NGRM500

Neutral Grounding Resistor Monitor

NGRM500_D00373_02_M_XXEN/03.2020

Manual EN

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1. Important information

1.1 How to use this manual

*This manual is intended for **qualified personnel** working in electrical engineering and electronics!*

Always keep this manual within easy reach for future reference. To make it easier for you to understand and revisit certain sections in this manual, we have used symbols to identify important instructions and information. The meaning of these symbols is explained below:

*This signal word indicates that there is a **high risk of danger** that will result in **death** or **serious injury** if not avoided.*

*This signal word indicates a **medium risk** of danger that can lead to **death** or **serious injury**, if not avoided.*

*This signal word indicates a **low-level risk** that can result in minor or **moderate injury** or **damage to property** if not avoided.*

*This symbol denotes information intended to assist the user in making **optimum use** of the product.*

1.2 Technical support: service and support

For commissioning and troubleshooting Bender offers:

1.2.1 First level support

Technical support by phone or e-mail for all Bender products

- Questions about specific customer applications
- Commissioning
- Troubleshooting

Telephone: +49 6401 807-760*
Fax: +49 6401 807-259
In Germany only: 0700BenderHelp (Tel. and Fax)
E-mail: support@bender-service.de

1.2.2 Repair service

Repair, calibration, update and replacement service for Bender products

- Repair, calibration, testing and analysis of Bender products
- Hardware and software update for Bender devices
- Delivery of replacement devices for faulty or incorrectly delivered Bender devices
- Extended warranty for Bender devices with in-house repair service or replacement devices at no extra cost

Telephone: +49 6401 807-780** (technical issues)
+49 6401 807-784**, -785** (commercial issues)
Fax: +49 6401 807-789
E-mail: repair@bender-service.de
Please send the devices for **repair** to the following address:

Bender GmbH, Repair-Service,
Londorfer Straße 65,
35305 Grünberg

1.2.3 Field service

On-site service for all Bender products

- Commissioning, parameter setting, maintenance, troubleshooting for Bender products
- Analysis of the electrical installation in the building (power quality test, EMC test, thermography)
- Practical training courses for customers

Telephone: +49 6401 807-752**, -762 **(technical issues)
+49 6401 807-753** (commercial issues)
Fax: +49 6401 807-759
E-mail: fieldservice@bender-service.de
Internet: www.bender-de.com

*Available from 7.00 a.m. to 8.00 p.m. on 365 days of the year (CET/UTC+1)
**Mo-Thu 7.00 a.m. - 8.00 p.m., Fr 7.00 a.m. - 13.00 p.m

1.3 Training courses

Bender is happy to provide training regarding the use of test equipment.
The dates of training courses and workshops can be found on the Internet at www.bender-de.com -> Know-how -> Seminars.

1.4 Delivery conditions

The conditions of sale and delivery set out by Bender apply.
For software products, the "Softwareklausel zur Überlassung von Standard- Software als Teil von Lieferungen, Ergänzung und Änderung der Allgemeinen Lieferbedingungen für Erzeugnisse und Leistungen der Elektroindustrie" (software clause in respect of the licensing of standard software as part of deliveries, modifications and changes to general delivery conditions for products and services in the electrical industry) set out by the ZVEI (Zentralverband Elektrotechnik- und Elektronikindustrie e.V., (German Electrical and Electronic Manufacturers' Association) also applies.
Conditions of sale and delivery can be obtained from Bender in printed or electronic format.

1.5 Inspection, transport and storage

Inspect the dispatch and equipment packaging for damage, and compare the contents of the package with the delivery documents. In the event of damage in transit, please contact Bender immediately.
The devices must only be stored in areas where it is protected from dust, humidity and spray or dripping water, and in which the specified storage temperatures can be assured.

1.6 Warranty and liability

Warranty and liability claims in the event of injury to persons or damage to property are excluded if they can be attributed to one or more of the following causes:

- Improper use of the device.
- Incorrect mounting, commissioning, operation and maintenance of the device.

- Failure to observe the instructions in this operating manual regarding transport, commissioning, operation and maintenance of the device.
- Unauthorised changes to the device made by parties other than the manufacturer.
- Non-observance of technical data.
- Repairs carried out incorrectly and the use of replacement parts or accessories not approved by the manufacturer.
- Catastrophes caused by external influences and force majeure.
- Mounting and installation with device combinations not recommended by the manufacturer.

This operating manual, especially the safety instructions, must be observed by all personnel working on the device. Furthermore, the rules and regulations that apply for accident prevention at the place of use must be observed.

1.7 Disposal

Abide by the national regulations and laws governing the disposal of this device. Ask your supplier if you are not sure how to dispose of the old equipment.
The directive on waste electrical and electronic equipment (WEEE directive) and the directive on the restriction of certain hazardous substances in electrical and electronic equipment (RoHS directive) apply in the European Community. In Germany, these policies are implemented through the "Electrical and Electronic Equipment Act" (ElektroG). According to this, the following applies:

- Electric and electronic equipment are not to be included in household waste.
- Batteries and accumulators are not to be included in household waste but must be disposed of in accordance with the regulations.
- Old electrical and electronic equipment from users other than private households which was introduced to the market after 13th August 2005 must be taken back by the manufacturer and disposed of properly.

For more information on the disposal of Bender devices, refer to our homepage at www.bender.de -> Service & support.

2. Safety instructions

2.1 General safety instructions

Part of the device documentation in addition to this manual is the enclosed "Safety instructions for Bender products".

2.2 Work activities on electrical installations

*Only **qualified personnel** are permitted to carry out the work necessary to install, commission and run a device or system.*

DANGER

Risk of electrocution due to electric shock!

Touching live parts of the system carries the risk of:

- *An electric shock*
- *Damage to the electrical installation*
- *Destruction of the device*

***Before installing and connecting the device, make sure** that the **installation** has been **de-energised**. Observe the rules for working on electrical installations.*

If the device is used outside the Federal Republic of Germany, the applicable local standards and regulations must be complied with. The European standard EN 50110 can be used as a guide.

2.3 Intended use

The NGRM500 is only intended for use in high-resistance grounded systems. In these systems, the NGRM500 monitors

- the current through the neutral grounding resistor (NGR),
- the voltage between the star point of the transformer and earth (voltage drop across the NGR),
- the condition of the neutral grounding resistor (NGR).

*Systems with a high-resistance grounded star point can be used when an **interruption of the power supply would involve excessive costs due to production stoppage** (e.g. automotive production, chemical industry). The ground fault that occurs between a phase and earth does not require power-supply tripping in many of these systems. A ground fault must be detected and eliminated as quickly as practicable, since the occurrence of another ground fault in a second phase would cause an overcurrent protective device to trip.*

In order to meet the requirements of applicable standards, customised parameter settings must be made on the device to configure it for local equipment and operating conditions. Any other use than that described in this manual is regarded as improper. Intended use includes following all the instructions in this manual.

2.4 Glossary

CD	**C**oupling **D**evice CD-series
CT	**C**urrent **T**ransformer
FFT	**F**ast **F**ourier **T**ransformation
HRG	**H**igh **R**esistance **G**rounding
I_{NGR}	NGR rated current
$I_{NGR\ nom}$	Nominal current through the NGR
NER	**N**eutral **E**arthing **R**esistor (NER = NGR)
NGR	**N**eutral **G**rounding **R**esistor
NTP	**N**etwork **T**ime **P**rotocol
PT	**P**otential **T**ransformer
R_{NGR}	NGR resistance value
$R_{NGR\ nom}$	NGR nominal resistance
R_S	Sense resistor; CD-series coupling device
PLC	**P**rogrammable **L**ogic **C**ontroller
U_{NGR}	Voltage on the NGR
$U_{NGR\ nom}$	Nominal voltage across the NGR
U_{sys}	System voltage
UTC	**U**niversal **T**ime **C**oordinated

3. Function

3.1 Device features

- Determination of R_{NGR} with passive and active measurement methods
- Continuous monitoring of the R_{NGR} even if the installation is de-energised;
- Alarm or trip on ground fault
- Monitoring of the current I_{NGR}
- Monitoring of the voltage U_{NGR}
- Ethernet communication
- Web server
- Language selection (German, English GB and US, Spanish, French)
- Test button (internal, external) with/without tripping
- FFT analysis of the measuring signals
- Pulser for manual ground fault location
- Relays to indicate ground faults and resistor faults
- Relay for shutdown of the power system after a configurable time
- Can be combined with RCMS… for automatic shutdown of feeders
- Graphical user interface
- Wide supply voltage range
- Range of use up to 2000 m AMSL
- Fault/History memory
- Analogue output of measured values (0…10 V, 4…20 mA, selectable parameters)
- Password protection
- Tripping on RMS, fundamental or configurable filter
- Detection of AC and DC ground faults

3.2 Functional description

The NGRM500 monitors NGR resistance R_{NGR}, neutral voltage U_{NGR} and current I_{NGR}. NGR resistance is measured using an active and a passive procedure:

active	The device generates an active test pulse and measures R_{NGR} even if the installation is de-energised.
passive	The resistance R_{NGR} is determined when I_{NGR} or U_{NGR} exceeds an internal threshold. The device measures the existing current and voltage and calculates R_{NGR}.

When the "auto" setting is selected, monitoring switches automatically between "active" and "passive" when neutral current or voltage exceeds or falls below the internal threshold. The threshold is 15 % of the nominal value and can be adjusted by Bender service if required.
A short circuit or interruption of the NGR is reliably detected in an energised as well as a de-energised installation with the active measurement method.

When the "passive" setting is selected, no switching between passive and active methods takes place. NGR resistance will not be monitored while the power system is de-energised, or when current and voltage are low.

The NGR fault relay output switches from alarm state to operating state when the measured resistance R_{NGR} is within the configured thresholds.

A ground fault is signalled via the corresponding Ground-fault relay and front panel GROUND FAULT LED, when I_{NGR} or U_{NGR} exceeds the setting. After the adjustable time delay has elapsed, the power system can be shut down by means of the Trip relay. When the ground-fault has been removed, the alarm will auto-reset, or can be reset if so configured.

Power systems from 400 V…25 kV can be monitored via the appropriate CD-series coupling device.

I_{NGR} is measured with **measuring current transformers** with a 5 A or 50 mA secondary.

