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# Electrical Safety in Mines





# Electrical Safety Products For the Mining Industry

## An Innovator in the Mining Industry for Over 70 Years

With our roots founded in the mining industry over 70 years ago, BENDER has become a global leader in ground fault protection and electrical safety equipment. Our years of technical experience and broad portfolio of products utilizing the latest in protection technology ensure creating the best solution to meet your needs. Our worldwide network of support staff ensures that your system remains in peak condition. Our products help you safeguard your personnel, equipment, and processes, while reducing your costs, maintenance, and downtime.



### Related Standards

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 decades of experience dedicated to the mining industry ensure that your system is protected with the equipment best fit for the job.

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

- CSA M421-11
- ASTM F1134-94(2007)
- AS/NZS 2081.1
- IEC 61557-8:2007
- IEC 61557-9:2009
- IEC 62020:2003







Monitoring Type ▶		Ground Fault			
Device Application ▶		Ground Fault Detection Ungrounded Systems		Ground Fault Monitoring Grounded and High-Resistance Systems	
Devices					
Application ▶		Mining Processes, Power Generation, and Power Distribution		Mining Processes, Power Generation, and Mobile Generators	
System Type ▶		1Ø AC Systems up to 300 V	1Ø and 3Ø, AC/DC, Pure DC, and Variable Frequency Drives (VFDs)	AC Systems, 1Ø and 3Ø	1Ø and 3Ø, AC/DC, Pure DC, and Variable Frequency Drives (VFDs)
Image(s) ▶					
Name(s) ▶		IR420-D4	IRDH275 / IRDH375	RCM420	RCMA423
Description(s) ▶		AC Ground Fault Detector	AC/DC Ground Fault Detector	AC Ground Fault Relay	AC/DC Ground Fault Relay
Refer To ▶		Page 4	Page 4	Page 5	Page 5
Required Accessories					
Image(s) ▶					
Name(s) ▶				W Series	WAB Series
Description(s) ▶				Current Transformers	Current Transformers

## A Complete Solution for Mining....

- Ground fault detectors for ungrounded AC and DC systems
- Ground fault relays for solidly grounded and high-resistance grounded AC and DC systems
- Ground fault monitoring equipment for equipment supplied by variable frequency drives (VFDs)
- Ground fault monitoring for offline equipment
- Combination monitors featuring ground fault monitoring, and neutral ground resistor (NGR) monitoring or ground continuity monitoring per CSA M421-11
- Voltage, frequency, and phase sequence / phase loss monitoring for single- and three-phase
- Load current monitoring for single- or three-phase
- Ground continuity monitoring for trailing cables
- Remote indicating and communicating solutions

## ... For Virtually All Equipment Types

- Motors
- Variable frequency drives
- Generators
- Conveyors, loaders, drillers
- Hoists
- Cranes
- Lighting circuits
- Pumps, fans, and compressors
- Excavators and conveyors
- Battery systems
- Trailing cables

Ground Fault		Voltage and Frequency	Load Current	Ground Continuity
Combination Monitoring High-Resistance Systems	Offline Equipment Any Systems	Any Systems	Any Systems	Grounded and High-Resistance Systems
Trailing Cables and Power Distribution	Offline / Standby Equipment	Power Distribution	Power Distribution	Trailing Cables
AC Systems, 1Ø and 3Ø	AC Systems	AC Systems, 3Ø	AC Systems, 3Ø	AC Systems
				
RC48C	IR420-D6	VMD420	CMD420	GM420
AC Ground Fault Relay and Ground Continuity Monitor	Ground Fault Monitor for Offline Equipment	Monitoring Relay for Voltage, Frequency, Phase Sequence, and Phase Loss	Monitoring Relay for Overcurrent and Undercurrent	Ground Continuity Loop Monitor
Page 6	Page 7	Page 7	Page 8	Page 8
				
W Series E6 Series	W Series CD1000			
Current Transformers Termination Module	Current Transformers NGR Module			

