

# Ground fault protection

Photovoltaic systems







# ENHANCED SAFETY SOLUTIONS

For solar arrays, from the leader in electrical safety.

## 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

## Comply with the latest 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 Part 1, Section 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 arrays

## Detecting ground faults on arrays - 100 kW or less



isoPV425 ground fault detector for ungrounded arrays

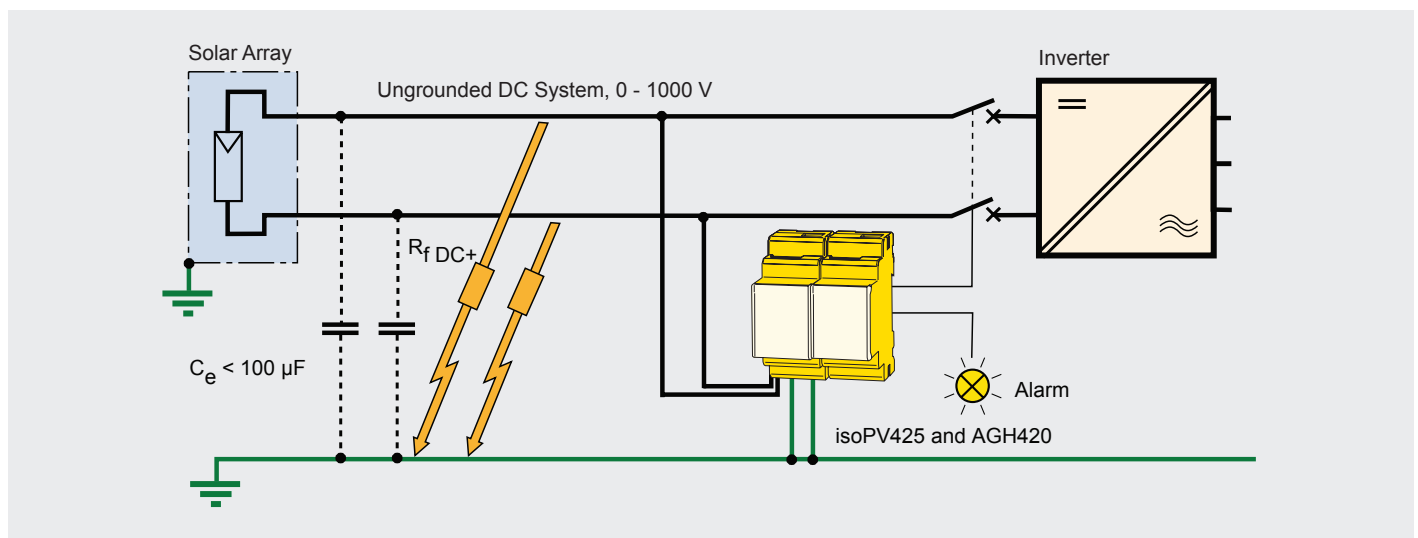
BENDER's isoPV425 (combined with included AGH420 voltage coupler) provides advanced ground fault monitoring capabilities for ungrounded photovoltaic systems up to 100 kW. The isoPV425 provides early indication of ground faults by monitoring the system's insulation resistance. Both AC and DC ground faults are detected using BENDER's advanced measuring principle.

The isoPV425 provides visual indication of an alarm state. A voltage-free SPDT alarm contact is also available.

The isoPV425 may also be used for determining PV circuit isolation prior to system startup.

### isoPV425 features:

- Fulfills ground fault detection requirements of NEC 690.35 and CEC Part 1, Section 64-018(1)(e)
- Fulfills requirements for checking PV isolation at startup
- Early indication of both AC and DC ground faults on the array side of the system
- Designed specifically for photovoltaic systems
- Detects ground faults from both positive to ground and negative to ground, as well as symmetrical faults
- Connects to small/medium size arrays up to 1000 VDC
- Additionally provides measurements of voltage to ground, leakage capacitance, and insulation resistance / impedance
- Works with system leakage capacitances up to 100  $\mu\text{F}$
- Digital display showing insulation resistance in real-time
- Two separately adjustable alarms
- Two configurable SPDT contact outputs
- Compatible with Bender's communication gateways for connection to modern networks, such as Ethernet and Modbus
- Compatible with Bender's advanced remote indicating stations, including the MK2430 and MK800



