Ground Fault Protection
Photovoltaic Systems
## Electrical safety solutions for photovoltaic systems

### Effective and efficient solutions for renewable energy
Running renewable energy systems efficiently requires a high level of availability, as well as effective protection against electrical safety hazards that may occur. BENDER's extensive experience in the renewable energy industries ensure that your system is provided with the most advanced electrical safety equipment on the market. A wide portfolio of products work with virtually every type of array and measure at different system levels.

- Compliance with the latest standards and code requirements for the photovoltaic industry
- Integratable solutions for virtually all levels of photovoltaic systems, including arrays, inverters, and combiner boxes
- Early detection of ground faults
- Preventative maintenance
- Effective system data management
- Integration into existing modern communication networks

### Related standards and requirements
As a leading innovator in the field of electrical safety, BENDER is always designing products to meet the latest requirements of standards and codes worldwide. Our years of experience dedicated to the solar industry ensure that your system is protected with the equipment best fit for the job.

Standards and code requirements taken into account include, but are not limited to:

- NEC 609.5
- NEC 690.35
- CEC 64-018
- UL 1741
- IEC 60364-4-41:2005-12
- IEC 61557-8:2007-01
- IEC 62109-2:2011-06
- IEC 60364-7-712:2002-05

### Ungrounded (Isolated) Arrays

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Early detection and advanced notification

Avoid unexpected shutdowns and fire
Unexpected ground faults in photovoltaic arrays frequently can create extended periods of downtime or increased risk of fire. Integrating BENDER products into your system ensures a high level of availability and helps avoid unexpected shutdowns.

The BENDER advantage
- Increased system availability
- Advanced warning of growing ground faults
- Protection of equipment and personnel, and against fire
- Detection of low-mA faults on grounded arrays, including faults from negative to ground
- Integrates into planned maintenance scheduling
- Remote signaling and communication solutions, including modern networks like Modbus/TCP

Receive advanced notification of faults with BENDER products

**Grounded (Non-Isolated) Arrays**

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<td>Monitoring at the master combiner box</td>
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Ungrounded (isolated) arrays
Detecting ground faults on arrays
Large scale arrays

Designed specifically for photovoltaic systems, BENDER's isoPV ground detector provides early indication of ground faults before leakage current may even be present. The isoPV is specifically designed for PV systems and detects both AC and DC ground faults by monitoring the system's insulation resistance.

The isoPV's digital display shows the insulation resistance in real-time. Alarm LEDs provide visual indication of an alarm state. Two voltage-free SPDT alarm contacts are available. The isoPV is compatible with BENDER's advanced communication system for remote visualization capabilities.

The isoPV may also be used for determining PV circuit isolation prior to system startup.

isoPV: Features
- Fulfills ground detection requirements of NEC 690.35 and CEC 64-018(1)(e)
- Early indication of both AC and DC ground faults on the array side of the system
- May also be used to check PV isolation before startup
- Designed specifically for photovoltaic systems
- Detects faults from positive to ground and negative to ground, as well as symmetrical faults
- Connects to virtually any size DC array up to 1760 V

isoPV digital ground fault detector for ungrounded arrays

- Works with leakage capacitances of up to 2000 μF
- Digital display showing insulation resistance in real-time
- Two separately adjustable alarms
- 2 SPDT output contacts
- (0)4 - 20 mA analog output
- Compatible with BENDER's communication gateways for Ethernet, Modbus, and Profibus
- UL 1998 listed

Ground fault monitoring of an ungrounded, large-scale array and inverter
BENDER’s isoPV485 provides advanced ground fault monitoring capabilities for ungrounded photovoltaic systems up to 100 kW. The isoPV485 provides early indication of ground faults by monitoring the system’s insulation resistance. Both AC and DC ground faults are detected using BENDER’s advanced measuring principle.

The isoPV485 provides visual indication of an alarm state. A voltage-free SPDT alarm contact is also available.

The isoPV485 may also be used for determining PV circuit isolation prior to system startup.

