BENDER

Electrical Safety in Mines

Ground Fault Protection Equipment for the Mining Industry




Power in electrical safety

The future needs a beginning

The 40s – how everything started

The roots of the BENDER Company date back to the year 1936 when Walther Bender, the founder of the company, began his work as an inspector for electrical power systems in open pit and underground coal mines in Germany.

Electrical installations, during that time period, had to be disconnected for high pot testing purposes, an activity which inevitably led to production outages. This inspired him to develop an "Insulation Monitoring Device and ground fault indicator for three-phase systems", the so called "IMD". In 1939 this work culminated in the first patent.

Now, it was possible to check the electrical installation during online operation thereby eleminating the need for costly power outages.
It is important to note that the German underground mining community employed a majority of ungrounded or floating power systems. The nature of these systems forbids the use of conventional current transformer based ground fault monitoring solutions.

The IMD was the first device to close this gap successfully.
Walther BENDER finally opened an office in 1946. It marked the beginning of the entire BENDER Group.

Dipl.-Ing. Walther Bender (†)

The 50s – a successful alliance

The IMD was offered as a compact stand-alone device to several large mining and industrial companies.

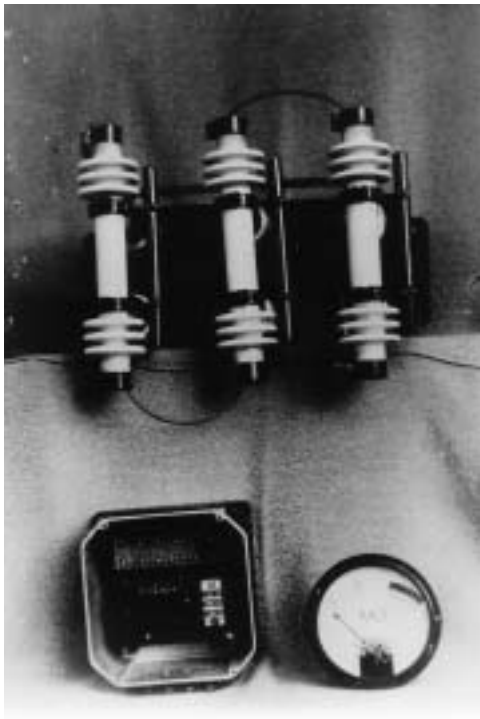
CALOR EMAG, a company specializing in switchgear and control equipment for coal mining, became an important business partner. There was instant synergy as the IMD ideally extended the company's product range and added the additional layer of safety requested by their customers.

In addition to their normal switchgear, CALOR EMAG also manufactures flame and explosion-proof enclosures for the mining and petrochemical industry.

The IMDs were mounted in the enclosures for their special electrical power distribution and control panels used in underground coal mining applications.

This was the beginning of a successful cooperation between the two companies which continued for decades thereafter.

The "BENDER office" in 1946



Patented IMD 1939

The 60s – an idea gains acceptance

It was only a matter of time when steel mills, railways, petrochemical plants, utilities and other diversified users were showing interest in the electrical safety features offered by the IMDs. BENDER Ground Fault Monitors were successfully used in ungrounded systems that could be found in limited numbers in these industries – everywhere, where increased electrical safety was paramount.
Thanks to future-oriented ideas and ongoing advancements in the research and development of new products, the customer base was extended to other markets.
BENDER added sensitive ground fault protection devices for solidly grounded and high-resistance grounded power systems as well.
This included a protection device for

underground lighting circuits. It enabled the user to automatically monitor ground faults and overloads on the lighting circuits. This was very important as the miners also used the lighting circuits for signal commands as a visual communication tool.
On the suggestion of the mining industry the series 906 ground fault lockout device – a miniaturized ground fault relay embedded into an epoxy resin block was developed. It's intent was to disconnect branches or feeders in case of a ground fault.
The 906 series incorporated off-line monitoring as an additional feature to prevent a restart of faulty equipment. This device has been used since then by a number of national and international manufacturers of flame and explosion-proof switchgear enclosures.
For heavy mining machines with flexible trailing cables, e.g in potash mining, the SKS100 series trailing cable protection device was developed. In addition to the insulation monitoring function, these units provided a ground integrity monitoring function as well as off-line monitoring to prevent a restart of faulty equipment.