3.3 Recommended minimum value R_{NGR} (tripping level 50 %)

Temperature range –40…+70 °C, field calibration at 25 °C
(Values shown in brackets: Limited temperature range 0…+40 °C, field calibration at 25 °C)

3.3.1 Recommended R_{NGR} for system voltage U_{sys} ≤ 4300 V

	CD1000/CD1000-2			CD1000-2	CD5000	
U_{sys}	400 V	600 V	690 V	1000 V	2400 V	4200 V
I_{NGR}						
1 A	231 Ω	346 Ω	398 Ω	577 Ω	1386 Ω	—
5 A	46 Ω	69 Ω	80 Ω	115 Ω	277 Ω	485 Ω
10 A	*(23 Ω)*	35 Ω	40 Ω	58 Ω	139 Ω	242 Ω
15 A	*(15 Ω)*	*(23 Ω)*	*(27 Ω)*	38 Ω	92 Ω	162 Ω
20 A	—	*(17 Ω)*	*(20 Ω)*	29 Ω	69 Ω	121 Ω
25 A	—	—	*(16 Ω)*	*(23 Ω)*	55 Ω	97 Ω
30 A	—	—	—	*(19 Ω)*	*(46 Ω)*	81 Ω
40 A	—	—	—	—	*(35 Ω)*	61 Ω
50 A	—	—	—	—	*(28 Ω)*	*(48 Ω)*
100 A	—	—	—	—	—	*(24 Ω)*

Tab. 3.1: Recommended R_{NGR} for system voltage U_{sys} ≤ 4300 V

3.3.2 Recommended R_{NGR} for system voltage U_{sys} > 4300 V

	CD14400					CD25000
U_{sys}	6000 V	6600 V	7200 V	11000 V	14 400 V	25 000 V
I_{NGR}						
1 A	—	—	—	—	—	—
5 A	693 Ω	762 Ω	831 Ω	1270 Ω	1663 Ω	—
10 A	346 Ω	381 Ω	416 Ω	635 Ω	831 Ω	1443 Ω
15 A	231 Ω	254 Ω	277 Ω	423 Ω	554 Ω	962 Ω
20 A	*(173 Ω)*	191 Ω	208 Ω	318 Ω	416 Ω	722 Ω
25 A	*(139 Ω)*	*(152 Ω)*	*(166 Ω)*	254 Ω	333 Ω	577 Ω
30 A	*(115 Ω)*	*(127 Ω)*	*(139 Ω)*	212 Ω	277 Ω	481 Ω
40 A	*(87 Ω)*	*(95 Ω)*	*(104 Ω)*	*(159 Ω)*	208 Ω	361 Ω
50 A	—	*(76 Ω)*	*(83 Ω)*	*(127 Ω)*	*(166 Ω)*	289 Ω
100 A	—	—	—	—	*(83 Ω)*	*(144 Ω)*

Tab. 3.2: Recommended R_{NGR} for system voltage U_{sys} > 4300 V

4. Installation

*Only **qualified personnel** are permitted to carry out the work necessary to install, commission and run a device or system.*

DANGER

Risk of electrocution due to electric shock!
Touching live parts of the system carries the risk of:

- An electric shock
- Damage to the electrical installation
- Destruction of the device

***Before installing and connecting the device, make sure** that the **installation** has been **de-energised**. Observe the rules for working on electrical installations.*

4.1 Dimension diagram NGRM500

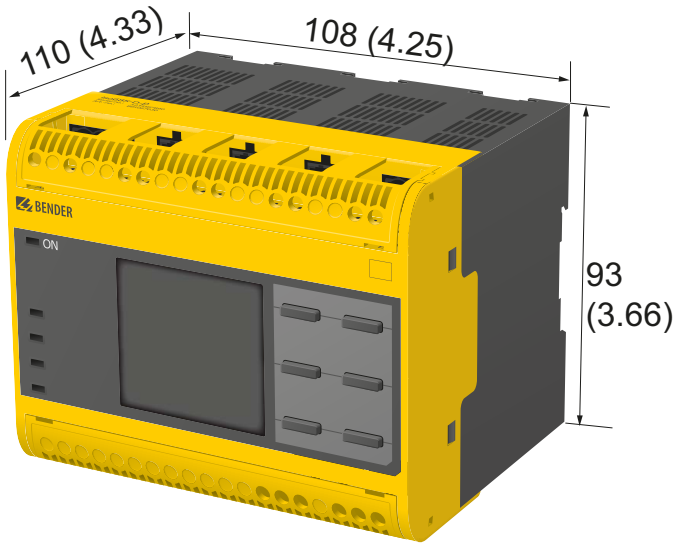


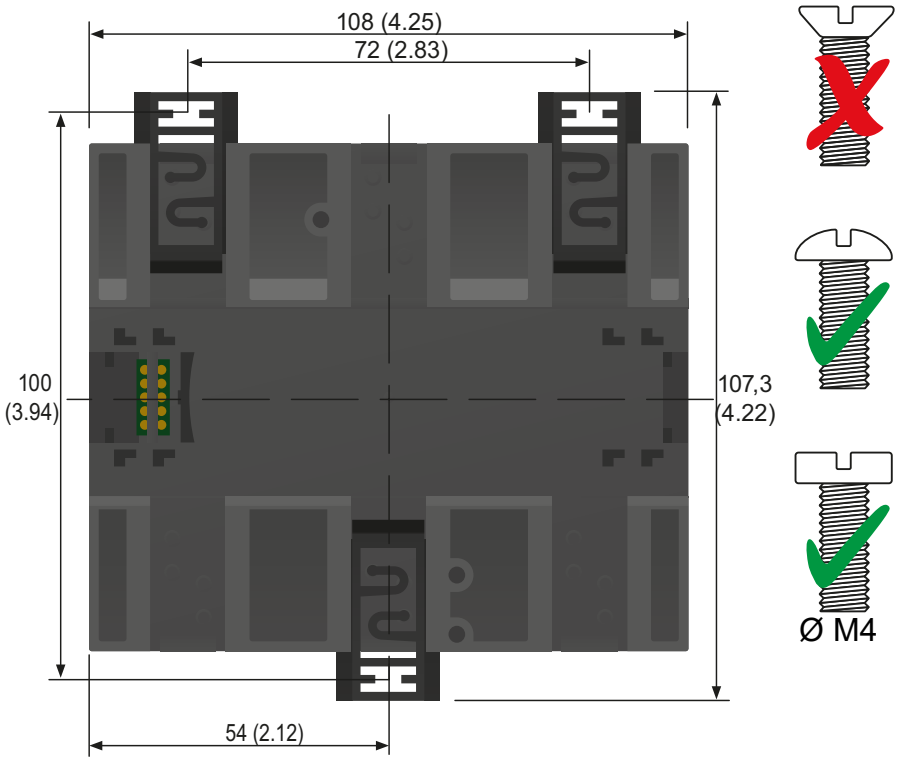
Fig. 4.1: Dimension diagram NGRM500; All dimensions in mm (in)

4.2 Enclosure views

Fig. 4.2: Enclosure view: top, front, bottom

4.3 Screw mounting

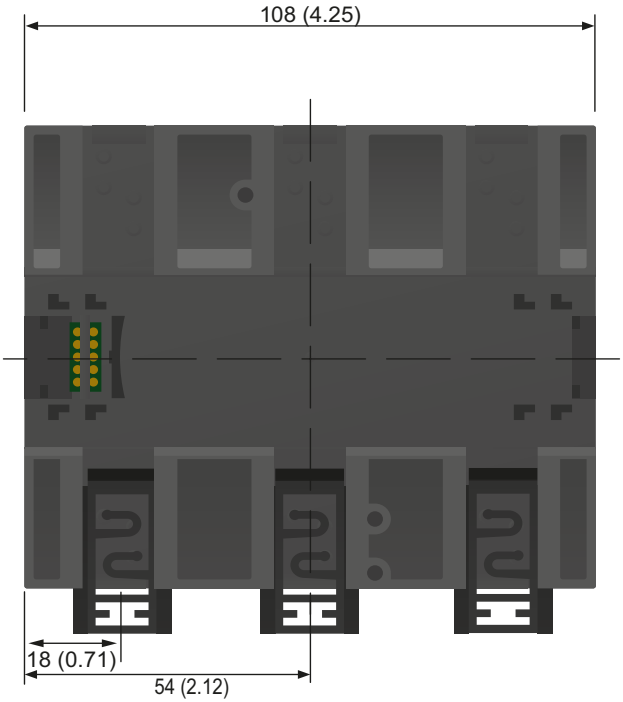
1. Fix the three mounting clips delivered with the device (two of them packed separately) manually or using a tool, as illustrated below.
2. Drill the mounting holes for the M4 thread according to the drilling template.
3. Fix the NGRM500 using three M4 screws.



Dimensions in mm (in)

4.4 DIN rail mounting

1. Fix the three mounting clips delivered with the device (two of them packed separately) manually or using a tool, as illustrated below.
2. Snap the NGRM500 on the DIN rail.
3. Fix the NGRM500 to the DIN rail by pushing the mounting clips until they click into place.



Dimensions in mm (in)

5. Connection

5.1 Connection requirements

*Only **qualified personnel** are permitted to carry out the work necessary to install, commission and run a device or system.*

DANGER

Risk of electrocution due to electric shock!

Touching live parts of the system carries the risk of:

- *An electric shock*
- *Damage to the electrical installation*
- *Destruction of the device*

***Before installing and connecting the device, make sure** that the **installation** has been **de-energised**. Observe the rules for working on electrical installations.*

CAUTION

Provide line protection!

According to DIN VDE 0100-430, a line protection shall be provided for the supply voltage.

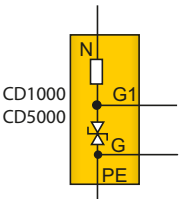
Check proper connection.

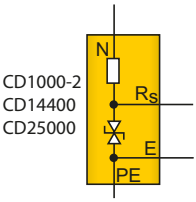
Prior to commissioning of the installation, check that the device has been properly connected and check that the device functions.

For UL applications:

- *Use 60/70 °C copper wires only.*
- *For UL and CSA applications, the supply voltage must be protected via **5 A** fuses.*

5.2 Connection descriptions of CD-series coupling device





N	Connection to star point
G1, R_S	Connection to R_S of the NGRM500
G, E	Connection to E of the NGRM500
PE	Connection to the protective earth conductor of the installation (PE)

5.3 Recommended connecting cable to coupling device CD…

CD…	Connection CD…	Cable lug	Metrical	Imperial
CD1000	N, G1, G	—	1.5 mm²	AWG 16
CD1000-2	N, R_S, E	—	1.5 mm²	AWG 16
	PE	M4	≥ 1.5 mm²	AWG 16 or greater
CD5000	G1, G	—	1.5 mm²	AWG 16
	N	M8 or M10	≥ 1.5 mm²	AWG 16 or greater
	PE	M6	≥ 1.5 mm²	AWG 16 or greater
CD14400 CD25000	R_S, E	—	1.5 mm²	AWG 16
	N	M5 or M10	≥ 1.5 mm²	AWG 16 or greater
	PE	M5	≥ 1.5 mm²	AWG 16 or greater

5.4 Star connection

5.4.1 Connection

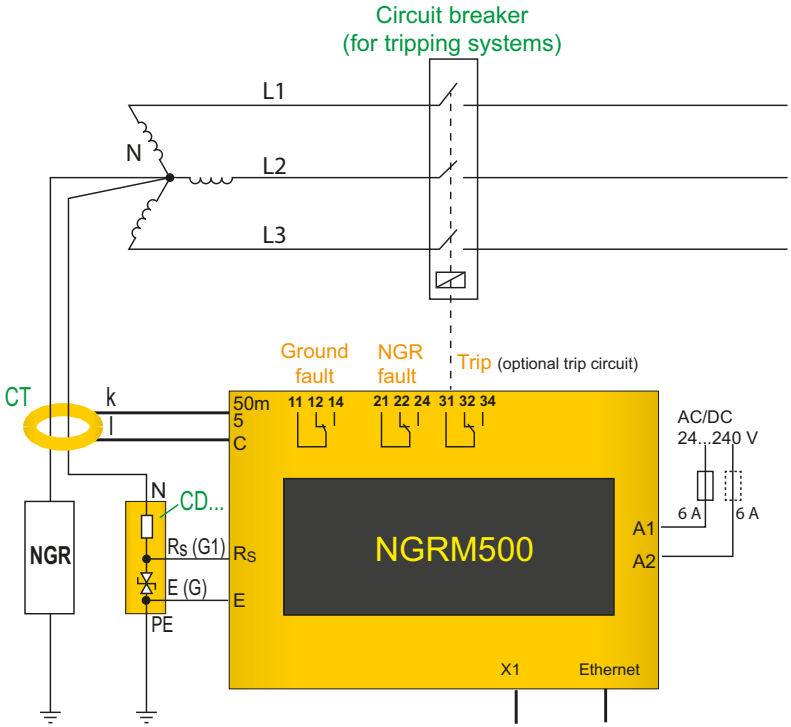


Fig. 5.1: Star configuration

The "N" connection of the CD-series coupling device should be as close to the transformer star point as possible.