# Ungrounded arrays

## Detecting ground faults on arrays - up to 1 MW



isoPV digital ground fault detector

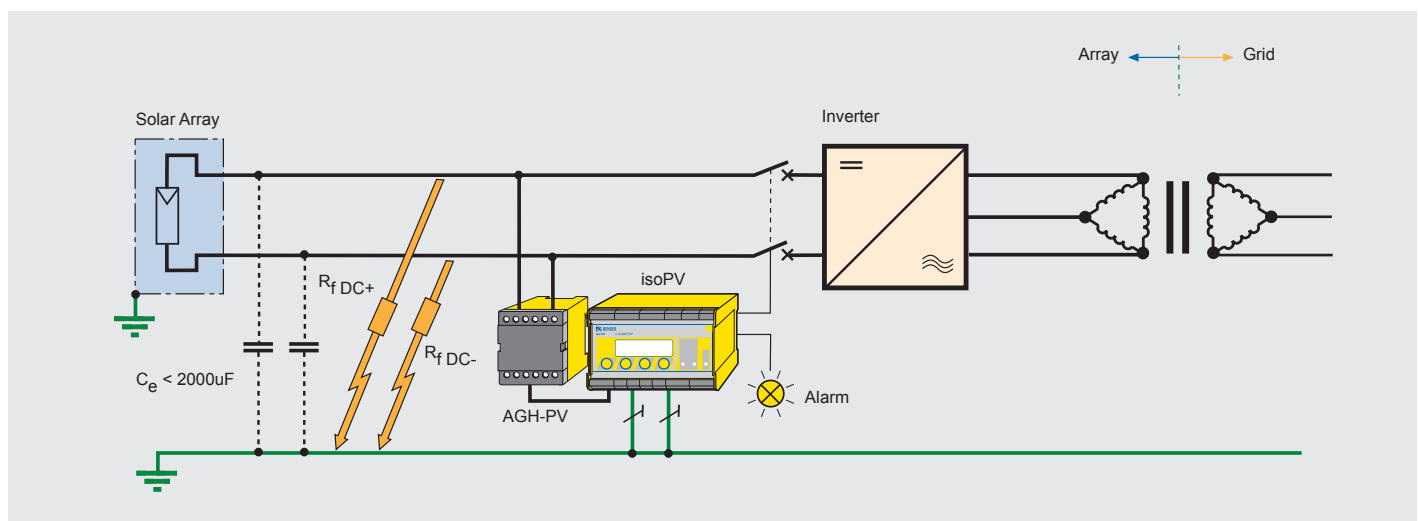
Designed specifically for photovoltaic systems, BENDER's isoPV ground detector provides early indication of ground faults before leakage current may even be present. The isoPV is specifically designed for PV systems and detects both AC and DC ground faults by monitoring the system's insulation resistance.

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 fault detection requirements of NEC 690.35 and CEC Part 1, Section 64-018(1)(e)
- Fulfills requirements for checking PV isolation at startup
- Early indication of both AC and DC ground faults on the array side of the system
- Designed specifically for photovoltaic systems
- Detects ground faults from both positive to ground and negative to ground, as well as symmetrical faults
- Designed for arrays up to 1 MW, 1100 VDC
- Additionally provides measurements of voltage to ground, leakage capacitance, and insulation resistance / impedance
- Designed for large systems: Works with leakage capacitances of up to 2000  $\mu\text{F}$ , low adjustable resistance setpoint of 200  $\Omega$  to 100 k $\Omega$
- Digital display showing insulation resistance in real-time
- Two separately adjustable alarms
- Two configurable SPDT contact outputs
- 0/4 - 20 mA analog output
- Compatible with Bender's communication gateways for connection to modern networks, such as Ethernet and Modbus
- Compatible with Bender's advanced remote indicating stations, including the MK2430 and MK800
- UL 1998 listed