The 70s – a new generation of protection devices for grounded power systems

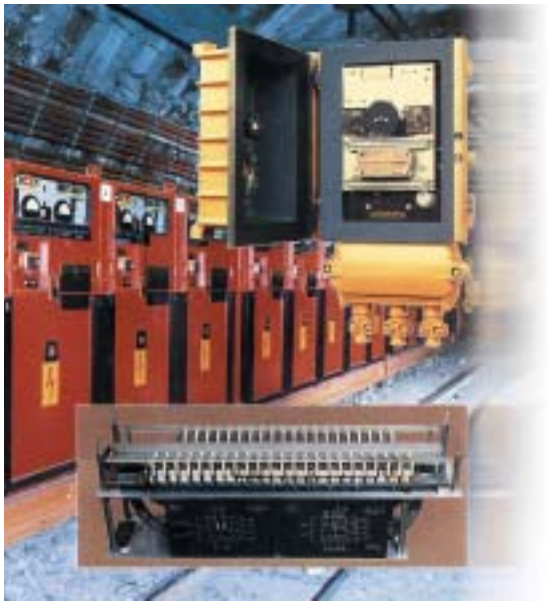
In 1972, Walther Bender turned-over the leadership of the company to his son and successor, Christian D. Bender, who conceptualized a globally oriented business plan. New factories were built in Germany and BENDER started the mass production of electrical safety devices and in particular a new generation of IMDs, covered under the trade mark A-ISOMETER.

Since then, the development of the company has been progressing at a rapid pace. International agreements and collaborations were established. Sales and support offices were established in more than 100 countries.
The idea of improving the safety of solidly grounded and high-resistance grounded systems by monitoring low levels of ground fault current resulted in the development of new products.

In 1974, the new HW and HWS series protective devices were applied to 6 and 10 kV switchgear and distribution panels.

In addition to the detection of ground fault current, the integrity of the equipment grounding conductor in high voltage cables could also be monitored and assessed.

The HW and HWS series high-voltage ground fault monitor opened up new markets in several fields of applications. For the first time, CALOR EMAG supplied this level of protection. The successful selling of the devices to mining companies in Belgium, France, Spain, Yugoslavia and Columbia led to an increase in the export business.



High-voltage Ground Fault Monitor 1976

The 80s – an astute move into North America

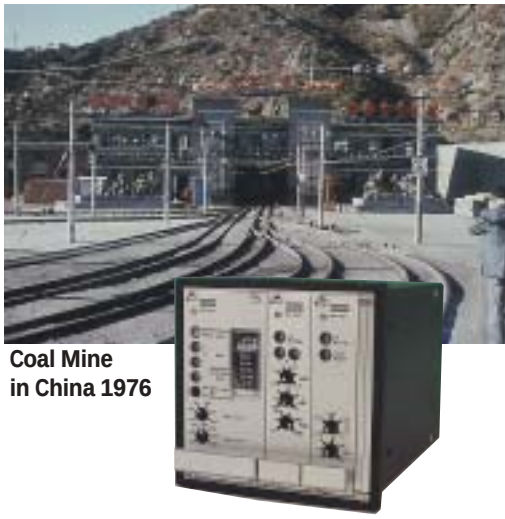
With the foundation of the subsidiary BENDER Inc. in Philadelphia, BENDER took up the challenge to establish the ground fault protection business for the global market and in particular in the North American market. American and Canadian companies had been customers of BENDER products already, but the high technical nature of electrical safety devices and the ever growing need for application support required the owner to take a serious look at a permanent representation in the U.S. and Canada. Both countries with their seemingly unlimited number of industrial applications had a growing need for electrical safety devices and solidly engineered ground fault solutions to their problems. Main power distribution systems were either ungrounded, solidly grounded or high-resistance grounded. The variety of BENDER products to accommodate the needs of these applications easily numbered into the hundreds.

BENDER became well-known for being the second-to-none expert in electrical safety and a reliable source for Electrical Safety Products.

The reliability of the HW and HWS series of high voltage ground fault monitors inspired well-known mining switchgear suppliers, such as SIEMENS, ABB, AEG and SAIT to use this protective device as well. This was how the HW monitor series found its way to Poland, Russia, China and the Ukraine.

In addition to ground fault current protection devices for the mining industry there was also a demand for a high-class electronic over current, and short-circuit protection and control device for flame and explosion-proof medium voltage switchgear.

BENDER's answer was the development of the R1G electronic protection relay.



Coal Mine in China 1976

The 90s – electronic power converters gain in popularity

Due to increasing power requirements in underground coal mines, a number of electric cables for 6/10 kV were connected in parallel and had to be routed down the mine shafts to the working underground sites. On the occurrence of a ground fault, all the cables had to be disconnected. In order to avoid a 100% shut down, BENDER was asked to develop a method for identifying the faulty cable. A practical and economical solution was developed. By using core-balance transformers located at the cable ends and creating an artificial resistive star point, it was possible to detect ground fault currents and identify the faulty cable with the HEP348 ground fault monitor.

