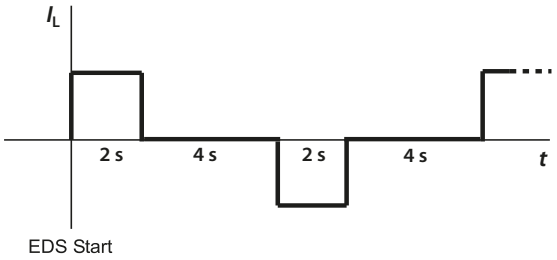



*Abb. 3.2: Pulse sequence of the internal locating current injector for insulation fault location*

If the EDS function is activated, the ISOMETER® starts with the insulation fault location as soon as the resistance value falls below the set response values $R_{an1}$ and $R_{an2}$. The LED "PGH ON" flashes during insulation fault location.

When permanently installed insulation fault locators (with master capability) are used, such as EDS460-D or EDS490-D, control and synchronisation of the locating current injector is carried out by one of the insulation fault locators in BMS master mode. For this purpose, the iso1685P has to communicate with the insulation fault locator via the BMS bus.

*During the insulation fault location process, the function of insulation resistance measurement is deactivated.*

### 3.3.3 Assignment of the alarm relays K1, K2, K3

- K1 switches when the value falls below the prewarning response value $R_{an1}$ (insulation resistance).
- K2 switches when the value falls below the alarm response value $R_{an2}$ (insulation resistance).
- K3 switches in the event of a device or connection error.

### 3.3.4 Deactivate device

When the device is deactivated, the coupling unit of the device is galvanically isolated from the system being monitored. The device does not measure the insulation resistance. The IT system is NOT being monitored! The device uncouples itself from the system to be monitored through an internal system isolating switch.
For example, this allows team operation of inverters, since in interconnected systems only one insulation monitoring device is allowed to be connected in each system.

For further information see page 25.

### 3.3.5 Measured value transmission to the control inputs of the inverter

All recorded measured values, operating messages and alarms are made available via the BMS bus.

### 3.3.6 History memory

All warnings, alarms and device errors are stored in the internal history memory with date and time. The time the event started, the time of acknowledgement and end of the event are recorded.
The history data is copied from the internal EEPROM to the History.csv file on the µSD card under the following conditions:

- following device start-up
- during operation once an hour
- when a compatible µSD card has been inserted

For the evaluation of the history memory, the Excel tool "iso1685 History.xlsx" can be made available. By way of example, history memory entries are shown on page 33.

Function

## 3.4 Self test

### 3.4.1 Self test after connection to the supply voltage

Once connected to the supply voltage, all internal measurement functions, the components of the process control such as data and parameter memory as well as the connections to earth are checked. Once the self test is finished, after approx. 5 s the normal measurement mode begins.
If a device or connection error is detected, the corresponding alarm will be signalled via the BMS bus as well as via the alarm relay K3 (31-32-34). This relay is continuously operating in N/C operation, i.e. it de-energises even in case of a complete device failure.
During this self test, when the device is being started, the alarm relays K1 and K2 are not switched.

### 3.4.2 Automatic self test

All supply voltages are continuously monitored. The following tests are continuously carried out in the background:

- Connection E-KE
- Temperature measurement of coupling device and locating current injector

A self test is automatically carried out at 24 hour intervals.
During the automatic self test, the alarm relays are **not** switched.

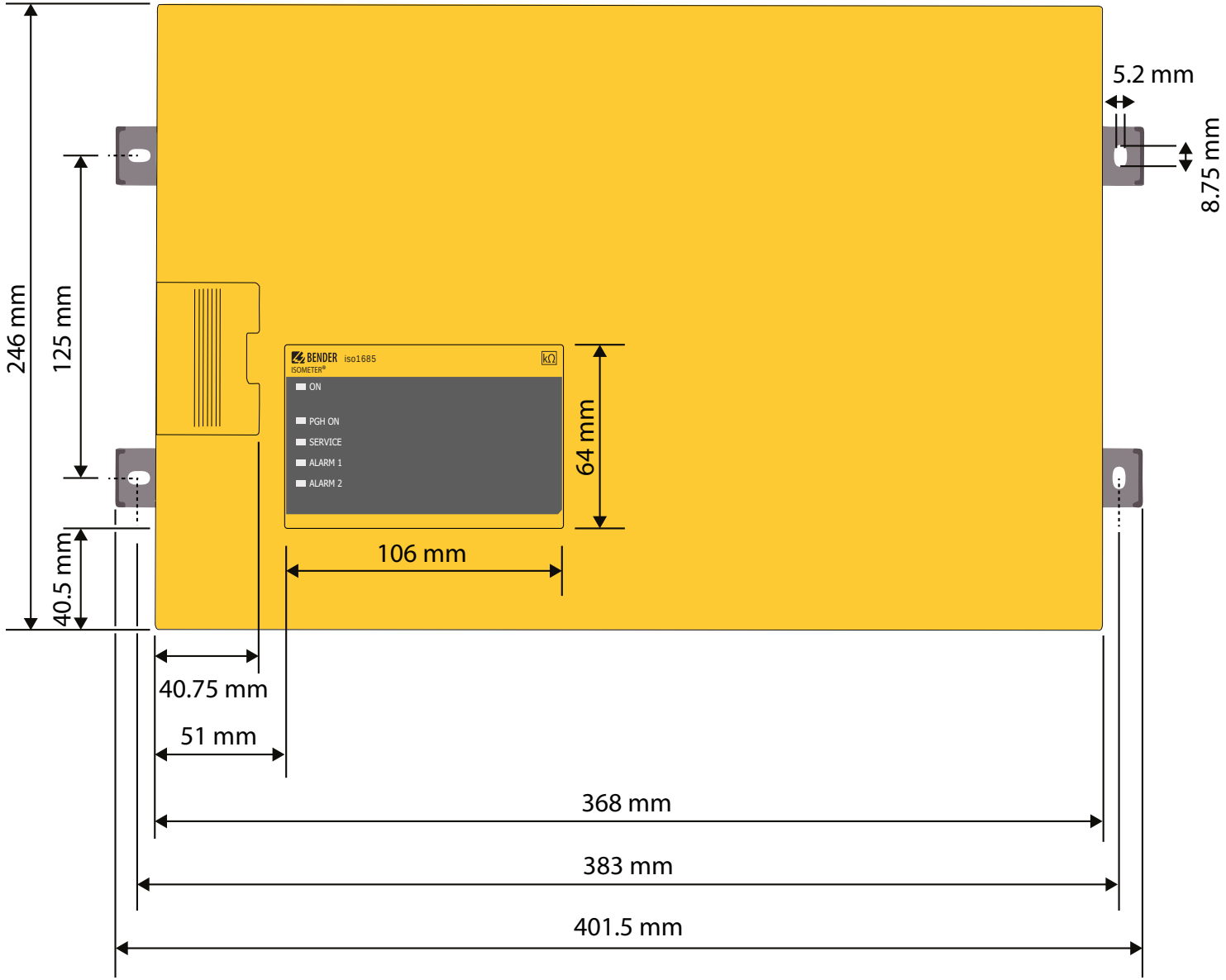
### 3.4.3 Manual self test

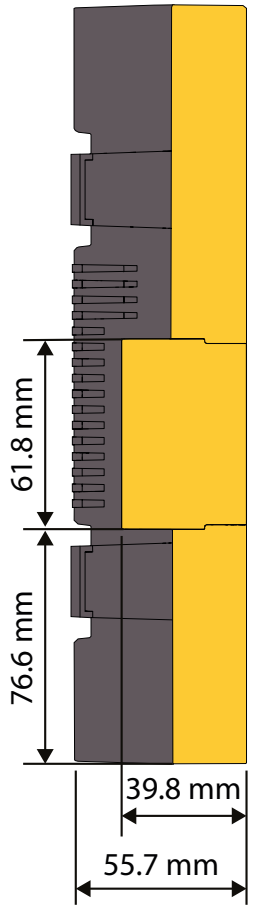
The self test is started via the BMS interface by a BMS master with test button.
Only in the manual self test mode, the following tests are carried out:

- internal Flash
- CPU register
- Watchdogs
- Oscillator
- Restart of the device including re-initialising and recalibration

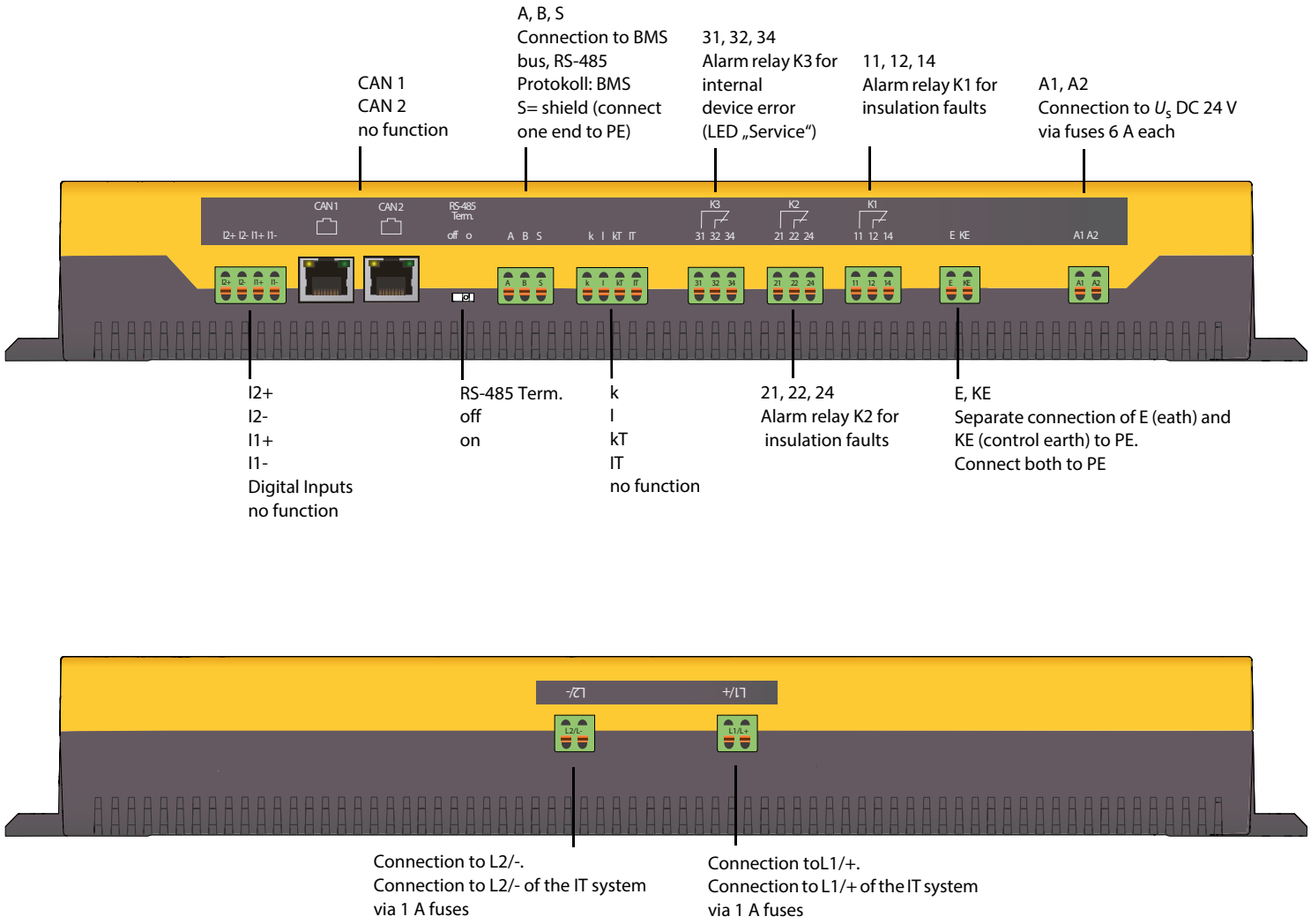
During the automatic self test all alarm relays are switched.