5.4.2 Connection with pulser

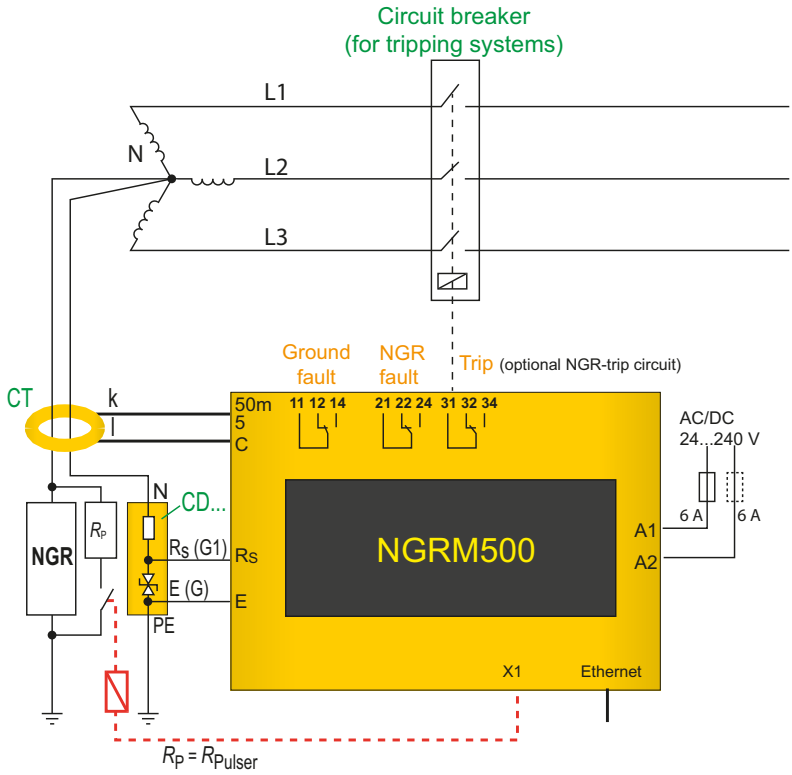


Fig. 5.2: Connection with pulser

The "N" connection of the CD-series coupling device should be as close to the transformer star point as possible.

An intermediate relay may be required between the power contactor of the pulser and digital output X1.

5.4.3 Artificial neutral (delta connection)

If no star point is available, the following circuit can create an artificial neutral.

Connection with a zigzag transformer

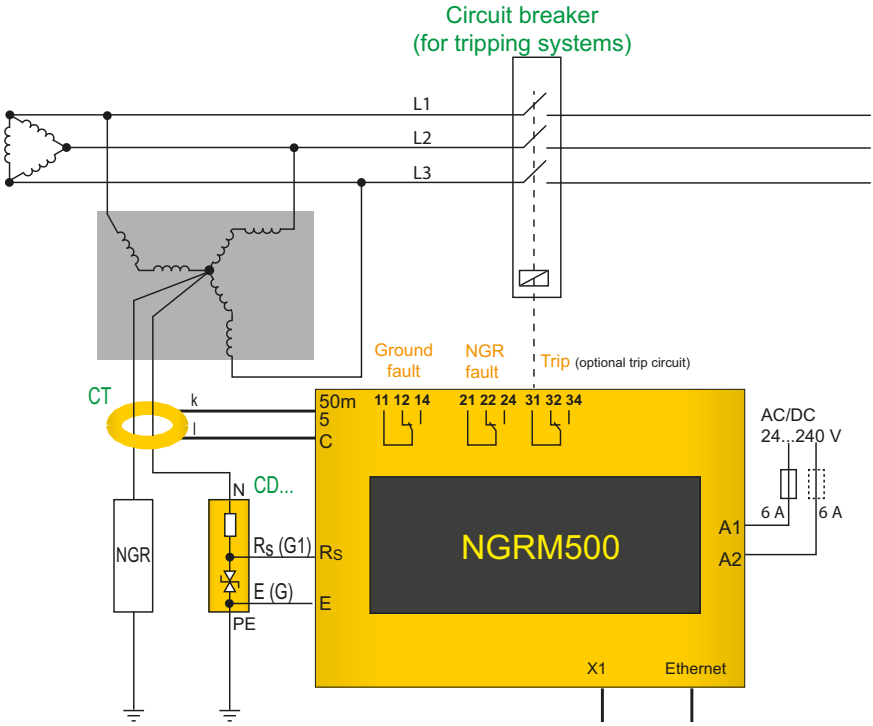
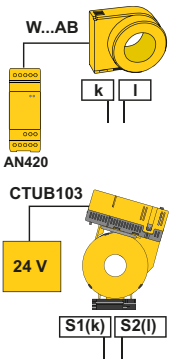
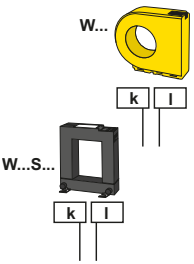
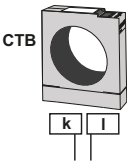


Fig. 5.3: Artificial neutral with a zigzag transformer

5.5 CT connections

Depending on the system to be monitored, a suitable measuring current transformer has to be chosen. All common measuring current transformers (50 mA or 5 A on the secondary side) can be used. The following table helps you with the choice:

System type	AC + DC	AC	AC
I_{NGR}	1…25 A	5…25 A	5…100 A
Frequency response range	0…3800 Hz	42…3800 Hz	50/60 Hz
Bender CT Ratio	600:1	600:1	60:5
Connecting cable	W…AB: max. 10 m CTUB103: max. 30 m	max. 40 m	max. 25 m (4 mm²/AWG 12) max. 40 m (6 mm²/AWG 10)
	provided cable or cable of 0.75…1.5 mm²/AWG 18…16)		
$I_{\Delta n}$ (Currents detected)	AC, pulsed AC, DC	AC, pulsed AC	AC, pulsed AC
Type	W35…120AB CTUB103 	W20…120 W1-S35…W5-S210 	CTB31…41 
CT: Terminal k	NGRM500: **50 mA**	NGRM500: **50 mA**	NGRM500: **5 A**
CT: Terminal l	NGRM500: **C**	NGRM500: **C**	NGRM500: **C**

Tab. 5.1: Selecting the right measuring current transformer

Measuring current transformer connection (W…AB)

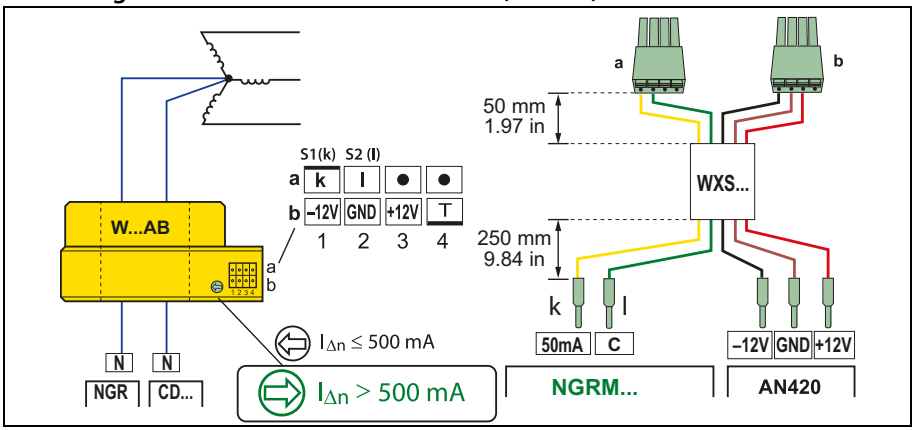


Fig. 5.4: Measuring current transformer connection W…AB

*When using a W…AB current transformer the **arrow on the top of the CT** must **point to the right** as shown in the wiring diagram (setting $I_{\Delta n}$ > 500 mA).*

5.6 Connection to relay outputs (Ground-fault, NGR-fault and Trip relays)

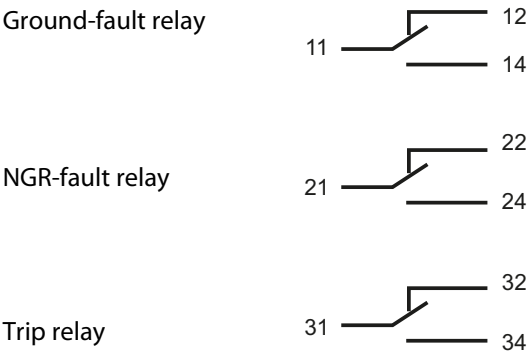
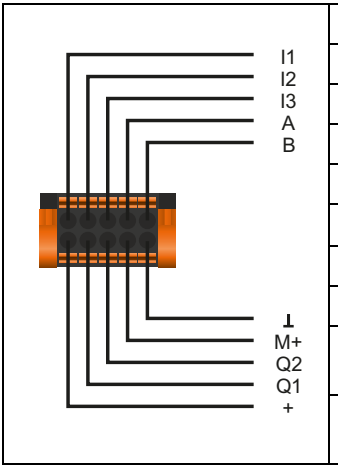


Fig. 5.5: Connection of relays, shown de-energized

5.7 Connection to the X1 interface

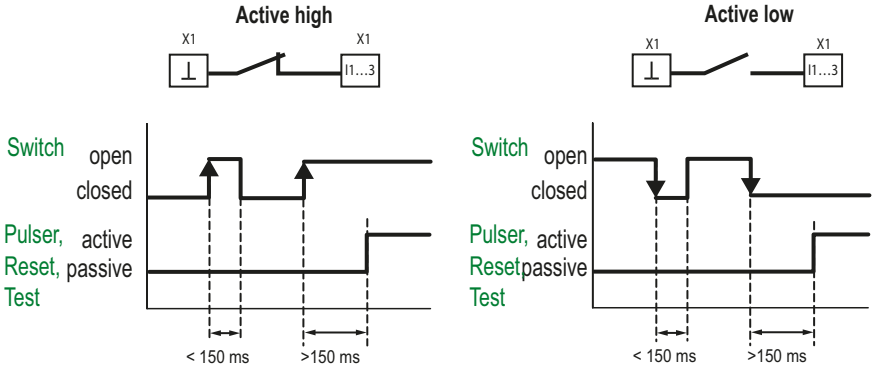


I1	Pulser IN
I2	Reset IN
I3	Test IN
A	Modbus RTU (A)
B	Modbus RTU (B)
⊥	Ground
M+	Analogue output
Q2	Open Collector: Pulser OUT
Q1	Open Collector: System state (system health)
+	Output for supply of external relays (+24 V, max. 100 mA)