Since the beginning of the nineties, high-powered variable speed drives have become common in big excavators.

Recognizing the impact of this new technology on the ability to detect and measure ground faults, BENDER developed the IRDH series of IMDs which incorporated a revolutionary new AMP (Adaptive Measuring Pulse) measuring principle that served to enhance the reliable operation of excavators and other heavy equipment. It quickly became the favorite in the mining community and was subsequently successfully applied worldwide.

R1G electronic protection relay

High-voltage GFR accessories

Bender today

The new millenium – new ideas based on 60 years of experience

BENDER recently upgraded its existing line of monitoring and protection devices for solidly grounded and high-resistive grounded systems to satisfy the growing demand for a reliable high-quality supplier to the mining industry in North America and around the globe.

The RC48N device measures the ground fault current (GFR) and monitors the integrity of the neutral grounding resistor (NGR) between the neutral point (starpoint) of a supply transformer and ground.

The RC48C incorporates a GFR and a ground continuity monitor (GCM) which checks the integrity of the equipment grounding conductor (EGC).

As a result of a continuing dialogue with mining customers, BENDER has been steadily expanding its product range. Pragmatic solutions are being offered in all application areas where electrical safety is paramount. The main emphasis by BENDER is on the following products:

- Ground fault current monitors
- Ground fault current relays
- Insulation monitoring devices
- Fixed and portable ground fault locating equipment
- Fixed and portable GFCIs
- Monitoring equipment at the system level
- Monitoring, alarm, control and operator panels

BENDER – known for its futuristic management strategy

From its humble beginnings in a small engineering office founded in 1946 and its roots in the mining industry where ELECTRICAL SAFETY has always been considered a high priority issue, BENDER has advanced to become a world leader in Electrical Safety Products.

Today the BENDER Group with its affiliated companies is structured and staffed with talented personnel comprising a work force in excess of 400 employees motivated to reduce cycle time from product inception to commissioning while still surpassing the quality control requirements of ISO 9001.
A considerable percentage of earnings is invested in R & D.

BENDER key personnel actively participate on National and International Standards committees and organizations interested in ELECTRICAL SAFETY issues throughout the Industrial, Mining and Healthcare market. A close network of agencies and distributors has been established on all continents.

BENDER headquarter in Grünberg 2000

Selection Guide

Ground Fault Monitors, Insulation Monitoring Devices, Ground Fault Protection and Location Systems meets AS, ASTM, CSA, EN, IEC, UL, VDE

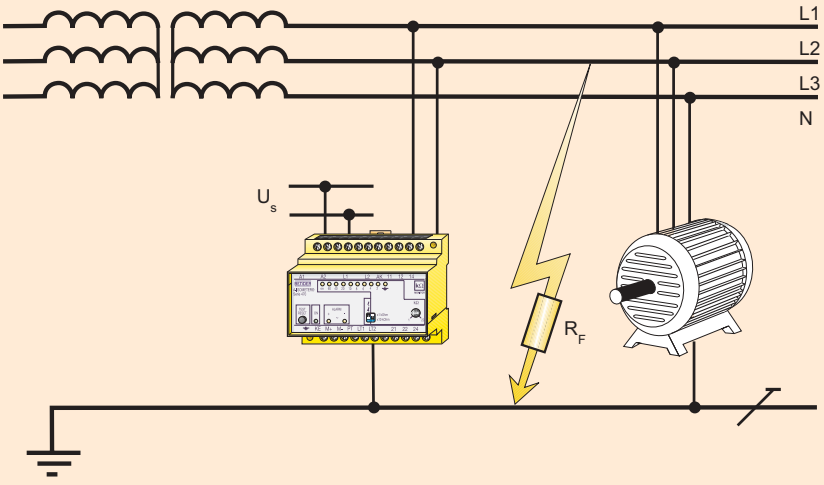
Measuring, monitoring & protection device	A Insulation Monitoring Device		B Ground Fault Relay	
Grounding strategy	ungrounded		solidly and high-resistance grounded	
System voltage	AC	AC/DC & DC	AC	AC/DC & DC
Page	8	9-10	11	
Application	mining processes, power generation and power distribution		mining processes, power generation and mobile gensets	
Images				
Type	IR 470 LY	IR 475 LY	RCM 460 Y	RCMA 470 LY
Response value	1...200 kOhm	2...500 kOhm	30...300 mA	30 mA...3 A
Notes	1 Alarm LED-Bargraph	2 Alarms LED-Bargraph	external CT	external CT
Images				
Type		IRDH 275	RCM 465 Y	RCMA 475 LY
Response value		1 k...10 MOhm	30...300 mA	30...500 mA
Notes		2 Alarms LC-Display	internal CT 26 mm	internal CT 18 mm
Images				
Type		IRDH 375	RCM 470 LY	
Response value		1 k...10 MOhm	10 mA...10 A	
Notes		2 Alarms LC-Display	external CT	
Images				
Type		IRDH 575	RCM 475 LY	
Response value		1 k...10 MOhm	10 mA...10 A	
Notes		for ground fault location	internal CT 18 mm	
Images				
Type			W-, WR-, WS- series	W...A series
Response value				
Notes			standard circular, split-core, rectangular	standard circular