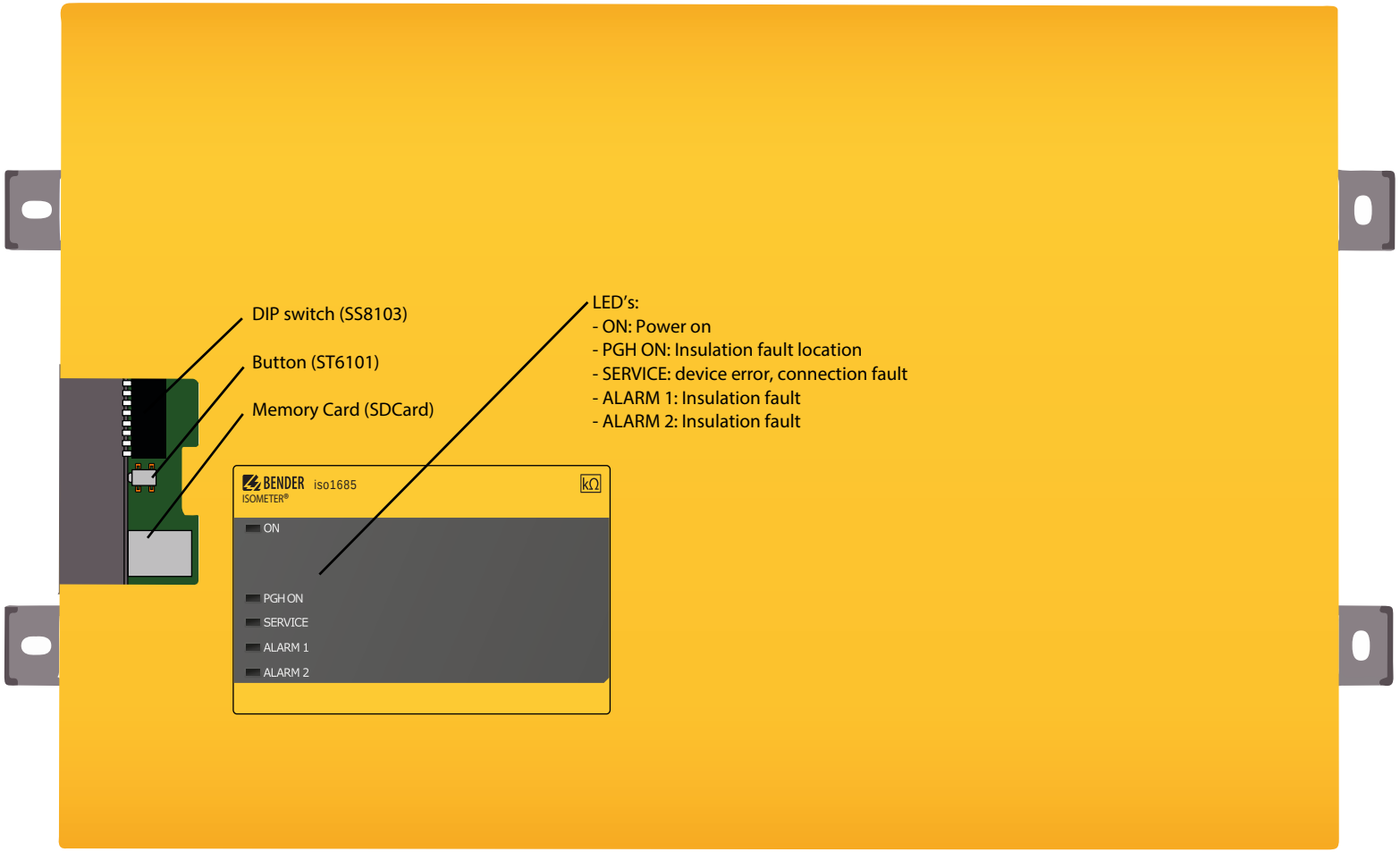
## 4.1 Dimensions



## 4.2 Terminals




DIP switch (SS8103)
Button (ST6101)
Memory Card (SDCard)
LED's:
- ON: Power on
- PGH ON: Insulation fault location
- SERVICE: device error, connection fault
- ALARM 1: Insulation fault
- ALARM 2: Insulation fault
BENDER iso1685
ISOMETER®
kΩ
ON
PGH ON
SERVICE
ALARM 1
ALARM 2

# 4.3 Display and operating controls

## 4.3.1 Display elements

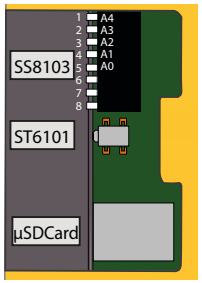

| | | |
|---|---|---|
| 1 | ON<br>(green) | Power On indicator<br>Flashes with a pulse duty factor of approx. 80 % and 1 Hz.<br>Device error:<br>Lights continuously, when the device stops functioning (device stopped).<br>Software update:<br>Flashes approx. three times faster during firmware update. Update time < 4 minutes |
| 2 | PGH ON<br>(yellow) | Insulation fault location:<br>Flashes with the cycle of the locating current. |
| 3 | PGH ON<br>(yellow) | The LED "PGH ON" flashes during insulation fault location. It indicates that the locating current for the insulation fault location is generated. |
| 4 | SERVICE<br>(yellow) | Internal device and connection error (system, earth): Lights continuously.<br>Also refer to the list of error codes on page 22. |
| 5 | ALARM 1<br>(yellow) | Insulation fault 1 (prewarning):<br>The "ALARM 1" LED lights continuously when the insulation resistance falls below the response value 1, $R_F < R_{an1}$ |
| | | Flashes: Connection fault, check earth and system (L1/+, L2/–) |
| 6 | ALARM 2<br>(yellow) | Insulation fault 2 (alarm):<br>The "ALARM 2" LED lights continuously when the insulation resistance falls below the response value 2, $R_F < R_{an2}$ |
| | | Flashes: Connection fault, check earth and system (L1/+, L2/–) |





## 4.3.2 Operating controls

The representation below shows the relative position of the operating elements.



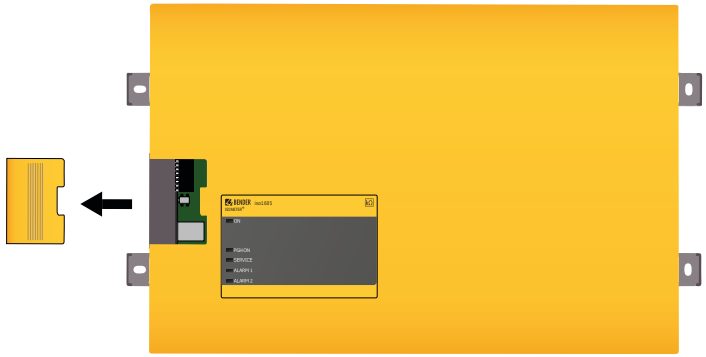

| Controls | Function |
|---|---|
| DIP switch<br>(SS8103) | BMS termination A4…A0<br>Leakage capacitance setting<br>Measurement speed setting |
| Button<br>(ST6101) | Alarm resetting<br>Firmware update |
| Memory card<br>(SDCard) | Memory for firmware and log files<br>(µSD-Card) |

## 4.3.3 Access to the DIP switch and µSD card via the service cover

Open the service cover by applying a little pressure to the ribbed area. Then drag the cover away from the device housing.
Once the cover has been removed, the following adjustments can be carried out:

- Change BMS address (SS8103)
- Set maximum leakage capacitance (SS8103)
- Change measurement speed t (SS8103)
- Reset Alarms (ST6101)

Additionally, you can read out e.g. alarms from the µSD card.



You can find a description of the DIP switch in "chapter 10. Technical data" and "chapter 8.5 Setting the BMS address".

## 5.1 Installation

Install the device using four M5 screws, also refer to the dimension diagram where the drilling holes are illustrated. When operating he device, it has to be placed in vertical position with the system coupling (L1/+, L2/–) on top. See also the dimension diagram on page 12.

## 5.2 Connection

### 5.2.1 Connection conditions

**DANGER**

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

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

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

**WARNING**

***Warning of insulation monitoring devices that do not work correctly!***
*Connect the terminals KE and E individually to the protective earth conductor PE.*

**CAUTION**

***Risk of injury from sharp-edged terminals!***
*Risk of lacerations. Touch the enclosure and the terminals with due care.*

**CAUTION**

***Risk of property damage due to unprofessional installation!***
*If more than one insulation monitoring device is connected to a conductively connected system, the system can be damaged. If several devices are connected, the device does not function and does not signal insulation faults. Make sure that only one insulation monitoring device is connected in each conductively connected system.*

**CAUTION**

***Ensure disconnection from the IT system!***
*When insulation or voltage tests are to be carried out, the device must be isolated from the system for the test period. Otherwise the device may be damaged.*

***Check proper connection!***
*Prior to commissioning of the installation, check that the device has been properly connected and check the device functions. Perform a functional test using an earth fault via a suitable resistance.*

*All terminals are pluggable push-wire terminals. Solid connecting wires can be directly plugged in. For connection of flexible cables, the push-wire terminals must be pushed open by pressing the corresponding orange interlocking mechanism with a flat-head screwdriver.*

### 5.2.2 Step-by-step connection of the ISOMETER®

Connect the device according to the wiring diagram.

