DC AC/DC PV

BENDER
The Power in Electrical Safety©

ISOMETER®
isoPV1685RTU / isoPV1686P

Insulation monitoring device for unearthed photovoltaic systems

isoPV1685RTU: software version D0532 V3.0x
isoPV1685P: software version D0525 V2.0x
From serial number 2108…

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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!*

*Read the manual **before** you begin to mount, connect, and commission the unit. Always keep the manual within easy reach for future reference following commissioning.*

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.

DANGER	*This signal word indicates that there is a **high risk of danger** that will result in **electrocution** or **serious injury** if not avoided.*
WARNING	*This signal word indicates a **medium risk of danger** that can lead to **death** or **serious injury** if not avoided.*
CAUTION	*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

1.2.1 End customer support and advice

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

- Questions concerning specific customer applications
- Commissioning
- Troubleshooting

Telephone: +49 6401 807-760 (365 days from 07:00 - 20:00 Uhr [MEZ/UTC +1])
Fax: +49 6401 807-259
0700BenderHelp (Tel. and Fax in Germany only)
E-mail: support@bender.de

1.2.2 Repair

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
- Extended guarantee, in-house repair service, 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.de

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

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

1.2.3 Customer service

On-site service for all Bender products

- Commissioning, parameter setting, maintenance, troubleshooting
- 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)/
+49 6401 807-753* (sales)
Fax: +49 6401 807-759
E-mail: fieldservice@bender.de
Internet: www.bender.de
* Mo-Thu 07:00 a.m. - 16:00 p.m. , Fr 07:00 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 -> 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 Manufacturers' Association) also applies. Amending the “General Conditions for the supply of Products and Services of the Electrical and Electronics Industry” (GL)*

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 Warranty and liability

Warranty and liability claims in the event of injury to persons or damage to property are excluded if they can be attributed to one or more of the following causes:

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

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

1.7 Disposal

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

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

- 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 -> 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".

*Read the operating manual **before** starting to mount, connect and com-mission the device. After successful commissioning, keep the manual within easy reach for future reference.*

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 instructions

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

IT systems with several ISOMETER®s
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. For IT systems coupled via diodes or capacitances 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.

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.

2.4 Intended use

The isoPV1685RTU and the isoPV1685P are used for insulation monitoring of large photovoltaic systems up to AC 1000V and DC 1500 V designed as IT systems. The measurement method specially developed for slow voltage fluctuations (MPP tracking) monitors the insulation resistance even in systems equipped with large solar generator panels where extremely high system leakage capacitances against earth exist due to interference suppression methods. Adaptation to system-related high leakage capacitances also occurs automatically.

The isoPV1685P generates locating current pulses required for insulation fault location. That allows the localisation 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, the equipment must be adjusted to local equipment and operating conditions by means of customised parameter settings. Please heed the limits of the range of application indicated in the technical data.

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

3. Function

3.1 Features isoPV1685RTU and isoPV1685P

The device version isoPV1685P provides a locating current injector.

- Insulation monitoring of large-scale photovoltaic systems
- 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. $R_{an1} \geq R_{an2}$ applies.
- Automatic adjustment to high system leakage capacitances up to 2000 µF, selectable range
- Connection monitoring of L+, L- for reverse polarity (DC only)
- Integrated locating current injector up to 50 mA (isoPV1685P only)
- Device self test with automatic message in the event of a fault
- Alarm relays separately adjustable for insulation fault 1, insulation fault 2 and device error
- CAN interface to output measured values, statuses and alarms
- RS-485 interface
  - isoPV1685P: BMS bus, e.g. to control the insulation fault location
  - isoPV1685RTU: BMS bus or Modbus (can be switched using the DIP switch)
- µSD card with data logger and history memory for alarms

Tabular overview of features

	isoPV1685RTU	isoPV1685P
Insulation fault localisation (locating current injector)		X
Digital inputs	X	X
µSD card	*	X
CAN bus	X	X
BMS bus	X	X
Modbus RTU	X	

* The µSD card is not equipped, but can be inserted later.

The isoPV1685RTU uses the RS-485 interface for the BMS bus or for Modbus RTU: The device can be switched between BMS and Modbus.

3.2 Product description

The ISOMETER® isoPV1685RTU is an insulation monitoring device for IT systems in accordance with IEC 61557-8. The ISOMETER® isoPV1685P is an insulation monitoring device for IT systems in accordance with IEC 61557-8 and IEC 61557-9.

The ISOMETER®s can be used in photovoltaic installations.

3.3 Functional description

3.3.1 General functional description

Insulation monitoring is carried out using an active measuring pulse which is superimposed onto the PV system to earth via the integrated coupling.

isoPV1685RTU:

If the insulation resistance between the PV system and earth falls below the preset prewarning response value R_{an1}, the "Alarm 1" LED lights and the alarm relay K1 switches. If the value also falls below response value R_{an2}, the "Alarm 2" LED also lights and the alarm relay K2 switches.

isoPV1685P:

If the insulation resistance between the PV system and earth falls below the preset prewarning response value R_{an1}, the "Alarm 1" LED lights and the alarm relay K1 switches. If the value also falls below response value R_{an2}, the "Alarm 2" LED also lights and the alarm relay K2 switches.

The locating current injector integrated in the device for insulation fault location is either activated externally via the BMS interface or via the internal backup master function if no external master has been connected. When starting the insulation fault location, the LED "PGH on" signals the locating current pulse.

The insulation fault location can be started manually via the digital input 1, e.g. for insulation fault location with mobile insulation fault locators (e.g. EDS195).

3.3.2 µSD card

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:

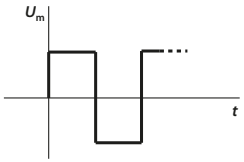
- Insulation resistance and leakage capacitance
- System voltage, partial voltages to earth, supply voltages
- Temperature locating current injector (isoPV1685P only)
- Temperature coupling L+, L–
- Insulation fault
- Connection faults and device errors

Following each start-up, a new log 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. The typical time that is needed until the maximum file size is reached is approximately 2 days. Hence, a µSD card with a memory space of 2 GByte can record data for approx. 400 days.

When the maximum data limit is reached on your card, the oldest file in each case will be overwritten. The history memory that is also copied to the µSD card contains all alarms in csv. format.

3.3.3 Insulation monitoring

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

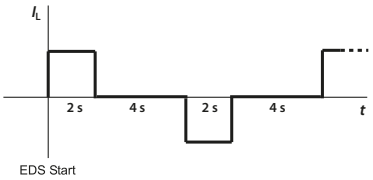


Pulse sequence of the measuring voltage for insulation fault monitoring

An insulation fault between the IT system and earth closes the measuring circuit. If the insulation resistance between system and earth falls below the set response values R_{an1} and R_{an2} (response value R_{an1} can be set equal or higher than R_{an2}), the associated alarm relays K1 (11, 12, 14) or K2 (21, 22, 24) switch. Detected insulation faults are signalled to other bus devices via the BMS bus. In addition, the alarm LEDs ALARM 1 or ALARM 2 light up.