# Ungrounded arrays

## Detecting and locating ground faults on arrays - above 1 MW



isoPV1685P ground fault detector

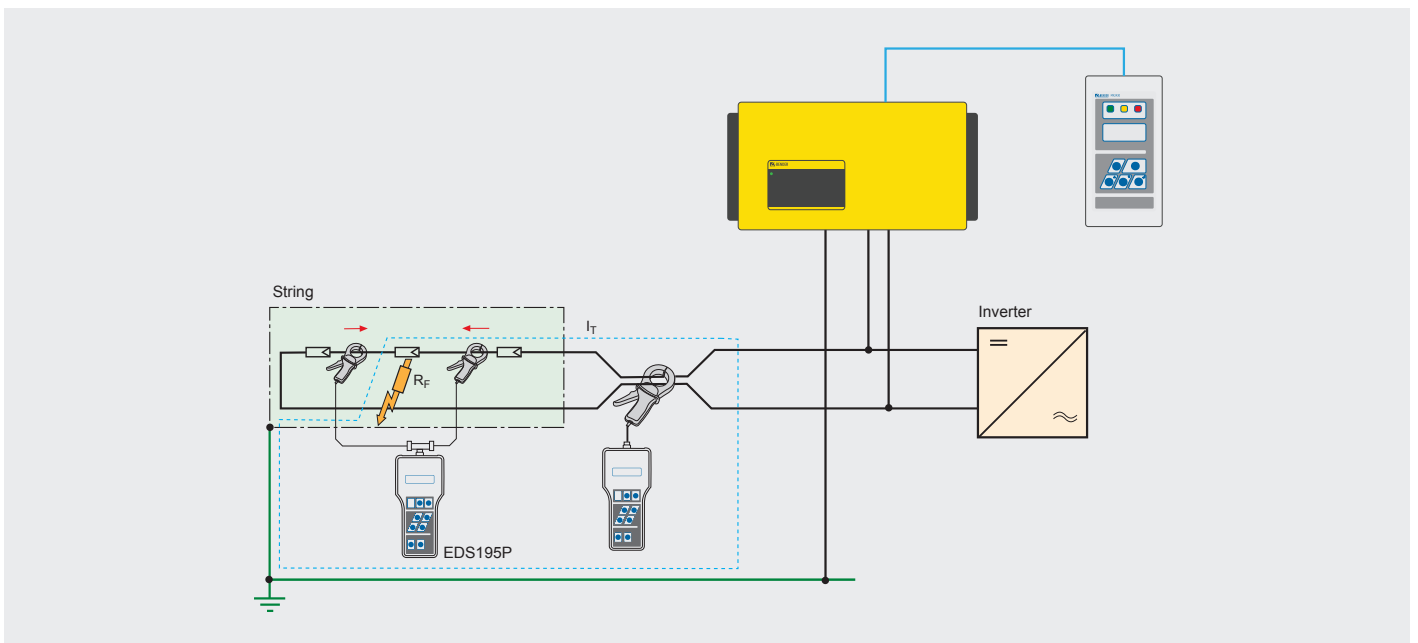
The Bender isoPV1685P is designed specifically for large scale, ungrounded PV arrays to detect and locate ground faults. Both AC and DC ground faults can be detected by monitoring the system's insulation resistance.

Two separately adjustable response values are available, over a very wide range to accommodate virtually all array sizes and types. The isoPV1685P is compatible with Bender's communication system, for integration into modern comm networks. Additionally, the isoPV1685P is compatible with Bender's ground fault location system to quickly locate faults down to the panel level.

The isoPV1685P may also be used for determining PV circuit isolation prior to system startup.

### isoPV1685P features:

- Fulfills ground fault detection requirements of NEC 690.35 and CEC Part 1, Section 64-018(1)(e)
- Fulfills requirements for checking PV isolation at startup
- Early indication of both AC and DC ground faults on the array side of the system
- Designed specifically for photovoltaic systems
- Detects ground faults from both positive to ground and negative to ground, as well as symmetrical faults
- Designed for large-scale arrays up to 1500 VDC
- Two separately adjustable alarms
- Designed for large systems: Works with leakage capacitances of up to 2000  $\mu\text{F}$ , low adjustable resistance setpoint of 200  $\Omega$  to 100 k $\Omega$
- Automatic datalogging of system, stored on microSD card
- Two configurable SPDT contact outputs
- 0/4 - 20 mA analog output
- Controls Bender's ground fault location system
- Compatible with Bender's communication gateways for connection to modern networks, such as Ethernet and Modbus
- Compatible with Bender's advanced remote indicating stations, including the MK2430 and MK800
- UL 1998 listed