Proceed as follows:

1. Connect terminal E and KE to earth (PE)
2. Connect terminal A and B to the BMS bus
3. Connect terminal S to the bus conductor shield (only at one end of the conductor)
4. Connect terminal L1/+ to L1 of the system to be monitored
5. Connect terminal L2/– to L2 of the system to be monitored

*The coupling terminals L1/+ and L2/– are locked. To unplug the terminals, the orange sliders must be slid towards the front (towards the device) to unlock the terminal. Now the terminal can be unplugged.*

6. Connect terminal A1/A2 to the supply voltage $U_s$
7. Connect alarm outputs 11/12/14, 21/22/24 and 31/32/34.

Installation and connection

### 5.2.3 Connecting the EDS to the ISOMETER®

**CAUTION**

***Risk of malfunctions due to excessive locating current on sensitive system parts!***

*The locating current flowing between the IT system and earth can cause controller faults in sensitive parts of the system, such as the PLC or relay. Ensure that the level of the locating current is compatible with the system to be monitored.*

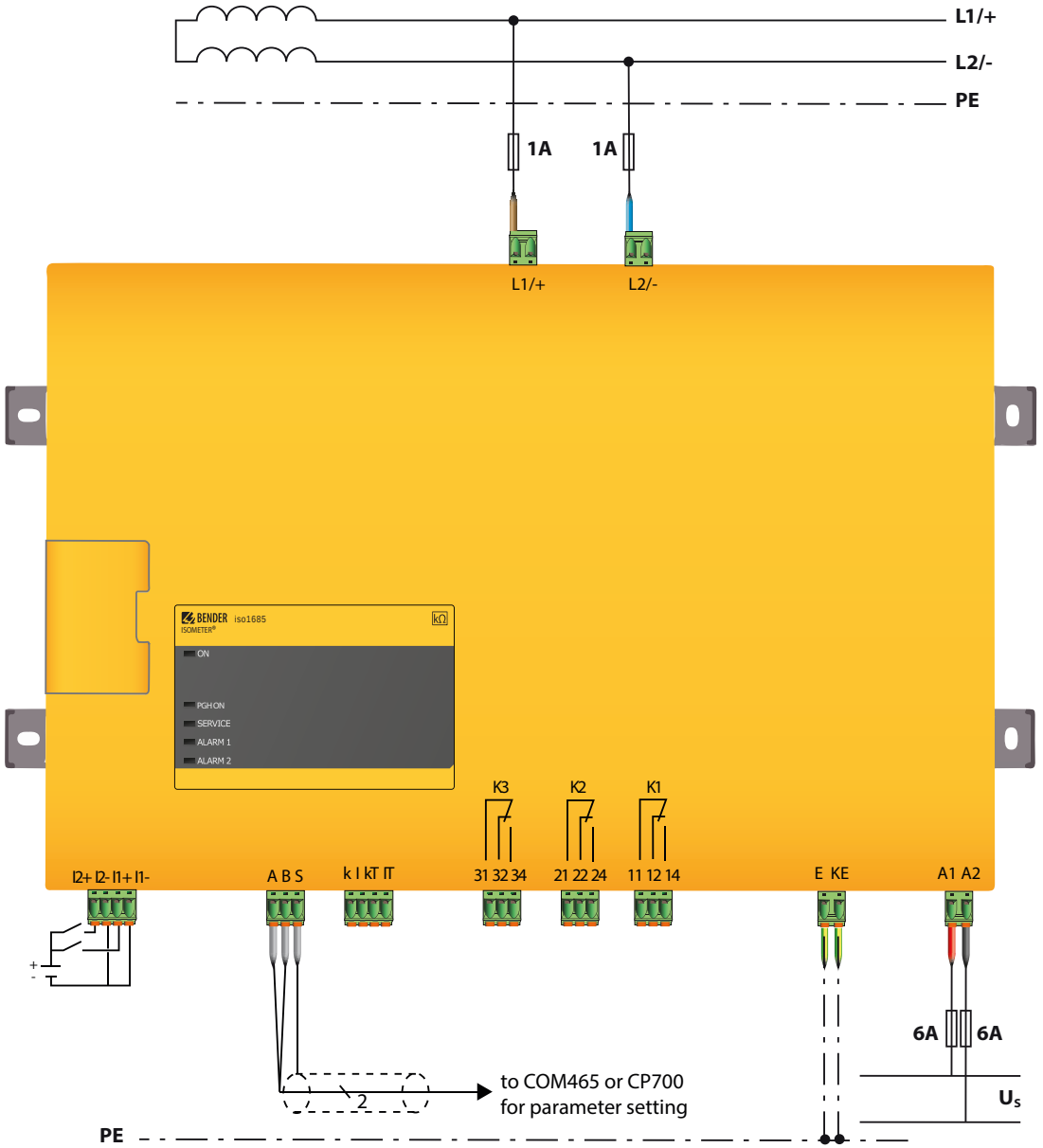
**CAUTION**

***Risk of incorrect measurement***

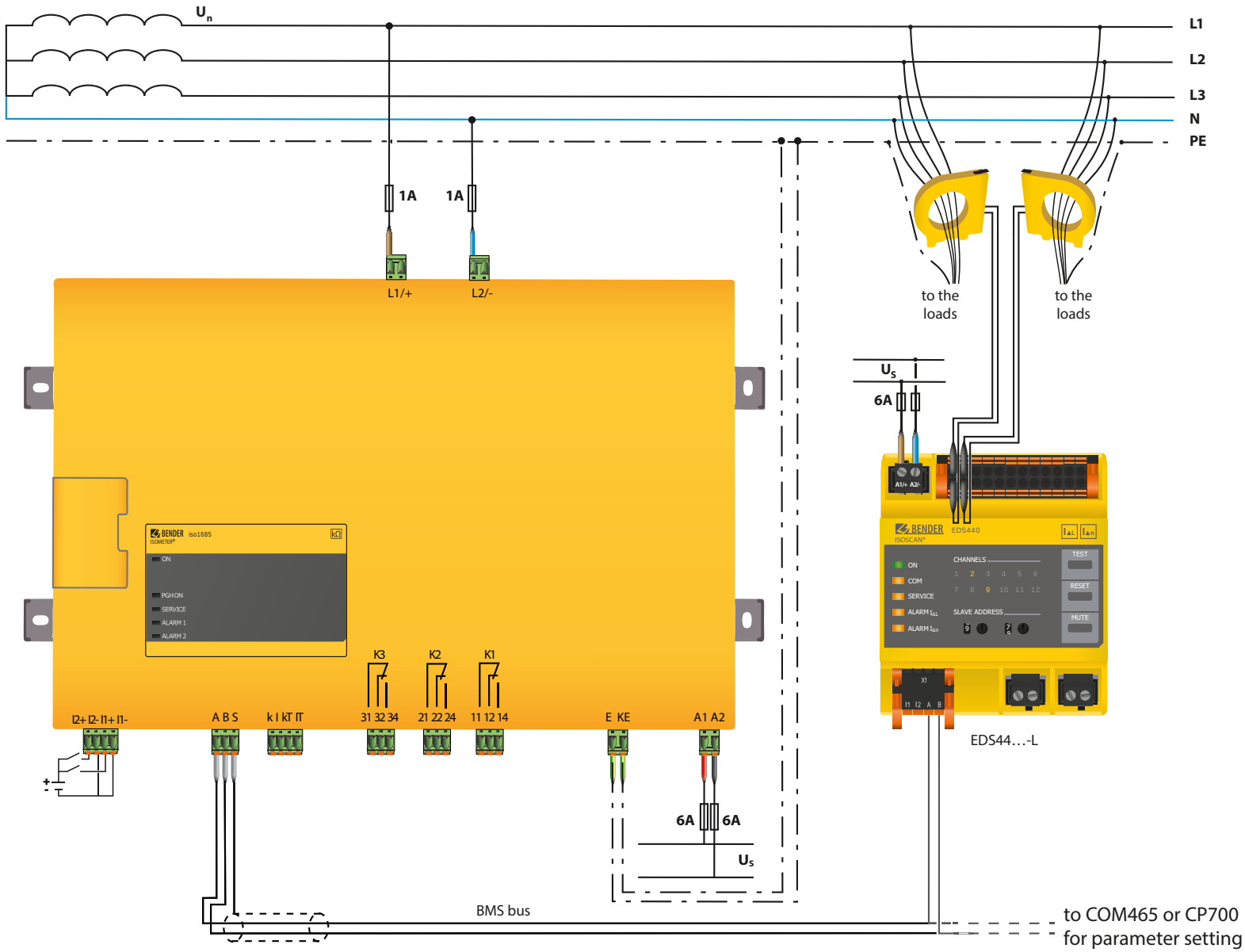
*The supplied locating current may influence other connected insulation fault location systems. If they measure the injected locating current, the measurement might be incorrect.*

*Insulation monitoring is deactivated while the insulation fault location is active.*