3.3.4 Insulation fault location

For insulation fault location, a suitable locating current is superimposed onto the faulty IT system with which insulation fault locators of the EDS... series can locate insulation faults. The ISOMETER® features an internal locating current injector with I_L DC 50 mA.



Pulse sequence of the internal locating current injector for insulation fault location

When permanently installed insulation fault locators (with master capability) such as the EDS440 are used, 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 isoPV1685P 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 and the coupling is disconnected from the mains.

3.3.5 Assignment of the alarm relays K1, K2, K3

Relay assignment

K1 switches when the value falls below the alarm 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 error or a connection fault.

3.3.6 Measured value transmission to the control inputs of the inverter

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

3.3.7 History memory

All warnings, alarms and device errors including "Come", "Go" and "Acknowledgement" timestamps are stored in the internal history memory.

The history data are copied from the internal EEPROM to the History.csv file on the µSD card under the following conditions:

- After device start-up
- During operation once per 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. This tool allows csv.-file data to be processed and evaluated. By way of example, history memory entries are shown on page 42.

The tool includes detailed information about the use.

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 error or a connection fault is detected, the corresponding alarm will be signalled via the CAN and the RS-485 interface as well as via the alarm relay K3 (31-32-34). This relay continuously operates 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
- System polarity
- Temperature measurement
- Measuring voltage generator

3.4.3 Manual self test

The self test is started via the CAN or RS-485 interface by a Modbus or BMS master with the test button or by any CAN bus device.

Only in the manual self test mode (via the CAN or RS-485 interface), the following tests can be carried out:

- Internal Flash
- Internal RAM
- CPU register
- Watchdogs
- Oscillator
- Function of the Iso measurement technique
- Restart of the device including re-initialising and recalibration (only when the test is requested via RS-485 interface)

3.4.3.1 Manual self test via the RS-485 interface

During the manual self test via the RS-485 interface, the alarm relays K1 (11-12-14) and K2 (21-22-24) are **switched**. K3 is only shortly switched **after a device restart** .

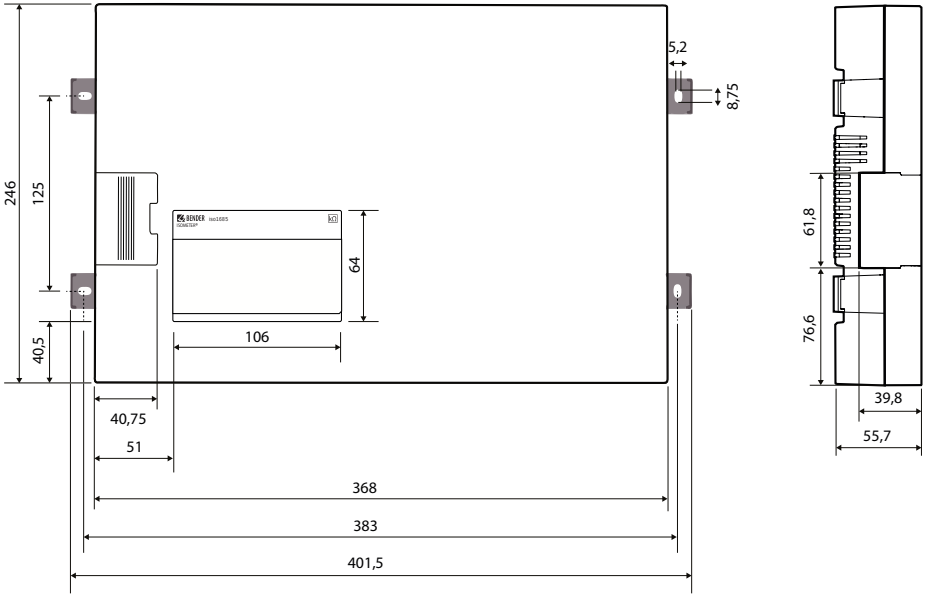
3.4.3.2 Manual self test via CAN bus

isoPV1685RTU and isoPV1685P:
During the insulation fault measurement test, the alarm relay **K1** (11-12-14) and the alarm relay **K2** (21-22-24) are **switched**. K3 **won't** be switched.

Once a month, carry out a manual self test via the CAN or RS-485 interface to ensure that the device functions correctly!

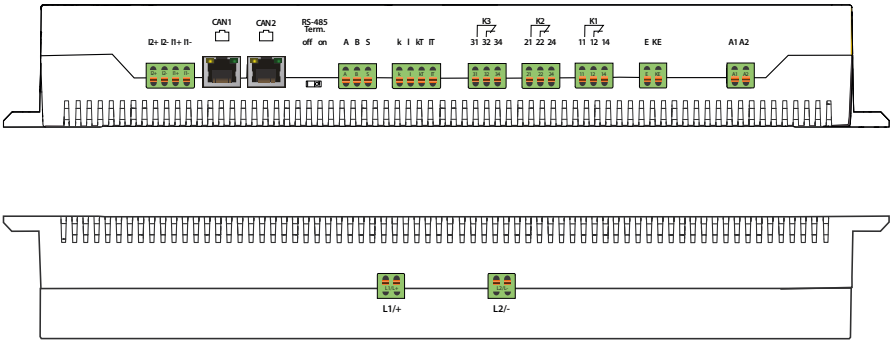
4. Device overview

4.1 Dimensions



All dimensions in mm

4.2 Connections



upper graphic	
I2+,I2- / I1+, I1-	digital Inputs
CAN1 / CAN2	no function
RS485 Term. off / on	RS-485 termination
A, B, S	RS-485 bus connection (A,B) Protocol: BMS S= PE potential Connect one end of shield
k, I, kT, IT	no function
31, 32, 34	Relay output for internal device errors (LED SERVICE)
21, 22, 24	Relay output for alarm 2 insulation faults
11, 12, 14	Relay output for alarm 1 insulation faults
E / KE	Separate connection of E (earth) and KE (reference) to PE. Connect both to PE
A1, A2	Supply voltage U_s DC 24 V Arbitrary polarity Connection via fuses, 2 A each
lower graphic	
L1/+	Connection to L1/+ of the IT system via 1 A fuse
L2/-	Connection to L2/- of the IT system via 1 A fuse