Tab. 5.2: Pin assignment X1 interface

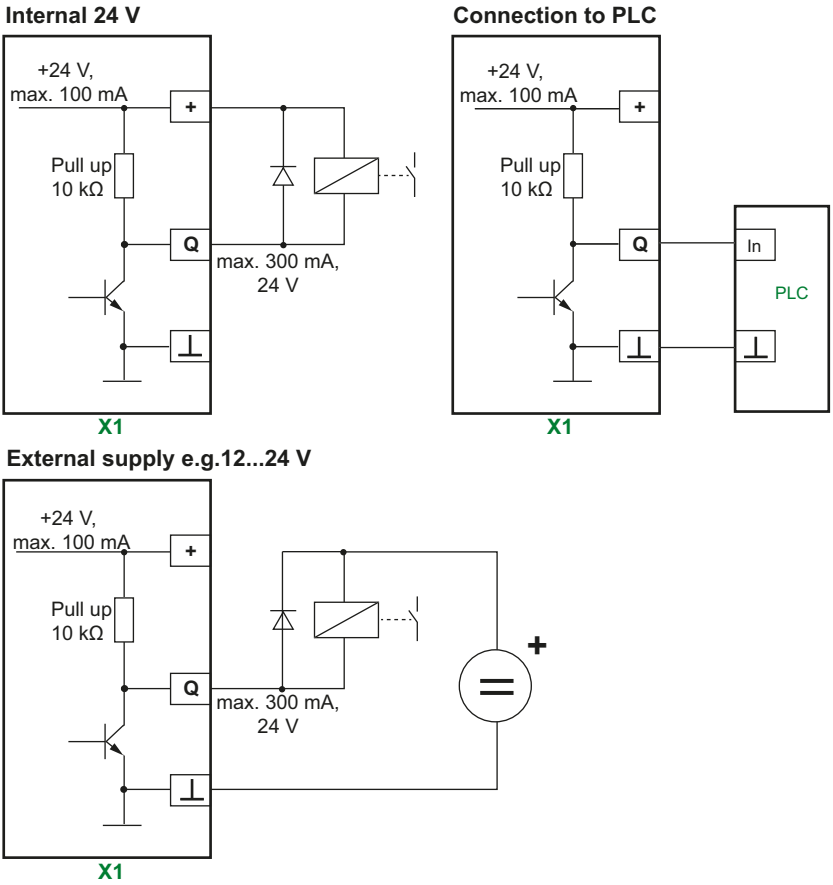
5.7.1 X1: Input I1…3

The input is only detected as "activated" after it has been activated for at least 150 ms. This way, short interference pulses are ignored.



Input I1…3: Potential-free contact to ground or
0 V and 24 V in conjunction with a PLC

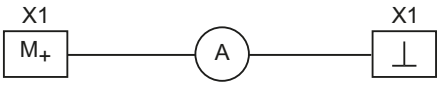
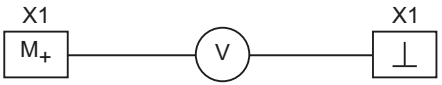
5.7.2 X1: Output Q1…2



Connection to Q1, Q2: external relay or PLC.

Observe maximum current values!
*The maximum **output current** on **X1** (+24 V) is **100 mA.***
In case of higher currents, the relays require an external 24-V supply.
*The maximum current on **Q1 and Q2 is 300 mA each**.*

5.7.3 X1: Analogue output

Analogue output	Mode	Permissible load
Current output 	0…20 mA	≤ 600 Ω
	4…20 mA	≤ 600 Ω
	0…400 µA	≤ 4 kΩ
Voltage output 	0…10 V	≥ 1 kΩ
	2… 0 V	≥ 1 kΩ

Either NGR **current** I_{NGR} or NGR **resistance** R_{NGR} can be assigned to the analogue output. A DC voltage or current signal proportional to the measured value is applied to the output.

The following overview shows how the output signals (A or V) are proportional to the measured values (Ω or A):

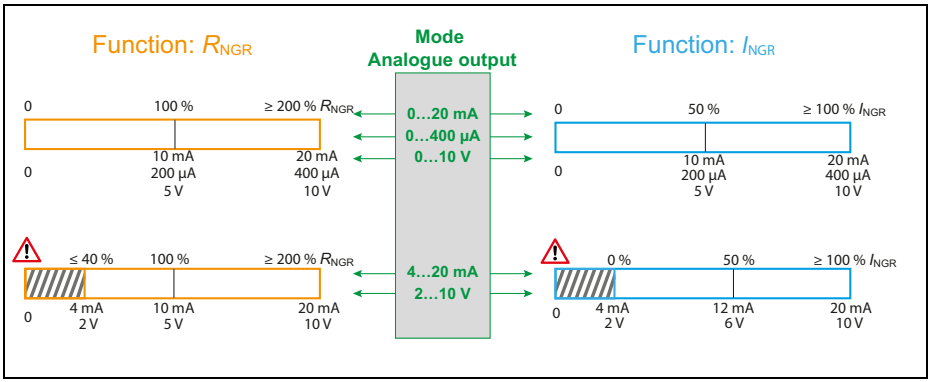
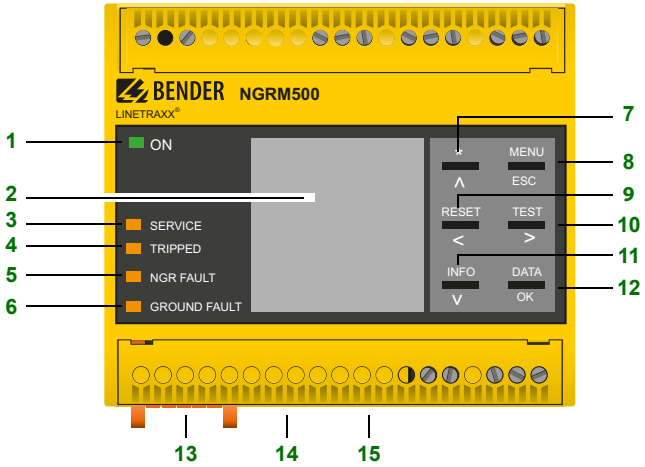


Fig. 5.6: Assignment of measured value to output signal

*In "4…20 mA" and "2…10 V" mode an output signal of 0 mA or 0 V indicates a **wiring error of the analogue interface**.*

6. User interface

6.1 Operating elements



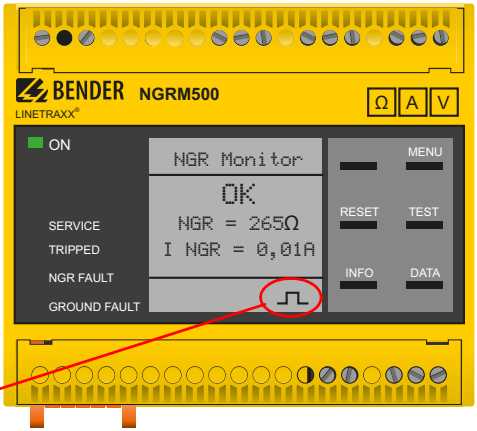
Legend to operating elements

No.	Description	Explanation
Display elements		
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 ($t_{NGR\ trip}$ elapses). The LED is on when an NGR fault has been detected. Trip relay and NGR relay have tripped.

No.	Description	Explanation
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 ($t_{GF\ trip}$ elapses). The LED is on: ground fault detected, trip relay has tripped (if so configured).
Device buttons		
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	Acknowledge and 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.
	v	Navigates down in a list or reduces a value.
12	DATA	Indicates data and values.
	OK	Confirms an action or a selection.
Interfaces		
13	X1	Interface X1(details see page 28)
14	ETH	Ethernet interface
15	R on/off	Terminating resistor for A/B (Modbus RTU)
Buzzer		Active in case of alarm and/or test

Tab. 6.1: Legend to operating elements

6.2 Standard display



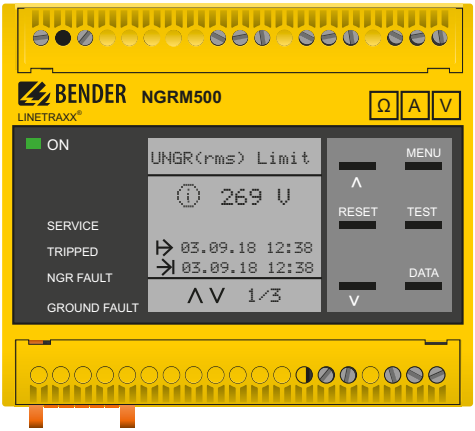
The pulse symbol in the lower part of the display indicates that the resistance of the R_{NGR} **is actively measured**.

6.3 Fault indication (active)

*Return from any (sub)menu to the **standard display** by pressing and holding ESC for more than 2 s.*

An active fault is indicated on the display with a ⚠ while the upper part of the display turns orange and indicates the fault message. 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 ˅ and ˄ buttons.

6.4 Fault indication (inactive)



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 ∨ and ∧ buttons. In addition to the type of fault and the associated alarm value, fault time-of-occurence and duration are indicated.

6.5 Acknowledging a fault message

In order to return to the standard display, the fault message must be acknowledged by means of the RESET button. Fault trips and messages can only be reset when the cause of fault has been eliminated.

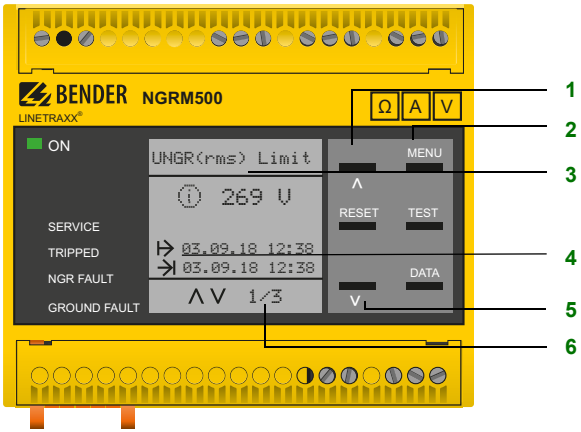
Acknowledging:
Press the RESET button, select "Acknowledge" and then OK to mute the buzzer(if enabled) and delete the messages from the standard display. After this, the NGR monitor returns to the standard display. No restart attempt takes place. The fault messages remain stored in the history memory.

Reset:
Press the RESET button, select "Reset" and then OK. The buzzer is muted and the fault messages are deleted from the standard display. If the installation is de-energised, restart attempts will be carried out, which will only be successful after the fault has been eliminated. The device returns to the standard display. The faults remain stored in the history.