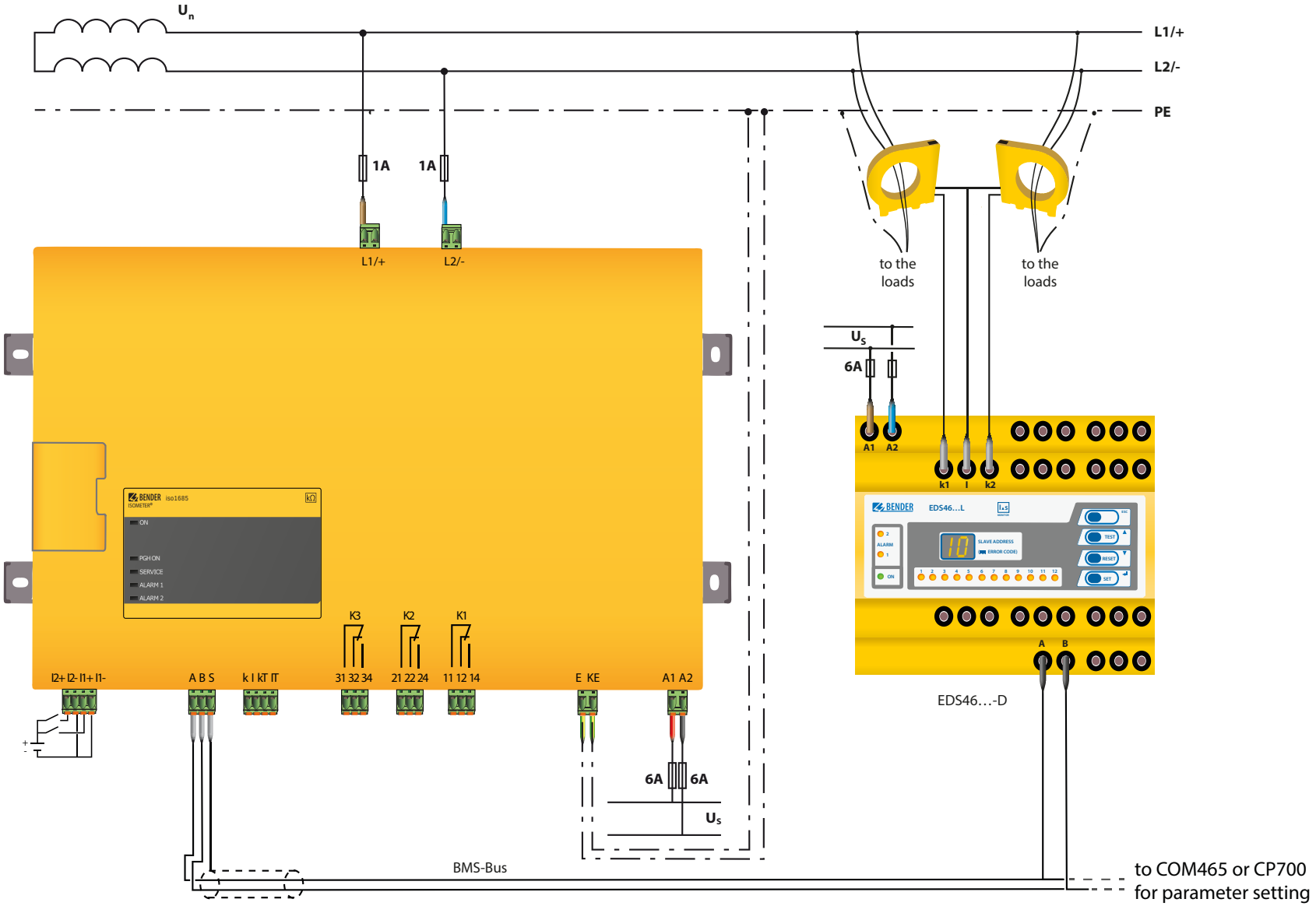
## 5. 3 Connection to an AC system



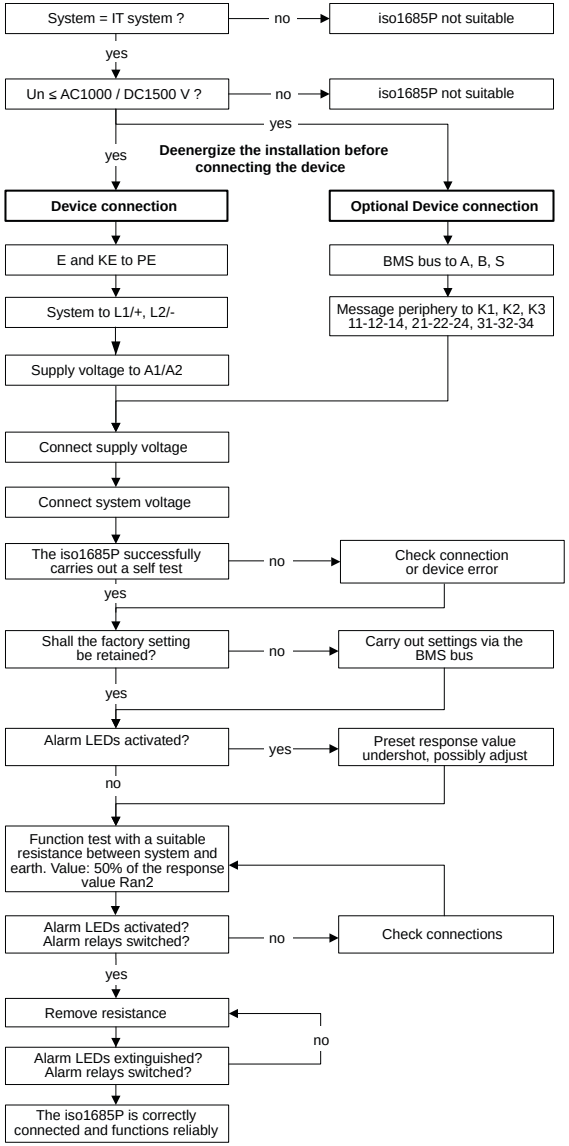
## 5.4 Connection example of the ISOMETER® with an insulation fault locator (EDS440-L) to a 3AC system



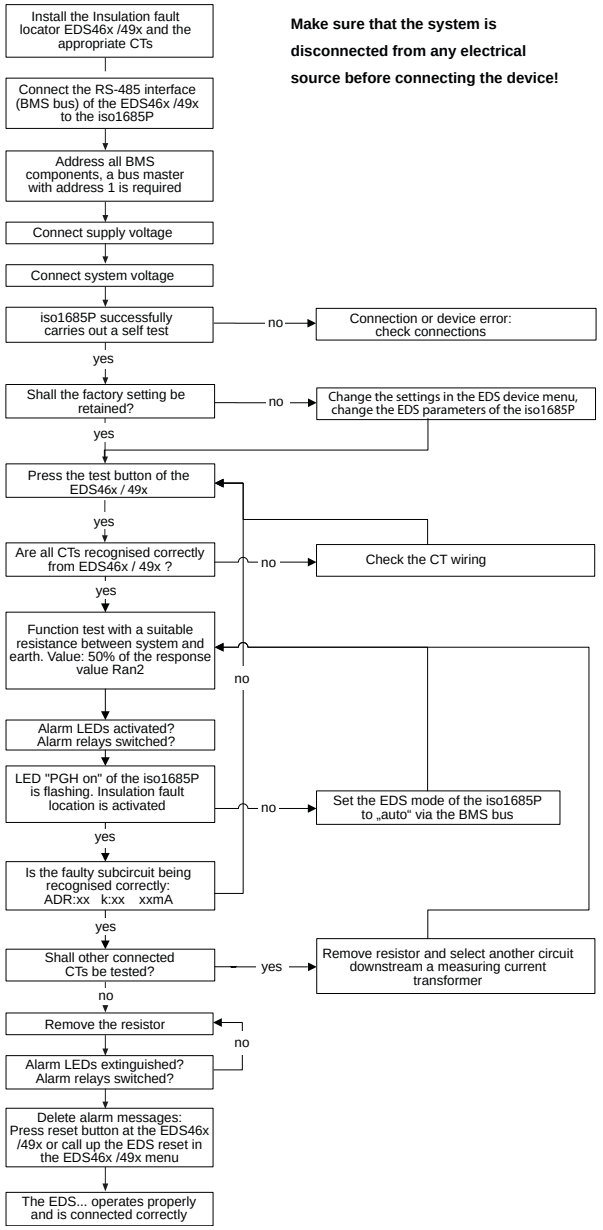
## 5.5 Connection example of the ISOMETER® with an insulation fault locator (EDS460) to an AC system



## 6.1 Commissioning flow chart insulation fault monitoring




## 6.2 Commissioning flow chart insulation fault location

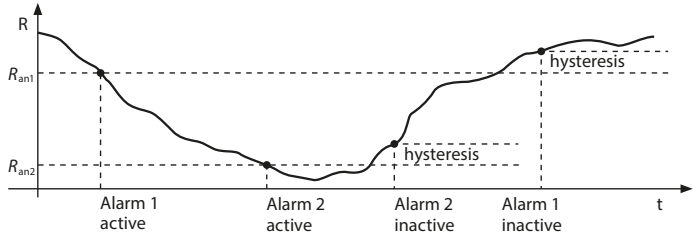


## 7.1 Setting the BMS bus adress

See page 28.

## 7.2 Alarm for insulation faults

The ISOMETER®'s limit values for alarm 1 and alarm 2 can be set via a BMS gateway (e. g. COM460IP) or a terminal tool and the BMS bus. Activation or deactivation of the two alarm levels Ran1 (alarm 1) and Ran2 (alarm 2) are illustrated in the following graphic: An alarm will become inactive as soon as the hysteresis of the set operating value is exceeded.




For alarm 1 and alarm 2 an insulation resistance of 200 Ω…1 MΩ can be set. Condition: alarm 1 ≥ alarm 2.

## 7.3 Setting the permissible system leakage capacitance or measurement speed

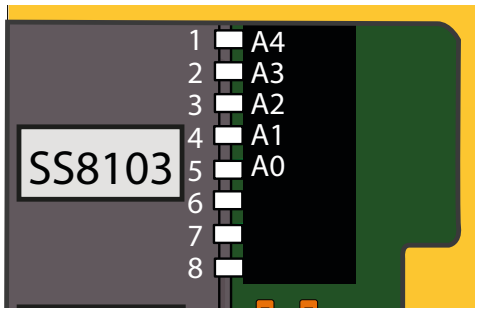
*Before changing the settings on the DIP switch make sure that the supply voltage is switched off.*

*When the maximum system leakage capacity $C_e$ max is set to 500 µF the upper limit of measuring range for the insulation resistance decreases from 1 MΩ to 200 kΩ. Therefore, check the setting of the response values $R_{an}$.*

Segments 6 and 7 of the DIP switch SS8103 are used to select the maximum system leakage capacitance $C_{e\,max}$ and to set the measurement speed. The measurement speed, for example, can be set to "Slow" in the event of frequently occurring false alarms caused by transients in the system. In the Slow mode, the measuring time doubles. Segment 8 is reserved.

DIP switch SS8103, segment 6:
OFF = 150 µF = $C_{e\,max}$
ON = 500 µF = $C_{e\,max}$

DIP switch SS8103, segment 7:
OFF = Fast
ON = Slow




Switch position:
Up = Off
Down = On

Settings

## 7.4 Digital Inputs

The ISOMETER® provides 2 digital inputs (I1, I2) that are freely configurable.

### 7.4.1 Digital Input 1

The the digital input's function is preset and cannot be adjusted.

| | | |
|---|---|---|
| • Test | Input will be activated for < 1 s | Sellf test of the device |
| • Gerät deaktivieren (Standby) | Input will be activated for > 2 s | The device DOES NOT measure the insulation resistance. The IT system is NOT being monitored! The device uncouples itself from the system to be monitored through an internal system isolating switch. |

### 7.4.2 Digital Input 2

The the digital input's function is preset and cannot be adjusted.

