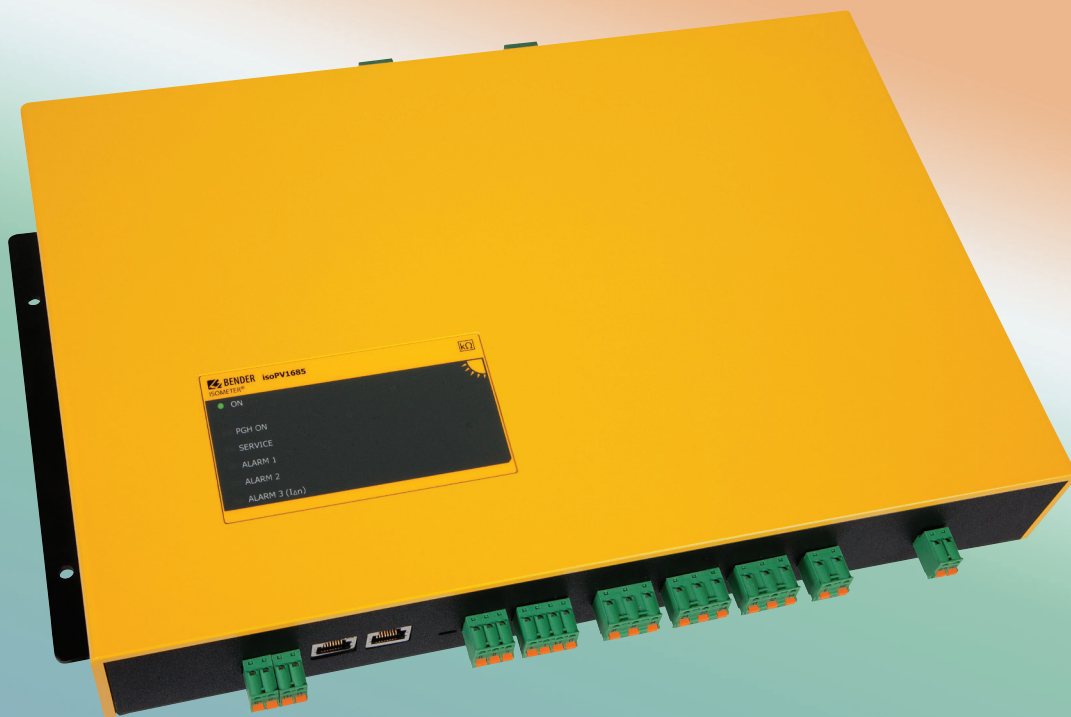**BENDER**
The Power in Electrical Safety™

isoPV1685P

Ground Fault Detector for Ungrounded Solar Arrays
And Isolation Tester Prior to Array Startup (Grounded and Ungrounded)
With Fault Location System Compatibility

Technical Bulletin
NAE1012440 / 11.2013

isoPV1685P

isoPV1685P

Features

- Fufills ground fault detection requirements of NEC 690.35 and CEC 64-018(1)(e) for ungrounded solar arrays

- Fufills upcoming 2014 requirements of NEC 690.5(A)(1) and NEC 690.35(C)(1) for isolation testing of grounded and ungrounded solar arrays prior to startup

- Designed specifically for ground fault detection on ungrounded PV systems including large scale arrays

- Works on systems up to 1000 VAC / 1500 VDC

- Detects symmetrical ground faults

- Two separate adjustable response values (200 Ω - 1 MΩ)

- Automatic adaptation to system leakage capacitance up to 2000 μF

- Self monitoring

- Connection monitoring

- Automatic self-test setting

- RS-485 interface for connection to BENDER communication gateways

- Automatic datalogging of system status, stored on microSD card

- Built-in and external test/reset

- Separate SPDT contact outputs for alarms and device error

- Normally energized (failsafe) or de-energized (non-failsafe) operation

- Easy-to-use, plug-in connectors

Approvals

Description

This device meets or exceeds the requirements of NEC 690.35 and CEC 64-018(1)(e) for ground fault detection on ungrounded solar arrays.

Designed specifically for photovoltaic systems, and below, the isoPV425 ground fault detector provides early indication of ground faults before leakage current may even be present. The device detects both AC and DC ground faults by monitoring the system's insulation resistance. The isoPV1685 can connect to systems up to 1000 VAC / 1500 VDC.

Two separately adjustable response values are available. Two SPDT contacts are available to trip on an active alarm, as well as a third SPDT contact for system and device errors. RS-485 communication is integrated for connection to BENDER's remote communication system.

