Neutral Grounding Resistors and High Resistance Grounding Systems

User Manual

Table of Contents

Preface

General safety instructions

Hazard of electric shock!
High voltage signs are recommended. Please ensure the resistor is properly grounded before applying power. Prior to performing any maintenance, remove power and wait thirty (30) minutes for the resistor to cool down.

Hazard of fire or burn!
Neutral grounding resistors have the potential to reach high temperatures. Protection, such as a mechanical housing around the resistor assembly, should be provided by the installer to prevent injury to personnel that may come into proximity to the installation and prevent contact with material that could be combustible due to these temperatures. Do not allow combustible or metallic matter into the NGR; otherwise, fire or accident could occur.

Laws and guidelines

Please follow any relevant local, regional, or national electrical codes when installing this product. These instructions particularly apply to mounting and wiring/cable requirements.

Target group and required knowledge

This instruction manual is exclusively for trained electrical personnel. Personnel should have knowledge of the following:

- Relevant electrical codes: bonding, wiring, and signage requirements
- Airflow and ambient conditions
- Material handling capabilities: potential use of forklift or lifting crane
- Skills for installation: hardware mounting, electrical connections
    - Knowledge of grounding grids and rods
- Capability to operate and test application of product

Quick start guide

1. Review this manual and the corresponding drawings.
2. Carefully unpack the equipment.
3. Inspect the products for damage.
4. Install any loose components shipped for field installation due to risk of shipping damage (such as bushings).
5. Verify resistance of resistor if an ohmmeter is available.
6. Verify insulation with an insulation resistance tester.

7. Use the lifting hardware to bring the product to its designated installation area.
8. Verify adequate clearance for air flow, 24” free space above enclosure, and 6” required surrounding sides of resistor enclosure.
9. Ground the equipment enclosure(s) using the designated bonding lugs and bars on the product drawing.
10. Ensure that the upstream equipment you intend to ground (i.e. power transformer or generator) has been disconnected from service and de-energized.
11. Connect the equipment that is intended to be grounded to the designated terminals; depending on the type of equipment this will require either one, two, or three conductors. Refer to product drawing for more details, generally:
    a. One conductor for neutral, labelled “N”
    b. Two conductors for neutral, labelled “N1” and “N”
    c. Three conductors for three phases, labelled “A”, “B”, and “C”
12. Connect the ground fault relay / controls to the resistor assembly either by wiring to the CT terminals or the shorting terminal block. May not be applicable if the relay is supplied pre-wired.
13. Energize the system and follow instructions of ground fault relay manual to calibrate if necessary.

Product description

The purpose of a Neutral Grounding Resistor is to limit the magnitude of ground fault currents in a power system. They are used with other electrical equipment, primarily power transformers and generators. Multiple factors (outside of the scope of this document) affect the design and equipment that is part of a “neutral grounding system”. This section provides the pertinent information on the different form factors and equipment you may have available.

As a reader of this manual, you are most likely responsible for providing one or more of the following:

- Neutral grounding resistor
- Necessary upstream equipment
- Ground fault protection relays
- NGR monitoring
- Controls, alarms, and communications for relay

This manual includes information on all of the above; as a result some sections will be inapplicable to your scope of responsibility.

Receiving, unpacking, and inspection

The boxes and enclosures must remain upright at all times. Do not put anything on top of the enclosure.

If a forklift is used, make sure not to damage any part of the enclosure. If eyebolts are available and are used for lifting, make sure the angle of the cables with the vertical is 45 degrees or less.

1. Remove packing slip and inspect contents, store documents in a safe place.
2. Unpack the unit carefully.

3. Inspect enclosure for any shipping damages, including deformities, dents, and large scratches. Do not accept the unit if significant damage is observed.
    a. Units with significant shipping damage should be returned. Please see section on product returns. Significant shipping damage is defined as destruction of internal components and/or resistor assembly.
    b. Units with minor shipping damage can be fixed in the field.
4. Do not dispose of packaging until product has completed its initial startup and basic testing. In the case of a product defect or malfunction, the same packaging should be used to return the product

On-site testing

Check the resistance value using an ohmmeter. The measured value must correspond to that of the resistance at room temperature and with the tolerance indicated in the specifications or in the drawing of the instrument. For low Ohmic value resistances it will be necessary to use a micro-ohmeter.

Check the insulation of the equipment using an insulation resistance tester. To perform this test, it is first necessary to make sure that the ground and neutral terminals are disconnected. Using a 1 kV DC insulation resistance tester the insulation between the resistive elements and the cabinet should be greater than 100 MΩ for nominal (Line-to-ground) voltages above 1000 V and 10 MΩ for voltages up to 1000 V.

Physical installation

Suitable locations for installation

Mount the resistor enclosure(s) as close as possible to the equipment being grounded. Ground the enclosure(s) as required by the Electrical Code by using the lug supplied in one of the legs of each enclosure or as indicated in the drawing.

For form factors where the resistor and electronics are separated, the distance between them cannot exceed 40 m. For units with AC/DC monitoring capability, this distance cannot exceed 10m.

For products with feeder monitoring, the distance between the current transformers and control unit cannot exceed 40 m.

The resistors will function as intended if used in applications where the ambient conditions do not exceed the values outlined in table below.

Ambient temperature operation	-30 to 40 ºC
Clearance distance required	24 inches of free space above resistor enclosure 6 inches surrounding all sides of resistor enclosure

Other environmental considerations include altitude, seismic activity, pollution, and elemental ingress.

- For installations above 1000 masl, ensure your original specification included this requirement.
- For areas with excessive seismic activity, ensure your original specification included this requirement.
- For areas with excessive pollution or elemental ingress, ensure your original specification included an adequate protection grade.

Mounting instructions

The product will come with complete drawing, which contains thorough information on mounting dimensions.

The mounting surface will determine the hardware used to mount the equipment, this is outside the scope of this document. When preparing hardware, ensure anchors are suitable for the weight of the system specified on the product drawing. The maximum tilt allowable is 22 degrees.

Do not mount on vibration dampeners unless specified in the drawings.

Installation of loose components

In order to avoid shipping damage, sometimes components are shipped loose for field installation. Typically this includes external ceramic bushings. In order to install them:

1. Unpack the bushing and ensure it is not cracked, inspect the contents to confirm it contains four main components: a rubber gasket, interior bracket, holding spring, and the ceramic bushing.
2. Place the rubber gasket on the exterior side of the enclosure where the hole is provided
3. Insert the bushing to place it over the gasket
4. Insert the interior bracket on the interior of the enclosure
5. Place the holding spring in the groove prior to fastening hardware on the interior bracket
6. Confirm the gasket is properly placed and sealing the bushing
7. Tighten the interior bracket

For support installing any other loose components, contact Bender.

General wiring instructions by terminal types

This section provides additional guidance on the types of terminals used for wiring power equipment or controls.

Mechanical lugs

The mechanical lug offered accepts wire gauges between 2 to 12 AWG. In order to connect to the mechanical lug:

1. Strip a suitable length (approximately less than 0.5 inches) of wire.
2. Loosen the large screw in the lug
3. Feed your stripped wire through the tab
4. Tighten the hardware

Terminal block

The maximum current of the terminal block being used will be identified on the product drawing, use this information to determine a suitable wire gauge, strip length, and torque.