6.6 History memory

*A **reset** can also be carried out via the input **I2**. It must be active for more than 150 ms.*

Up to 1023 alarm messages and device errors with date and time stamp can be stored in the history memory. If the maximum number of memory entries is reached, the oldest entry will be overwritten by a new event record.
Display the history memory at MENU > 3. History



Legend, display history memory

No.	Explanation
1	View next message
2	Exit view
3	Fault description Alarm value
4	Fault appeared (fault start time) Fault disappeared (fault end time)
5	View previous message
6	Number of the selected fault/Fault message count

7. Menu

7.1 Overview

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}, $U_{harm\ rel}$,

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
- Response values — $U_{NGR\ Trip}$, $I_{NGR\ Trip}$, $>R_{NGR}$, $<R_{NGR}$, $t_{NGR\ trip}$, GF trip, $t_{GF\ trip}$, Alarm stored, $t_{restart}$, 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
  - Digital 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, Clock, $U_{sys\ L\text{-}L}$, 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

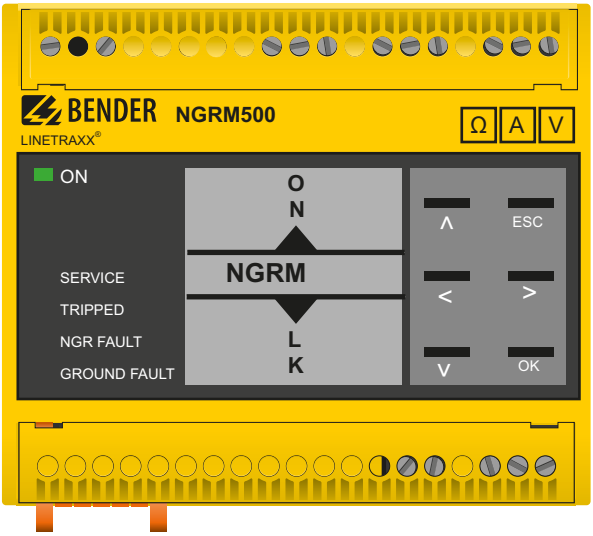
7.2 Navigating through the menu

Select a submenu using the ∨ and ∧ buttons and press OK or >.
Return from any submenu to the main menu by pressing ESC or <.

*Return from any (sub)menu to the **standard display** by pressing and holding ESC for more than 2 s.*

7.3 Changing settings

Enter settings with text/numbers directly. There is a corresponding representation in the menu items:



∨ and ∧ buttons:	Scroll to the letter/number.
< and > buttons:	Shift left and right in the word.
ESC:	Reject entry
OK:	Save entry

7.4 Data measured values (menu 1)

List of measured values. Navigate through the list using the ∨ and ∧ buttons.

Parameter	Explanation
R_{NGR}	NGR resistance value
$R_{NGR\ rel}$	NGR relative[1)] resistance value
Method	Measurement method (see menu 6.3)
R_{Sense}	Resistance value CD-series coupling device
I_{RMS}	Current RMS value
$I_{RMS\ rel}$	Current relative[1)] RMS value
U_{RMS}	Neutral voltage RMS value
$U_{RMS\ rel}$	Neutral voltage relative[1)] RMS value
I_{fund}	Current RMS value (fundamental frequency)
$I_{fund\ rel}$	Current relative[1)] RMS value (fundamental frequency)
U_{fund}	Neutral voltage RMS value (fundamental frequency)
$U_{fund\ rel}$	Neutral voltage relative[1)] RMS value (fundamental frequency)
I_{harm}	Current RMS value (for selected harmonic frequency range)[2)]
$I_{harm\ rel}$	Current relative[1)] RMS value (for selected harmonic frequency range)[2)]
U_{harm}	Neutral voltage RMS value (for selected harmonic frequency range)[2)]
$U_{harm\ rel}$	Neutral voltage relative[1)] RMS value (for selected harmonic frequency range)[2)]

Tab. 7.1: Data measured values (menu 1)

Note

1) Relative measured values always indicate the ratio of the measured value to the nominal value in percent.

2) The selected harmonics (filter bandwidth) are configured in the menu 6.5.11 and 6.5.12.

7.5 Harmonics (menu 2)

The measured harmonics are represented in a bar graph as a percentage of the measured value in relation to the nominal value. Change between the harmonic **voltage** and **current** displays using the ∨ and ∧ buttons.
Scroll through the **harmonics up to the 64th order** using the < and > buttons.

All harmonics are always displayed, regardless of the settings in the menus 6.5.11 and 6.5.12.

Use ESC to return to the main menu.

7.6 History (menu 3)

Alarm messages (since switching on the device or deleting the last history) are saved.

History: Navigate through the list using the ∨ and ∧ buttons.
Delete: After confirming, the history is irreversibly deleted.

7.7 Pulser (menu 4)

A ground fault can be located by means of a measuring clamp and the pulser function. The pulser relay is designed as Open Collector.

Pulser (menu 4.1)

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

t_{pulse} (menu 4.2)

The pulse period can be set between 1…10 s.

The set pulse period is only effective if the pulser (menu 4.1) is not "inactive".

The following diagram shows an overview of the pulser control:

Pulser control

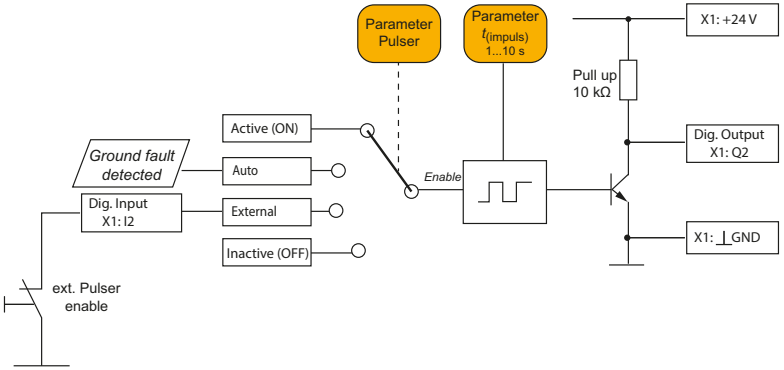


Fig. 7.1: Pulser control

7.8 Display (menu 5)

Choose whether the measured values for R_{NGR} and I_{NGR} should be displayed as absolute (in Ω or A) or relative (in % to the reference value). The relative value is the ratio of the measured value to the nominal value.

7.9 HRG settings (menu 6)

7.9.1 HRG system (menu 6.1)

Menu	Parameter	Setting range	Explanatory notes
6.1.1	$U_{sys\ (L-L)}$	400 V…25 kV	System phase-to-phase voltage
6.1.2	CD-NGRM	CD1000, CD5000, CD14400 CD25000 Other	For CD1000 and CD1000-2, select "CD1000" in the menu. The selection depends on the system voltage U_{sys}.
6.1.3	Frequency	50 or 60 Hz	Nominal frequency
6.1.4	$I_{NGR\ nom}$	0.5…100 A	Nominal value of the NGR current
6.1.5	$R_{NGR\ nom}$	15…5000 Ω	Nominal value of the used NGR resistance

Tab. 7.2: HRG system (menu 6.1)

7.9.2 CT (menu 6.2)

Menu	Parameter	Setting range	Explanatory notes
6.2.1	CT primary	1…10,000	Ratio of the CT on the primary side
6.2.2	CT secondary	1…10,000	Ratio of the CT on the secondary side
6.2.3	CT connection	5 A, 50 mA	Used CT connection

Tab. 7.3: CT (menu 6.2)

7.9.3 NGR (menu 6.3)

Menu	Parameter	Setting range	Explanatory notes
6.3.1	Method	auto, passive	**auto**: automatic changeover between active and passive resistor monitoring **passive**: only passive resistor monitoring (see page 14)
6.3.2	PT primary	1…10,000	Ratio of the potential transformer on the primary side
6.3.3	PT secondary	1…10,000	Ratio of the potential transformer on the secondary side

Tab. 7.4: NGR (menu 6.3)

7.9.4 Response values (menu 6.4)

Behaviour of the trip relay in the event of a ground fault

Set whether a ground fault (response value violation U_{NGR} and/or I_{NGR}) should switch the Trip relay or not. Set the filter type for NGR current and voltage ("total RMS", "fundamental", or "harmonics") that leads to a violation of the response value at "Trip signal" (menu 6.5.10).

a) Ground-fault trip (GR trip) (menu 6.4.6) "on"

When a *ground fault* is detected

- the **ground-fault relay** (connections 11, 12, 14) switches **immediately** (40 ms).
- the **trip relay** (connections 31, 32, 34) switches **after $t_{GF\ trip}$ has elapsed**.

b) Ground-fault trip (GR trip) (menu 6.4.6) "off"

When a *ground fault* is detected

- the **ground-fault relay** (connections 11, 12, 14) switches **immediately** (40 ms).
- the **trip relay** (connections 31, 32, 34) **does not** switch, $t_{GF\ trip}$ is ignored.

Resistor faults

Resistor faults (response value violation R_{NGR}) are independent of the "GR trip" settings: The **NGR fault relay** (connections 21, 22, 24) switches within the response time of approximately 7.5 s. The **Trip relay** (connections 31, 32, 34) switches with a **delay** according to the $t_{NGR\ trip}$ setting.

Restart of the installation (Auto-reset: restart attempts)

Set whether the installation should be restarted manually or automatically after a ground fault or resistor fault.

a) Restart installation manually (alarm stored (menu 6.4.8) "on")

In the event of a fault, the Trip relay changes state and the installation shuts down (if so configured). The fault must be eliminated and the relay trip/installation is restarted via a manual reset (menu 9), via RESET key or via input I2. If the restart is not successful, it must be retried (after further fault elimination).

b) Restart installation automatically (alarm stored (menu 6.4.8) "off")

In the event of a fault, the Trip relay changes state and the installation shuts down (if so configured). The fault must be eliminated. After the configured time delay $t_{restart}$ has elapsed, the NGRM500 attempts to restart the installation automatically. The Trip relay switches from the tripped state and, if the fault condition is still present, it will trip again after the set delay. If the restart is not successful, $t_{restart}$ elapses again and another restart attempt takes place. The number of restart attempts can be selected between 1 and 5.

The NGRM500 remains in "Alarm stored" mode (menu 6.5.8) even after a shutdown.

Relay and restart response values

Menu	Parameter	Setting range	Explanatory notes
6.4.1	U_{NGR} trip	10…90 %	Value in % of the nominal value at which the ground-fault relay trips. The Trip relay only trips (with the configured delay) when the ground-fault trip is set to "on" (6.5.6).
6.4.2	I_{NGR} trip	10…90 %	
6.4.3	> R_{NGR}	110…200 %	High or low resistance value in % of the nominal value at which the Trip relay and the NGR relay operate.
6.4.4	< R_{NGR}	10…90 %	

Menu	Parameter	Setting range	Explanatory notes
6.4.5	$t_{NGR\ trip}$ On the device: t(NGRtrip)	0…60 s	Time delay between NGR fault detection and shutdown by the trip relay. $t_{NGR\ trip}$ is added to the response time.
6.4.6	Ground-fault trip	on	**Ground fault**: Trip relay switches after the time delay t_{trip} has elapsed. **NGR fault**: Trip relay switches immediately (< 7.5 s) or after the time delay $t_{NGR\ trip}$ (0…60 s) has elapsed.
		off	**Ground fault**: Trip relay does not switch. **NGR fault**: Trip relay switches immediately (< 7.5 s) or after the time delay $t_{NGR\ trip}$ (0…60 s) has elapsed.
6.4.7	$t_{GF\ trip}$ [1)] On the device: t(GFtrip)	100 ms…24 h	Time delay between ground-fault detection and operation of the Trip relay; only used when ground-fault trip is set to "on" (6.5.6).
6.4.8	Alarm stored	on	Triggered Trip relay must be reset **manually** (RESET or input I2)
		off	**Automatic** restart attempts after $t_{restart}$ has elapsed (max. number like setting 6.5.9)
6.4.9	$t_{restart}$ On the device: t(restart)	100 ms…24 h	Time delay between fault elimination and automatic restart; only used when alarm stored (6.5.8) is set to "off".
6.4.10	Restart count	1…5	Number of restart attempts within 24 h; only used when alarm stored (6.5.8) is set to "off".