The isoPV1685 can be combined with other equipment to create a ground fault location system. Faults can be located down to the faulty string with both portable and fixed installed equipment.

The isoPV425 may also be used for determining PV system isolation prior to startup on both grounded and ungrounded solar arrays, per the upcoming 2014 requirements of NEC 690.5(A)(1) and NEC 690.35(C)(1).

Function

Ground fault detection is carried out by measuring the system insulation resistance to ground via an active measuring pulse. When the measured insulation resistance falls below the prewarning alarm value R_{an1}, the "Alarm 1" LED lights and relay K1 (11/12/14) switches state. When the value falls below the main alarm value R_{an2}, the "Alarm 2" LED lights and relay K2 (21/22/24) switches state. If an internal device error occurs, relay K3 (31/32/34) will switch state.

Ground fault location is externally activated via external equipment (fixed installed EDS location units or MK2430/MK800 series remote stations). Once initiated, a tracer signal is injected into the system, which is located by either installed BENDER current transformers, or portable location equipment. The LED "PGH on" lights when fault location is active.

Automatic Data Logging and Alarm History

During operation, system status is logged automatically. Recorded data is taken at regular intervals and stored on an integrated microSD card. System values recorded during operation include:

- Insulation resistance and leakage capacitance values
- Line voltage to ground
- Supply voltage
- Various internal temperatures (current controller, fault location injector, line coupling)
- Connection errors
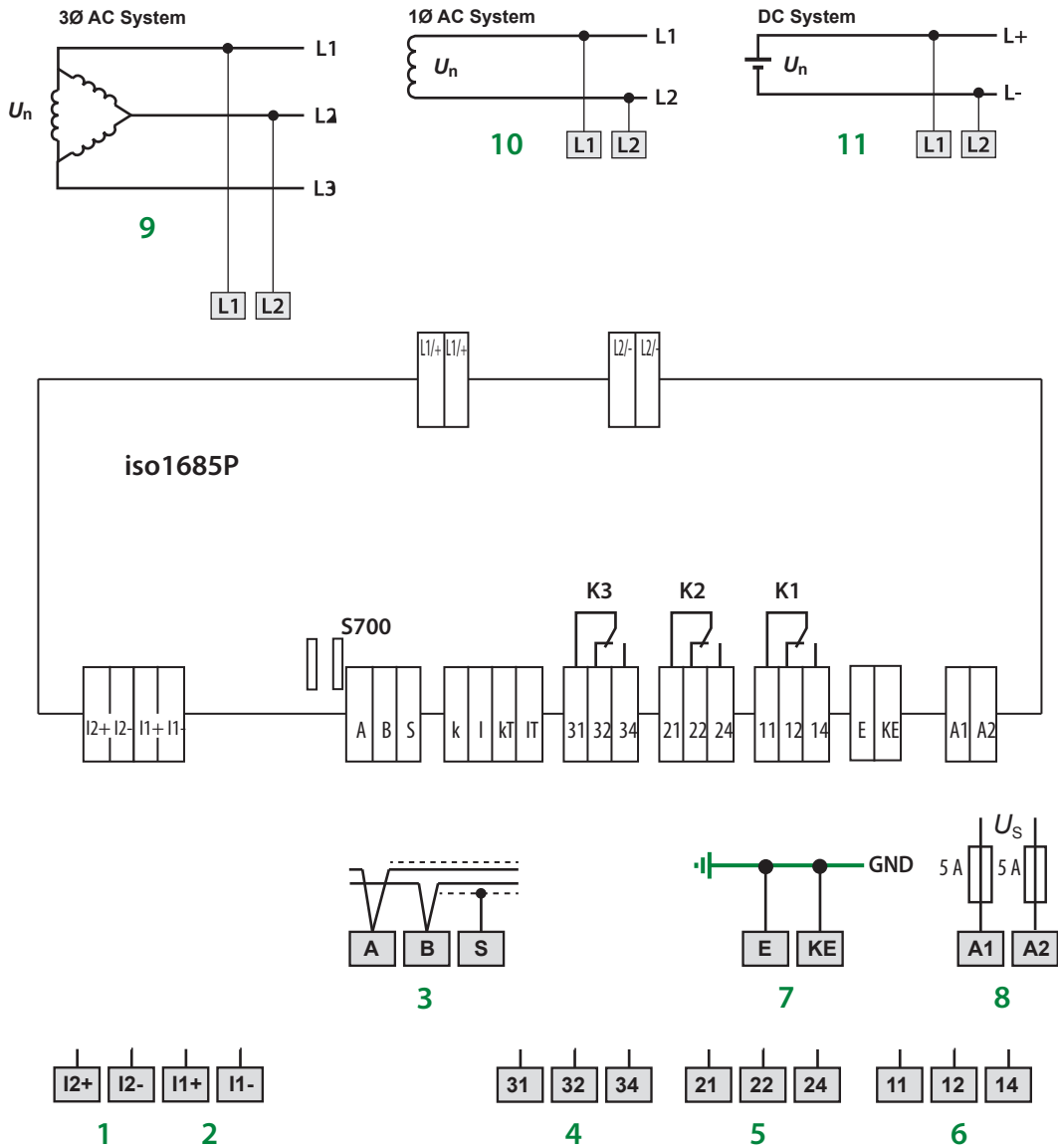- Internal device errors