# Ground Fault Detectors Ungrounded Systems



## IR420-D4

*Ground Detector for Ungrounded AC Systems up to 300 V*

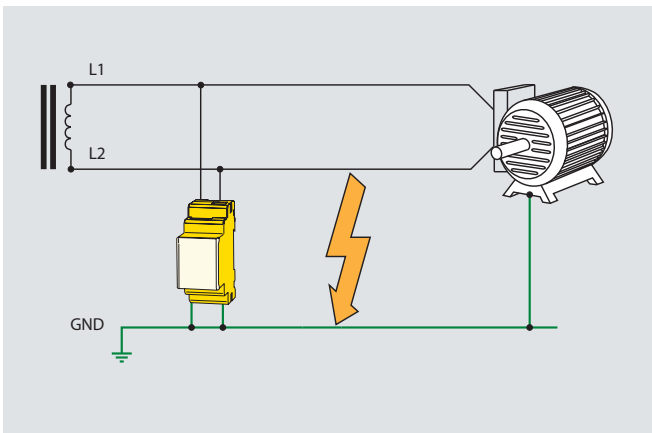
The IR420-D4 ground fault detector monitors ungrounded AC circuits up to 300 V for early indication of ground faults. A digital display gives real-time readings of the system's insulation resistance to ground to provide predictive maintenance capability and troubleshooting for ground faults. Its compact size allows for easy installation and retrofitting.

### Features

- For AC systems up to 300 V
- Digital display with real-time readout
- Adjustable setpoint from 1 to 200 kΩ
- Two separately adjustable alarms with N.E. / N.D. SPDT contacts for each

### Applications

- Single-phase AC systems
- Motors, fans, pumps
- Generators
- Lighting circuits
- Conveyors, loaders, pumps, loaders



## IRDH275 and IRDH375

*Ground Detector for Ungrounded AC/DC Systems*

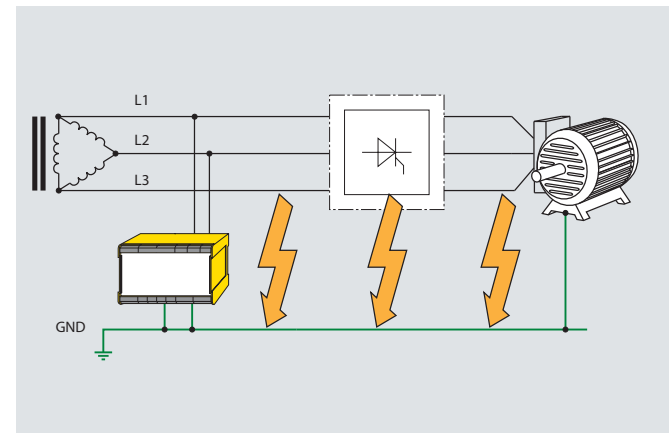
The IRDH series of ground detectors provides state-of-the-art protection for your ungrounded system. The AMP Plus measuring principle ensures that an accurate measurement is taken through all forms of power conversion, such as DC rectifiers and variable frequency drives (VFDs). A digital display gives a real-time reading of the system's resistance. Optional RS-485 communication is available.

### Features

- For AC and DC systems up to 793 VAC, 650 VDC (voltage couplers extends range up to 7.2 kV AC, 1.6 kV DC)
- Digital display with real-time readout
- Adjustable setpoint from 1 kΩ to 10 MΩ
- Two separately adjustable alarms

### Applications

- Single- and three-phase AC and DC
- Variable frequency drives (VFDs)
- Systems with high leakage capacitances
- Battery systems





# Ground Fault Monitors

## Grounded and High-Resistance Grounded Systems



### RCM420

*Ground Fault Relay for Grounded and HRG AC Systems*

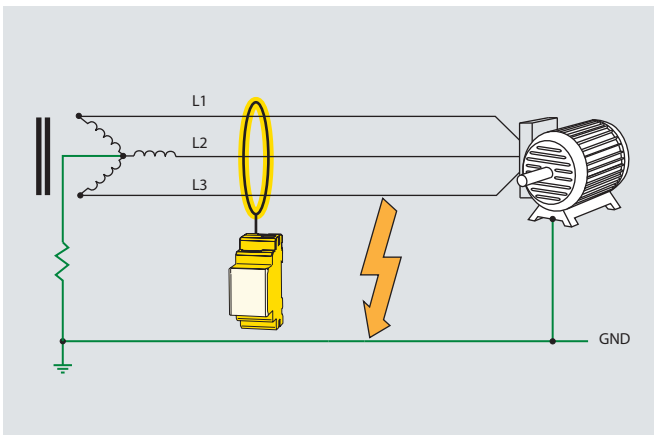
The RCM420 monitors the leakage current on grounded and high-resistance grounded AC systems by utilizing an external current transformer for measurements. The digital display shows the ground fault current in real-time. Adjustable trip levels and time delays allow for equipment-specific settings. A pre-alarm setting allows for advanced notification of growing faults. Two SPDT contacts are available. Options with analog outputs are also available.