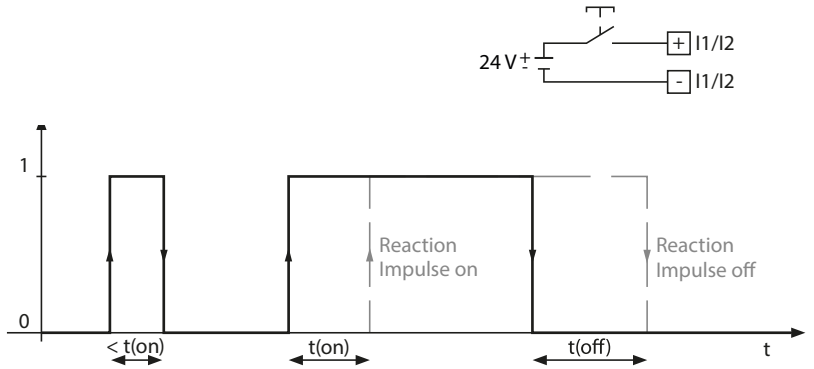
| | |
|---|---|
| • Reset | Reset of fault and alarm messages |

### 7.4.3 Mode of the digital inputs

The operating mode for the digital input can be set to the following values:

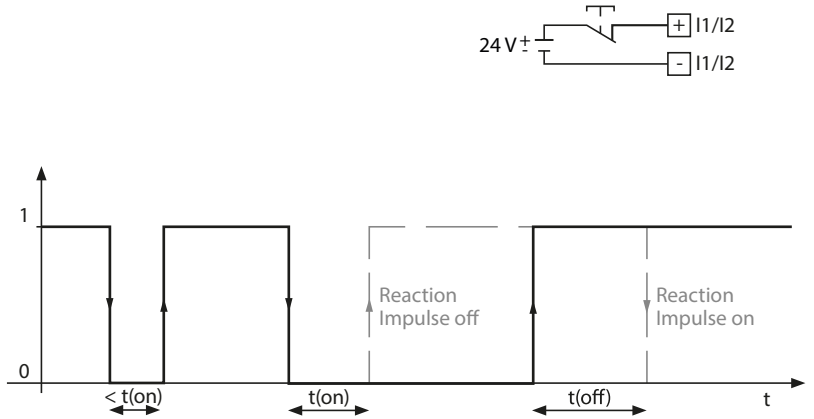
• Active high

An event is carried out on the rising edge of the digital input (low to high).
Response time t(on)/t(off) after a switch-on signal.




• Active low

An event is carried out on the falling edge of the digital input (high to low).
Response time t(on)/t(off) after a switch-off signal.



## 7.5 Relays

The ISOMETER® provides a total of 3 alarm relays (K1, K2, K3). The settings for K3 are preset and cannot be adjusted.
The following parameters for K1 and K2 can be set via a BMS gateway (e.g. COM460IP) or a terminal tool and the BMS bus:

### 7.5.1 TEST

The functional test of the relay can be activated or deactivated. This only applies to the manual test and not to the cyclic device self test:

- on — The manual test checks the switching function of the relay
- off — The manual test does not check the switching function of the relay

### 7.5.2 Function

- K1 (11/12/14) — Alarm 1 for insulation fault. The status of the relay changes when the value falls below the set response value $R_{an1.}$
- K2 (21/22/24) — Alarm 2 for insulation fault. The status of the relay changes when the value falls below the set response value $R_{an2.}$
- K3 (31/32/34) — Device error. The status of the relay changes in the event of an internal device error.

### 7.5.3 Operating mode

The relay mode can be adapted to the application:

- N/C — Normally closed - N/C operation contacts11-12-14/ 21-22-24 (The alarm relay is energised during normal operation).
- N/O — Normally open - N/O operation contacts 11-12-14/ 21-22-24 (The alarm relay is de-energised during normal operation).



## 7.6 Insulation fault location

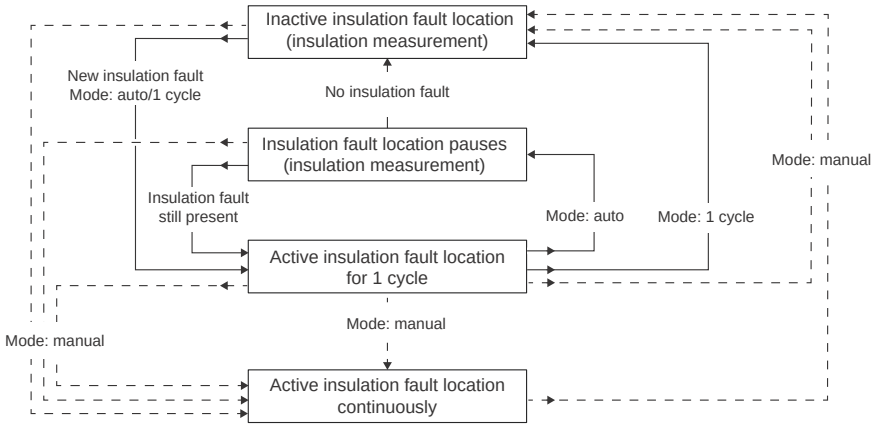
### 7.6.1 Current

Set the maximum locating current for the insulation fault location from 1…50 mA. You can set this paramenter via a BMS gateway (e.g. COM460IP) or a terminal tool and the BMS bus.

### 7.6.2 Mode

To locate insulation faults, select one of the four available modes for insulation fault location.

- off — The insulation fault location is deactivated.
- Manual — In manual mode, the insulation fault location starts immediately. If you start the insulation fault location, it remains active without considering the insulation resistance and the alarm message of the ISOMETER®.
- auto — In auto mode, the insulation fault location starts automatically as soon as the response value of alarm 2 of the ISOMETER® has fallen below the preset value. The insulation fault location is cyclically interrupted for an insulation measurement. If the insulation fault still exists after the interruption, the insulation fault location starts again. The insulation fault location only stops if alarm 2 is inactive. If a new insulation fault appears, the insulation fault location restarts automatically.
- 1 cycle — In 1-cycle mode, the insulation fault location starts automatically as soon as the response value of alarm 2 of the ISOMETER® has fallen below the preset value. The insulation fault location is stopped after one cycle.
If the insulation fault still exists after the interruption, the insulation fault location does NOT start again. If a new insulation fault appears, the insulation fault location restarts automatically for one cycle.




### 7.6.3 Deactivate device

When the device is deactivated, the coupling unit of the device is galvanically isolated from the system being monitored. The device does not measure the insulation resistance. The IT system is NOT being monitored!
The device uncouples itself from the system to be monitored through an internal system isolating switch.

The device can be activated and deactivated via:

- A digital input
- The BMS channel 10:
  - Activate the standby mode using the BMS command STDBY 1
  - Deactivate the standby mode using the BMS command STDBY 0
  - Query the current state using the BMS command TRSH? 10

The standby mode of the ISOMETER®, for example, allows team operation of inverters, since in interconnected systems only one insulation monitoring device is allowed to be connected in each system.



## 7.7 Fault memory

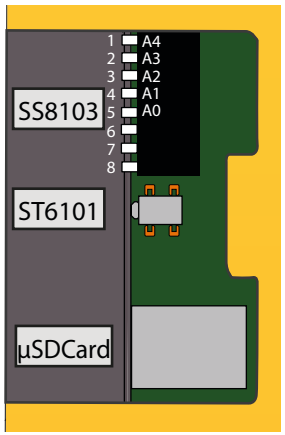
There are three ways to activate or deactive the fault memory:

- BMS gateway (z. B. COM460IP)
- BMS bus
- Button ST6101

| | |
|---|---|
| • on | If a fault becomes inactive, the programmed outputs remain in fault condition until they are reset manually. |
| • off | If a fault becomes inactive, the programmed outputs automatically change the state. |

## 7.8 Resetting fault messages

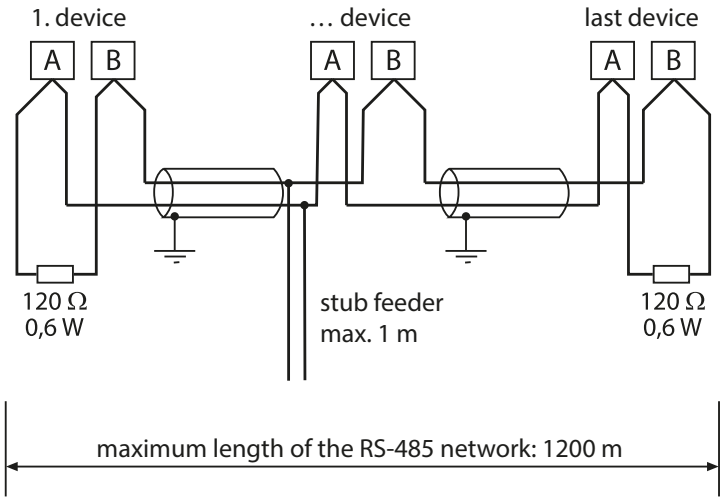
Recorded errors are provided as alarm messages on the BMS bus.
Pressing the reset button ST6101 will reset these error messages. If the error continues to exist, the message will be generated again. You can also reset the fault message via the BMS bus.

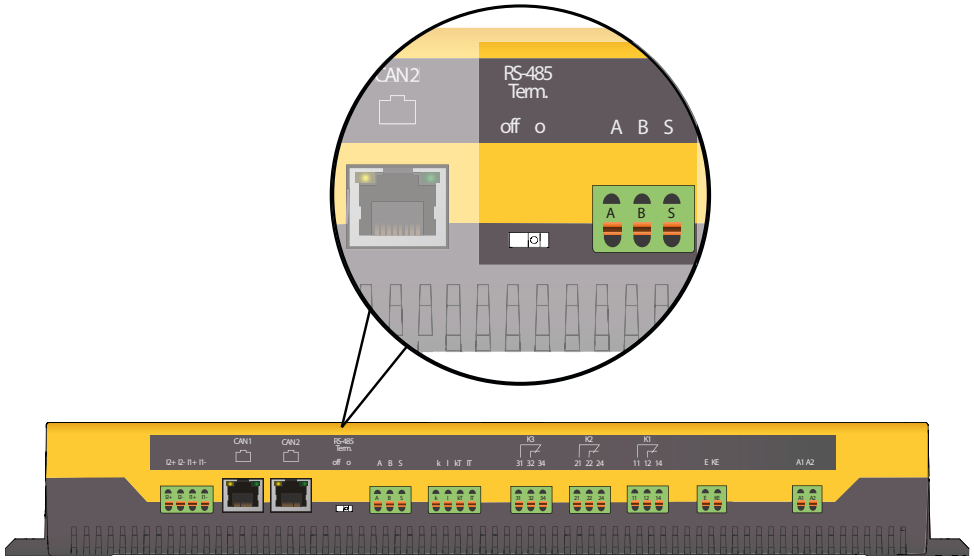


## 8.1 RS-485 interface with BMS protocol

The RS-485 interface, galvanically isolated from the device electronics, serves as a physical transmission medium for the BMS protocol. When an ISOMETER® or other bus-capable devices are interconnected via the BMS bus in a network, the BMS bus must be terminated at both ends with a 120 Ω resistor. For this purpose, the device is equipped with the terminating switch RS-485 Term. (ON/OFF).