C	D	E	F
Ground Fault Relay & Ground Continuity Monitor Canadian Standard CSA M421-00	Ground Fault Relay & Ground Continuity Monitor	Ground Continuity Monitor	Off-line Insulation Monitor
solidly and high-resistance grounded	solidly, impedance or resistance grounded	All	All
AC	AC (up to 10 kV)	AC & DC	AC & DC
12 / **13**	**14**	**15**	**15**
trailing cables, power distribution	trailing cables, power distribution	trailing cables	standby equipment
				
RC 48 C	RC 48 N	HW 135	RM 475 LY	IREH 470 Y2
I_Δ 0.1...10 A	I_Δ 0.1...10 A	I_Δ 0.1...10 A	50...1000 Ohm	0,1...2/ 0,5...10 MOhm
ground continuity and parallel path monitoring via pilot wire	monitoring of neutral grounding resistor	ground continuity and parallel path monitoring via pilot wire	ground continuity and parallel path monitoring via pilot wire	2 Alarms

Ground Fault Protection for Surface and Underground Mining

A-ISOMETER® IR470LY – Insulation Monitoring Device

A-ISOMETER® IR470LY



Principal diagram IR470LY

General:

The A-ISOMETER® IR470LY series monitors the insulation resistance of ungrounded single- and three-phase AC systems up to AC 50...400Hz 0...793V.

In order to avoid indeterminate conditions, DC loads should be isolated from the system being monitored.

Features:

- LED bar graph to indicate the insulation resistance level
- Extended voltage range via coupling devices

Applications:

- Motors
- Lighting circuits
- Ventilation fans
- Generators
- Longwall equipment
- Conveyors
- Cutting machines
- Power shovels
- Loaders
- Drag lines
- Pumps
- Power tools

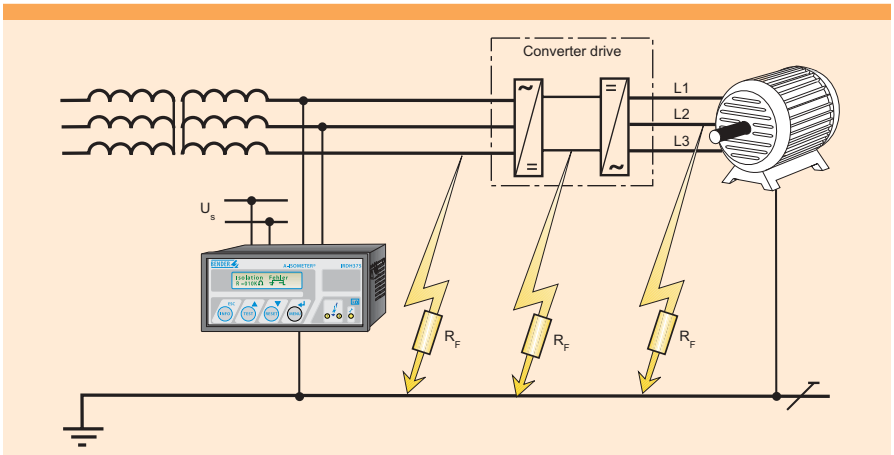
Standards:

- IEC 61577-8:1997-02
- EN 61557-8:1997-03
- DIN EN 61557-8 (VDE 0413) Teil 8:1998-05
- ASTM F 1669-96

A-ISOMETER® IRDH275 / IRDH375 – Insulation Monitoring Device

IRDH275

IRDH375



Principal diagram IRDH375

General:

The A-ISOMETER® of the IRDH275/375 series monitors the insulation resistance of ungrounded power supply systems. The devices are suitable for universal use in 3(N)AC, AC/DC 0...793V, and DC 0...650V systems. AC systems may include DC and induction motor drives using, respectively, rectifier- and inverter-type power electronic converters of various types including the well-known PWM DC-to-AC inverter.