#### Features

- For single- and three-phase AC systems
- Digital display with real-time readout
- Adjustable setpoint from 10 mA to 10 A with pre-alarm
- Two separately adjustable alarms with N.E. / N.D. SPDT contacts for each

#### Applications

- Motors
- Lighting circuits
- Pumps
- HVAC equipment



### RCMA423

*Ground Fault Relay for Grounded and HRG AC/DC Systems*

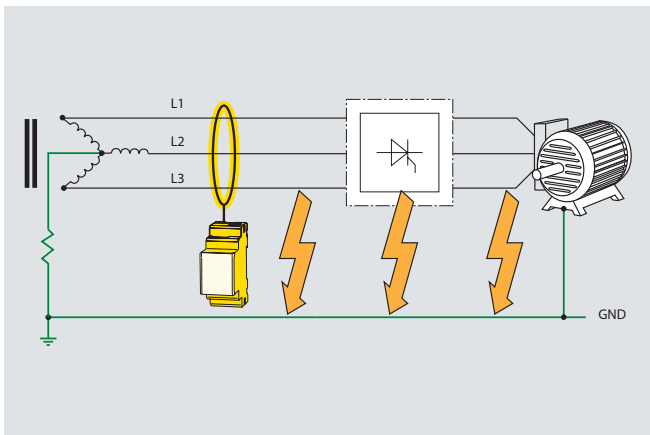
The RCMA423 incorporates the latest technology to detect ground faults on grounded and high-resistance grounded AC and DC systems by using an external current transformer for measurements. The RCMA423 detects through power conversion, including systems with variable frequency drives (VFDs). The digital display shows the ground fault current in real-time. Adjustable trip levels and time delays allow for equipment-specific settings.

#### Features

- For single- and three-phase AC and DC systems
- Digital display with real-time readout
- Adjustable setpoint from 30 mA to 3 A with pre-alarm
- Two separately adjustable alarms with N.E. / N.D. SPDT contacts for each

#### Applications

- Systems with variable frequency drives (VFDs)
- Battery systems and charging systems
- Excavators and conveyors
- Pumps, fans, and compressors
- Conveyors, loaders, drag lines, pumps



# Combination Monitoring High-Resistance Grounded Systems



## RC48C

*Ground Fault and Ground Continuity Monitor*

The RC48C incorporates a ground fault relay to monitor low level ground fault currents in high resistance grounded systems, utilizing a current transformer for measurement. A wide range of sizes are available. In addition, a ground continuity monitor is incorporated to check the integrity of the equipment grounding conductor.

The grounding conductor and pilot wire terminate at the E65 module located at the end of the trailing cable. This allows for the determination of type and magnitude of the fault, whether series or parallel.

### Features

- For high-resistance grounded systems
- Adjustable ground fault alarm value and time delays
- Latching operation
- Switchable band pass filter

### Applications

- Systems with trailing cable in resistance grounded systems



## RC48N

*Ground Fault and Neutral Grounding Resistor Monitor*

The RC48N monitors the integrity of high-resistance grounded installations. The incorporated ground fault relay monitors the magnitude of the ground fault current and alarms after exceeding the adjustable trip level, utilizing a current transformer for measurement. A wide range of sizes are available.