Maximum continuous current	Acceptable wire gauges	Wire type	Wire strip length	Torque ratings
115 A	2-3 AWG	Copper	1/2 in	50 lb-in
	4-6 AWG			45 lb-in
	8 AWG			40 lb-in
	10-14 AWG			35 lb-in
175 A	2/0 - 1/0 AWG	Aluminum	3/4 in	120 lb-in
	1 – 6 AWG			120 lb-in
	8 AWG	Copper		40 lb-in
	10 – 14 AWG			35 lb-in
255 A	250 kcmil	Aluminum	1 1/16 in	275 lb-in
	4/0 AWG			275 lb-in
	3/0-2 AWG			275 lb-in
	4-6 AWG			275 lb-in

Ring / hook terminals

For very small resistors or for components such as coupling devices, refer to the product drawing and/or component manuals for additional installation instructions.

Shorting terminal block

The shorting terminal blocks used typically accept 22 through 6 AWG Copper cable. Consult your product drawing for the complete part number, which you can use to find additional installation instructions. Be sure to remove shorting screws after installation is complete.

Internal NEMA pads

NEMA pad designs and installation requirements are governed by ANSI/NEMA CC 1-2009, “Electric Power Connection for Substations”. We recommend you read this publicly available standard for more information on how to connect to the terminals we provide.

The drawing will provide the details of each NEMA pad so it may be connected with a compatible bar. Local electrical codes will indicate if bolted or welded connections should be used, our recommendation is to use bolts for ease of maintenance.

There are three standard designs offered depending on the specifications:

Type	Hole diameter	Hole-to-hole length (from center)
2-hole	0.28 in	1.5 in
2-hole	0.56 in	1.75 in
4-hole	0.56 in	1.75 in

External bushings

Bushings can be provided in an exposed format, or enclosed format. Typically, bushings are used on higher voltage applications where you will be using very thick cables with a large bend radius. Exposed bushings should only be used when the resistor and bushing is protected from contact (using an animal fence for example). The process for connecting to bushings is the same as described in the NEMA pad section.

Depending on the product being offered and the size of the bushing, it may need to be shipped separately to protect from damages during shipment. Refer to the "Physical Installation" section of the manual for more info.

Grounding & bonding

You must follow your electrical code to adequately ground and bond the product.

Refer to the product drawing for bonding points on metallic enclosures, typically available as mechanical lugs. There may be multiple grounding points within enclosures, typically accessible as grounding bars (i.e. NEMA pads) or terminal blocks. All grounding terminals will be labelled as "G" or "Ground".

Electrical installation

When installing a neutral grounding resistor, you will need to wire the equipment being grounded (i.e. power transformer or generator) to the terminals we provide. The type of terminals we provide for this will be determined by the current, voltage, and your specifications. You may be connecting to other upstream equipment within the grounding system. In this manual, we will refer to this as *power equipment wiring*.

In addition to this, if we are not providing you an integrated unit, you must perform the wiring between the relay and the measuring instruments of the resistor. The type of terminals we provide for this will be determined by your specifications. In addition to this, you need to deliver power to these controls so they are energized. In this manual, we will refer to this as *controls wiring.*

The types of terminals you are provided with are always clearly labelled on the product drawing you receive.

Power equipment wiring

General instructions

You will connect to the furthest upstream equipment within the neutral grounding system. Depending on your specifications this can be a disconnect switch, grounding transformer, the neutral grounding resistor, and the coupling device.

Always consult the product drawing to determine which equipment you must connect to.

Generally:

- Disconnect switches will be furthest upstream
- Grounding transformers will be downstream of disconnect switches

- Resistors will be downstream of grounding transformers
- Coupling devices will always be parallel to the resistor
- If you have a coupling device without any other upstream equipment, you must connect to it in addition to the resistor
- If there is multiple three-phase equipment wiring required (i.e. terminals A, B, and C), we will always try to create shared terminals for convenience (e.g. a zig-zag transformer and control power transformer will share the same terminals)
- For all other custom equipment, refer to the product drawing or contact the Bender support team

Resistor

Follow the general wiring instructions to connect to the terminal specified as either “N” or “Neutral”.

Coupling device

There are typically two ways you can connect to the coupling device.

Option one: connect to the neutral point of the equipment being grounded (i.e. power transformer or generator)

Option two: connect to the neutral point of the NGR

It is recommended to use option one. This is a code requirement in Canada, but it is a best practice irrespective of the installation location. This facilitates monitoring of the whole neutral path all the way up to the grounded equipment and eliminates any false sense of security – it is possible for the neutral path outside of the resistor to fail and it is important to monitor it. The cable must be brought through the current transformer loop prior to connecting to the coupling device.

It is recommended to use a single conductor shielded cable rated to the system specifications. For additional recommendations on cables, consult Appendix B – Cable recommendations.

The coupling device will come with a ring terminal or terminal block, identify the terminal labelled as “N” and connect to it by following the general wiring instructions provided previously.

Grounding transformers

There are two types of transformers that are grouped into a greater category of grounding transformers.

Step-down transformers are used to reduce the voltage, resulting in a lower voltage resistor. The process of connecting to this is the exact same as any resistor terminal, it will be clearly labelled as the neutral input.

Zig-zag transformers are used when you are grounding a delta wound power transformer. The zig-zag transformer will be pre-wired to the neutral grounding resistor. The only difference is you now have three separate conductors, labelled Phases A, B, and C that you are connecting to, rather than a single neutral.

Disconnect switches

Disconnect switches on NGRs are typically only be used when there is a main-tie-main or a generator application. It is undesirable to leave a neutral floating. If you are disconnecting an NGR for maintenance, ensure your system is de-energized or an alternate grounding path is used.

Consult your product drawing for the disconnect switch being offered, and reference the component manual for instructions on how to connect to it. All other wiring to downstream equipment will be completed by Bender unless specified otherwise.

Control power transformer

Although unrelated to the neutral grounding function, if your system comes with a control power transformer it is more convenient to wire the primary of the transformer at this time. Depending on the voltage and current, the control power transformer will either be bar-type (NEMA pad connectors), or come with terminal blocks.

Consult your product drawing for the control power transformer being offered, and reference the manual for instructions on how to connect to it. All other wiring to downstream equipment will be completed by Bender unless specified otherwise. In other words, the control power transformer will be wired to the relay and auxiliary components requiring power if we are supplying them.

Controls wiring

This section only applies if you are supplying your own relay and will be completing the wiring between the relay and measuring instruments, or if you have requested a remote / separated control box. If you have purchased an integrated package, this section does not apply to your system.

Connecting to a neutral current transformer or potential transformer

Depending on your monitoring method (voltage or current), you will have a current transformer or potential transformer.

If a shorting terminal block has been provided, the transformer terminals have already been brought out to the block. Wire between the relay terminals and the shorting terminal block. Be sure all shorting screws have been removed when connecting and subsequently energizing the unit.