**isoPV485: Features**

- Fulfills ground detection requirements of NEC 690.35 and CEC 64-018(1)(e)
- Early indication of both AC and DC ground faults on the array side of the system
- May also be used to check PV isolation before startup
- Designed specifically for photovoltaic systems
- Detects faults from positive to ground and negative to ground, as well as symmetrical faults

**isoPV485 ground fault detector for ungrounded arrays**

- Connects to small/medium size arrays up to 1000 VDC
- Works with system leakage capacitances of up to 100 μF
- Digital display showing insulation resistance in real-time
- Two separately adjustable alarms
- 2 SPDT output contacts
- 2 - 10 V analog output

**Ground fault monitoring on a small-scale, ungrounded PV array**
Grounded (non-isolated) arrays
Detecting ground faults at the inverter
Inverters 10 kW or less

The RCMA278 employs state-of-the-art technology to detect both AC and DC ground faults with a very small, PCB-style form factor. The module is designed to be integrated directly into inverters. Outputs include an analog voltage output, as well as a switching transistor output.

**RCMA278: Features**
- Fulfills ground fault detection requirements of UL 1741
- Detects both AC and DC ground faults
- Detects low-mA ground faults from both positive to ground and negative to ground
- 0 - 100 mA measurement range, AC/DC
- Wide frequency range (0 - 500 Hz)
- Separate switching and proportional measurement outputs
- UL 1998 listed
Grounded (non-isolated) arrays
Detecting ground faults at the inverter
Inverters greater than 10 kW

The RCMA423 digital monitor detects both AC and DC ground faults over a widely adjustable range. Utilizing an external current transformer, the RCMA423 monitors the inverter ground for any ground faults that may occur. A digital display shows the amount of ground fault current in real-time. Two sets of voltage-free SPDT contacts are available, as well as options including analog outputs.

**RCMA423: Features**
- Fulfills ground fault detection requirements of NEC 690.5 and UL 1741
- Detects both AC and DC ground faults
- Detects low-mA ground faults from both positive to ground and negative to ground
- 30 mA - 3 A alarm level range, AC/DC
- Wide frequency range (0…2000 Hz)
- CT connection monitoring
- Digital display showing readings in real-time
- Two voltage-free SPDT contact outputs
- Options available for analog outputs
- UL listed

Inverter monitoring with the AC/DC capable RCMA423

RCMA423 AC/DC ground fault monitor
Grounded (non-isolated) arrays
Detecting ground faults at the combiner box
Individual monitoring

RCMB20 and RCMB35 series ground fault monitoring modules integrate easily into combiner boxes and inverters by having all electronics integrated into the measuring current transformer - no additional monitoring modules required. Both AC and DC faults are detected by the modules, as well as low-mA faults from either pole to ground. Standard models feature an analog output based on the measured leakage current, with an option available featuring a switching output on a fixed alarm point.

**RCMB20 / RCMB35: Features**
- Fulfills ground fault detection requirements of NEC 690.5
- Detects both AC and DC ground faults
- Detects low-mA ground faults from both positive to ground and negative to ground
- Easily integratable, no external monitor - CT only
- UL listed

**-500 series models:**
- 0 - 500 mA measurement range
- Wide frequency range (0…500 Hz)
- 4-20 mA analog output

**-30 series models:**
- 30 mA alarm value
- Wide frequency range (0…1 kHz)
- Switching output

**RCMB20 / RCMB35 series ground fault monitoring modules**

**RCMB20/35 integrated into combiner boxes**
Grounded (non-isolated) arrays
Detecting ground faults at the master combiner
Multi-channel monitoring

RCMS series devices provide a single point of monitoring for up to 12 separate combiner boxes and branches. Both AC and DC ground faults can be detected. A digital display shows each channel’s readings in real-time. The RCMS490 additionally features separate contact outputs for each individual channel. RCMS series monitors are also compatible with BENDER's digital communication system.