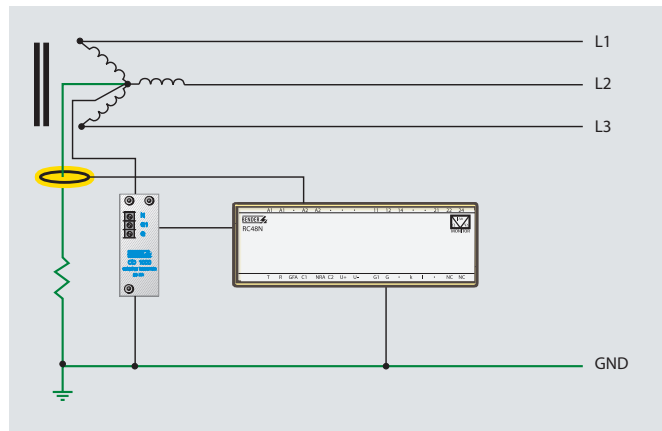
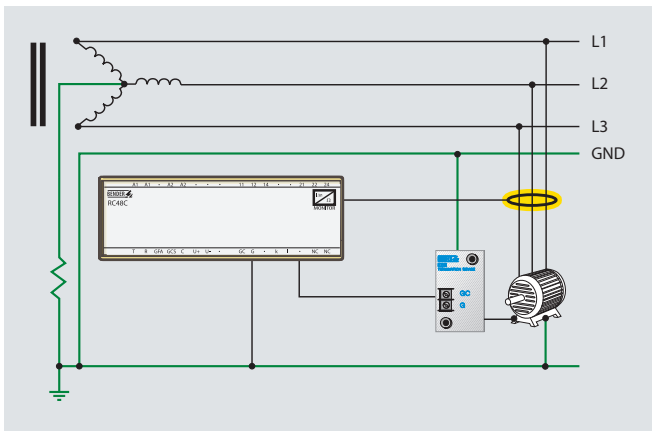
In addition, when combined with the CD1000, the RC48N monitors the integrity of the neutral grounding resistor or conductor. The device alarms when the resistance of the neutral-to-ground point exceeds the set response value.

### Features

- For high-resistance grounded systems up to 1000 VAC
- Adjustable alarm values
- Latching operation
- Switchable band pass filter

### Applications

- High-resistance grounded installations





# Voltage, Frequency, And Offline Fault Monitoring



## IR420-D6

*Ground Fault Detector for Offline / Standby Equipment*

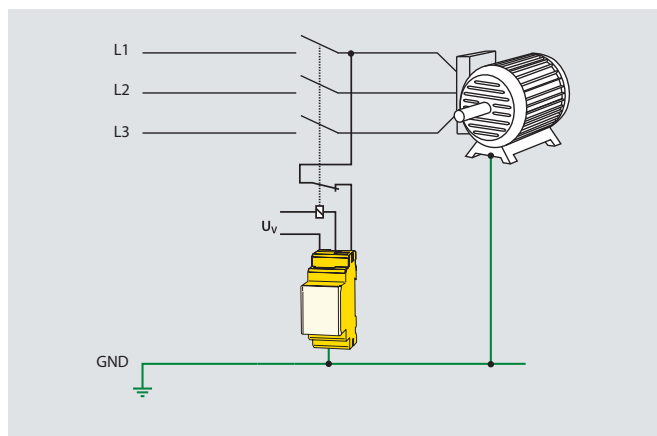
The IR420-D6 monitors offline / disconnected equipment for ground faults in grounded, high-resistance grounded, and ungrounded systems. A digital display shows the level of the equipment's insulation resistance in real-time. Adjustable trip levels allow for equipment-specific settings. Two SPDT alarm contacts are available.

### Features

- For disconnected loads on grounded, HRG, and ungrounded systems
- Digital display with real-time readout
- Adjustable setpoint from 100 kΩ to 10 MΩ
- Two separately adjustable alarms with N.E. / N.D. SPDT contacts for each

### Applications

- Motors, pumps, slide-valve drives, elevators
- Fire extinguisher pumps
- Exhaust air extraction systems
- Standby / emergency equipment