If you are connecting directly to the transformer terminals -- the secondary terminals of the transformer may have been short circuited with a jumper for protection against induced voltage. Double check the terminals and remove the jumper before connecting the terminals to the ground fault relay. Typically, terminals will be feed-through, brass studs, or bar type. For feed-through terminals, strip a small length and feed cables through appropriate terminals. For brass studs, connect via ring terminals. For bar types, connect in the same fashion as a NEMA pad.

Consult the relay manual for additional information on current transformer connections.

Connecting to a coupling device

This section specifically refers to wiring between the coupling device and the relay. For wiring to monitor the neutral path, refer to the “Power equipment wiring” section.

Always consult your product drawing and the manual for the relay you are using for instructions on how to connect the coupling device. Generally, there are two terminals available, either labelled G1 and G, or R and G. Both of these terminals must be connected to the relay.

System integration

This section applies to integrating the equipment into a greater system. Wherever possible, we recommend using communications to integrate the neutral grounding system into a SCADA system. In addition to this, we recommend connecting alarming equipment such as strobe lights or buzzers.

Depending on your enclosure configuration, access to the relay may or may not be available via knockouts. You may have to drill holes in order to access the required ports of the relay.

For further instructions on how to connect to the relay, please consult the relay manual.

Powering the controls

In order for your relay to function you must connect power to it. Always review your product drawing to confirm which inputs are suitable. You can double check this information by reviewing the relay manual. Most relays will support either 120VAC or 24VDC, depending on the model configuration you ordered.

If we supplied a control power transformer along with a relay, ensure you completed the wiring for the control power transformer primary in the “Power equipment wiring” section.

Review the product drawing to determine if additional power source connections are required.

Operation and maintenance

The “operation” aspect of the NGR is done through the ground fault relay and associated controls.

If you received an integrated package, the controls will either be available by push buttons / switches, a Human Machine Interface (HMI), or directly on the relay itself.

- For push buttons / switches: follow the instruction plate on the physical product, or refer to the product drawing for instructions
- For HMIs: follow the instructions on the screen or refer to the relay manual, basic instructions available in Appendix C – Ground fault relay manuals.
- For direct relay controls: follow the instructions in the relay manual, basic instructions available in Appendix C – Ground fault relay manuals.

Routine cleaning and physical inspection

The resistor enclosure must be inspected periodically. The recommendable frequency of inspection is 6 months. In case of environments with heavy dust accumulation should be inspecting and cleaning the resistors more frequently.

1. De-energize the system and allow the unit to cool down for at least 30 minutes.
2. Remove resistor covers or inspection door to allow for visual inspection of internal components.
3. Ensure that all internal connections and fasteners are tight, that no insulators are cracked and that there are no signs of damage from heat, vibration, etc.
4. Clean the unit for excessive dust or dirt. If water is used for cleaning make sure the unit is perfectly dry by using towels and then air drying wherever possible.

5. Use an Ohmmeter to verify the unit's resistance and the continuity of all connections. Resistance should be +/- 10% of the nominal value (see nameplate).
6. Use a Megger or Hi-pot to verify the insulation.
7. Re-attach resistor cover or close the inspection door.

Pulsing on high-resistance grounding

Pulsing controls activate a contactor that changes the NGR resistance by adding or shorting portions of the resistor. This modulates the ground-fault current and appears as a zero-sequence current upstream from the source of the fault. The detailed instructions for activating or de-activating pulsing are available in the next section "Basic relay operation and testing".

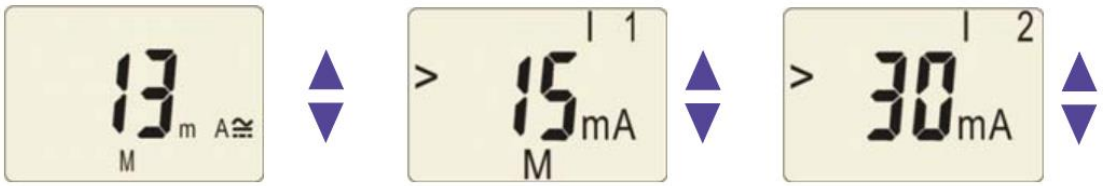
Feeder ground fault relays or a portable ammeter is used to trace along cables and conduits, if the pulse current is detected then the fault is downstream from the point of measurement. Once the source of the fault has been identified, de-activate pulsing, open the feeder, reset the relay, repair the source of the fault, re-connect the feeder, and reset the relay again.

Basic relay operation and testing

Bender RCMA423 / RCM420

Operation

By default, the currently measured residual current is displayed. The current response values I1 (pre-warning) and I2 (alarm) can be displayed using the Up and Down key. Press the Enter key to return to the measured value.



On normal operation, the ON LED lights up indicating that the relay is in operation.

If the ground fault current exceeds the alarm response value (alarm 1 or alarm 2) for the specified time delay, the AL1 or AL2 LED light will be operate at the same time as the auxiliary contact.

The alarm will remain stored until the RESET button is held for greater than 1.5 seconds.

Self-test

To test the relay, press the TEST button for great than 1.5 seconds, the device will carry out a self-test. During this test, internal faults can be detected and will be displayed in the form of an error code. Typical error codes are described below. The alarm relays are not checked during this test. While the test button "T" is pressed and held down, all device-related display elements appear on the display. Typical error codes are described below:

Error Code	Meaning

E.01	*Fault CT connection monitoring* Appropriate action: Check CT connection for short-circuit or interruption. After eliminating the fault, the error code will be automatically deleted.
E.02	*Fault CT connection monitoring during manual self test.* Appropriate action: Check CT connection for short-circuit or interruption. After eliminating the fault, the error code will be automatically deleted.
E…	Appropriate action when error codes > 02 occur: Carry out a reset. Reset the device to factory setting. After eliminating the fault, the error code will be automatically deleted. If the fault continues to exist, please contact Bender Service.

Bender RC48N

Operation

On normal operation, ON LED lights up indicating that the RC48N is in operation.
In case the ground current exceeds the alarm response value and the time delay the “Alarm Ground Fault“ LED lights up and the auxiliary contact will operate.
In case the voltage across the neutral grounding resistor exceeds the preset value or when the NGR’s resistance exceeds 2 KΩ the “Alarm Resistor Fault“ LED lights up and the auxiliary contact will operate.
It remains stored until the built-in or the external RESET button is pressed.

Self-test

Pressing TEST button makes the relay simulate a residual current and operate accordingly. Press the RESET button deletes alarm messages.

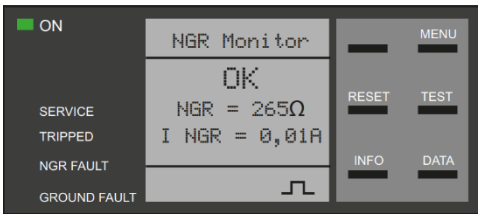
Pulsing

Pulsing will be available by a selector switch. If it is not, please refer to the RC48N manual for additional instructions.