Features:

- Wide response range 1 kOhm... 10 MOhm
- Separately adjustable set points for pre-warning/main alarm
- Comprehensive self-monitoring function
- Info key for the indication of the selected parameters and current system leakage capacitance

Applications:

- Variable-speed drives
- Systems with high leakage capacitances
- Battery systems

Standards:

- IEC 61577-8:1997-02
- EN 61557-8:1997-03
- DIN EN 61557-8 (VDE 0413) Teil 8:1998-0
- ASTM F 1669-96

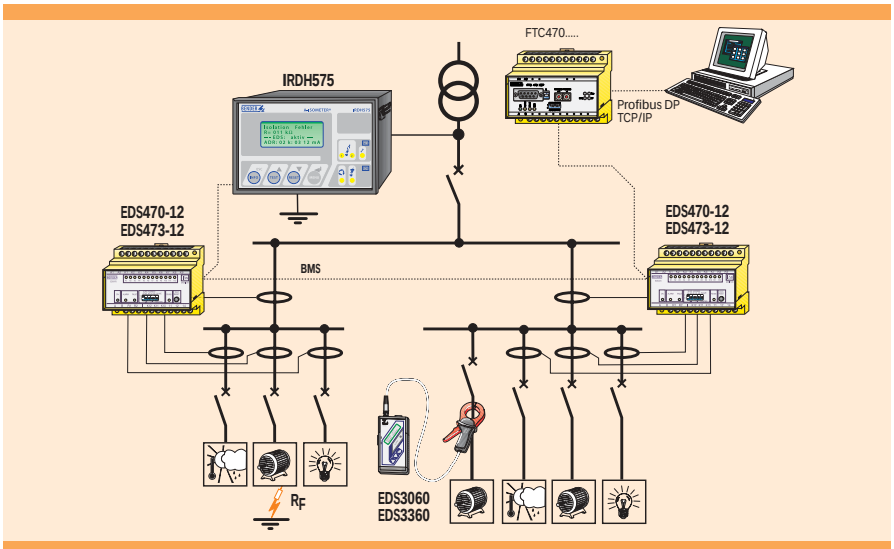
A-ISOMETER® IRDH575 – Insulation Monitoring Device and Fault Location Test Unit

General:

The A-ISOMETER® of the IRDH575 series monitors the insulation resistance of ungrounded power supply systems.

It is suitable for universal use in 3(N)AC, AC/DC 0...793V and DC 0...650V systems. AC systems may include extensive DC loads such as a thyristor-controlled DC drives.
In combination with insulation fault evaluators of the EDS47... series with the appropriate measuring current transformers, the IRDH575 can be incorporated into an insulation fault location system. For insulation fault location in branch circuits, the portable insulation fault location system EDS30.. can be utilized.

A-ISOMETER® IRDH575



Principal diagram IRDH575

Features:

- Separately adjustable response values for pre-warning/main alarm
- Comprehensive selfmonitoring function
- Info key for the indication of the selected parameters and the current system leakage capacitance
- Can be extended to provide an insulation fault location system

Applications:

- Substations
- Main circuits
- Control circuits

Portable ground fault location equipment EDS3060 series

Standards:

- IEC 61557-9:1999-09
- EN 61557-9:1999-11
- DIN EN 61557-9 (VDE 0413 Teil 9):2000-08
- ASTM F 1669-96

RCM460Y/465Y, RCM470LY/475LY
RCMA470/475LY

c UL us LISTED

RCM460Y/465Y, RCM470LY/475LY – High sensitivity Ground Fault Current Monitor

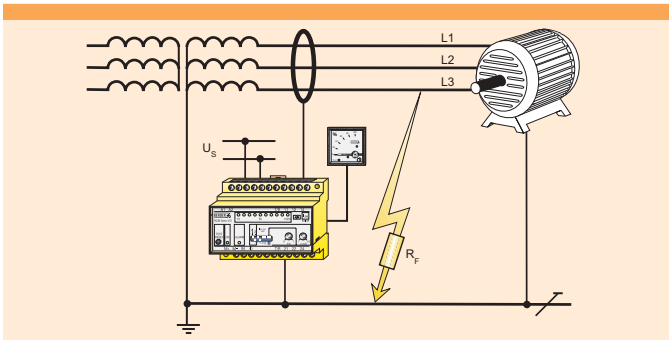
RCM475LY

General:

The ground fault current monitors of the RCM... series monitor the leakage current (AC or pulsating current) of grounded power supply systems by means of an external core-balance transformer (RCM460Y/RCM470LY) or with a built-in core-balance transformer (RCM465Y/RCM475LY).