An RS-485 network that is not terminated is likely to become unstable and may result in malfunctions. Only the first and last device in one line may be terminated. Hence, stub feeders in the network must not be terminated. The length of the stub feeders is restricted to 1 meter.



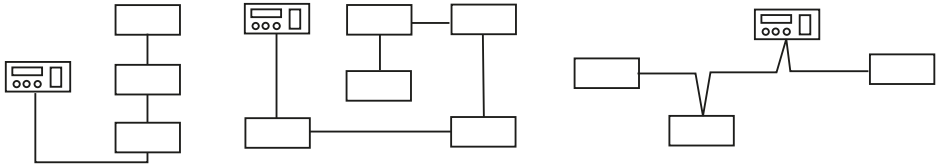



## 8.2 Topology RS-485 network

The optimum topology for an RS-485 network is a daisy-chain connection. In this connection, device 1 is connected to device 2, device 2 to device 3, device 3 to device n etc. The RS-485 network represents a continuous path without branches.

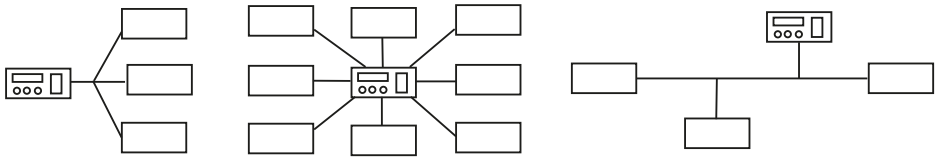
**Correct arrangement**

Three examples for correct arrangement:



**Wrong arrangement**

Three examples for wrong arrangement:

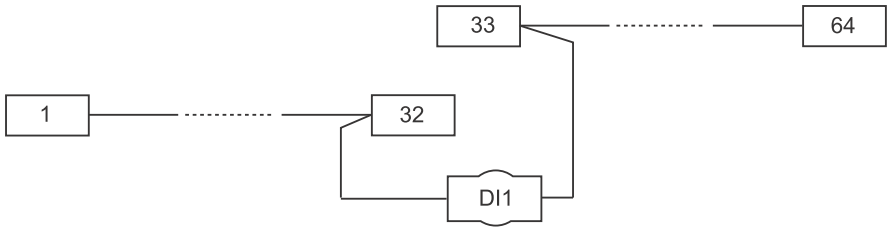


**Wiring**

The following type of wiring is recommended for the RS-485 network:

- Shielded cable, core diameter ≥ 0.8 mm
  - (e.g. J-Y(St)Y 2x0.8), shield connected to earth (PE) on one end.
  - Connection to terminals A and B.

The number of bus nodes is restricted to 32 devices. If more devices are to be connected, Bender recommends the use of a DI1 repeater.




Device communication via the BMS bus

## 8.3 BMS protocol

This protocol is an essential part of the Bender measuring device interface (BMS bus protocol). Data transmission generally makes use of ASCII characters.
Interface data are:

- Baud rate: 9600 baud
- Transmission: 1 start bit, 7 data bits, 1 parity bit, 1 stop bit (1, 7, E, 1)
- Parity: even
- Checksum: sum of all transmitted bytes = 0 (without CR and LF)

The BMS bus protocol works according to the master-slave principle. Only one master may exist in each network. All bus devices are identified by a unique BMS address. The master cyclically scans all other slaves on the bus, listens to their signals and then carries out the corresponding commands.
A device receives the MASTER function by assigning **Bus address 1** to it.

*The iso1685P can only be operated as BMS SLAVE!*

**BMS master**

A master can query all measured values, alarm and operating messages from a slave. If bus address 1 is assigned to a device, this device automatically represents the master, i.e. all addresses between 1 and 150 are cyclically scanned via the BMS bus for alarm and operating messages. If the master detects incorrect answers from a slave, the fault message "Fault RS-485" will be output via the BMS bus.
Fault causes may be:

- Addresses are assigned twice
- A second master exists on the BMS bus
- Interference signals occur on the bus lines
- A defective device is connected to the bus
- Terminating resistors are not activated or connected

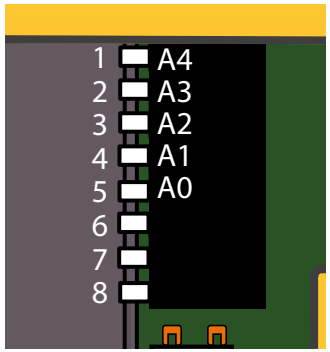
## 8.4 Commissioning of an RS-485 network with BMS protocol

- Interconnect terminals A and B of all bus devices in one line
- Switch the terminating resistors on at the start and the end of the RS-485 network. If a device at the end of the bus is not terminated, connect a 120 Ω resistor to terminals A and B
- Switch the supply voltage on
- Assign the master function and address 1 to a bus-capable device
- Assign addresses (2…33) to all other bus devices in consecutive order

## 8.5 Setting the BMS address

The factory setting of the BMS address can be changed using the DIP switch SS8103. Factory setting BMS address = 2.

Switch position:
Up = Off
Down = On




| | DIP switch SS8103 | | | | |
|---|---|---|---|---|---|
| **BMS- Adr.** | **A4** | **A3** | **A2** | **A1** | **A0** |
| 2 | 0 | 0 | 0 | 0 | 0 |
| 3 | 0 | 0 | 0 | 0 | 1 |
| 4 | 0 | 0 | 0 | 1 | 0 |
| 5 | 0 | 0 | 0 | 1 | 1 |
| 6 | 0 | 0 | 1 | 0 | 0 |
| 7 | 0 | 0 | 1 | 0 | 1 |
| 8 | 0 | 0 | 1 | 1 | 0 |
| 9 | 0 | 0 | 1 | 1 | 1 |
| 10 | 0 | 1 | 0 | 0 | 0 |
| .. | .. | .. | .. | .. | .. |
| ... | ... | ... | ... | ... | ... |
| 33 | 1 | 1 | 1 | 1 | 1 |

## 8.6 Starting the firmware update via the BMS bus

The firmware can be updated via the BMS bus using the BMS update manager which can be obtained from Bender.



## 8.7 Alarm and operating messages via the BMS bus

Messages are transmitted to a maximum of 12 BMS channels. All alarm and operating messages which may occur are described below.

### 8.7.1 Alarm messages

| Alarm | Channel | Meaning |
|---|---|---|
| Alarm 1 (insulation fault) | 1 | Insulation resistance < response value $R_{an1}$ |
| Alarm 2 (insulation fault) | 2 | Insulation resistance < response value $R_{an2}$ |
| Connection system | 4 | Connection error (available from software version 2.x) |
| Connection PE | 5 | Connection error: E/KE not connected to PE |
| Device error | 7 | Internal device error with error code |
| Overtemperature coupling | 10 | Overtemperature coupling L1/+ |
| Overtemperature coupling | 11 | Overtemperature coupling L2/– |
| Overtemperature PGH | 12 | Overtemperature of the locating current injector |

### 8.7.2 Operating messages

| Alarm | Channel | Meaning |
|---|---|---|
| Insulation resistance | 1 | Insulation resistance ≥ response value $R_{an1}$ |
| Insulation resistance | 2 | Insulation resistance ≥ response value $R_{an2}$ |
| Leakage capacitance | 4 | Leakage capacitance $C_e$ to earth |
| System voltage | 5 | Voltage between L1/+ and L2/– |
| Partial voltage U+/PE | 6 | Voltage between L1/+ and PE |
| Partial voltage U-/PE | 7 | Voltage between L2/– and PE |
| PGH current | 8 | Current locating current of the locating current injector (PGH) |
| Temperature coupling | 10 | Current temperature of the coupling L1/+ |
| Temperature coupling | 11 | Current temperature of the coupling L2/– |
| Temperature PGH | 12 | Current temperature of the locating current injector |