A new data logging file is created upon startup. A new file is generated afer the currently used logging file reaches 10 MB in size. The file name contains the date and time of file creation.

Additionally, the alarm history memory is stored on the microSD card in CSV format.
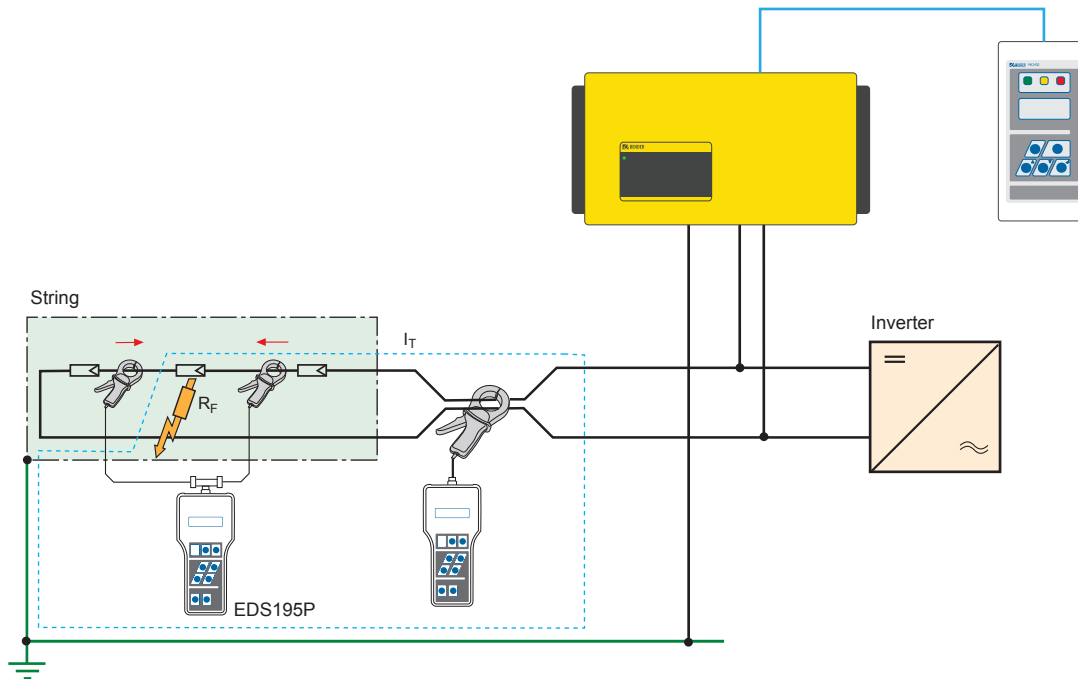
Ordering Information

Alarm Value Range	Supply Voltage	Part No.	Ordering No.
200 Ω - 1 MΩ	18 - 30 VDC	**isoPV1685P-425**	**B 9106 5801**