## VMD420

*Voltage, Frequency, Phase Loss and Phase Sequence Relay*

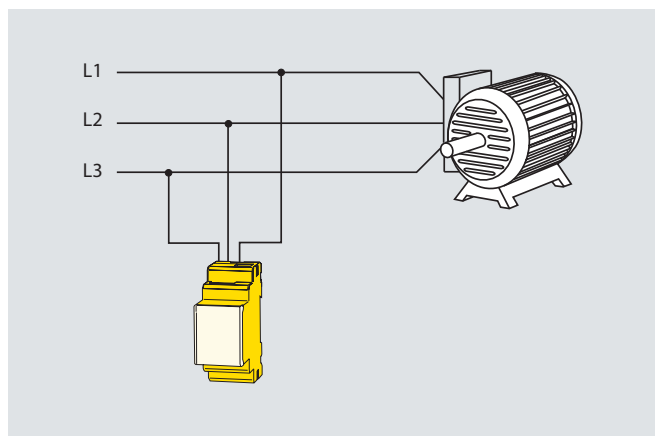
The VMD420 is an all-in-one, compact device for monitoring voltage, frequency, phase sequence, and phase loss in three-phase AC systems. A digital display shows the values in real-time. Widely adjustable trip levels are available for voltage and frequency. Two SPDT alarm contacts are available which may be set to trigger on any combination of alarms. Single-phase AC and DC versions also available.

### Features

- For three-phase AC systems (single-phase AC and DC versions also available)
- Monitors for voltage, frequency, phase sequence, and/or phase loss
- Digital display with real-time readout
- Two separately adjustable alarms with N.E. / N.D. SPDT contacts for each

### Applications

- Power distribution
- Motors and pumps
- Generators





# Current and Ground Continuity Monitoring



## **CMD420 / CMD421**

### *Three-Phase Overcurrent and Undercurrent Relay*

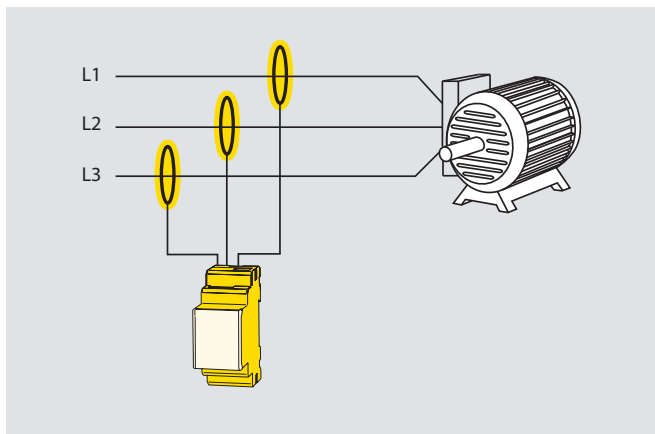
The CMD420 and CMD421 are compact devices monitoring for overcurrent and/or undercurrent in three-phase AC systems. Current transformers with a 1 A secondary (CMD420) or 5 A secondary (CMD421) may be utilized. Once the ratio of the CT is entered into the device, values shown on the digital display in real-time will be values seen on the primary side. Two separately adjustable alarms are available, as well as two SPDT alarm contact outputs. Single-phase versions are also available.

#### **Features**

- For three-phase AC systems (single-phase versions available)
- Utilizes current transformers for monitoring
- Digital display with real-time readout
- Two separately adjustable alarms with N.E. / N.D. SPDT contacts for each

#### **Applications**

- Motors and pumps
- Power distribution



## **GM420**

### *Ground Continuity Loop Monitor*

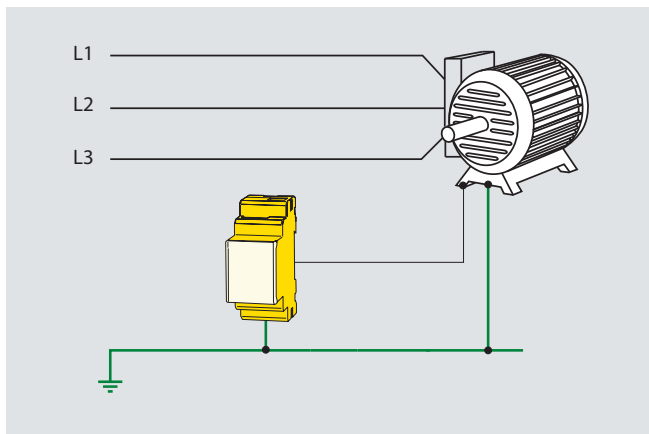
The GM420 monitors the integrity of the equipment ground conductor in AC systems. As well as monitoring for a break in continuity, the GM420 can also measure the resistance of the ground loop set between the equipment grounding conductor and pilot wire to ensure properly connected and high quality ground. The digital display shows the resistance of the loop in real-time. The GM420 also monitors for any transient voltages that may occur between the two monitoring points.