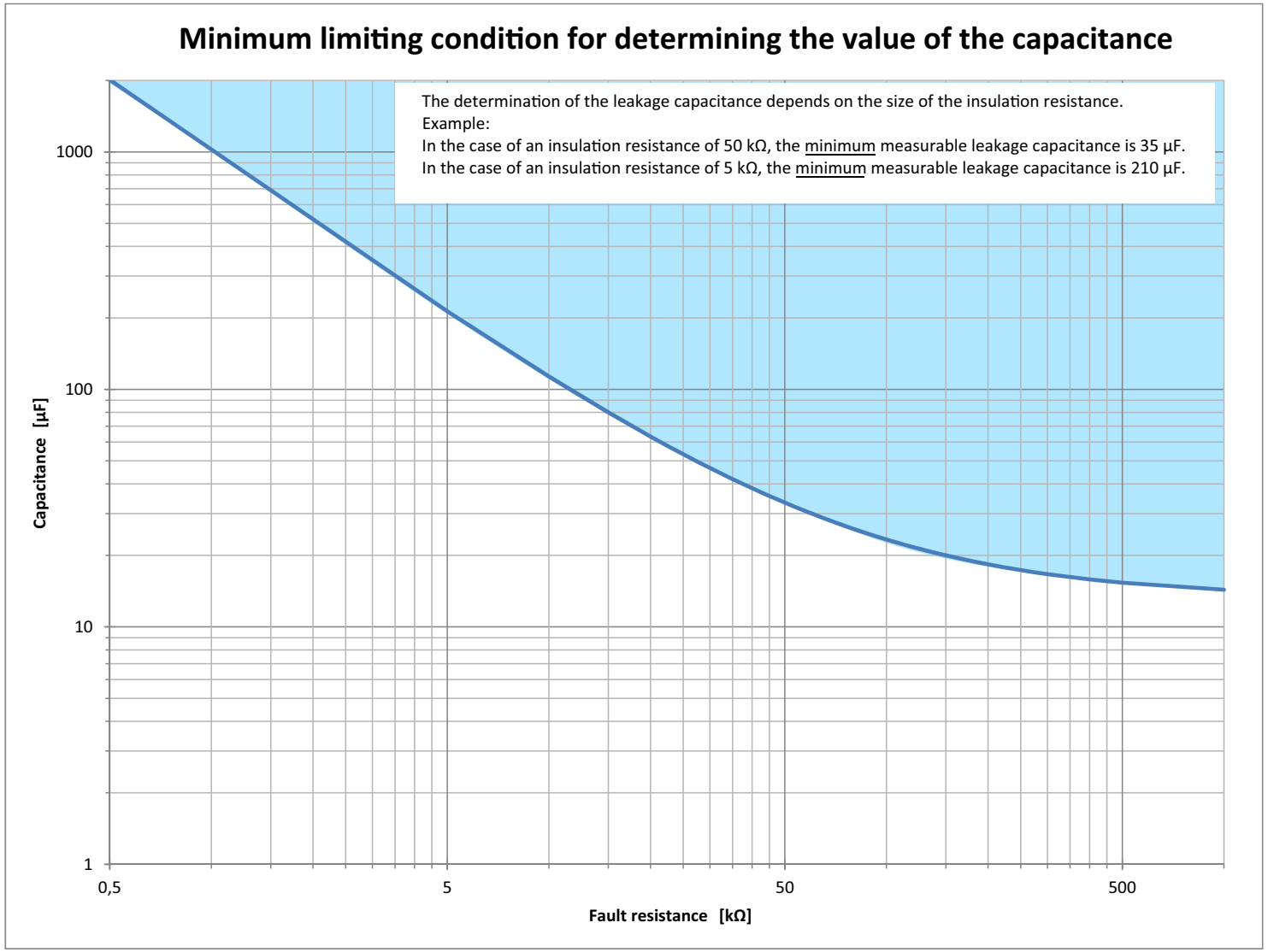
Device communication via the BMS bus

### 8.7.3 Error codes

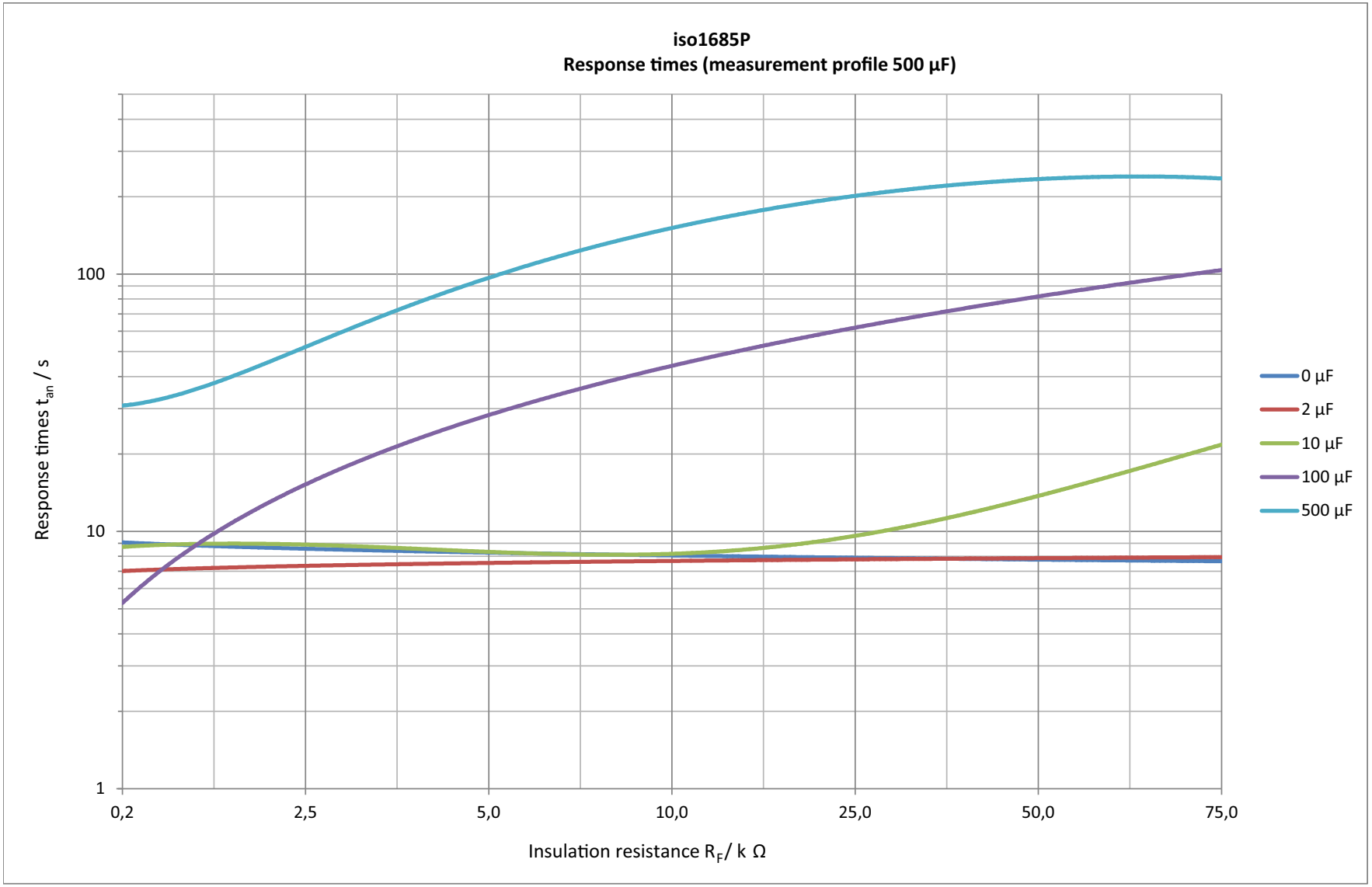
The following list contains all relevant error codes output via the BMS bus. The right-hand column describes the relevant action to be taken in each case.

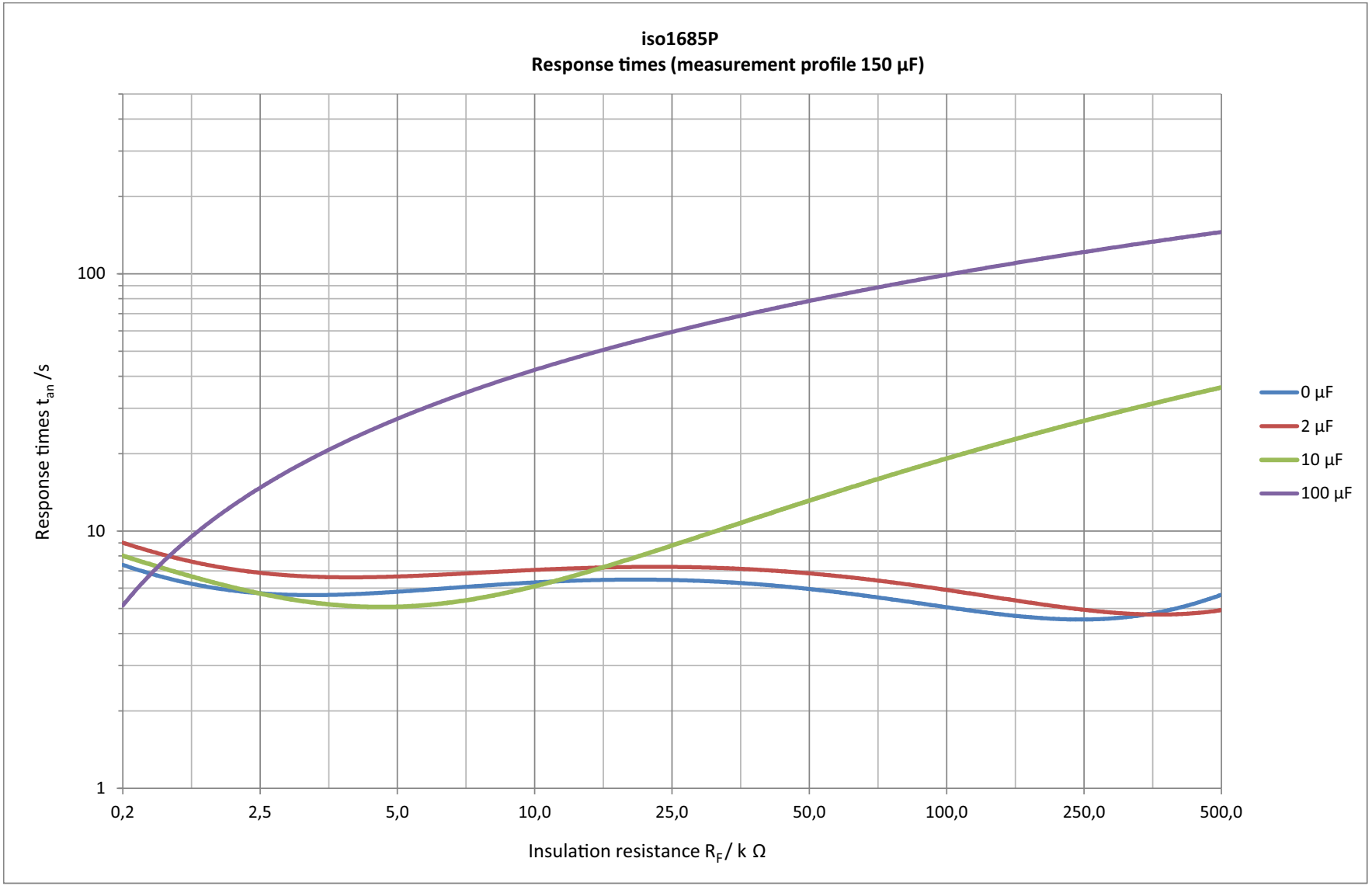
| BMS error code | Components | Fault | Action |
|---|---|---|---|
| 0.30 | Connection | Connection earth (E/KE) | Check connection |
| 0.40 | Connection | Connection system (L1/+, L2/–) | Check connection |
| 4.05 | Parameter | Incorrect measurement method selected | Change measurement method |
| 7.63 | System | Timeout system management | Restart the device |
| 8.11 | Hardware | Self test insulation measurement | Contact service |
| 8.12 | Hardware | Hardware measuring voltage source | Replace device |
| 8.31 | Hardware | PGH: locating current too high | Replace device |
| 8.32 | Hardware | PGH: locating current cannot be switched off | Replace device |
| 8.42 | Hardware | Supply voltage ADC | Replace device |
| 8.43 | Hardware | Supply voltage +12 V | Replace device |
| 8.44 | Hardware | Supply voltage –12 V | Replace device |
| 8.45 | Hardware | Supply voltage +5 V | Replace device |
| 8.46 | Hardware | Supply voltage +3.3 V | Replace device |
| 9.61 | Parameters | Insulation measurement | Load factory settings and set parameters again |
| 9.63 | Parameters | Locating current injector | Load factory settings and set parameters again |
| 9.64 | Parameters | Voltage measurement | Contact service |
| 9.70 | System | General software error | Restart the device |
| 9.71 | System | Control flow | Restart the device |
| 9.72 | System | Programme sequence insulation measurement | Restart the device |
| 9.74 | System | Programme sequence locating current injector | Restart the device |
| 9.75 | System | Programme sequence voltage measurement | Restart the device |
| 9.76 | System | Programme sequence temperature measurement | Restart the device |
| 9.77 | System | Programme sequence history memory | Restart the device |
| 9.78 | System | Programme sequence console | Restart the device |
| 9.79 | System | Programme sequence self test | Restart the device |
| 9.80 | System | Stack error | Restart the device |
| 9.81 | System | Internal programme sequence | Restart the device |
| 9.82 | System | Internal programme sequence | Restart the device |