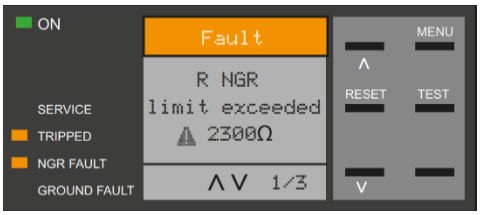
Open resistor test

1. Disconnect the terminal N from coupling device.
2. Pass: The ALARM Resistor Fault should be on.
3. Reconnect the terminal N to coupling device.
4. The ALARM Resistor Fault should be off.
5. Reset the alarm.

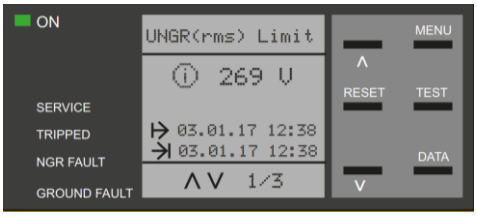
Operation



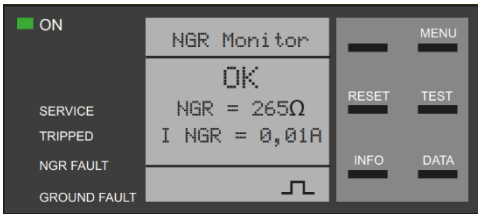
System normal:
By default, the currently measured NGR current and resistance is displayed.



Active fault:
Depending on the fault type, the GROUND FAULT, NGR FAULT, TRIPPED or SERVICE LEDs will be on. If several fault messages appear, navigate through the faults using the V and Λ buttons.

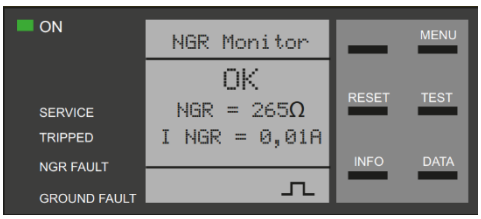


Inactive fault:
An inactive fault is indicated on the display with a ⓘ.
If more than one fault has occurred, the number of faults is also indicated in the lower part of the display. This message means that there has been a fault in the past but the device is no longer in fault condition. If several fault messages appear, navigate through the faults using the V and Λ buttons. In addition to the type of fault and the associated alarm value, you can see when the fault occurred and how long it was active for.



Acknowledging and resetting a fault:
In order to return to the standard display of the NGR monitor, the fault message must be acknowledged by:
RESET > Acknowledge >Ok
The buzzer will be muted after acknowledging the fault.

Fault messages can only be reset when the cause of fault has been eliminated by:
RESET > Reset >Ok



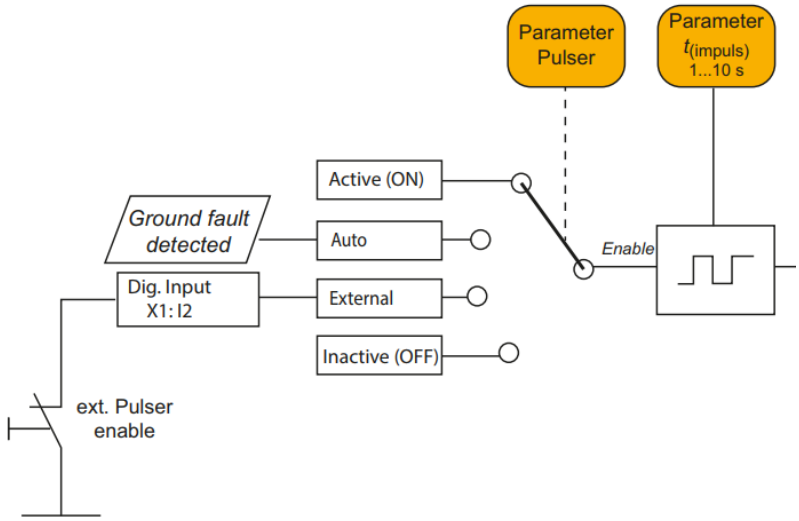
Active fault:
Depending on the fault type, the GROUND FAULT, NGR FAULT, TRIPPED or SERVICE LEDs will be on. If several fault messages appear, navigate through the faults using the V and Λ buttons.

Pulsing

The NGRM700 has a built-in pulsing control system to help locate ground fault using a hand-held detector. To activate the pulsing, go to the Pulser (menu 4.1) and select:

- Active - The pulsing is continuously active regardless of ground faults that have occurred.
- External - The external input "Pulser In" can activate the pulsing at any time.
- Auto - The pulsing activates automatically in the event of a ground fault.
- Inactive - The pulser output is disabled.

The pulse period can be set between 1 and 10 s in menu 4.2. The following diagram shows an overview of the pulser control.



Self-test

Starting the test Start the test whether directly by pressing the TEST button or via the menu 10.3 or the input I3 (activate for more than 150 ms). The auxiliary contacts will operate during the test.

Open resistor test

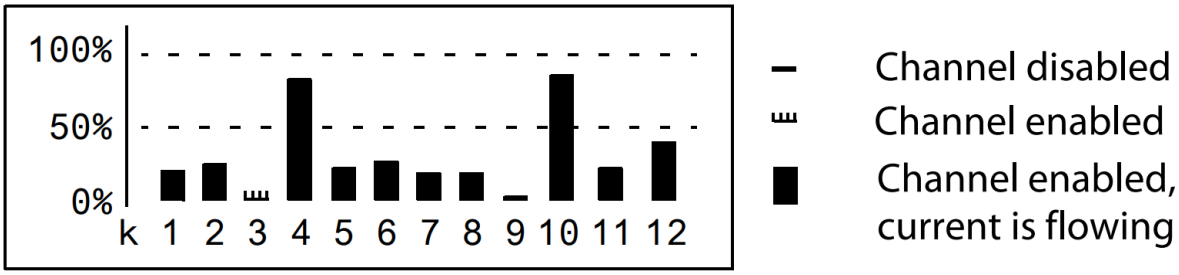
1. Disconnect the terminal N from coupling device.
2. Pass: The ALARM Resistor Fault should be on.
3. Reconnect the terminal N to coupling device.
4. The ALARM Resistor Fault should be off.
5. Reset the alarm.

Short resistor test

1. Disconnect the terminal N from coupling device to neutral.
2. Connect the terminal N from coupling device to terminal G.
3. Pass: The ALARM Resistor Fault should be on.
4. Disconnect the terminal N from coupling device to terminal G
5. Reconnect the terminal N from coupling device to neutral.
6. The ALARM Resistor Fault should be off.
7. Reset the alarm.

Operation

In operating mode, you will see a bar graph on the RCMS490…-D display. For each of the 12 measuring channels, it shows what percentage of the set alarm value I Δn2 (alarm) and I Δn1 (prewarning) has been reached.



In the case of a ground fault in one or more feeders, this fault will be shown in the display and can be changed using V and Λ buttons. The corresponding relay will be operating as the alarms 1 or 2, according to the set current.

Pressing button INFO, the initial screen will be shown and the current will be shown in a bar graph which each channel current.

Removing the ground fault, the relay will be back to the initial state.