# Ungrounded arrays

## Locating ground faults on large scale arrays



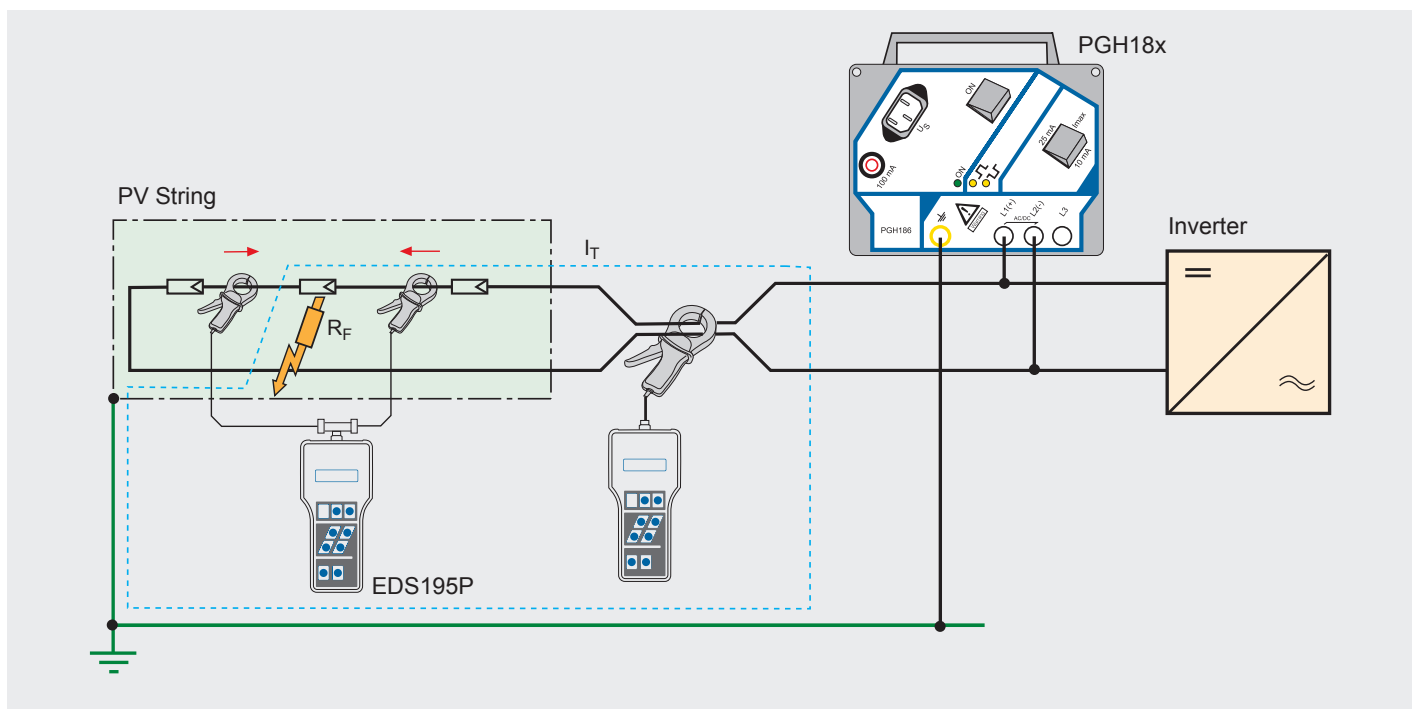
EDS3090 series portable ground fault location system

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 EDS195P, a powerful, easy-to-use hand-held tool used for locating faults.

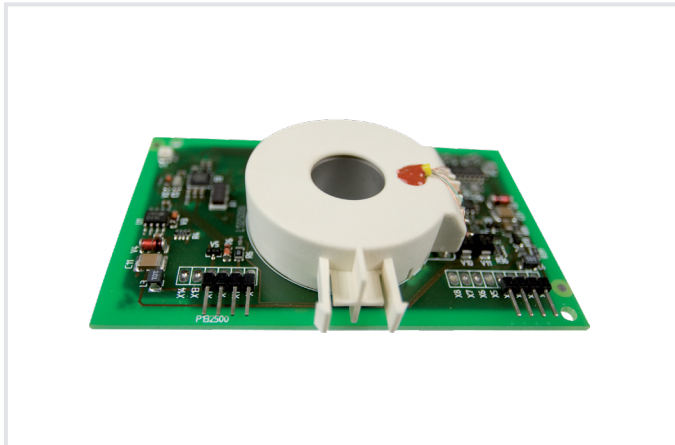
### EDS3090 series features:

- Locate ground faults down to the faulty solar panel
- Significantly decrease fault location time and costs
- Fault location carried out while the array remains online
- Easy-to-carry, robust case for technicians
- Modular system concept tailored to application



# Grounded arrays

## Detecting ground faults at the inverter



RCMA278P-S ground fault detection module



RCMA423 ground fault monitor

### For inverters 10 kW or less

The RCMA278P-S employs state-of-the-art technology to detect both AC and DC ground faults in a very small, PCB-style form factor. The module is designed for integration directly into inverters. Outputs include an analog voltage output, as well as a switching transistor output.