## 9.1 The measurable leakage capacitance depends on the insulation resistance



### 9.1.1 Response time for insulation measurement




iso1685P
Response times (measurement profile 150 µF)
Response times $t_{an}$ /s
100
10
1
0,2
2,5
5,0
10,0
25,0
50,0
100,0
250,0
500,0
Insulation resistance $R_F$ / k Ω
0 µF
2 µF
10 µF
100 µF

## 9.2 Example of alarms stored in the history memory

| Index | ID | Minimum / Maximum | | Unit | Description | Test | StartTime/ AcknowledgeTime / EndTime | | |
|---|---|---|---|---|---|---|---|---|---|
| Index of the history memory | ID of the entry | Min. and Max. value during the alarm | | Unit | Type of the entry (Message) | Message due to the test? | Start time/ Acknowledge time / End time of the message | | |
| Idx:797 | ID:34 | = 104 | = 104 | -- | No CT connected | No | 28.3.12 15:17 | -- | 28.3.12 15:42 |
| Idx:757 | ID:43 | = 200 | < 202 | Ω | Insulation fault | No | 13.3.12 13:50 | -- | 13.3.12 18:50 |

## 10.1 Data for iso1685P in tabular form

( )* = factory setting

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

Insulation coordination acc. to IEC 60664-1
Rated insulation voltage ..... DC 1500 V
Overvoltage category (OVC) ..... III
Rated impulse withstand voltage ..... 8 kV
Rated insulation voltage ..... 1500 V
Pollution degree exterior ..... 3
Voltage test, routine test (IEC 61010-1) ..... 2.2 kV

### Voltage ranges

Nominal system voltage range $U_n$ ..... AC 0...1000 V/DC 0...1500 V
Tolerance of $U_n$ ..... AC +10 %/DC +6 %
Frequency range of $U_n$ ..... DC, 1...460 Hz
Supply voltage $U_s$ (see also device nameplate) ..... DC 18...30 V
Frequency range of $U_s$ ..... DC
Power consumption ..... ≤ 7W

### Measuring circuit for insulation monitoring

Measuring voltage $U_m$ (peak value) ..... ±50 V
Measuring current $I_m$ (at $R_F = 0\ \Omega$) ..... ≤ 1.5 mA
Internal DC resistance $R_i$ ..... ≥ 70 kΩ
Impedance $Z_i$ at 50 Hz ..... ≥ 70 kΩ
Permissible extraneous DC voltage $U_{fg}$ ..... ≤ DC 1500 V
Permissible system leakage capacitance $C_e$ ..... ≤ 500 µF (150 µF)*
Measuring range leakage capacitance ..... 20...500 µF
Tolerance measurement of $C_e$ ..... ±10 % ±10 µF
Frequency range measurement of $C_e$ ..... DC, 30...460 Hz

### Response values for insulation monitoring

Response value $R_{an1}$ (alarm 1) ..... 200 Ω...1 MΩ (10 kΩ)*
Response value $R_{an2}$ (alarm 2) ..... 200 Ω...1 MΩ (1 kΩ)*
Condition response value ..... $R_{an1} \geq R_{an2}$
Upper limit of the measuring range when set to $C_{emax} = 500$ µF ..... 200 kΩ
Relative uncertainty (10 kΩ...1 MΩ) (acc. to IEC 61557-8) ..... ±15 %
Relative uncertainty (0.2 kΩ...< 10 kΩ) ..... ±200 Ω ±15 %
Hysteresis ..... 25 %

### Time response

Response time $t_{an}$ ..... see page 31

### Measuring circuit for insulation fault location (EDS)

Locating current $I_L$ DC ..... ≤ 50 mA
Test cycle/pause ..... 2/4 s

### Memory

µSD card for history memory and log files ..... ≤ 32 GB

### LEDs

ON (operation LED) ..... green
PGH ON ..... yellow
SERVICE ..... yellow
ALARM 1 ..... yellow
ALARM 2 ..... yellow

### Digital inputs

Operating mode, adjustable ..... active high, active low
Function digital input 1 ..... Test (< 1s) / Standby (> 2s)
Function digital input 2 ..... reset
High level ..... 10...30 V
Low level ..... 0...0.5 V

### Serial interfaces

Interface/protocol ..... RS-485/BMS
Connection ..... terminals A/B
Cable length ..... ≤ 1200 m
Shielded cable (shield to functional earth on one end) ..... 2-core, ≥ 0.6 mm², z. B. J-Y(St)Y2x0.6
Shield ..... terminal S
Terminating resistor, can be connected (term. RS-485) ..... 120 Ω (0.5 W)
Device address, BMS bus ..... 2...33 ( 2)*

### Switching elements

Switching elements ..... 3 changeover contacts: K1 (insulation fault Alarm 1), K2 (insulation fault Alarm 2), K3 (device error)
Operating principle K1, K2 ..... N/C operation n.c. /N/O operation n.o. (N/C operation n.c.)*
Operating principle K3 ..... N/C operation n.c., cannot be changed
Contact data acc. to IEC 60947-5-1:
Utilisation category ..... AC 13 AC 14 DC-12 DC-12 DC-12
Rated operational voltage ..... 230 V 230 V 24 V 110 V 220 V
Rated operational current ..... 5 A 3 A 1 A 0.2 A 0.1 A
Minimum contact rating ..... 1 mA at AC/DC ≥ 10 V

Technical data

### Connection (except system coupling)

Connection type ..... pluggable push-wire terminals
Connection, rigid/flexible ..... 0.2…2.5/ 0.2…2.5 mm²
Connection flexible with connector sleeve, without/with plastic sleeve ..... 0.25…2.5 mm²
Conductor sizes (AWG) ..... 24…12

### Connection of the system coupling

Connection type ..... pluggable push-wire terminals
Connection, rigid/flexible ..... 0.2…10/0.2…6 mm²
Connection, flexible with ferrules, without/with plastic sleeve ..... 0.25…6/0.25…4 mm²
Conductor sizes (AWG) ..... 24…8
Stripping length ..... 15 mm
Opening force ..... 90…120 N

### Environment/EMC

EMC ..... IEC 61326-2-4
Classification of climatic conditions acc. to IEC 60721:
Without solar radiation, precipitation, water, icing. Condensation possible temporarily:
Stationary use (IEC 60721-3-3) ..... 3K5 (except condensation and formation of ice)
Transport (IEC 60721-3-2) ..... 2K3
Long-time storage (IEC 60721-3-1) ..... 1K4
Classification of mechanical conditions acc. to IEC 60721:
Stationary use for iso1685P (IEC 60721-3-3) ..... 3M4
Stationary use for iso1685PW (IEC 60721-3-3) ..... 3M7
Transport (IEC 60721-3-2) ..... 2M2
Long-term storage (IEC 60721-3-1) ..... 1M3
Deviation from the classification of climatic conditions:
Ambient temperature ..... -40 …+ 70 °C
Ambient temperature transport ..... -40 …+ 80 °C
Ambient temperature long-term storage ..... -25 …+ 80 °C
Area of application ..... ≤ 3000 m AMSL

### Other

Operating mode ..... continuous operation
Position of normal use ..... vertical, system coupling on top
PCB fixation ..... lens head screw DIN7985TX
Tightening torque ..... 1.0…1.5 Nm
Degree of protection, internal components ..... IP30
Degree of protection, terminals ..... IP30
Flammability class ..... V-0
Weight ..... 650 g
( )* = factory setting

## 10.2 Factory settings

| Parameters | Parameter Condition | can be set via |
|---|---|---|
| Insulation response value $R_{an1}$ | 10 kΩ | BMS |
| Insulation response value $R_{an2}$ | 1 kΩ | BMS |
| Fault memory insulation measurement | off | BMS |
| Relay K1 (11/12/14) | N/C operation | BMS |
| Relay K2 (21/22/24) | N/C operation | BMS |
| Relay K3 (31/32/34) | N/C operation | – |
| EDS mode | auto | BMS |
| PGH current | 30 mA | BMS |
| Standby mode (disconnection from the mains) | off | BMS |
| Reset to factory setting | --- | BMS |
| BMS address | 2 | SS8103 |
| BMS termination | ON | SS8101 |
| Permissible system leakage capacitance | ≤ 150 µF | SS8103 |
| Measurement speed | Fast | SS8103 |

Technical data

## 10.3 Standards and certifications

The iso1685P was designed according to the following standards:
- DIN EN 61557-8 (VDE 0413-8)
- IEC 61557-8
- DIN EN 61557-9 (VDE 0413-9)
- IEC 61557-9
- IEC 61326-2-4
- DIN EN 60664-1 (VDE 0110-1)

## 10.4 Ordering data

| Type | Response value range | Nominal voltage | Supply voltage * | Art. No. |
|---|---|---|---|---|
| iso1685P-425 | 200 Ω…1 MΩ | AC 0…1000 V<br>DC 0…1500 V | DC 18…30 V | B91065801 |
| iso1685PW-425 | 200 Ω…1 MΩ | AC 0…1000 V<br>DC 0…1500 V | DC 18…30 V | B91065801W |

The data labelled with an * are absolute values

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