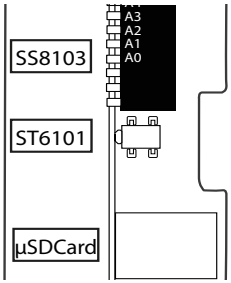
4.3 Display and operating controls

4.3.1 Display elements

1	ON (green)	Power On indicator: Flashes with a pulse duty factor of approx. 80 %. Device error: Lights continuously when the device stops functioning (device stopped). Software update: Flashes approx. three times faster during the firmware update than in the standard mode, update time < 4 minutes.
2	PGH ON (yellow)	Insulation fault location (isoPV1685P only) The LED "PGH ON" flashes during insulation fault location. It indicates that the locating current for the insulation fault location is generated.
3	SERVICE (yellow)	Internal device error and connection fault . (System, earth, measuring current transformer): Lights continuously. Also refer to the list of error codes on page 29
4	ALARM 1 (yellow)	Insulation fault 1 (prewarning): 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
5	ALARM 2 (yellow)	Insulation fault 2 (alarm): The "ALARM 2" LED lights continuously when the insulation resistance falls below the response value 2, $R_F < R_{an2}$
6	ALARM 3 (yellow)	no function

4.3.2 Operating elements in the service lid

The representation below shows the position of the operating elements



Operating elements	Function
DIP switch (SS8103)	isoPV1685RTU: • Switching between BMS and Modbus: A4 • BMS /Modbus address setting: A3…A0 • Leakage capacitance setting • Measurement speed setting
	isoPV1685P: • BMS address setting: A4…A0 • Leakage capacitance setting • Measurement speed setting
Button (ST6101)	• Alarm reset
Memory card (µSD card)	• Memory for log files and history memory (µSD card);

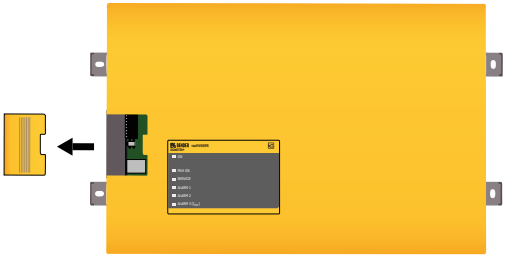
4.3.3 Access to DIP switch and to the µSD card via the service lid

Open the service lid by pressing gently on the ribbed surface and pulling the lid from the enclosure away.

After removing the lid the following settings can be carried out:

- Changing the BMS address or the Modbus address (SS8103)
- Setting the maximum leakage capacitance (SS8103)
- Changing the measurement speed (SS8103)
- Resetting alarms (ST6101)

In addition, you can access the µSD card to read out stored alarms, for example.



For a description of the DIP switches, refer to Chapter 7.3 Setting the system leakage capacitance or measurement speed on page 31.

5. Mounting and connection

5.1 Mounting

Mount the device using four M5 screws, refer also to the dimension diagram where the drilling holes are illustrated (see "Dimensions" on page 19). Mount the device so that the display can be read during operation and the mains connection is (L1/+, L2/–) positioned at the top.

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 may be damaged. If several devices are connected, the device does not work and does not signal insulation faults. Make sure that only one insulation monitoring device is connected.
Heat on the enclosure surface!
The surface temperature of 60 °C can be exceeded under certain operating conditions.
Keep the cooling slots uncovered by keeping a distance of at least 15 cm above and at least 10 cm below the device to adjacent objects in order to ensure constant air circulation.
Risk of injury from sharp-edged terminals!
Risk of lacerations. Touch the enclosure and the terminals with due care.

5.2 Connection

5.2.1 Connection requirements

*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.*

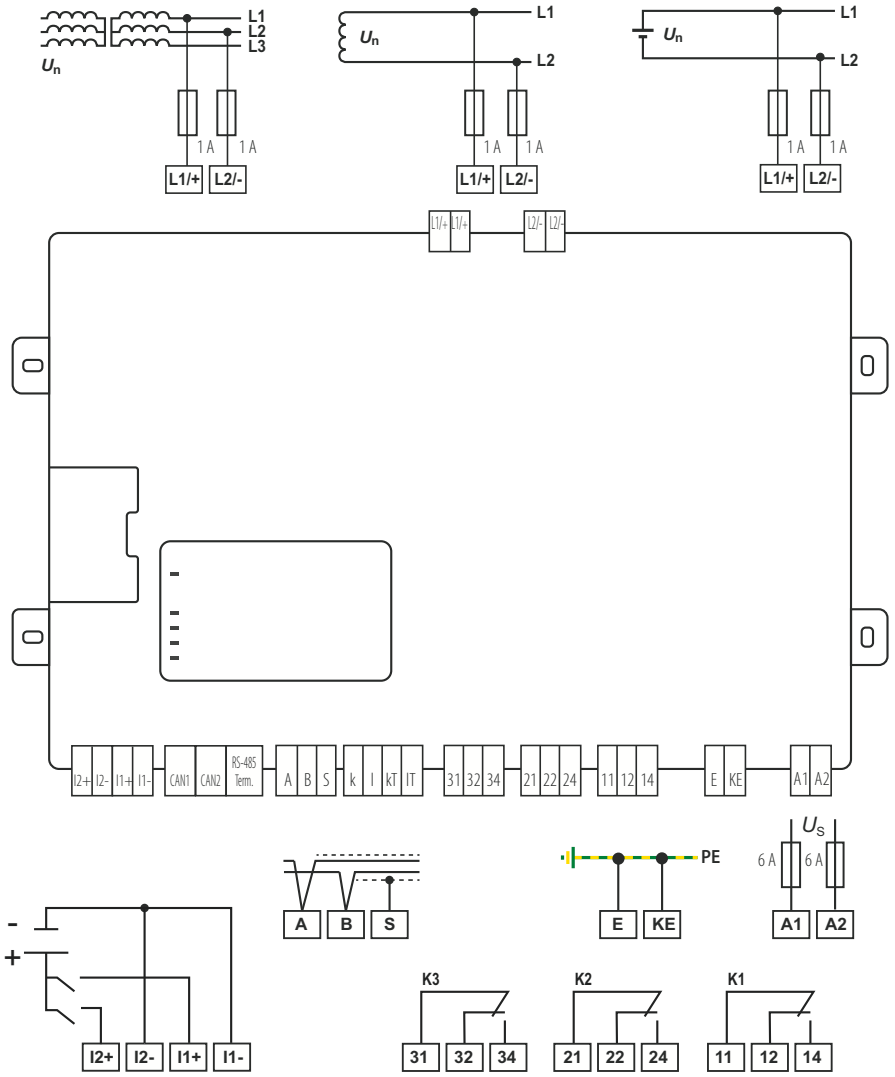
Ensure disconnection from the IT system!
When insulation or voltage tests are to be carried out, the device must be isolated from the system for the test period. Otherwise the device may be damaged.

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.

Pluggable push-wire terminals
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 Wiring diagram

Connect the device with the help of the connection and terminal diagram. Use the adjacent legend.



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.