Self-test

A test serves to check the device function (hardware components) of the RCMS. A test can be activated pressing press the "TEST" button on the RCMS front panel for at least one second.
The RCMS… responds as follows:
"ALARM 1" and "ALARM 2" LEDs light up.
All alarm relays
An entry is stored in the history memory with the suffix "TEST".
RCMS…-D…: The progress of the test is indicated on the display

Storage, returns, and warranty

Storage

Our resistors can be stored indoors for prolonged periods of time.

Do not stack skids and keep the units horizontal.

The resistors can be kept in the same packaging as they were shipped, except in high humidity conditions where it’s recommended to remove the plastic cover to avoid condensation.

Some units can also be stored outdoors, please consult with the factory.

Returns

Please examine the equipment immediately upon receipt. If any damage to the unit is detected notify Bender immediately.

Bender will assess the damage and provide technical assistance to determine if the unit can be repaired in the field or if a product return is the optimal choice.

Before any equipment is returned, because of damage, ordering mistake or any other reason, please request a return authorization, fill it out, send it to info@benderinc.com and include a copy of the form with the shipment.

Warranty

Bender is not responsible for products delivered in good condition to the courier that arrive damaged to the final destination (unless otherwise stated) but we will help you make a claim to the courier if required.

All claims must be made within 30 days of delivery.

Bender warrants the products to be free from defects under proper use, maintenance and installation for two years from the date of delivery unless otherwise stated.

This warranty is limited to repair or replacement of the defective part or product according to our judgment and will not include installation, removal, transportation expenses or losses due to equipment failure.

We must be informed of the claim by the purchaser as soon as the problem is observed.

Defective products should not be sent to our location unless authorized in writing by one of our employees.

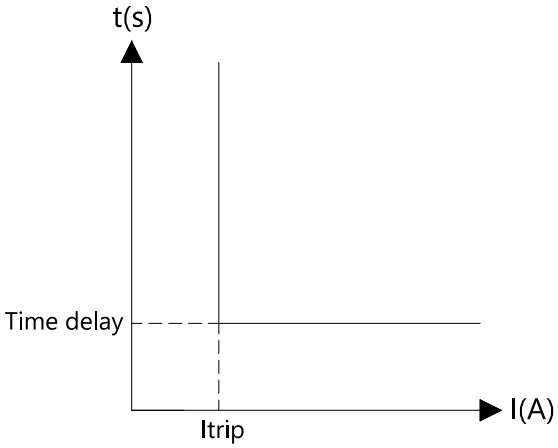
Bender shall not be liable for any claims arising from special, indirect or consequential damages nor from any loss of production or other losses resulting from the failure of any equipment.

All warranty and product returns inquiries should be direct to info@benderinc.com.

Appendix A – Relay parameter modifications

This section applies to any ground relays provided by Bender after all connections have been made in accordance with the respective electrical drawing.

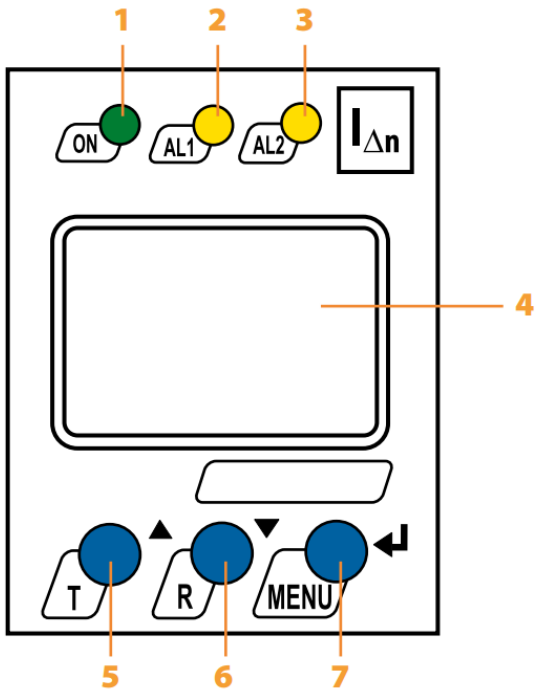
All relays leave of Bender tested and set according to the application for which they are intended. The set parameters can be found in a table on the electrical diagram and the typical operation curve for the neutral monitoring relays is showed below.



If any parameter needs to be changed, the basic instructions can be found in this manual on the section corresponding to the relay model. More information can be found on the relay manufacturer's website.

Bender RCMA423 / RCM420

User interface and functions



No.	Symbol	Description
1	ON	Power On LED “ON” (green); lights when supply voltage is applied and flashes in the event of system fault alarm respectively in the event of CT malfunction

2	AL1	Alarm LED “AL1” (yellow), prewarning lights when the set response value IΔn1 is exceeded or flashes in the event of system fault alarm respectively in the event of CT malfunction
3	AL2	Alarm LED “AL2” (yellow), alarm; lights when the set response value IΔn2 is exceeded or flashes in the event of system fault alarm respectively in the event of CT malfunction
4		Multi-functional LC display
5	T	Test button “T”: to call up the self-test
	∧	Arrow up button: parameter change, to move up in the menu
6	R	Reset button “R”: to delete saved alarms
	∨	Arrow down button: parameter change, to move down in the menu
7	Menu	“MENU” button: to call up the menu system
	↵	Enter button: to confirm parameter change
		“ESC” button: press the button > 1.5 seconds

Menu structure

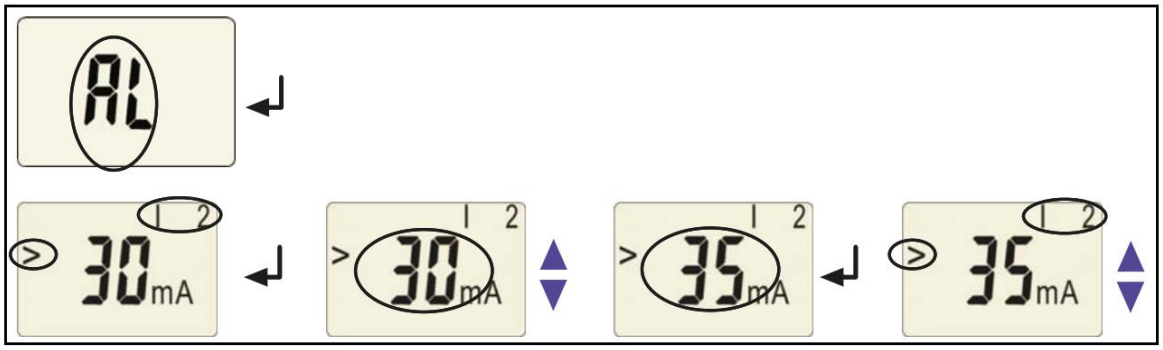
Menu	Sub Menu	Menu item	Activation	Adjustable parameter
AL (response - values)	→	> I2	- (Hi)	$I_{\Delta n2}$ (Alarm 2)
		> I1	- (Hi)	$I_{\Delta n1}$ as % of $I_{\Delta n2}$ (Alarm 1, prewarning)
		Hys	-	Hysteresis $I_{\Delta n1}$ / $I_{\Delta n2}$
out (output control)	→	M	ON	Fault memory (on/off/con)
		1	-	Operating mode K1 (n.c.)
		2	-	Operating mode K2 (n.c.)
		RL	-	Reload function (memory = off)
	r1 (K1: (assignment alarm category)	1 Err	ON	Device error at K1
		r1 I1	ON	Prewarning $I_{\Delta n1}$ at K1
		r1 I2	off	Alarm $I_{\Delta n2}$ at K1
		1 tES	ON	Device test
	r2 (K2: (assignment alarm category)	2 Err	ON	Device error at K2
		r2 I1	off	Prewarning $I_{\Delta n1}$ at K2
		r2 I2	ON	Alarm $I_{\Delta n2}$ at K2
		2 tES	ON	Device test