Menu	Parameter	Setting range	Explanatory notes
6.4.11	Trip signal	RMS	Trips on the full-spectrum RMS value (*f* = DC…3.8 kHz).
		Fundamental	Trips on the RMS value of the fundamental.
		Harmonics	Trips on the RMS value within the harmonic filter upper and lower limits (6.5.11 and 6.5.12).
6.4.12	Upper limit harmonic	0…32: 0 = DC 1 = fundamental 2 = 2nd harmonic … 32 = 32nd harmonic	Indicate range of harmonics that will trigger the Trip relay and Ground-fault relay if the threshold value has been exceeded; only active when "Harmonics" is selected at 6.5.10.
6.4.13	Lower limit harmonic		

Tab. 7.5: Response values (menu 6.4)

Note:

1) Observe the maximum trip time (see Tab. 8.1) and the restart time ($t_{restart}$) for the installed CD-series coupling device when setting the time delay t_{trip}.

7.9.5 System settings (menu 6.5)

Menu	Parameter		Setting range	Explanatory notes
6.5.1	Ground-fault relay	Mode (6.5.1.1)	Fail-safe, non-fail-safe	1)
		Relay test (6.5.1.2)	on, off	2)
6.5.2	NGR relay	Mode (6.5.2.1)	Fail-safe, non-fail-safe	1)
		Relay test (6.5.2.2)	on, off	2)
6.5.3	Trip relay	Mode (6.5.3.1)	Fail-safe, non-fail-safe	1)
		Relay test (6.5.3.2)	on, off	2)

Menu	Parameter		Setting range	Explanatory notes
6.5.4	Analogue	Mode (6.5.4.1)	0…20 mA 4…20 mA 0…400 µA 0… 10 V 2… 10 V	3)
		Function (6.5.4.2)	I_{NGR}, R_{NGR}	
6.5.5	Digital inputs/outputs	System health OUT (6.5.5.1)	Fail-safe, non-fail-safe	1)
		Pulser OUT (6.5.5.2)	Fail-safe, non-fail-safe	
		Pulser IN (6.5.5.3)	Active high Active low	**Active high**: Activation of the function when input level changes from "low" to "high" **Active low**: Activation of the function when input level changes from "high" to "low"
		RESET IN (6.5.5.4)		
		TEST IN (6.5.5.5)		
6.5.6	Buzzer	Buzzer alarm (6.5.6.1)	on, off	**on**: each alarm activates buzzer **off**: alarm does not activate buzzer
		Buzzer test (6.5.6.2)	on, off	**on**: test activates buzzer **off**: test does not activate buzzer

Tab. 7.6: System settings (menu 6.5)

Legend, Tab. 7.6

1) Fail-safe: The relay is energised during normal operation and is de-energised in the event of a fault

Non-fail-safe: The relay is de-energised in normal operation and is energised in the event of a fault

2) When set to "on", the function of the relay is checked during a test by switching it.

3) Analogue output (menu 6.5.4)

Either NGR **current** I_{NGR} or NGR **resistance** R_{NGR} can be assigned to the analogue output. In doing so, the voltage or current is proportional to the measured value. See chapter 9.1 for more details.

7.9.6 Field calibration (menu 6.6)

During field calibration, all tolerances of the connected CD-series coupling device and the NGR are taken into account. The measured value is calibrated to the set nominal value of the NGR ($R_{NGR\ nom}$).
In order to achieve high accuracy, start the device and let it run for at least one hour in the operating environment before carrying out the field calibration.

The Trip relay is switched during field calibration!

7.10 Device settings (menu 7)

Further information on configurable parameters can be found in the following table.

Menu	Parameter		Note
7.1	Language		German English GB English US Spanish French
7.2	Clock	Time (7.2.1)	Set local time
		Format (7.2.2)	12 h (am/pm) 24 h
		Summer time (7.2.3)	Automatic change? [1]
		Date (7.2.4)	Set date
		Format (7.2.5)	dd.mm.yy mm-dd-yy
		NTP (7.2.6)	Synchronisation on/off [2]
		NTP server (7.2.7)	IP address NTP server
		UTC (7.2.8)	Time zone [3]

Menu	Parameter		Note
7.3	Interface[4]	Write access (7.3.1)	Allow, deny
		Ethernet (7.3.2)	DHCP (7.3.2.1)
			IP (7.3.2.2)
			SN (7.3.2.3)
			Std.GW (7.3.2.4)
			DNS server (7.3.2.5)
			Domain
		BCOM (7.3.3)	System name (7.3.3.1)
			Subsystem (7.3.3.2)
			Device address (7.3.3.3)
			Timeout (7.3.3.4)
			TTL for subscription (7.3.3.5)
		Modbus TCP (7.3.4)	Port 502 (7.3.4.1)
		Modbus RTU (7.3.5)	Address (7.3.5.1)
			Baud rate (7.3.5.2)
			Parity (7.3.5.3)
			Stop bits (7.3.5.4)
7.4	Display[5]	Brightness (7.4.1)	0…100 %
		Decimal separators (7.4.2)	Comma, point
7.5	Password	Password (7.5.1)	Factory setting 0000
		Status	on, off
7.6	Factory settings		Changes are discarded and reset to factory settings
7.7	Software	Update via interface	[6]
		UPDATE	
7.8	Service	For Bender service only	

Tab. 7.7: Device settings overview (menu 7)

Explanatory notes Tab. 7.7

1) **Summer time (menu 7.2.3)**

`off` **No** automatic change between summer time and standard time.

`DST` **Daylight Saving Time**
Automatic change between summer time and standard time according to North American regulation. North American summer time begins on each second Sunday in March at 02:00 local time by setting the clock forward by one hour from 02:00 to 03:00 local time. Summer time always ends the first Sunday in October at 03:00 local time by setting the clock back one hour from 03:00 to 02:00.

`CEST` **Central European Summer Time**
Automatic change between summer time and standard time according to Central European regulation. Central European summer time begins on each last Sunday in March at 02:00 CEST by setting the clock forward by one hour from 02:00 to 03:00. Central European summer time always ends on the last Sunday in October at 03:00 CEST by setting the clock back one hour from 03:00 to 02:00.

When set to "DST" or "CEST", changing between summer time and normal time is only done on the date of the official time change.

2) **NTP (menu 7.2.6)**

`on` Synchronisation via NTP server is enabled. To use this function, configure the NTP server.

`off` Synchronisation is disabled.

3) **UTC (menu 7.2.8)**

Set the time according to UTC (Coordinated Universal Time). For Germany, set +1 for wintertime (MEZ) and +2 for summer time (MESZ).

4) Interface (menu 7.3)

Set the parameters for connecting other communication devices to the NGRM500 in the interface menu:

Write access (menu 7.3.1)

Set whether the parameters of the device can be changed via Modbus and web server. Displaying and reading out data via Modbus and web server is always possible, regardless of this setting.

- `Allow` Allow external parameter setting.
- `Deny` Deny external parameter setting.

Ethernet (menu 7.3.2)

Set the parameters for communication with other devices via the Ethernet interface. The Ethernet interface can be used for communication with Modbus, web server and BCOM.

DHCP (menu 7.3.2.1)

`on` Enable automatic IP address assignment (IP address, subnet mask, standard gateway). Manual address settings are ignored.

`off` Disable automatic IP address assignment. Enter settings (IP address, subnet mask and standard gateway) manually in the menu

The used IP address is displayed in the Info menu (INFO button or menu 9).

IP (menu 7.3.2.2)

Set the appropriate IP address for the NGRM500.

SN (menu 7.3.2.3)

Set the appropriate subnet mask.

Std. GW (menu 7.3.2.4)

If a standard gateway is used, enter the IP address here.

DNS server (menu 7.3.2.5)

If a DNS server is used, enter the server's IP address. For questions regarding the configuration of a DNS server, please contact your network administrator.

Domain (menu 7.3.2.6)

Enter the domain. For questions regarding the configuration of the domain, please contact your network administrator.

BCOM (menu 7.3.3)

Set the parameters for communication with other devices via BCOM. For further information, refer to "BCOM" on page 48.

System name (menu 7.3.3.1)

Enter the system name of the network in which the devices are located. In order to guarantee that all devices are able to communicate via BCOM, all devices must have the same system name.

Subsystem (menu 7.3.3.2)

Configure the subsystem address of the network in which the devices are located. The devices can communicate with subsystems with the same or different subsystem addresses.

Device address (menu 7.3.3.3)

Assign a device address. Each device must have a different address to distinguish it from others in the system and ensure correct communication.

Timeout (menu 7.3.3.4)

Set the timeout for messages between 100 ms…10 s. This time specification defines the maximum permissible time for a device to respond.

TTL for subscription (menu 7.3.3.5)

Set a time between 1 s…1092 min. This time determines in what intervals the NGRM500 sends messages to e.g. a gateway. Severe alarms are always sent immediately.

Modbus TCP (menu 7.3.4)

Settings for communication with other devices via Modbus TCP.

Port 502 (menu 7.3.4.1)

Choose whether Modbus TCP should be used:

on Modbus TCP can be used for communication with other devices.

off Modbus TCP cannot be used for communication with other devices.

Modbus RTU (menu 7.3.5)

Settings for communication with other devices via Modbus RTU.

Address (menu 7.3.5.1): 1…247

Baud rate (menu 7.3.5.2): the selectable options are

- 9.6 kbaud,
- 19.2 kbaud,
- 38.4 kbaud,
- 57.6 kbaud

Parity: the selectable options are "even", "odd", "none"

Stop bits: the selectable options are "1", "2", "auto"

[5] Display (menu 7.4)

Brightness (menu 7.4.1)

Adjust the display brightness between 0…100 % in steps of 10. If no button is pressed on the display for 15 minutes, the brightness of the display decreases. After pressing a button, the display returns to the initial brightness.

[6] Software (menu 7.7)

Update via interface (menu 7.7.1)

off Software updates cannot be carried out via the web interface

on Software updates can be carried out via the web interface

UPDATE (menu 7.7.2)

If a software package has been transferred to the device, the package can be installed (again) here.

7.11 Commissioning (menu 8)

The commissioning wizard queries all relevant parameters.