Terminal, Socket	Connections
I2+, I2–	Digital input isoPV1685RTU: Reset / (Memory) isoPV1685P: out of function
I1+, I1–	Digital input isoPV1685RTU: Test (signal ≤ 1,5 s) / Standby (signal > 2 s) isoPV1685P: Start of the insulation fault location in manual mode
CAN2 CAN1	Connection to CAN bus, 2 x RJ-45, can be terminated with CAN 120-Ω termination plug.
A, B, S	Connection to Modbus or BMS bus, RS-485, S= shield (connect one end to PE), can be terminated with terminating switch RS-485 Term.
k, l/kT, lT	no function
31, 32, 34	Alarm relay K3 for internal device errors.
21, 22, 24	Description of relay assignment according to device type, see page 16; Alarm relay K2 for insulation faults.
11, 12, 14	Alarm relay K1 for insulation faults.
E, KE	Separate connection of E and KE to PE.
A1, A2	Connection to U_s = DC 24 V via fuses, 6 A each.
L+, L–	Connection to the network to be monitored.

WARNING

Injuries, fires and property damage due to short circuits

According to DIN VDE 0100-430, you can dispense with protective devices for short-circuit protection for coupling the terminals "L1/+" and "L2/-" to the IT system to be monitored if the line or cable is designed in such a way that the risk of a short circuit is kept to a minimum. Ensure short-circuit-proof and earth-fault-proof routing.

5.2.3 Connecting the EDS to the ISOMETER® isoxx1685DP

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

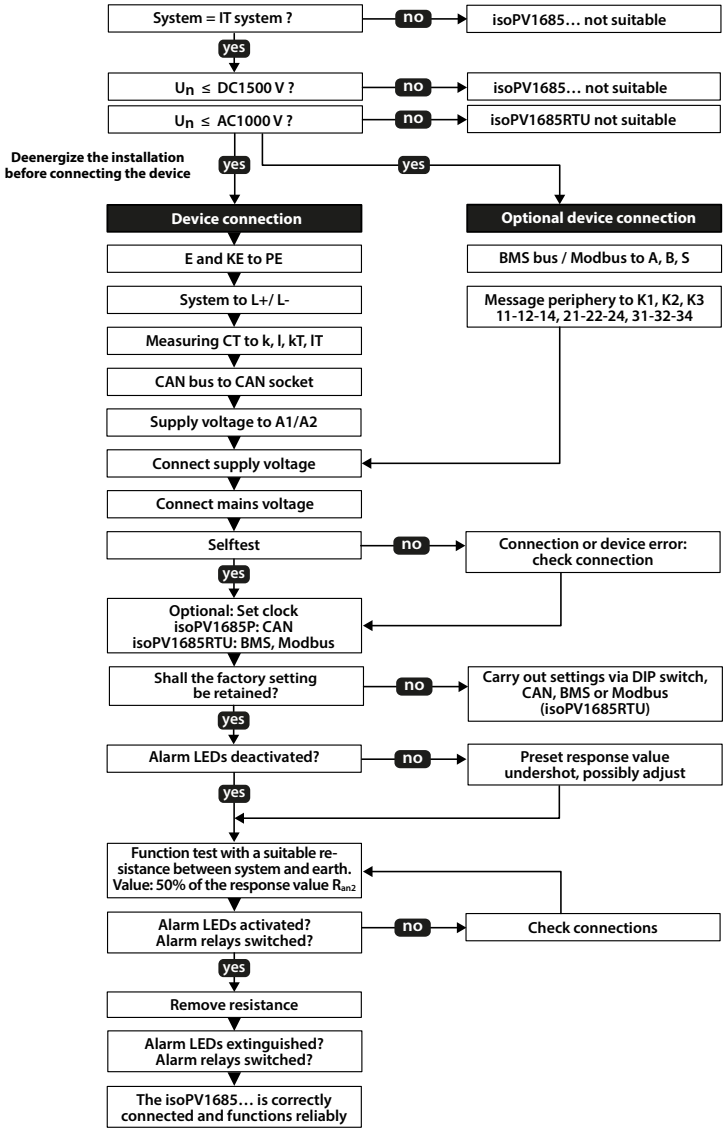
Risk of incorrect measurement

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

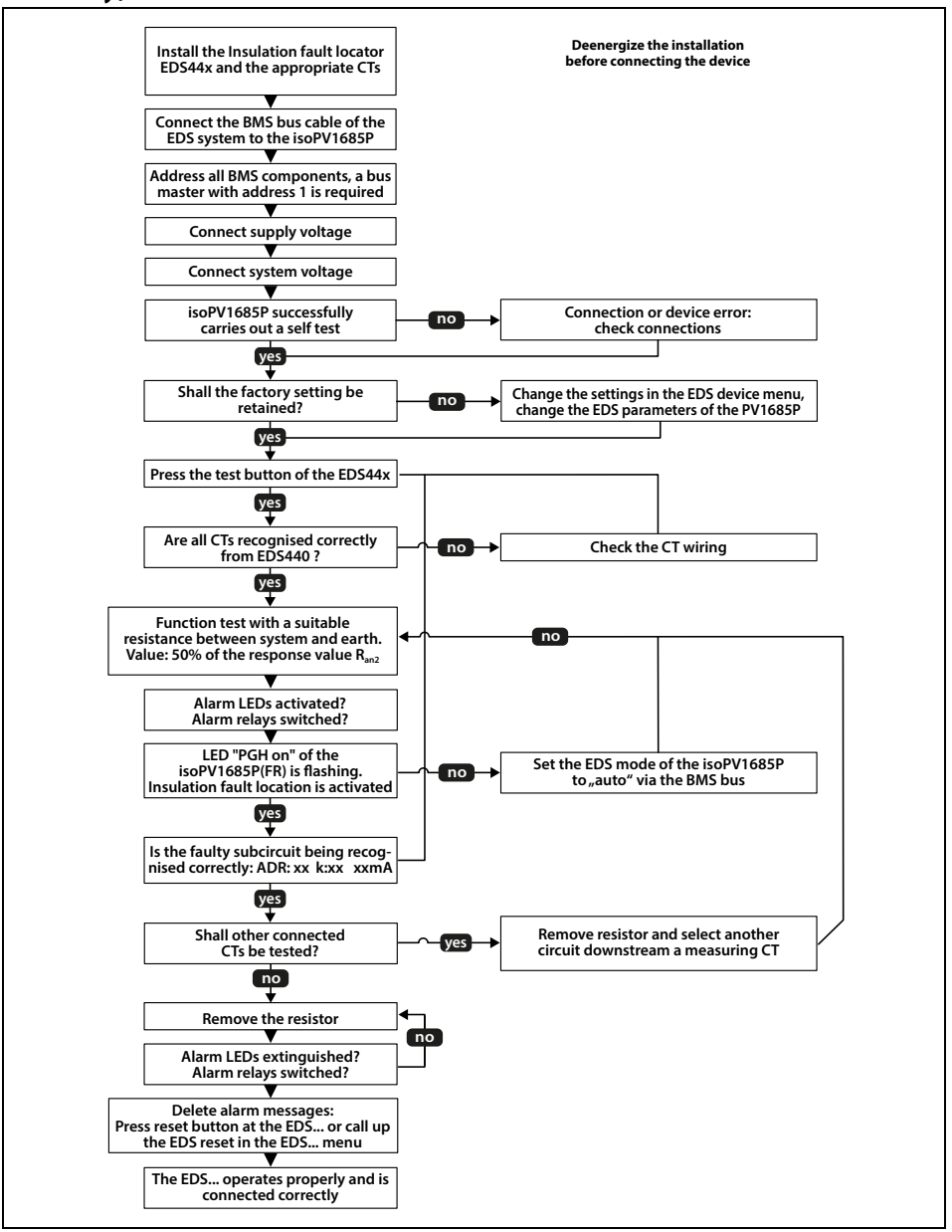
Insulation monitoring is deactivated while the insulation fault location is active.