Menu	Sub Menu	Menu item	Activation	Adjustable parameter
t (timing check)	→	t on 1	-	Response delay K1
		t on 2	-	Response delay K2
		T	-	Start-up delay
		t off	-	Delay on release K1/K2
Set (device control)	→	I 12	HI	Selectable parameters: High, window function, low
		🔒	off	Parameter setting via password
		FAC	-	Restore factory settings
		SYS	-	Function blocked
InF	→		-	Display hard / software version
HiS	→	Clr	-	History memory for the first alarm value, erasable

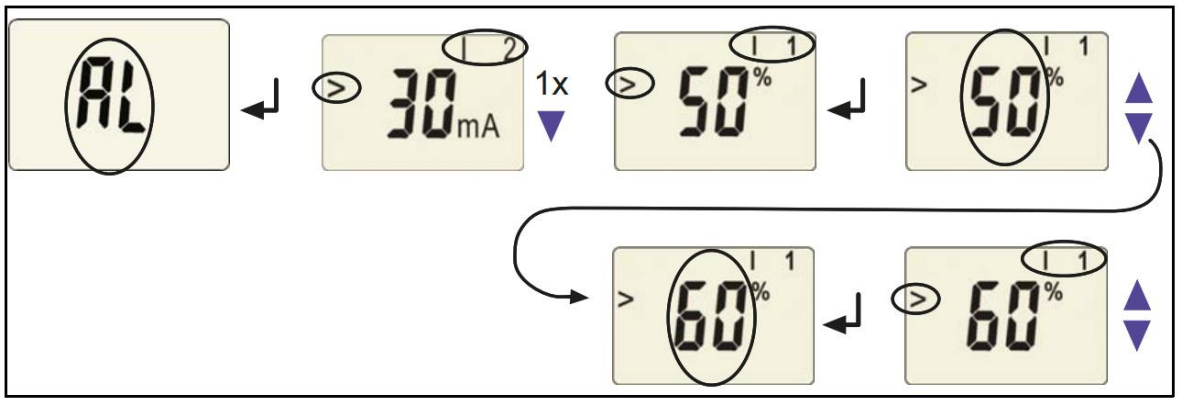
Changing NGR current trip value

If the trip values for the NGR needs to be changed, it can be done through by the interface following the sequence:

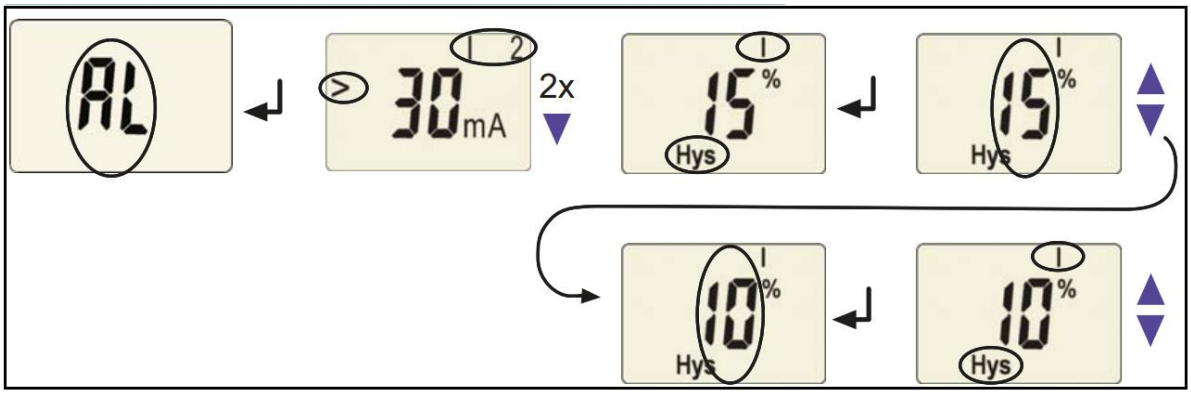
Changing the response value I2 (alarm overcurrent)

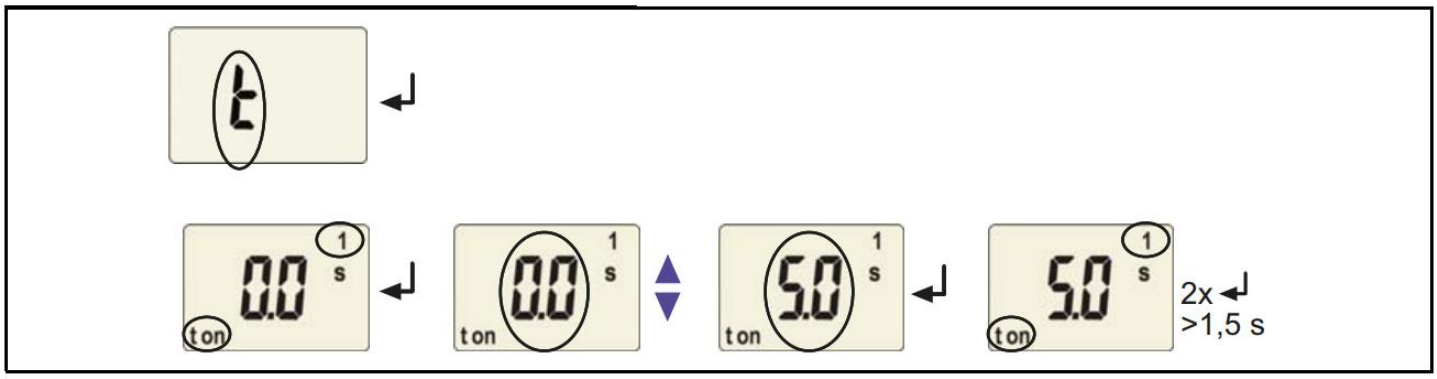


Changing the response value I1 (prewarning overcurrent)