#### RCMA278P-S features:

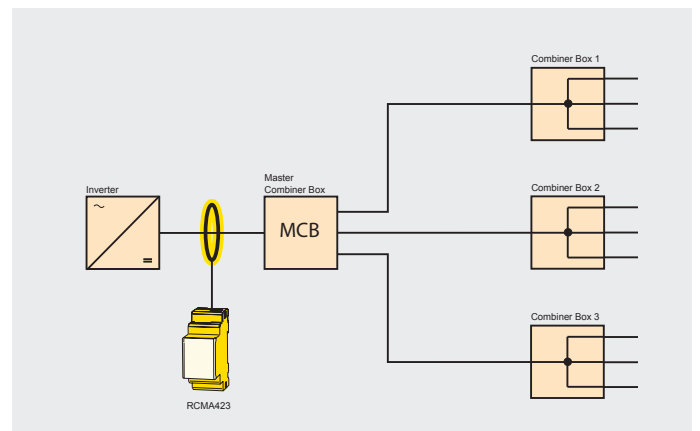
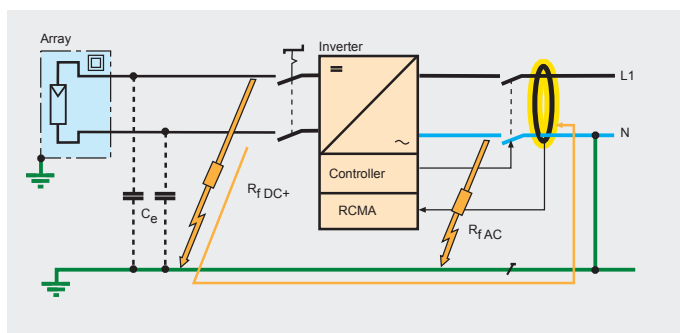
- Fulfills ground fault detection requirements of UL 1741
- Detects both AC and DC ground faults
- Detects low-mA ground faults from both positive to ground and negative to ground
- 0 - 100 mA measurement range, AC/DC
- Wide frequency range (0 - 500 Hz)
- Separate switching and proportional measurement outputs
- UL 1998 listed

### For inverters greater than 10 kW

The RCMA423 digital ground fault monitor detects both AC and DC ground faults over a widely adjustable range. Varying sizes of external current transformers are available. A digital display shows the amount of ground fault current in real-time. Outputs include two voltage-free SPDT contacts.

#### RCMA423 series features:

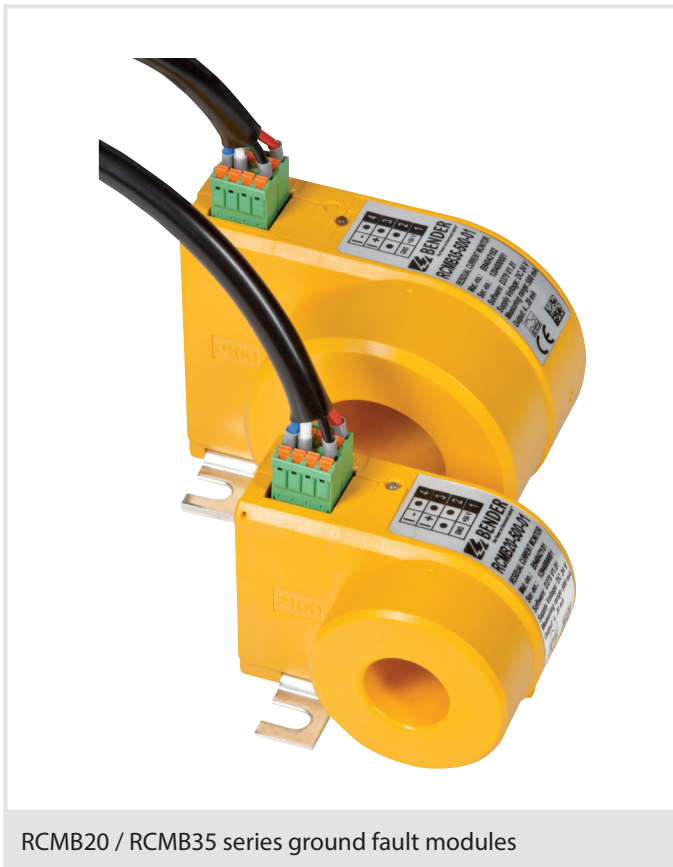
- Fulfills ground fault detection requirements of NEC 690.5 and UL 1741
- Detects both AC and DC ground faults
- Mitigates the blind spot issue - detects low-mA ground faults from both positive to ground and negative to ground
- 30 mA - 3 A measurement range, AC/DC
- Wide frequency range (0 - 2000 Hz)
- Digital display showing readings in real-time
- Two voltage-free SPDT contact outputs





# Grounded arrays

## Detecting ground faults at the combiner box



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 series features:

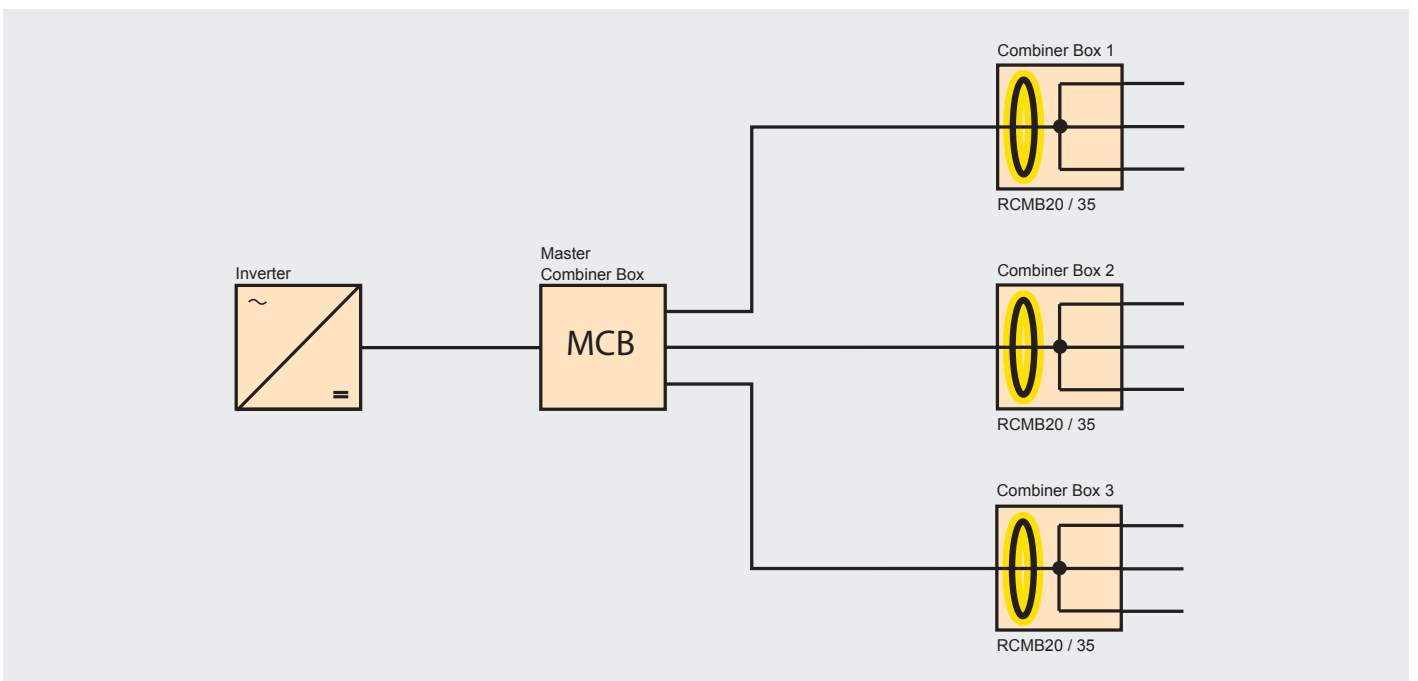
- Fulfills ground fault detection requirements of NEC 690.5
- Detects both AC and DC ground faults
- Mitigates the blind spot issue - detects low-mA ground faults from both positive to ground and negative to ground
- Easily integratable, no external monitor - all electronics built into current transformer

### -500 series features:

- 0 - 500 mA measurement range
- Wide frequency range (0 - 500 Hz)
- 4-20 mA analog output