Wiring

3Ø AC System

U_n

L1

L2

L3

9

L1 L2

1Ø AC System

U_n

L1

L2

10

L1 L2

DC System

U_n

L+

L-

11

L1 L2

iso1685P

L1/+ L1/+   L2/- L2/-

S700

K3 **K2** **K1**

I2+ I2- I1+ I1-   A B S   k I kT IT   31 32 34   21 22 24   11 12 14   E KE   A1 A2

A B S

3

GND

E KE

7

U_S

5 A   5 A

A1 A2

8

I2+ I2- I1+ I1-

1   **2**

31 32 34   21 22 24   11 12 14

4   **5**   **6**
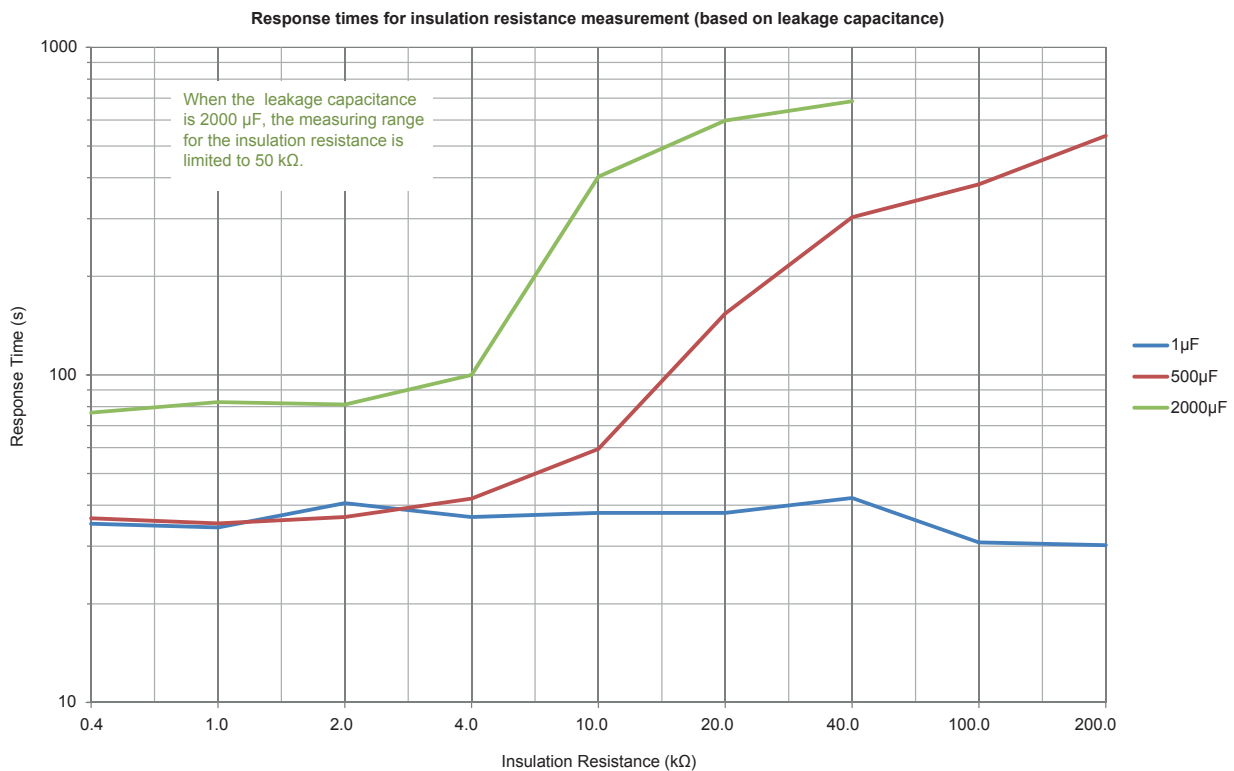
1 - Currently inactive (future digital input)
2 - Currently inactive (future digital input)
3 - Connection to BENDER RS-485 bus
4 - Alarm relay K3, switches on internal device errors
5 - Alarm relay K2, switches on active main alarm
6 - Alarm relay K1, switches on active prealarm

7 - Separate connections to ground
8 - Supply voltage for device, see ordering information
9 - Connections to three-phase AC system
10 - Connections to single-phase AC system
11 - Connections to DC system

Example Application: Portable Fault Location on an Array String

Response Times for Insulation Resistance Measurement

Response times for insulation resistance measurement (based on leakage capacitance)

When the leakage capacitance is 2000 µF, the measuring range for the insulation resistance is limited to 50 kΩ.

Response Time (s)

Insulation Resistance (kΩ)

— 1µF
— 500µF
— 2000µF

Technical data

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

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

Voltage ranges

Nominal system voltage U_n	AC 1000 V/DC 1500 V
Supply voltage U_S (also see nameplate)	DC 18 - 30 V
Power consumption	≤ 7 W
Power consumption	≤ 7.5 VA

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}	$\leq$ DC 1500 V
Permissible system leakage capacitance C_e	≤ 2000 µF (500 µF)*

Response values for insulation monitoring

Reponse value R_{an1} (Alarm 1)	200 Ω - 1 MΩ (10 kΩ)*
Response value R_{an2} (Alarm 2)	200 Ω - 1 MΩ (1 kΩ)*
Upper measurement range limit, with the setting $C_{emax} = 2000$ µF	50 kΩ
Relative uncertainty (10 kΩ - 1 MΩ) (acc. to IEC 61557-8)	± 15 %
Relative uncertainty (0.2 kΩ - < 10 kΩ)	$\pm 200\Omega$ ± 15 %
Response time t_{an}	see table
Hysteresis	25 %, +1 kΩ