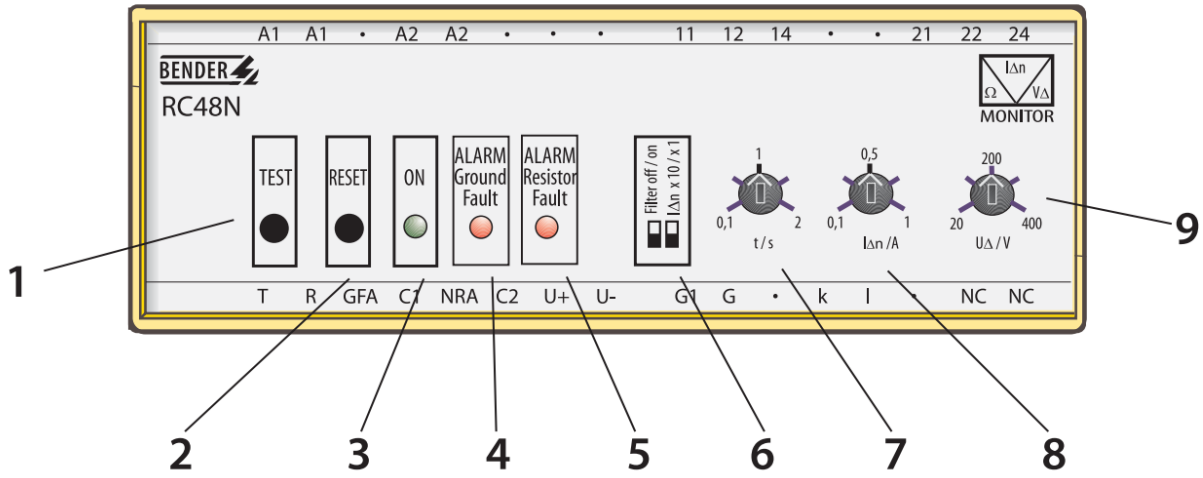


Setting the hysteresis of the response value setting the response delay ton (1 or 2)



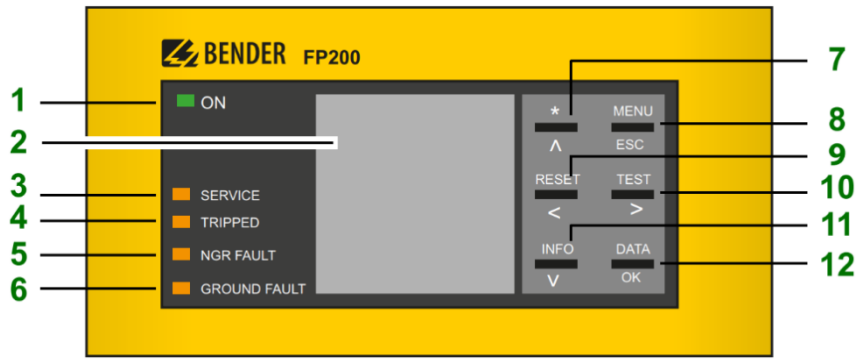


User interface and functions



No.	Designation	Description
1	Test	Pressing the TEST button initiates the following sequence: a test residual current is simulated, after the expiry of the response time an alarm is recognized which causes the alarm relay to switch and the “Alarm Ground Fault“ LED to light up. The alarm message is stored
2	Reset	Pressing the RESET button deletes alarm messages.
3	ON	ON LED lights up indicating that the RC48N is in operation
4	ALARM Ground Fault	“Alarm Ground Fault“ LED lights up when the ground fault current exceeds the alarm response value and the time delay
5	ALARM Resistor Fault	“Alarm Resistor Fault“ LED (red) lights up when the voltage across the neutral grounding resistor exceeds the preset value or when the NGR’s resistance exceeds 2 KΩ
6	DIP Switch configuration	Filter off / on: bandpass filter 50 ... 60 Hz When the bandpass filter is switched on, only the narrowband 50 ... 60 Hz components of the residual current are detected. This function can be used to avoid false trippings caused by the occurrence of harmonics and transient components in the residual current
		IΔn x 10 / x 1: for setting the residual current response value IΔn/A: x1 - 0.1 A to 1 A x10 - 1 A to 10 A
7	T/S	For setting the maximum time delay t/s for the residual current measurement from 0.1 to 2 seconds
8	IΔn/A	Setting the residual current response value to 0.1 A to 1 A respectively 1 A to 10 A.
9	UΔ/V	Setting of the response value for voltages across the neutral grounding resistor from 20 to 400 V

User interface and functions



No.	Designation	Description
1	ON	Operation LED, green; on when power supply is available
2		The LC display shows device and measurement information.
3	SERVICE	The LED is on when there is either a device fault or a connection fault, and when the device is in maintenance mode.
4	TRIPPED	The LED is on when the trip relay has been tripped due to an NGR fault, a ground fault or a system error.
5	NGR FAULT	The LED flashes in case of a prewarning: NGR fault detected, NGR relay has tripped, trip relay has not tripped yet (NGR trip elapses). The LED is on when an NGR fault has been detected. Trip relay and NGR relay have tripped.
6	GROUND FAULT	The LED flashes in case of a prewarning: ground fault detected, ground-fault relay has tripped, trip relay has not tripped yet (tGF trip elapses). The LED is on: ground fault detected, trip relay has tripped, installation has not been shut down yet.
7	∧	Navigates up in a list or increases a value.
8	MENU	Opens the device menu.
	ESC	Cancels the current process or navigates one step back in the device menu.
9	RESET	Resets alarms
	<	Navigates backwards (e.g. to the previous setting step) or selects parameter.
10	TEST	Starts the device self-test.
	>	Navigates forwards (e.g. to the next setting step) or selects parameter.
11	INFO	Shows information.
	∨	Navigates down in a list or reduces a value
12	DATA	Indicates data and values
	OK	Confirms an action or a selection

Menu structure

1. Data meas. values

R_{NGR}, $R_{NGR\ rel}$, Method, R_{sense}, I_{rms}, $I_{rms\ rel}$, U_{rms}, $U_{rms\ rel}$, I_{fund}, $I_{fund\ rel}$, U_{fund}, $U_{fund\ rel}$, I_{harm}, $I_{harm\ rel}$, U_{harm}, $U_{harm\ rel}$, U_{L1L2}, U_{L2L3}, U_{L3L1}, f, $U_{1\text{-}E\ rms}$, $U_{2\text{-}E\ rms}$, $U_{3\text{-}E\ rms}$, T

2. Harmonics

3. History

History, Delete

4. Pulser

Pulser, t_{Impuls}

5. Display

R_{NGR}, I_{NGR}

6. HRG settings

- HRG system — U_{sys} (L-L), f, $I_{NGR\ nom}$, $R_{NGR\ nom}$
- CT — CT primary, CT secondary, CT connection
- NGR — Method, PT primary, PT secondary
- Phase monitor — Phase monitor, PT primary, PT secondary
- Response values — $U_{NGR\ Trip}$, $I_{NGR\ Trip}$, $>R_{NGR}$, $<R_{NGR}$, $t_{NGR\ trip}$, GF trip, $t_{GF\ trip}$, $t_{restart}$, Alarm stored, Max. no. of restarts, Trip signal, Upper limit harmonics, Lower limit harmonics
- System settings
  - Earth fault relay ····· Mode, Relay test
  - NGR relay ····· Mode, Relay test
  - Trip relay ····· Mode, Relay test
  - Analogue ····· Mode, Function
  - Dig. in/out ····· System OUT, Pulser OUT, Pulser IN, Reset IN, Test IN
  - Buzzer ····· Buzzer alarm, Buzzer test
- Field calibration

7. Device settings

Language, Clock, Interface, Display, Password, Factory setting, Software, Service