#### **Features**

- Digital display with real-time readout
- Checks for ground break and ground integrity
- Two separately adjustable alarms with N.E. / N.D. SPDT contacts for each

#### **Applications**

- Trailing cable with pilot wire conductor
- Ground loops
- Equipment grounding monitoring





## Current Transformers for RCM420 / RCMA423 / RC48C / RC48N

BENDER's monitoring equipment for grounded and high-resistance grounded systems utilize passive current transformers for monitoring sensitive levels of leakage current. Only one current transformer is required per device, and work for both single-phase and three-phase systems. A wide range of sizes are available.

W series current transformers are utilized with the RCM420, RC48C, and RC48N for ground fault monitoring. A simple two-wire connection is made between the device and the current transformer.

WAB series current transformers are utilized with the RCMA423. They have the ability to detect both AC and DC faults, as well as faults on variable frequency drives (VFDs).

## Voltage Couplers for IRDH275 / IRDH375

BENDER's voltage couplers work in combination with the IRDH275 and IRDH375 ground detectors for ungrounded systems to extend the nominal voltage range that may be connected. Each coupler features a simple connection to the ground detector and may be placed in a separate, high-voltage cabinet if desired.

- The AGH150W-4 connects to DC systems and extends the voltage range to 1600 VDC.
- The AGH520S connects to AC systems and extends the voltage range to 7200 VAC.
- The CD1000 is used with the RC48N ground fault monitor and extends the NGR monitoring range to 1000 VAC.

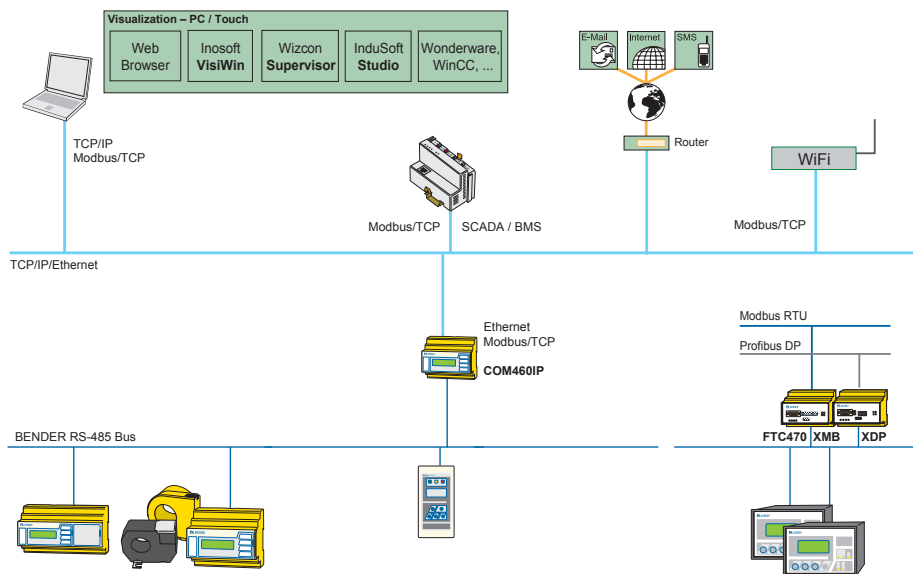


## Remote Indicators

BENDER features a wide range of remote indicators and remote stations compatible with devices that support analog or digital outputs. Several feature remote test and reset capability as well as other features:

- 7204 / 9604 series meters provide a simple analog meter for reading the connected device's leakage / insulation level.
- RI2000 series remote indicators work with the RC48C and RC48N and provide trip indication as well as test and reset functionality.
- MK2430 and MK800 remote stations work with devices with communication capability, such as the IRDH275, and provide a single station for indicating and testing multiple devices.