6. Commissioning

6.1 Commissioning flow chart insulation fault monitoring



6.2 Commissioning flow chart insulation fault location (isoPV1685P only)



7. Settings

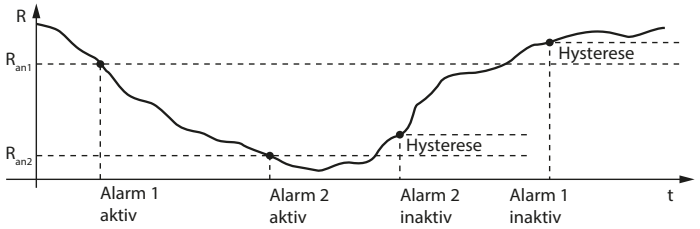
7.1 Setting BMS address

Refer to "Setting the BMS address" on page 37.

7.2 Setting an alarm for insulation faults

You can set the limit values for alarm 1 and alarm 2 of the ISOMETER® via the BMS bus by means of a BMS gateway (e.g. COM460IP) or a terminal program. Activation or deactivation of the two alarm levels R_{an1} for alarm 1 and R_{an2} for 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.



One insulation resistance from 200 Ω…1 MΩ can be set respectively for alarm 1 and alarm 2. Condition: alarm 1 ≥ alarm 2.

7.3 Setting the system leakage capacitance or measurement speed

These settings may only be changed when the PV voltage is switched off.

When the maximum system leakage capacitance $C_{e\ max}$ is set to 2000µF the upper limit of measuring range for the insulation resistance decreases from 1MΩ to 50kΩ. Therefore, check also the settings of the response value R_{an}.

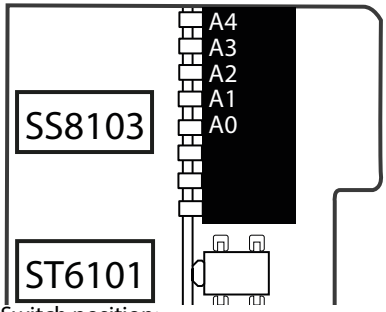
The switch 6 of the DIP switch SS8103 is used to set the profile considering the maximum system leakage capacitance $C_{e\ max}$.

The measurement speed can be changed using switch 7.

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

DIP switch SS8103, segment 6:
OFF = 500 µF = $C_{e\ max}$
ON = 2000 µF = $C_{e\ max}$

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



Switch position:
Up = Off
Down = On

7.4 Parameter setting of the insulation fault location (isoPV1685P only)

Set the value of the locating current required for insulation fault location to 1...50 mA. You can make this setting via the BMS bus by means of a BMS gateway (e.g. COM460IP) or a terminal program.

In order to be able to locate insulation faults, select one of the four available modes for insulation fault location by means of the BMS gateway (e.g. COM460IP) or terminal program via the BMS bus or Modbus.

off

The insulation fault location is deactivated.

manual

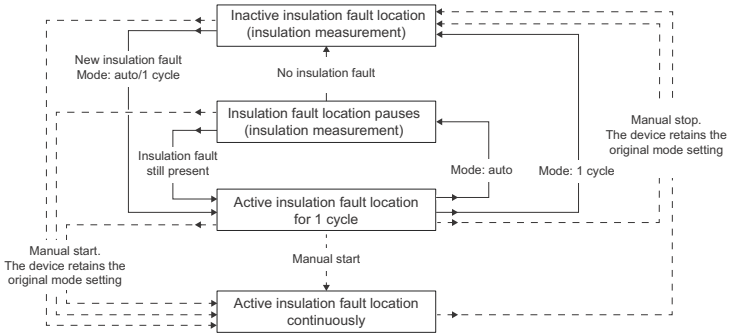
In manual mode, the insulation fault location starts immediately. If you start the insulation fault location, it remains active without considering the insulation resistance and the alarm message of the ISOMETER®.

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.

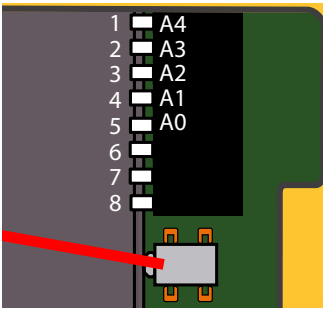


7.5 Resetting alarm messages

Recorded faults are provided as alarm messages on the BMS bus and the CAN bus.

Pressing the reset button ST6101 will reset these alarm messages. If the fault continues to exist, the message will be generated again.

The fault can also be reset by means of the acknowledgement command via the CAN bus.



7.6 Parameter setting with the iso1685 set tool

The parameters of the isoPV1685RTU can be set with the iso1685 set tool.

- You can download the software at:
  https://www.bender.de/en/service-support/downloads

By using the iso1685 set program you confirm the following conditions:
Bender provides this software free of charge and without any warranty. By using this software you agree that you are using the software at your own risk. Bender does not assume any responsibility for possible software errors or defects and does not guarantee that the software works error-free and reliably. Furthermore, Bender does not accept liability for direct or indirect damage that may arise from the use of the software.

The iso1685 set tool can only be used if there is no master in the BMS system.

8. Device communication

Over the RS-485 interface of the device, data can be transferred either via the BMS protocol or the Modbus RTU protocol. The protocol and the protocol parameters are set in the "Interface" menu 8.2 (6.3).

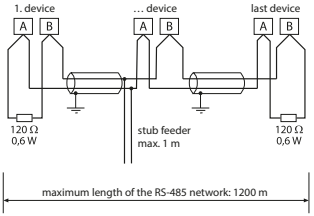
The isoPV1685P uses the RS-485 interface for the BMS bus.
The isoPV1685RTU uses the RS-485 interface for the BMS bus or for Modbus RTU - the device can be switched between BMS and Modbus. When this manual refers to the RS-485 interface, it means the function available or set in the device (BMS or Modbus).