8. Commissioning

Setting Language, Setting Clock, Setting $U_{sys\ L\text{-}L}$, f, $I_{NGR\ nom}$, $R_{NGR\ nom}$, $CT_{primary}$, $CT_{secondary}$, $CT_{Connection}$, Field calibration

9. Info

Device information, Software information, Clock and date information, Ethernet information

10. Alarm

Acknowledge, Reset, Test

Changing NGR current trip value

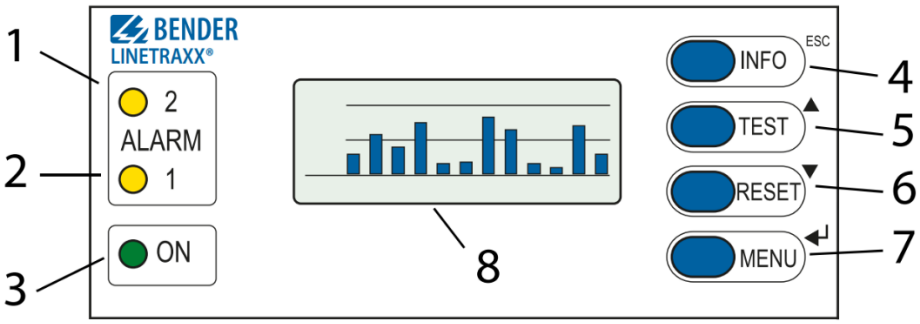
If the trip values for the NGR needs to be changed, it can be done through by the interface following the sequence:

Feature	Menu Sequence	Setting
NGR Current Trip value	Menu > 6. HGR Settings > Response Values > $I_{NGR\ trip}$	This value is displayed in % of $I_{NGR\ Nominal}$ and can be set from 10 to 90 %
NGR Nominal Current Value	Menu > 6. HGR System > $I_{NGR\ Nom}$	This value is displayed in Amperes and can be set from 1 to 100 A
NGR trip time	Menu > 6. HGR Settings > Response Values > $T_{NGR\ trip}$	This value is displayed in second and can be set from 0 to 60 s

Communications

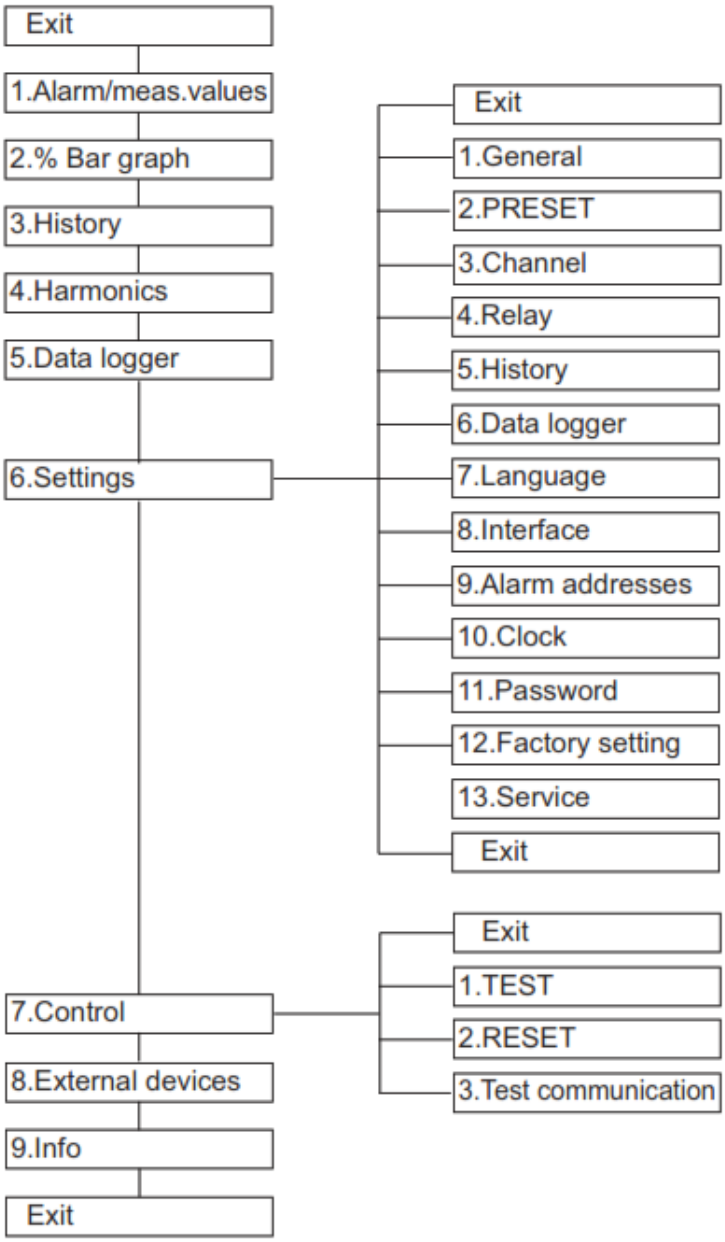
The NGRM 700 is able to communicate through BCOM (Bender Protocol), Modbus TCP/IP, Modbus RTU and HTML. The device is set with IP address according to the table of parameters in the electrical diagram. The HTML access can be done directly by a computer, inserting the IP address in a browser at any device connected at the same Local Network.

User interface



1	The "ALARM 2" LED lights up if the measured value falls below or exceeds the "Alarm" response value in a measuring channel or until an error is indicated by the digital input.
2	The "ALARM 1" LED lights up if the measured value falls below or exceeds the "prewarning" response value in a measuring channel or in case of a device error.
3	LED "ON“ lights up when the device is switched on and flashes until the device is ready for operation during switching on.
4	"INFO" button: to call up standard information ESC button: to exit the menu function without changing parameters
5	"TEST" button: to call up automatic test Up button: to change parameters, scroll
6	"RESET" button: to acknowledge alarm and fault messages Down button: to change parameters, scroll
7	"MENU" button: to toggle between the standard display, menu and alarm display Enter button: to confirm parameter changes
8	Illuminated graphic LCD

Menu structure



Setting active channels and response values

The relay is set to work with all 12 channels. If any channel will not be used, the respective CT monitor function should be deactivated. The response value for each channel is default set in 30 mA.

If necessary, change this functions, follows the sequence:

Feature	Menu Sequence	Setting

Active channels	Menu > 6. Settings > 3. Channel > Select the Channel > 8. CT Monitor > Of	On or Off. Default is On for all 12 channels
Response value	Menu > 6. Settings > 3. Channel > Select the Channel > 2. Resp. Value	From 6 mA to 20 A. Default is 30 mA for all 12 channels

Appendix B – Cable recommendations

Always consult your applicable electrical code for cable requirements.

Appendix C – Ground fault relay manuals

RCM420
RCMA423
RC48N
NGRM700
RCMS460 / RCMS490

benderinc.com

USA: Exton, PA
+1 800.356.4266
info@benderinc.com
www.benderinc.com

Canada: Missisauga, ON
+1 800.243.2438
info@bender-ca.com
www.benderinc.com

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