# Communication Solutions



*A comprehensive solution for integrating BENDER equipment into modern networks*

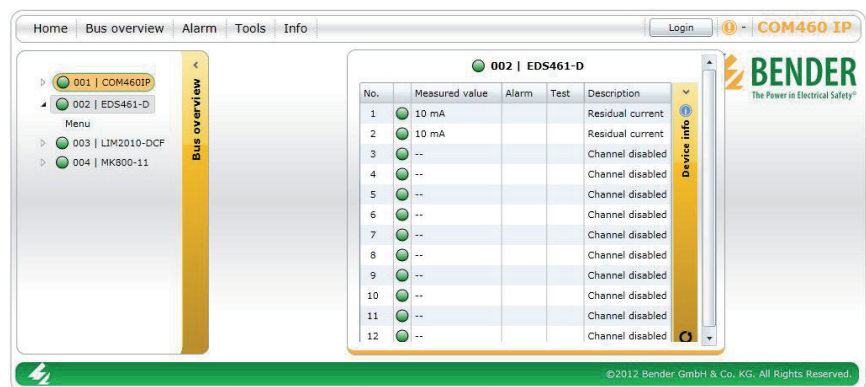
## Simplistic Network Integration

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:

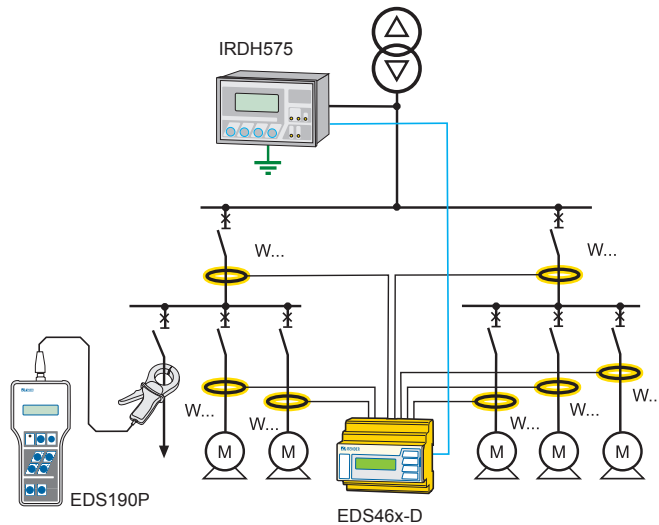
- Reading / alarm levels in real-time
- Timestamped data logging
- Customizable alarm messages
- Building / schematic footprint display
- E-mail / SMS capability
- Centralized device configuration
- Reporting tools
- Status screen for smartphones



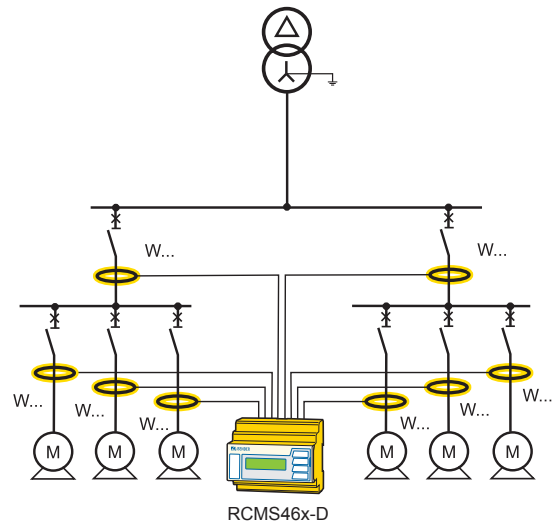
*Always know the status of your system with the COM460IP's detailed visualization*

# Ground Fault Location Solutions for Substations

## Ungrounded Systems - IRDH / EDS Series



## Grounded and HRG Systems - RCMS Series



*BENDER's ground fault location systems find faults without shutting down*

### Locate Faults While the System Remains Online

BENDER's advanced line of ground fault location equipment helps save time, money, and ensures system continuity by finding ground faults in grounded, high-resistance grounded, and ungrounded systems while the system remains online. A combination of installed and portable equipment can locate faults down to the load level.

Installed equipment automates the process of both detecting and locating faults, while providing communication capabilities to remote locations and personnel.

Portable equipment provides predictive maintenance and gives your technicians the flexibility to conduct ground fault location on routine schedules.

### Advantages

- Ground fault location while the system remains online
- Fast location of faults
- Works on AC, DC, and mixed AC/DC systems
- Reduced maintenance costs and downtime
- Indication of fault shown on LCD displays of location module, ground detector, and remote indicators
- Communication capability with installed devices
- Modular design allows for simple retrofitting / upgrading
- Ungrounded systems: Indication of fault shown on LCD displays of location module, ground detector, and remote indicators
- Grounded / HRG systems: Harmonics analysis of ground fault current



# 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 down-time, 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



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