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).

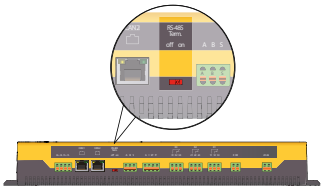
An RS-485 network that is not terminated is likely to become unstable and cause malfunctions. Only the first and last device in one line may be terminated. Hence, stub feeders in the network must not be terminated. The length of the stub feeders is restricted to a maximum of 1 m.

8.1.1 Topology RS-485 network



Connection to the terminals A and B.

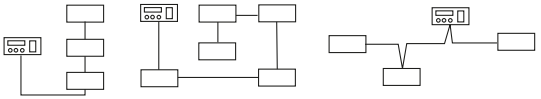
Termination



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.

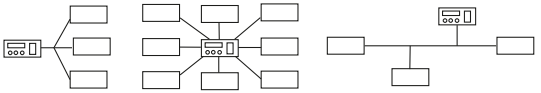
Correct arrangement

Three examples for correct arrangement:



Wrong arrangement

Three examples for wrong arrangement:

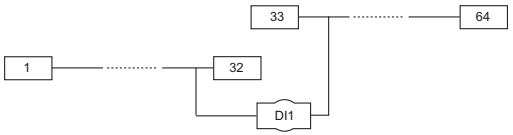


Wiring

The following cable is recommended for wiring 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.

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



8.1.2 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, waits for their response and then carries out the corresponding commands.

A device receives the master function by assigning **bus address 1** to it.

8.1.3 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 operates as master, i.e. all addresses between 1 and 150 are cyclically scanned for alarm and operating messages via the BMS bus. If the master detects incorrect answers from a slave, the fault message "Fault RS-485" will be output via the BMS bus.

The following fault causes may exist:

- 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

8.1.4 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...90) to all other bus devices in consecutive order.

8.1.5 Address setting and termination

Correct address setting and termination is essential for proper functioning of the isoxx1685xx-xxx series insulation monitoring device.

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!

8.1.6 Setting the BMS address

The ISOMETER® cannot switch on a potential termination at the BMS bus. Even though this is not expected to cause communication problems, the ISOMETER® should be operated as BMS slave if possible (BMS address > 1).
If no other device with master capabilities is available on the bus, the ISOMETER® can be set to master (BMS address 1).

Before the ISOMETER® takes over the backup master function after being switched on, it waits to see if another master connects to the system.
Waiting period: BMS address minus 1 = waiting period in minutes.
Example: The iso1685DP has BMS address 3. It waits 3 minus 1 minutes (= 2 minutes) for a master to connect.

Set the BMS address ((1)2…90) in the device menu via the following path:

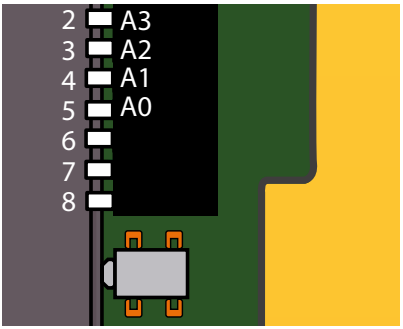
Device settings* > *Interface* > *BMS* > *BMS address.

isoPV1685RTU:

The A4 switch of the dip switch SS8103 is used to switch between BMS and Modbus (refer to 8.4 "RS-485 interface with Modbus protocol" on page 40).

Switch position:

Up = Off
Down = On

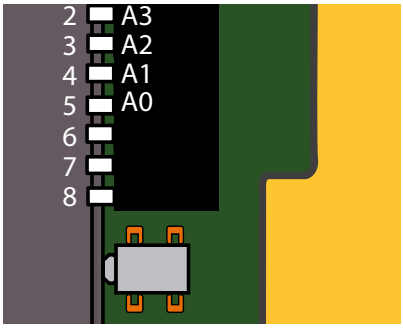


	DIP switch SS8103			
BMS addr.	**A3**	**A2**	**A1**	**A0**
2	0	0	0	0
3	0	0	0	1
4	0	0	1	0
5	0	0	1	1
6	0	1	0	0
7	0	1	0	1
8	0	1	1	0
9	0	1	1	1
10	1	0	0	0
..	..	..	..	..
...	...	...	...	...
17	1	1	1	1

isoPV1685RTU:

Switch position:

Up = Off
Down = On



	DIP switch SS8103				
BMS addr.	**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

8.1.7 Alarm and operating messages via BMS bus

Messages are transmitted via up to 12 BMS channels. All alarm and operating messages that may occur are described below.

8.1.7.1 Alarm messages

Alarm	Ch.	Meaning
Alarm 1 (insulation fault)	1	Insulation resistance < response value R_{an1} (prewarning)
Alarm 2 (insulation fault)	2	Insulation resistance < response value R_{an2} (alarm)
Connection system (reverse polarity)	4	Connection fault: L+, L– reversed
Connection PE	5	Connection fault: E/KE not connected to PE
Device error	7	Internal device error with error code
Overtemperature coupling	10	Overtemperature coupling L+
Overtemperature coupling	11	Overtemperature coupling L–
Overtemperature PGH	12	Overtemperature of the locating current injector; Channel only used in isoPV1685P

8.1.7.2 Operating messages

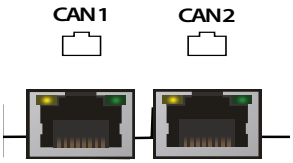
Alarm	Ch.	Meaning
Insulation resistance	1	Insulation resistance ≥ response value R_{an1}
Insulation resistance	2	Insulation resistance ≥ response value R_{an2}
Leakage capacitance	4	Leakage capacitance C_e to earth
Mains voltage	5	Voltage between L+ and L–
Partial voltage U+/PE	6	Voltage between L+ and PE
Partial voltage U-/PE	7	Voltage between L– and PE
PGH current	8	Present locating current of the locating current injector (PGH) Channel only used in isoPV1685P
Temperature coupling	10	Present temperature of the coupling L+
Temperature coupling	11	Present temperature of the coupling L–
Temperature PGH	12	Present temperature of the locating current injector Channel only used in isoPV1685P

8.1.8 Performing a 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.

8.2 CAN bus

Independently of this manual, communication via CAN interface is specified in a separate document. It can be downloaded at https://www.bender.de/en/service-support/download-area/. The CAN bus termination is carried out from the outside by means of a 120-Ω termination plug.