Measuring circuit for fault location (EDS)

Locating current I_L DC	≤ 50 mA
Test pulse/break	2 s/4 s

Inputs

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

Serial interfaces

BMS:

Interface/protocol	RS-485/BMS
Connection	terminals A/B
Cable length	1200 m
Shielded cable (shield to functional gnd on one end)	2-core, ≥ 0.6 mm², e.g. J-Y(St)Y 2x0.6
Shield	terminal S
Terminating resistor, can be enabled (term. RS-485)	120 Ω (0.5 W)
Device address, BMS bus	2 - 33 (2)*

Switching elements

Switching components	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., fixed setting
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

Connection (except power supply connection)

Connection type	push-wire terminals
Connection properties	
rigid/flexible	0.2 - 2.5 mm² / 0.2 - 2.5 mm²
flexible with ferrules without/with plastic sleeve	0.25 - 2.5 mm²
Conductor sizes (AWG)	24 - 12

Power supply connection

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

Environment/EMC

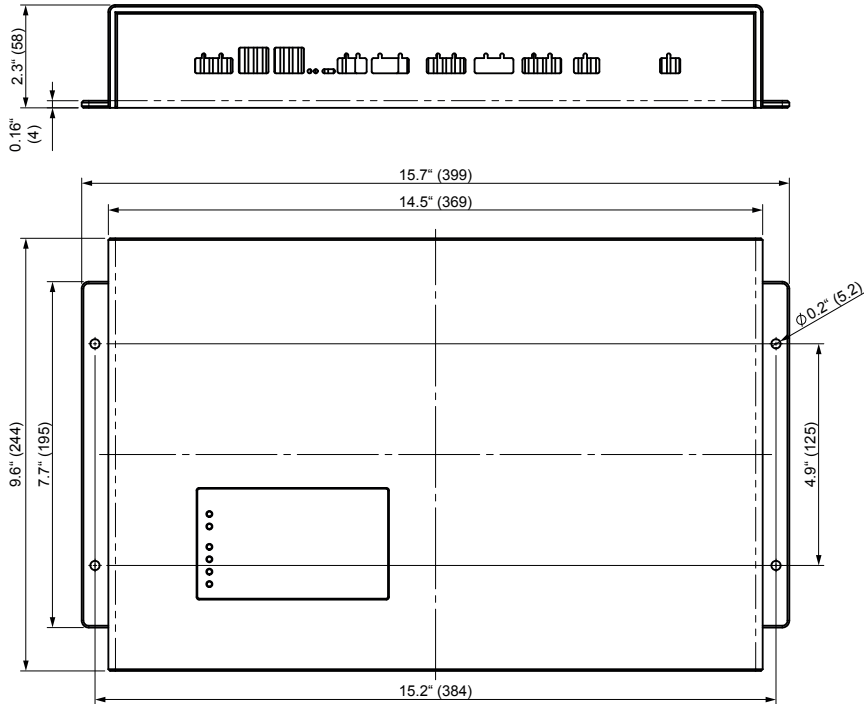|	
EMC	IEC 61326-2-4 Ed. 1.0
Classification of climatic conditions acc. to IEC 60721:	
Without solar radiation, precipitation, water, icing. Condensation possible temporarily:	
Stationary use (IEC 60721-3-3)	3K5
Transport (IEC 60721-3-2)	2K3
Long-term storage (IEC 60721-3-1)	1K4
Classification of mechanical conditions acc. to IEC 60721:	
Stationary use (IEC 60721-3-3)	3M4
Transport (IEC 60721-3-2)	2M2
Long-term storage (IEC 60721-3-1)	1M3
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 %
Air pressure	700 - 1060 hPa (max. height 4000 m)

Other

Operating mode	continuous operation
Position of normal use	vertical, power system connection at the top
PCB fixing	lens head screw DIN7985TX
Tightening torque	4.5 Nm
Board-to-board distances	31 mm
Degree of protection	IP00
Software version	D366 V1.0
Weight	650 g

( )* = factory setting

Dimensions

Dimensions in inches (mm)

2.3" (58)

0.16" (4)

15.7" (399)

14.5" (369)

Ø 0.2" (5.2)

9.6" (244)

7.7" (195)

4.9" (125)

15.2" (384)

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