Language (8.2)	Select
Date (8.3)	Set
Time (8.4)	Set
Usys L-L (8.5)	System voltage
Frequency (8.6)	50 or 60 Hz
INGR nom (8.7)	
RNGR nom (8.8)	
CT primary (8.9)	
CT secondary (8.10)	
CT connection (8.11)	50 mA or 5 A
Field calibration (8.12)	Start or do not start

7.12 Info (menu 9)

The NGRM500's settings can be viewed in the Info menu. Navigate through the different views using the arrow buttons:

Device	Name, serial number, article number
Software	Measurement equipment software version, HMI software version
Clock	Time, date, summer time
Ethernet	IP address, DHCP status, MAC address

7.13 Alarm (menu 10)

Acknowledge	Mute buzzer, delete message from the standard display, fault message remains stored in the history memory. If the installation is de-energised, no restart attempts will take place.
Reset	Mute buzzer, delete message from the standard display, fault message remains stored in the history memory. If the installation is de-energised, restart attempts will be carried out, which will only be successful after the fault has been eliminated. The device returns to the standard display.
Test	Since the relays are not monitored in the hardware or software, the relays must be tested at regular intervals on proper functioning. The frequency of the test cycle is subject to the safety requirements of the operator but it should be carried out at least every six months.

During the test it must be ensured that the relays can actually switch! The following settings are required:

Ground-fault relay	***menu 6.6.1.2** relay test "on"*
NGR relay	***menu 6.6.2.2** relay test "on"*
Trip relay	***menu 6.6.3.2** relay test "on"*

8. Initial commissioning

The following parameters must be entered for initial commissioning:

- **System voltage U_{sys}** (phase-to-phase)
  The corresponding coupling device must be used depending on the system voltage:
  for U_{sys} ≤ 4.3 kV: CD1000, CD1000-2, CD5000 (20 kΩ)
  for U_{sys} > 4.3 kV: CD14400, CD25000 (100 kΩ)
- **Ratio** of the used **potential transformer** ($U_{NGR\ nom}$) if used
- NGR rated current ($I_{NGR\ nom}$)
- **Ratio** of the used **measuring current transformer**
  (600:1 for W… and W…AB measuring current transformers)
- NGR rated resistance $R_{NGR\ nom}$

Parameters are set in the
main menu > 6. HRG settings.
*Alternatively, you can follow the setup wizard (**Main menu > 8. Commissioning**).*

8.1 Response values

The following parameters can be adjusted:

- Trip threshold for voltage (U_{NGR})
- Trip threshold for current (I_{NGR})
- Trip thresholds for resistance (R_{NGR})

***Low trip threshold values** may lead to **false tripping**, while with **high trip threshold values** the device may not trip at all.*

Voltage trip threshold (U_{NGR})

The threshold is set as a percentage of $U_{NGR\ nom}$.
Setting range of trip threshold U_{NGR}: 10…90 % (factory setting 60 %)

Current trip threshold (I_{NGR})

The trip threshold is set as a percentage of $I_{NGR\ nom}$.
Setting range of trip threshold I_{NGR}: 10…90 % (factory setting 60 %).

Resistance trip thresholds (R_{NGR})
Both trip thresholds for resistance are set as a percentage of $R_{NGR\ nom}$.
Setting range of trip threshold R_{NGR}
10…90 % (factory setting 50 %)
110…200 % (factory setting 200 %).
In the case of the **passive measurement method** the resistance R_{NGR} is determined using the current and voltage measurements. Accuracy depends on the measuring current transformer.
In the case of the **active measurement method** the device generates an active test pulse and measures R_{NGR} even if the installation is de-energised.

8.2 Output relays operating modes

The factory setting for the relays is fail-safe. In the case of a device test, the relays change state. The settings can be changed in *menu 6.6.1…6.6.6* (see page 45).

8.2.1 Field calibration

After the parameters have been entered, a field calibration must be carried out. During this process, the set nominal resistance value of the NGR calibrates to the measured resistance.

Start field calibration in the
main menu > 6.7 Field calibration.

If calibration is not possible (e.g. due to incorrect settings) an error message appears (6.10).

8.2.2 Trip times

The three relays have different trip times:

- Ground-fault relay 40 ms, not configurable
- NGR fault relay 7.5 s, not configurable
- Trip relay 100 ms…24 h, configurable for ground faults;
  0…60 s, configurable for NGR faults

Explanatory notes on Trip relay

- In case of a ground fault, $t_{GF\ trip}$ is only considered when "GR trip" (menu 6.5.6) is enabled. When "GR trip" is disabled, the trip relay does not switch in the event of a ground fault.
- In case of an NGR fault, $t_{GF\ trip}$ is ignored, the trip relay switches after time delay $t_{NGR\ trip}$ has elapsed.
- The setting for $t_{GF\ trip}$ must under no circumstances be longer than the maximum possible operating time of the CD-NGRM… coupling device.
  The table shows an overview of the t(GFtrip) settings for the coupling device used:

U_{sys}	Coupling device	Max. t_{trip} (Menu 6.5.7)	Ground-fault trip settings (menu 6.5.6)
400…690 V	CD1000	24 h	on or off
	CD1000-2		
691…1000 V	CD1000	300 s	on
	CD1000-2	24 h	on or off
	CD5000		
1001…4300 V	CD5000	24 h	on or off
4301…14550 V	CD14400	60 s	on
	CD25000		
14551…25000 V	CD25000	10 s	on

Tab. 8.1: Maximum trip times t(GFtrip) for the used CD-NGRM

Ground-fault relay timing diagram

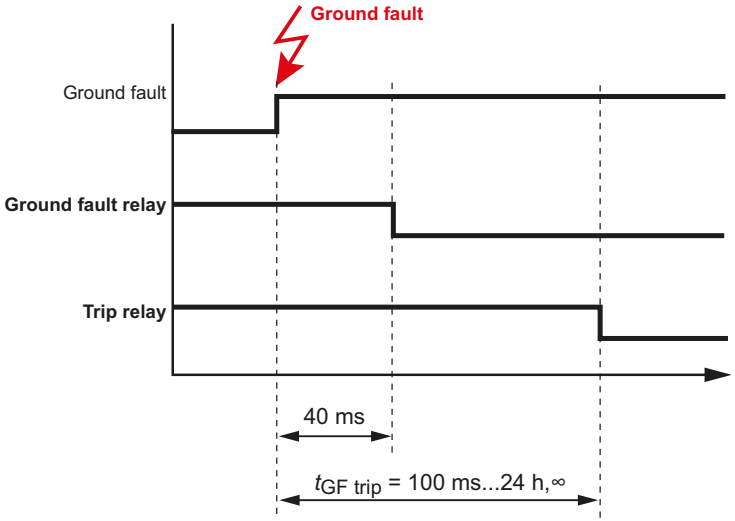


Fig. 8.1: Ground-fault relay timing diagram

NGR relay timing diagram

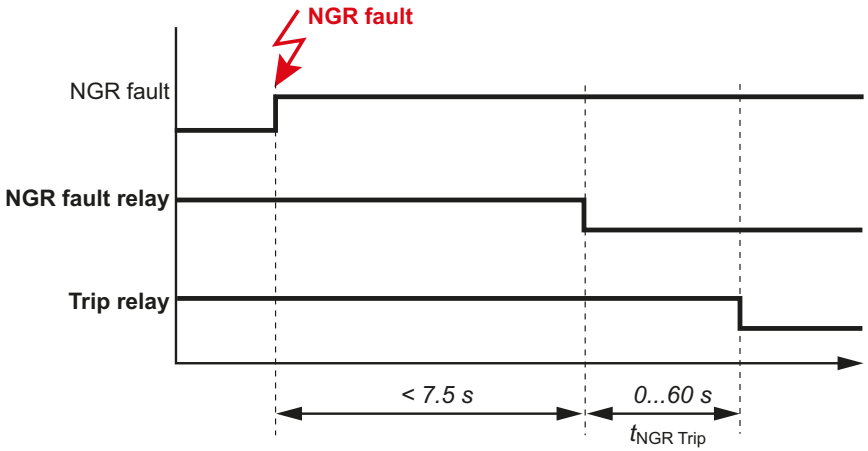


Fig. 8.2: NGR relay timing diagram

8.3 Trip signal: RMS, fundamental, harmonics

The NGRM500 trip-signal frequency response can be selected via the "Trip signal" parameter (menu 6.5.10). Trip signal can be:

RMS
The RMS value of current or voltage over the entire frequency range (up to approx. 3.8 kHz).

Fundamental
Only the RMS value of the fundamental component (50 or 60 Hz).

Harmonics
The filtered RMS value of the selected range of harmonics
H0 = DC
H1 = fundamental
H2 = 2nd Harmonics
…
H32 = 32nd Harmonics

In the "Harmonics" measured value display (menu 2) all spectral lines are always displayed. This is independent of the trip signal setting.

On the standard display, the measured values are is indicated as

- *resistance in Ω or %*
- *current in A or %*

Setting is entered in the main menu > 5: Display.

8.4 Initial measurement

During device start, all measured values are recorded.

9. Analogue and digital I/O configuration

9.1 Analogue output (menu 6.6.4)

Either NGR **current** I_{NGR} or NGR **resistance** R_{NGR} can be assigned to the analogue output. A voltage or current signal proportional to the measured value is applied to the output. The following settings are possible:

Mode (menu 6.6.4.1)

- 0…20 mA Permissible load ≤ 600 Ω
- 4…20 mA Permissible load ≤ 600 Ω
- 0…400 µA Permissible load ≤ 4 kΩ
- 0…10 V Permissible load ≥ 1 kΩ
- 2…10 V Permissible load ≥ 1 kΩ

For further information, see „X1: Analogue output“ on page 30.

Function (menu 6.6.4.2)

Set which measured values are assigned to the analogue output. Setting options:

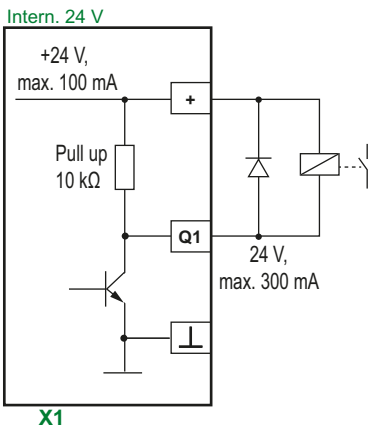
- I_{NGR}
- R_{NGR}

9.2 Digital outputs (Q1, Q2)

The digital outputs can draw current (sink).
The maximum current for the Open-Collector output is 300 mA for each output.
Since the "+24 V" connection can only provide 100 mA, it might be required to use an external voltage supply (+24 V) for the relays.