8.3 Error codes BMS and CAN bus

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

Error code		Error		To do
BMS	CAN	Component	Description	
0.10	0x2040	Connection	CT connection	Check connection
0.30	0x2008	Hardware	Connection to earth (E/KE)	Check connection
8.11	0x8003	Hardware	Self test insulation monitoring	Contact service
8.12	0x8007	Hardware	Measuring voltage source	Replace the device
8.21	0x8004	Hardware	Self test residual current monitoring	Contact service
8.31	0x8007	Hardware	PGH: Locating current too high	Replace the device
8.32	0x8007	Hardware	PGH: Locating current isn't to switch out	Replace the device
8.41	0x8005	Connection	Mains voltage (L+, L-) polarity incorrect	Check connection
8.42	0x8007	Hardware	Supply voltage ADC	Replace the device
8.43	0x8007	Hardware	Supply voltage +12 V	Replace the device
8.44	0x8007	Hardware	Supply voltage -12 V	Replace the device
8.45	0x8007	Hardware	Supply voltage +5 V	Replace the device
8.46	0x8007	Hardware	Supply voltage +3,3 V	Replace the device
9.61	0x8006	Parameter	Insulation resistance measurement	Download factory setting and parameterise new
9.62	0x8006	Parameter	Residual current measurement	Download factory setting and parameterise new
9.63	0x8006	Parameter	Locating current injector	Download factory setting and parameterise new
9.64	0x8008	Parameter	Voltage measurement	Contact service
9.71	0x80FF	System	Program sequence insulation monitoring	Re-start device
9.72	0x80FF	System	Program sequence residual current measurement	Re-start device
9.73	0x80FF	System	Program sequence locating current injector	Re-start device
9.74	0x80FF	System	Program sequence voltage measurement	Re-start device
9.75	0x80FF	System	Program sequence temperature measurement	Re-start device
9.76	0x80FF	System	Program sequence history memory	Re-start device
9.77	0x80FF	System	Program sequence console	Re-start device
9.78	0x80FF	System	Program sequence self test	Re-start device
9.79	0x80FF	System	Stack error	Re-start device

8.4 RS-485 interface with Modbus protocol

Modbus is an internationally widely used protocol for data transfer between devices.

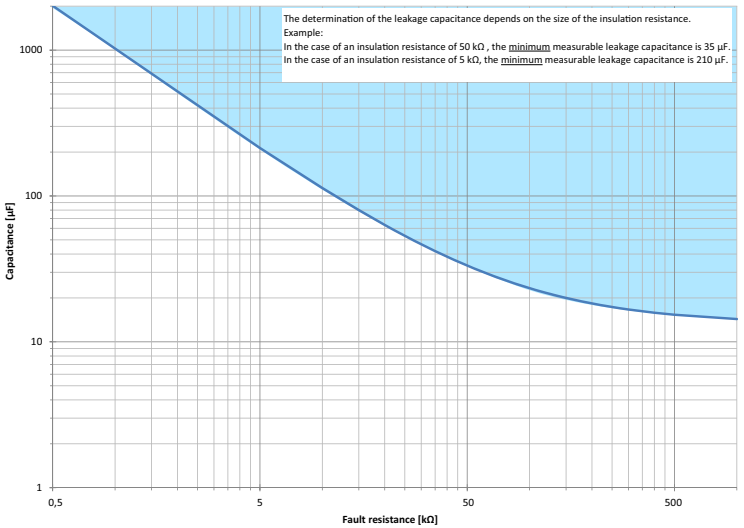
All measured values, messages and parameters are stored in virtual register addresses. Data can be read out with a read command on a register address. With a write command, data can be written into a register address.

The register addresses of the individual measured values and parameters can be found in the "isoxx1685Dx_D00272_00_A_XXDE" manual with the title "ISOMETER® isoxx1685Dx device family - Modbus settings" at https://www.bender.de/en/service-support/download-area/.

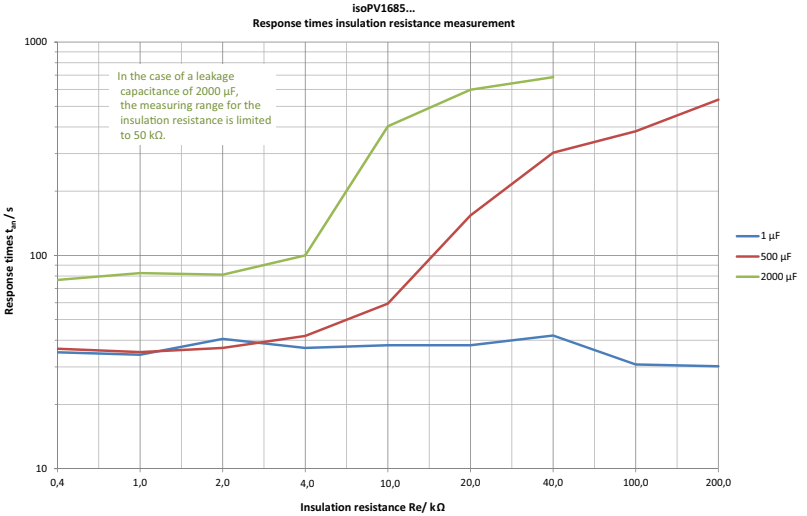
9. Diagrams

9.1 The leakage capacitance depends on the ins. resistance

Minimum limiting condition for determining the value of the capacitance



9.2 Response time for insulation measurement



9.3 Example of alarms stored in the history memory

Index	Idx 231	Index history memory
ID	ID43	Entry ID
Alarm	Insulation fault	ALarm type
Min	< 200	Minimum alarm value
Max	= 200	Maximum alarm value
Unit		Unit
Test	None	Alarm during test
Start Time	27.04.12 13:59	Start time of the alarm
Ack Time		Time of acknowledgement
Stop Time	27.04.12 13:59	End time of the alarm

10. Technical Data

10.1 Factory settings

Parameters	Value Status	isoPV1685P: can be set via	isoPV1685RTU: can be set via
Insulation response value R_{an1}	10 kΩ	BMS, CAN	BMS, Modbus, CAN
Insulation response value R_{an2}	1 kΩ	BMS, CAN	BMS, Modbus, CAN
Fault memory insulation measurement	off	BMS	BMS, Modbus
Relay K1 (11/12/14)	N/C operation	BMS	BMS, Modbus
Relay K2 (21/22/24)	N/C operation	BMS	BMS, Modbus
Relay K3 (31/32/34)	N/C operation	–	–
EDS mode	auto	BMS	–
PGH current	30 mA	BMS	–
Reset to factory settings	---	BMS	BMS, Modbus
BMS address	2	SS8103	SS8103
BMS termination	ON	RS-485 Term.	SS8103
CAN termination	OFF	CAN1, CAN2	–
Permissible system leakage capacitance	≤ 500 µF	SS8103	SS8103
Measurement speed	Fast	SS8103	SS8103
Time	not defined	CAN	BMS, Modbus