Features:

- For predictive maintenance of electrical installations and loads
- Alarm instead of power interruption
- Independent of load current and system voltage
- Continuous indication of the magnitude of the ground fault current (RCM470/475)



Principal diagram RCM470LY

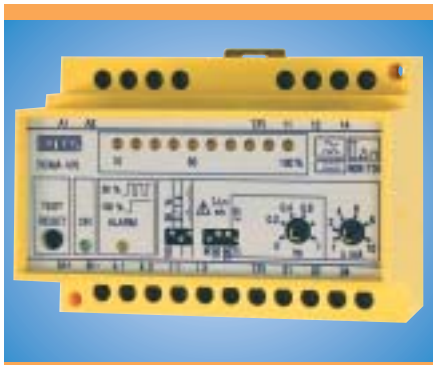
Applications:

- Motors
- Lighting circuits
- Pumps
- HVAC equipment

RCMA470LY/475LY – High sensitivity Ground Fault Current Monitor

General:

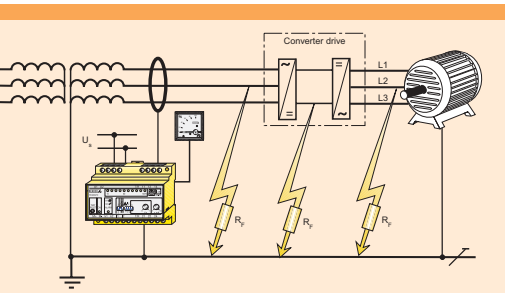
The RCMA 470/475 series is characterized by a high sensitivity and a frequency response from DC to high multiples of the system frequency.
There are many applications that require this level of performance. For one, the ground fault current waveform, in DC-motor and AC induction motor drives with appropriate power electronic converters, will contain a pure DC component. As another example, ground fault currents on the load side of six-pulse converters or rectifiers with a smoothing network will also contain a significant pure DC component.



RCMA470LY

Features:

- AC/DC sensitive residual current measurement
- Selectable pre-warning/main alarm
- Internal and remote indication of the residual current



Principal diagram RCMA470LY

Applications:

- Systems with variable-speed drives
- Battery systems
- Charging stations
- Excavator and conveyor systems
- Mills and vibrators
- Pumps, fans, compressors

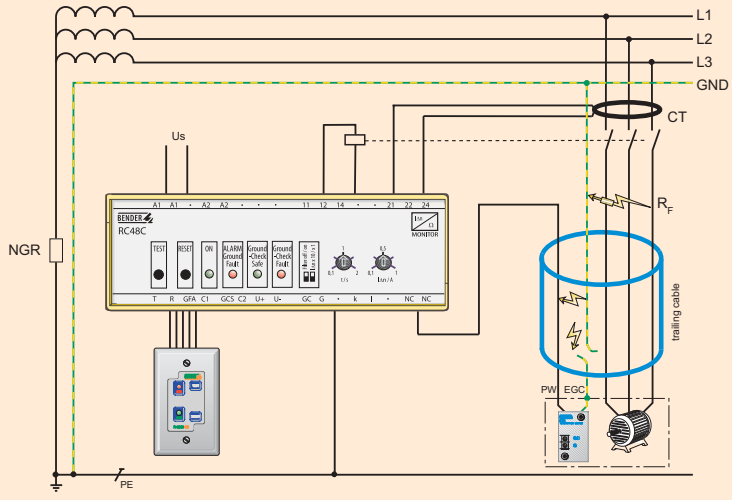
RC48C – Ground Fault Current and Ground Continuity Monitor

RC48C

General:

The RC48C incorporates a ground fault relay (GFR) to monitor low level ground fault currents in high-resistance grounded installations. There is also a built-in ground continuity monitor (GCM) which checks the integrity of the equipment grounding conductor (EGC)

The EGC and pilot wire (PW) terminate into the E6S device located at the end of the trailing cable. This device allows for the determination of the type and magnitude of the fault, whether series or parallel.