RCMS Series: Features
- Fulfills ground fault detection requirements of NEC 690.5
- Detects both AC and DC ground faults
- Detects low-mA ground faults from both positive to ground and negative to ground
- Ideal for fire prevention due to ground faults
- Monitor up to 12 separate combiner boxes from one device
- 10 mA - 10 A adjustable alarm level, AC/DC, individually adjustable for each channel
- Wide frequency range (0 - 2000 Hz)
- CT connection monitoring
- Digital display showing readings in real-time
- Voltage-free DPDT common output, individual SPST outputs for each channel (RCMS490 version)
- Compatible with BENDER's communication gateways for Ethernet, Modbus, and Profibus
- UL listed

Monitoring individual combiner boxes with RCMS460-D monitor and Ethernet / Modbus/TCP communication
The EDS3090PG ground fault location system significantly decreases the time needed to locate ground faults in isolated arrays with a simple, easy-to-use location system. Using a special concept derived from BENDER's years of experience with photovoltaic systems, the EDS3090PG system can locate ground faults down to the string level and even the defective module. All location is carried out while the array still remains online.

The portable kit comes with a robust carrying case and is optimal for maintenance personnel and technicians. Varying size portable clamps ensure the system works with varying size arrays. The EDS3090 kit comes with the EDS190P, a powerful, easy-to-use handheld tool used for locating faults.

EDS3090PG: Features
- Locate faults down to the string level on isolated arrays
- Significantly decrease fault location time and costs
- Fault location carried out while the array is online
- Easy-to-carry, robust case for technicians
- Modular system concept tailored to application
Communication solutions
Ethernet and Modbus integration

Simplistic Network Integration

BENDER’s line of communication products allow for fast notification of personnel when a problem has occurred. Critical systems monitored by BENDER equipment may be connected to a variety of remote indicators to notify personnel of the current status of the system. Communication gateways bring your electrical safety network into the 21st century by displaying system information via several standard protocols, such as Ethernet, MODBUS, and PROFIBUS.

The Ethernet gateway device additionally features an easy-to-use status page, accessible through a web browser. E-mail and SMS messaging when an alarm has occurred is also available. Utilizing this communication system allows for timely and cost-effective deployment of service personnel and can help avoid equipment damage or failure.

The COM460IP - Advanced Visualization

Devices that support BENDER’s communication bus may be connected to the COM460IP, which provides an advanced visualization screen to know the status of your system in real-time. When connected to a standard Ethernet network, the COM460IP can be accessed from a standard web browser, and supports features such as:

- Reading / alarm levels in real-time
- Timestamped data logging
- Customizable alarm messages
- Building / schematic footprint display
- E-mail / SMS capability
- Centralized device configuration
- Reporting tools
- Status screen for smartphones
- Modbus/TCP system integration

Always know the status of your system with the COM460IP’s detailed visualization
Solutions For Your Electrical Safety Needs
With our complete portfolio of relay protection products

For over 70 years, BENDER has been a leader in meeting electrical safety needs with our large portfolio of ground fault protection products. BENDER products enhance the safety of electrical systems and help to save money, reduce downtime, and give the peace of mind that your system is protected by the latest in electrical safety technology.

- Ground Fault Monitors and GFCIs for grounded and high-resistance grounded systems
- Ground Fault Detectors for ungrounded systems
- Voltage, Current, and Frequency Relays
- Remote Communication Solutions

**Ground Fault Protection for Ungrounded Systems**
- ISOMETER® Ground Detector Series
- EDS Ground Fault Location Systems

**Ground Fault Protection for Grounded Systems**
- RCM Series Ground Fault Monitors for Single-Phase and Three-Phase AC Systems
- RCMA Series Ground Fault Monitors for Single-Phase AC, Three-Phase AC, and DC Systems
- RCMS Series Multi-Channel Ground Fault Monitors for Single-Phase AC, Three-Phase AC, and DC Systems
- Lifeguard Series Ground Fault Circuit Interrupters for Single-Phase AC, Three-Phase AC, and DC Systems

**General Purpose Protection Relays**
- Undervoltage and Overvoltage Relays for AC and DC Systems
- Overfrequency and Underfrequency Relays
- Overcurrent and Undercurrent Relays for AC and DC Systems

**Communication Solutions**
- Standard Communication Converters for Ethernet, MODBUS, and PROFIBUS
- Customizable Visualization Capabilities
- Simple System Integration

Visit [www.bender.org](http://www.bender.org) for information, tools, and more:
- Complete listings of products, documentation, datasheets, and technical information
- Knowledgebase of technical information answering your ground fault questions
- Product selection tools, including ground fault relays, current transformers, and more
- Local representative information