### -30 series features:

- 30 mA alarm value
- Wide frequency range (0 - 1 kHz)
- Switching output



# Grounded arrays

## Detecting ground faults at the master combiner box

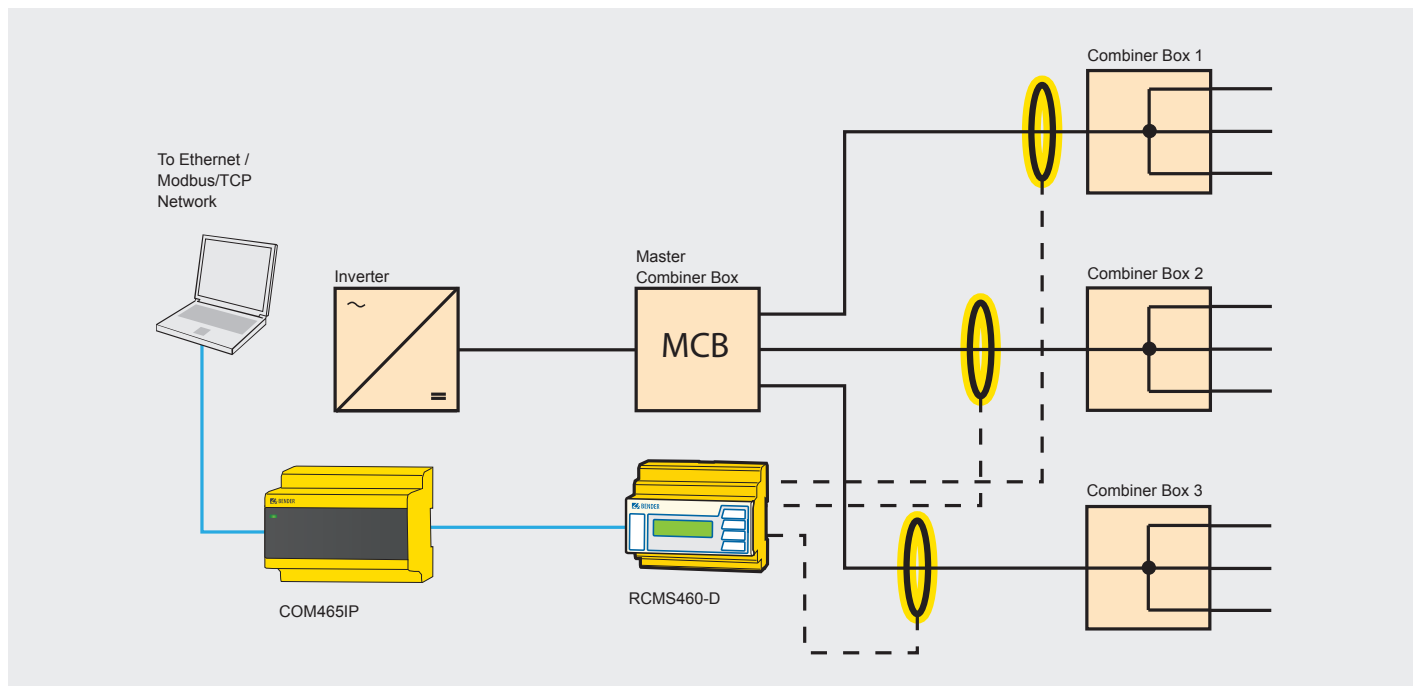


RCMS series devices provide a single point of monitoring for up to 12 separate combiner boxes and branches. Both AC and DC ground faults can be detected over a widely adjustable alarm range.

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, as well as remote indicating stations including the MK800 and MK2430.

### RCMS series features:

- Fulfills ground fault detection requirements of NEC 690.5
- Detects both AC and DC ground faults
- Mitigates the blind spot issue - 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 twelve (12) separate channels individually from one device
- Each channel may be individually set to a unique trip level over a widely adjustable range (10 mA - 10 A, AC/DC)
- Wide frequency range (0 - 2000 Hz)
- Digital display showing each channel's readings in real-time
- Harmonics analysis
- Two common SPDT contact outputs
- RCMS490 models feature individual contact outputs for each channel
- Compatible with Bender's communication gateways and remote indicating stations