Principal diagram RC48C

Features:

- Remote alarm indicator and operator panel
- Fault memory
- Band pass filter

Applications:

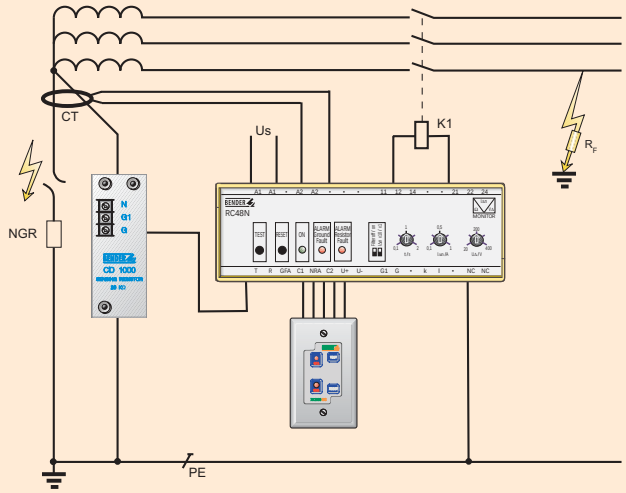
- Trailing cables in resistance grounded installations

Standards:

- CSA M421-00: July 2000: Use of electricity in mines
- AS 2081.1-AS 2081.5: Electrical equipment for Coal Mines
- IEC 62020:1998-08: Residual Current Monitors

RC48N – Ground Fault Current and Neutral Grounding Resistor Monitor

RC48N



Principal diagram RC48N

General:

The RC48N monitors the integrity of a high-resistance grounded installation. It is not possible to detect a ground fault if there is an open in the neutral grounding resistor (NGR) and/or the neutral grounding conductor. The NGR monitor continuously checks for the existence of this condition and alarms when the resistance of the neutral-to-ground path exceeds the trip point level.

The GFR monitors the magnitude of the ground fault current and alarms when it exceeds the adjustable trip level. Generally the core-balance CT is in the neutral-to-ground path but can be located so as to encircle the phase and neutral conductors in the service panel on the load-side of the circuit breakers.

Features:

- For systems up to 5 kV
- Storage of alarm events
- Test and reset button
- Adjustable response values
- Remote alarm indicator and operator panel

Applications:

- High-resistance grounded systems

Standards:

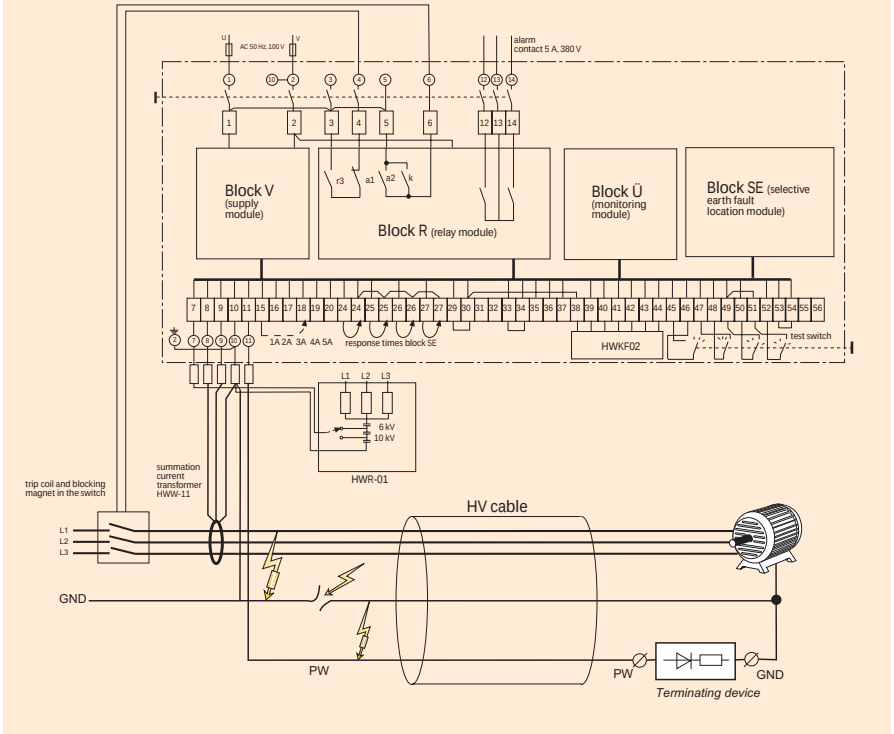
- CSA M421-00: July 2000: Use of electricity in mines
- AS 2081.1-AS 2081.5: Electrical equipment for Coal Mines
- IEC 62020:1998-08: Residual Current Monitors

HW135 – High Voltage Ground Fault Current and Ground Continuity Monitor

HW135

General:

The HW135 monitors a trailing high voltage cable in accordance with the German standard for mine safety DIN VDE 0118 in electrical installations for ground fault, open-circuit of the ground conductor, and for conducting objects penetrating the cable.
Ground fault monitoring is based on the residual current monitoring principle. The evaluation of the ground fault current is accomplished by processing the signal from the zero sequence current transformer HWW-11.
The ground continuity monitoring loop is completed by means of the EV22S terminating device which is located at the load end of the trailing cable.