10.2 Tabular data isoPV1685...

( )* = factory settings

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

Insulation coordination according to IEC 60664-1
Rated voltage ..... DC 1500 V
Rated impulse voltage/pollution degree 8 kV/2

Voltage ranges

Nominal system voltage U_n isoPV1685RTU ..... AC 1000 V, DC 0...1500 V
Nominal system voltage U_n isoPV1685P ..... DC 0...1500 V
Nominal frequency range with AC coupling ..... 50/60 Hz +/-1 Hz
Tolerance of U_n ..... AC + 10 %; DC +6 %
Supply voltage U_s (see also device nameplate) ..... DC 18...30 V
Power consumption ..... ≤ 7 W

Measuring circuit for insulation monitoring

Measuring voltage U_m (peak value) ..... ±50 V
Measuring current I_m (at $R_F = 0$ W) ..... ≤ 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 ..... ≤ 2000 µF (500 µF)*

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)*
Upper limit of the measuring range when set to C_{emax} = 2000 µF ..... 50 kΩ
Relative uncertainty (10 kΩ . . . 1 MΩ) (acc. to IEC 61557-8) ..... ±15 %
Relative uncertainty (0.2 kΩ . . . < 10 kΩ) ..... ±200 Ω ±15 %
Response time t_{an} ..... see page 41
Hysteresis ..... 25 %, +1 kΩ

isoPV1685P only:
Measuring circuit for insulation fault location (EDS)

Locating current I_L DC ..... ≤ 50 mA
Test cycle/pause ..... 2/4 s
Number of turns of test winding 10

Displays, memory

LEDs for alarms and operating states ..... 2x green, 4 x yellow
µSD card (Spec. 2.0) for history memory and log files ..... ≤ 32 GByte

Inputs

Digital inputs DigIn1/DigIn2:
High level ..... 10 . . . 30 V
Low level ..... 0 . . . 0.5 V

Serial interfaces

BMS/Modbus:

Interface/protocol ..... isoPV1685RTU: RS-485/BMS(Slave)/Modbus RTU (Slave); Protocol switchable
..... isoPV1685P: RS-485/BMS(Slave)
Connection ..... terminals A/B
..... Shield: terminal S
Cable length ..... ≤ 1200 m
Shielded cable (shield to functional earth on one end) ..... 2-core, ≥ 0.6 mm^2, e.g. J-Y(St)Y 2 x 0.6
Terminating resistor, can be connected (RS-485 Term.) ..... 120 Ω (0.5 W)
Device address, BMS bus or Modbus adjustable (DIP switch) ..... isoPV1685RTU: 2 . . . 17
Devices address, BMS bus adjustable (DIP switch) ..... isoPV1685P: 2 . . . 33

CAN:

Protocol ..... acc. to SMA/Bender specification V2.5
Frame format ..... CAN 2.0A 11-bit identifier
Baud rate ..... 500 kBit/s
Connection via 2 x RJ45 acc. to CiA-303-1 connected in parallel ..... Pin 1: CAN-H
..... Pin 2: CAN-L
..... Pin 3, 7: CAN-GND
CAN identifier permanently set acc. to the specification above
Cable length ..... ≤ 130 m
Shielded cable ..... CAT 5 with RJ45 plug
Terminating resistor, can be connected (Term. CAN) ..... 120 Ω (0.5 W)
Potential of the socket housing ..... functional earth potential

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 or N/O operation (N/C operation)*
Operating principle K3 ..... N/C operation, 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
For UL application:
Utilisation category for AC control circuits with 50/60 Hz (Pilot duty) B300
AC load of the alarm relay outputs ..... AC 240 V, 1.5 A in case of a power factor of 0.35
AC load of the alarm relay outputs ..... AC 120 V, 3 A in case of a power factor of 0.35
AC load of the alarm relay outputs ..... AC 250 V, 8 A in case of a power factor of 0.75 to 0.80
DC load of the alarm relay outputs ..... DC 30 V, 8 A in case of ohmic load

Connection (except system coupling)

Connection type ..... pluggable push-wire terminals
Connection, rigid/flexible ..... 0.2...2.5 mm^2/0.2...2.5 mm^2
Connection, flexible with ferrule, without/with plastic sleeve ..... 0.25...2.5 mm^2
Conductor sizes (AWG) ..... 24. . . 12

Connection of the system coupling

Connection type ..... pluggable push-wire terminals
Connection, rigid/flexible ..... 0.2...10 mm^2/0.2...6 mm^2
Connection, flexible with ferrule, without/with plastic sleeve ..... 0.25...6 mm^2/0.25...4 mm^2
Conductor sizes (AWG) ..... 24 . . . 8
Stripping length ..... 15 mm
Opening force ..... 90 . . . 120 N

Environment/EMC

EMC ..... IEC 61326-2-4 Ed. 1.0
Classification of climatic conditions acc. to IEC 60721:
Without solar radiation, precipitation, water, icing. Condensation possible temporarily:
Stationary use (IEC 60721-3-3) 3K23
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
Deviation from the classification of climatic conditions:
Ambient temperature during operation ..... –40 . . . +70 °C
Ambient temperature transport ..... –40 . . . +80 °C
Ambient temperature long-term storage ..... –25 . . . +80 °C
Relative humidity ..... 10 . . . 100 %
Atmospheric pressure ..... 700...1060 hPa (max. height 4000 m)

Other

Operating mode ..... continuous operation
Position of normal use ..... vertical, system coupling on top
PCB fixation ..... lens head screw DIN7985TX
Tightening torque ..... 4.5 Nm
Degree of protection, internal components IP30
Degree of protection, terminals IP30
Weight ..... ≤ 1300 g
( )* = factory settings

10.3 Standards, approvals and certifications

The isoPV1685 was designed according to the following standards:

- DIN EN 61557-8 (VDE 0413-8)
- IEC 61557-8
- IEC 61557-9
- IEC 61326-2-4
- IEC 60730-1
- DIN EN 60664-1 (VDE 0110-1)
- UL508
- UL1998 (software) isoPV1685RTU in DC cirquits only

Only isoPV1685RTU
in DC cirquits

10.4 Ordering details

Type	Nom. system voltage U_n	Supply voltage U_s*	Art. No.
isoPV1685RTU-425	AC 1000 V DC 1500 V	DC 18…30 V	B91065603
isoPV1685P-425	DC 1500 V	DC 18…30 V	B91065604

* Absolute values

10.5 Change log

Date	Document-version	Software version	Condition / Changes
11/2021	07	isoPV1685RTU: D0532 V3.0x isoPV1685P : D0525 V2.0x	Editorial revision NEW: isoPV1685RTU, can be used in AC circuits, Digital inputs - P. 9, Table modified - P. 28, Diagrams scaled, Alarmsettings new formated - UKCA-Certificate - Change log
03/2023	08		Editorial revision Modifications UL

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