# Communicate and integrate

Advanced tools to quickly locate, inform, and analyze



COM465IP communication gateway

## Standard features:

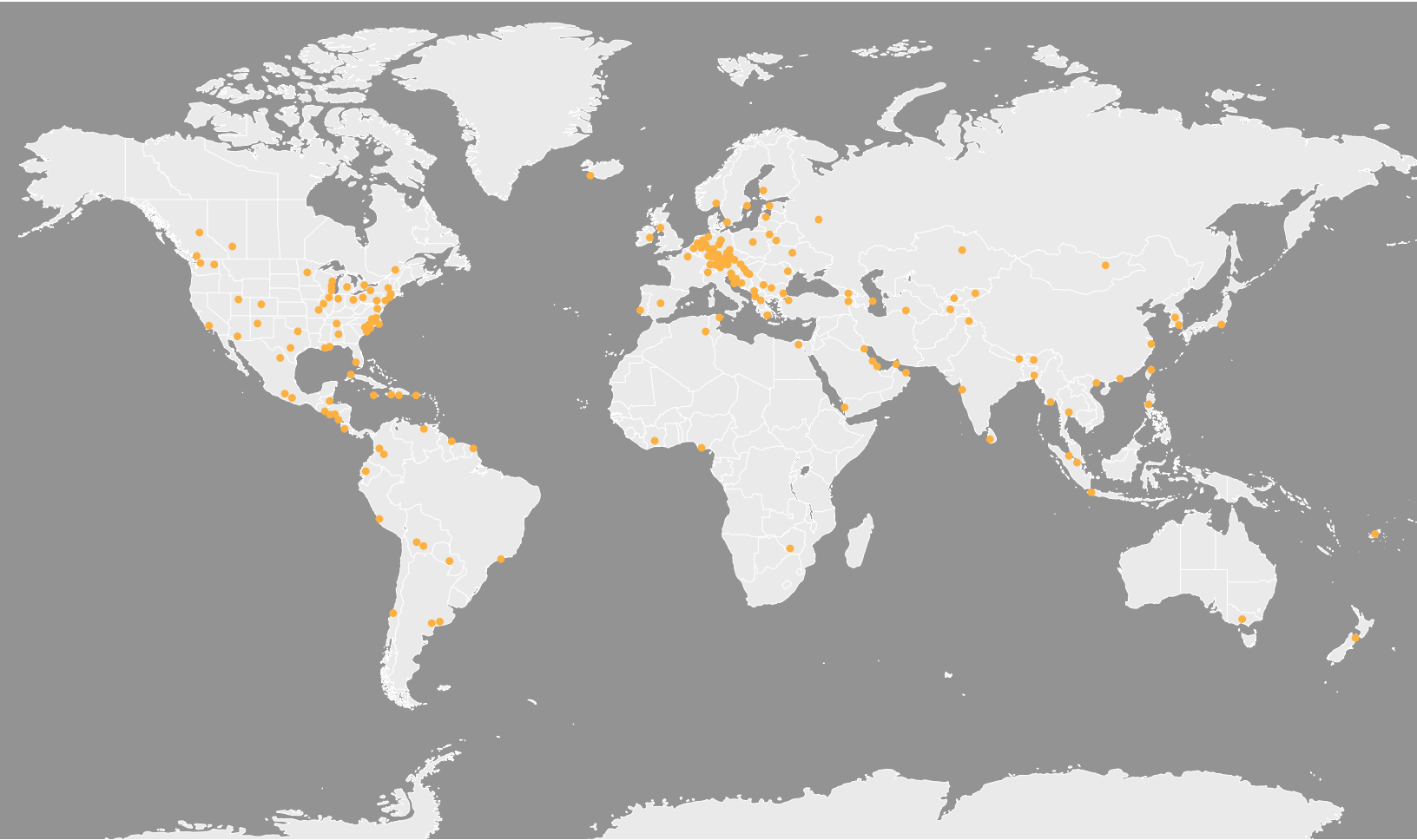
- Adds supported Bender and third party devices to modern industrial communication networks
- Modern, responsive web interface working in virtually any web browser
- Connects to standard Ethernet networks
- Check the status of devices and alarms across multiple communication protocols on a single screen
- Third party device support - connect third party Modbus/TCP devices to view specified data points
- Supports virtual setpoints - create custom alarms using conditional or mathematical alarms, combine multiple devices, and integrate third party devices

## Key additional options:

- Identify devices and alarm channels with custom names
- Receive e-mail notifications on specified trigger events
- Connect Bender devices to Modbus/TCP networks
- Remotely modify settings for connected Bender equipment
- System visualizations - visual overviews of systems with equipment locations; identify physical locations of alarms with no programming required

The screenshot displays the Bender web interface. At the top, the Bender logo and 'CP700 COMTRAXX' are visible on the left, and 'CP700 Address 1-1' with a date '2/17/16 11:10 AM' and a language dropdown 'EN' are on the right. A dark sidebar on the left contains navigation options: 'Bus overview', 'SUBSYSTEM 1' (with a red warning icon), 'Device overview' (highlighted), 'Edit texts', and 'Report'. The main content area is titled 'Device overview' and features a search bar and 'Grid/List' view toggles. Below, four device cards are shown: 'CP700 Main Station' (Address 1, green checkmark), 'RCMS460-D PDP-01 Ground Fault' (Address 2, red warning icon), 'PEM735 PDP-01 Power Quality' (Address 3, green checkmark), and 'VD700 PDP-01 Custom Alarm' (Address 6, green checkmark). Each card includes a legend for protocols (BMS, BCOM, TCP, RTU) and a settings icon.

**Bender is located in 70 countries around the world!**



**USA • Exton, PA**

800.356.4266 / 610.383.9200 • [info@bender.org](mailto:info@bender.org)  
[www.benderinc.com](http://www.benderinc.com)

**Canada • Mississauga, ON**

800.243.2438 / 905.602.9990 • [info@bender-ca.com](mailto:info@bender-ca.com)  
[www.bender-ca.com](http://www.bender-ca.com)

**Mexico • Ciudad de Mexico**

+972 517-7147 / + (55) 4955 1198 • [info@bender.com.mx](mailto:info@bender.com.mx)  
[www.bender.com.mx](http://www.bender.com.mx)

**South America, Central America, Caribbean**

+1 (484) 288-7434 • [info@bender-latinamerica.com](mailto:info@bender-latinamerica.com)  
[www.bender-latinamerica.com](http://www.bender-latinamerica.com)

**Chile • Santiago de Chile**

+56 2.2933.4211 • [info@bender-cl.com](mailto:info@bender-cl.com)  
[www.bender-cl.com](http://www.bender-cl.com)