Principal diagram HW135

Features:

- Cable lengths up to 2 miles
- Premises demanding a high level of safety, e.g. explosion-proof high voltage switchboards

Applications:

- Monitoring of supply cables without mechanical protection in underground mines
- Ground fault clearing in underground mining
- Monitoring of excavators with trailing cables, e.g. tunnel boring machines

RM475LY – Ground Continuity Monitor

RM475LY

General:

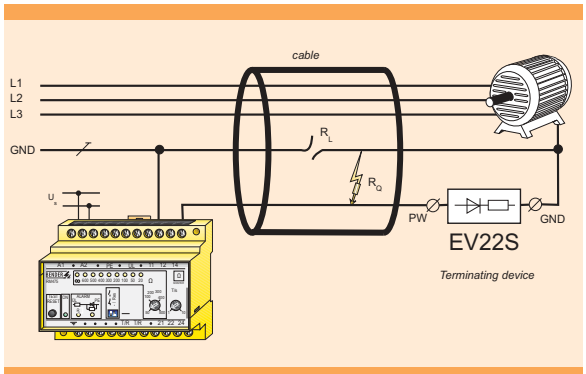
The RM475LY when combined with the EV22S terminating device monitors the equipment grounding conductor (EGC) for continuity and any unwanted parallel path between the EGC and the pilot wire (PW) or earth ground.

Features:

- LED bar graph indicator
- Suitable for installation in standard distribution panels
- Fault memory

Applications:

- Trailing cable with pilot wire conductor
- Stray ground loops



Principal diagram RM475LY

A-ISOMETER® IREH470Y2 – Insulation Monitoring Device for Off-line Equipment

General:

The IREH... series device monitors the insulation resistance of disconnected loads in grounded and ungrounded power supply systems. The devices are used, for example, to monitor pump-motors and slide-valve drives found, respectively, in fire-fighting and dewatering equipment.

Features:

- External measured-value display
- Nominal range can be extended via coupling devices
- Pre-warning/main alarm

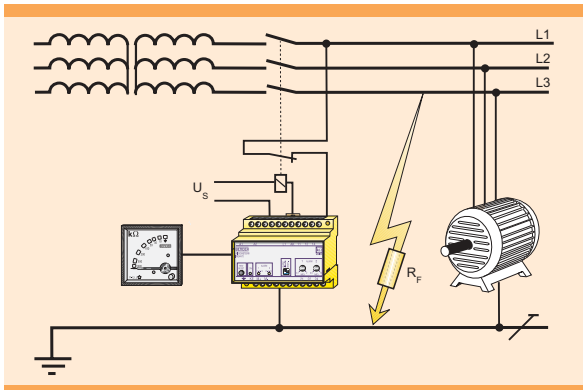
Applications:

- Fire extinguisher pumps
- Exhaust air extraction systems
- Motors
- Water pumps
- Slide-valve drives
- Elevators

Standards:

- IEC 61577-8:1997-02
- EN 61557-8:1997-03
- DIN EN 61557-8 (VDE 0413) Teil 8:1998-05
- ASTM F 1134-88

A-ISOMETER® IREH470Y2



Principal diagram IREH470Y2

Dipl.-Ing. Christian D. Bender

Today our vision has become a reality. With full commitment and the ability to assert ourselves, we pursue our goal to be a worldwide market leader in electrical safety products.

Walther Bender House

Our know-how and the competency of our employees is strong evidence that you have put your trust in the right partner.

Production facilities

Modern production facilities with ISO 9001 certification and thorough product testing have become the hallmark for quality products with a long operational life.

Seminar group

Together we develop innovative solutions that meet the demands of our customers.

Dipl.-Ing. W. BENDER GmbH & Co. KG
P-O. Box 11 61 • D-35301 Grünberg • Germany
Londorfer Str. 65 • D-35305 Grünberg• Germany
Phone: +49 (0) 64 01 - 807 0 • Fax: +49 (0) 64 01 - 807 259
E-Mail: info@bender-de.com • www.bender-de.com

BENDER

Power in electrical safety