9.2.1 Use of Q1: System condition

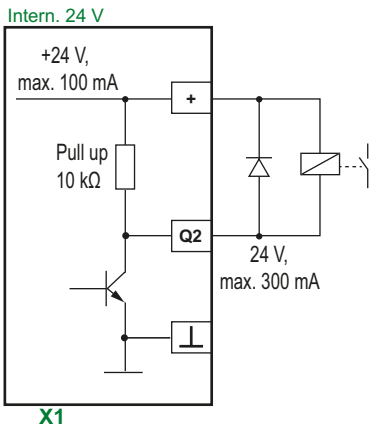
Mode	No system error detected	System error detected [1]
Fail-safe	on energised Q1 low	off de-energised Q1 high
Non-fail-safe	off de-energised Q1 high	on energised Q1 low



[1] The SERVICE LED is also on

9.2.2 Use of Q2: Pulser

Mode	Inactive	Active
Fail-safe	on energised Q2 low	off de-energised Q2 high
Non-fail-safe	off de-energised Q2 high	on energised Q2 low



9.3 Digital inputs

The inputs are detected as "activated" after the contact has been **activated (high or low) for at least 150 ms**. This way, short interference pulses are ignored.
For further information, refer to page 28.

10. Test cycle

Since the output relays are not monitored in the hardware or software, they must be tested at regular intervals to verify proper functioning. The frequency of the test cycle is subject to the safety requirements of the operator but it should be carried out at least every six months.

During the test it must be ensured that the relays can actually switch off!
The following settings are required:

Ground-fault relay	***menu 6.6.1.2** relay test "on"*
NGR relay	***menu 6.6.2.2** relay test "on"*
Trip relay	***menu 6.6.3.2** relay test "on"*

Starting the test
Start the test by pressing the TEST button, via menu 10.3 or the input I3.

11. Factory settings

Menu	Factory settings
Menu 6.1: HRG system	
1. $U_{sys\ (L-L)}$	400 V
2. CD-NGRM	CD1000
3. Frequency	50 Hz
4. $I_{NGR\ nom}$	5 A
5. $R_{NGR\ nom}$	470 Ω
Menu 6.2: CT	
1. CT primary	600
2. CT secondary	1
3. CT connection	50 mA
Menu 6.3: NGR	
1. Method	auto
2. PT primary	1
3. PT secondary	1
Menu 6.4: Response values	
1. $U_{NGR\ trip}$	60 %
2. $I_{NGR\ trip}$	60 %
3. > R_{NGR}	150 %
4. < R_{NGR}	50 %
5. $t_{NGR\ trip}$	0 s
6. Ground-fault trip	yes
7. $t_{GF\ trip}$	5 s
8. Alarm stored	on
9. $t_{restart}$	5 s

Menu	Factory settings
10. Restart count	2
11. Trip signal	RMS
12. Upper limit harmonic	32
13. Lower limit harmonic	0
Menu 6.5: System settings	
1. Ground-fault relay	Mode: fail-safe Rel. test: on
2. NGR relay	Mode: fail-safe Rel. test: on
3. Trip relay	Mode: fail-safe Rel. test: on
4. Analogue	Mode: 4-20 mA Function: R NGR
5. Dig. in/out	System OUT: fail-safe Pulser OUT: non-fail-safe Pulser IN: active high RESET IN: active high TEST IN: active high
6. Buzzer	Buzzer alarm: off Buzzer test: on

12. Error codes

Error code/ Service code	Description/Cause	Action
6.10	Error during field calibration	Restart field calibration. If the error persists, contact Bender service.
6.11	Field calibration could not be started	The installation must operate error-free before starting a field calibration. Restart field calibration. If the error persists, contact Bender service.
7.61…7.63	Connection between measuring equipment and display unit interrupted or disturbed.	Check connection between measuring equipment and display unit. Restart device.
8.03 and 8.12	Error in the measuring signal generation	Restart device. If the error persists, contact Bender service.
8.43	Error in the internal power supply unit (*positive supply voltage*)	Restart device. If the error persists, contact Bender service.
8.44	Error in the internal power supply unit (*negative supply voltage*)	Restart device. If the error persists, contact Bender service.
8.46	Error in the internal power supply unit (*supply voltage*)	Restart device. If the error persists, contact Bender service.
8.48	Error in the internal power supply unit (*reference voltage*)	Restart device. If the error persists, contact Bender service.
All other error codes		Contact Bender service.

13. Technical data

13.1 Tabular data

Insulation coordination according to IEC 60664-1/IEC 60664-3/DIN EN 50178

Definitions

Supply circuit (IC1) ..... (A1, A2)
Measuring circuit/Control circuit (IC2) ..... (RS, E, CT), (X1, ETH)
Output circuit 1 (IC3) ..... (11, 12, 14)
Output circuit 2 (IC4) ..... (21, 22, 24)
Output circuit 3 (IC5) ..... (31, 32, 34)
Rated voltage ..... 250 V
Overvoltage category III

Rated impulse voltage

IC1/(IC2. . .5) ..... 4 kV
IC2/(IC3. . .5 ..... 4 kV
IC3/(IC4. . .5) ..... 4 kV
IC4/(IC5) ..... 4 kV

Rated insulation voltage

IC1/(IC2. . .5) ..... 250 V
IC2/(IC3. . .5) ..... 250 V
IC3/(IC4. . .5) ..... 250 V
IC4/(IC5) ..... 250 V
Pollution degree exterior 3

Safe isolation (reinforced insulation) between

IC1/(IC2. . .5) ..... overvoltage category III, 300 V
IC2/(IC3. . .5) ..... overvoltage category III, 300 V
IC3/(IC4. . .5) ..... overvoltage category III, 300 V
IC4/(IC5) ..... overvoltage category III, 300 V

Voltage tests (routine test) acc. to IEC 61010-1

IC1/(IC2. . .5) ..... AC 2.2 kV
IC2/(IC3. . .5) ..... AC 2.2 kV
IC3/(IC4. . .5) ..... AC 2.2 kV
IC4/(IC5) ..... AC 2.2 kV

Supply voltage

Nominal supply voltage U_S ..... AC/DC, 48 . . . 240 V
for UL applications ..... AC/DC, 48 . . . 240 V
for AS/NZS 2081 applications ..... AC/DC, 48 . . . 230 V
Tolerance U_S ..... ±15 %
Tolerance U_S (for UL applications) ..... −50 . . . +15 %
Tolerance U_S (for AS/NZS 2081 applications) ..... −25 . . . +20 %
Frequency range U_S ..... DC, 40 . . . 70 Hz
Power consumption (max.) ..... ≤ 7 W / 16 VA

Monitoring R_{NGR}

Measuring input R_S ..... < 33 V RMS
Measuring range NGR (with R_S = 20 kΩ) active ..... 0 . . . 10 kΩ
Measurement uncertainty for T = 0 . . . +40 °C ..... ±20 Ω
Measurement uncertainty for T = −40 . . . +70 °C ..... ±40 Ω
Measuring range NGR (with R_S = 100 kΩ) active ..... 0 . . . 10 kΩ
Measurement uncertainty for T = 0 . . . +40 °C ..... ±30 Ω
Measurement uncertainty for T = −40 . . . +70 °C ..... ±80 Ω
Setting range $R_{NGR\ nom}$ ..... 15 Ω . . . 5 kΩ
Response value $R_{NGR\ nom}$ ..... 10 . . . 90 % $R_{NGR\ nom}$
..... 110 . . . 200 % $R_{NGR\ nom}$
Response delay NGR relay ..... 7 s (±2.5 s)
Response delay Trip relay ..... 0 . . . 60 s

Monitoring I_{NGR}

Measuring circuit 5 A
Nominal measuring current I_n ..... DC / 50/60 Hz / 50 . . . 3200 Hz 5 A
Maximum continuous current ..... 2 x I_n
Overload capacity ..... 10 x I_n for 0.03 s
Measurement accuracy ..... ±2 % of I_n
Load ..... 10 mΩ
Measuring circuit 50 mA
Nominal measuring current I_n ..... DC /50/60 Hz / 50 . . . 3200 Hz 50 mA
Maximum continuous current ..... 2 x I_n
Overload capacity ..... 10 x I_n for 2 s
Measurement accuracy ..... ±2 % of I_n
Load ..... 68 Ω

Measuring circuits 5 A and 50 mA
- Response value I_{NGR} ... 10 . . . 90 % $I_{NGR\ nom}$
- Response delay Ground-fault relay ... ≤ 40 ms (±10 ms)
- Response delay Trip relay (configurable) ... 100 ms . . . 24 h, ∞

Tolerance t_{trip} when set to
- RMS ... −20 . . . 0 ms
- Fundamental ... 0 . . . +150 ms (filter time)
- Harmonics ... 0 . . . +150 ms (filter time)

Measuring current transformer ratio primary ... 1 . . . 10,000
Measuring current transformer ratio secondary ... 1 . . . 10,000
Measuring range ... 2 x I_{NGR} nom

Coupling

R_S for U_{sys} ≤ 4.3 kV ... CD1000, CD1000-2, CD5000 (20 kΩ)
R_S for U_{sys} > 4.3 kV ... CD14400, CD25000 (100 kΩ)

Monitoring U_{NGR}

U_{NGR} with R_S = 20 kΩ ... DC / 50/60 Hz / 50 . . . 3200 Hz; (400/√3) . . . ≤ (4300/√3) V
U_{NGR} with R_S = 100 kΩ ... DC / 50/60 Hz / 50 . . . 3200 Hz; > (4.3 /√3) . . . (25/√3) kV
Measuring range ... 1.2 x U_{NGR} nom
Overload capacity ... 2 x U_{NGR} for 10 s
Measurement accuracy ... 2 % of $U_{NGR\ nom}$ with $U_{NGR\ nom}$ = ($U_{sys\ (L-L)}$/√3)
Voltage response value ... 0 . . . 90 % U_{NGR} nom
Response delay Ground-fault relay ... ≤ 40 ms (±10 ms)
Response delay Trip relay (configurable) ... 100 ms . . . 24 h, ∞

Tolerance t_{trip} when set to
- RMS ... −20 . . . 0 ms
- Fundamental ... 0 . . . +150 ms (filter time)
- Harmonics ... 0 . . . +150 ms (filter time)

PT ratio primary ... 1 . . . 10,000
PT ratio secondary ... 1 . . . 10,000

DC immunity in case of active R_{NGR} measurement
- with R_S = 20 kΩ ... DC ±12 V
- with R_S = 100 kΩ ... DC ±60 V

Digital inputs

Galvanic separation ... no
Length connecting cables ... max. 10 m
U_{in} ... DC 0 V, 24 V
Overload capacity ... −5 . . . 32 V

Digital outputs

Galvanic separation ..... no
Length connecting cables ..... max. 10 m
Currents (sink) for each output ..... max. 300 mA
Voltage ..... 24 V
Overload capacity ..... –5 . . . 32 V

Analog output (M+)

Operating mode ..... Linear
Functions ..... I_{NGR}, R_{NGR}
Current ..... 0 . . . 20 mA (≤ 600 Ω), 4 . . . 20 mA (≤ 600 Ω), 0 . . . 400 µA (≤ 4 kΩ)
Voltage ..... 0 . . . 10 V (≥1 kΩ), 2 . . . 10 V (≥ 1 kΩ)
Tolerance related to the current/voltage end value ..... ± 20 %

Ground-fault, NGR, Trip relay outputs

Switching elements ..... changeover contacts (Form C)
Operating mode ..... configurable fail-safe/non-fail-safe
Electrical endurance, number of cycles 10,000
Switching capacity ..... 2000 VA / 150 W
Contact data acc. to IEC 60947-5-1
- Rated operational voltage AC ..... 250 V/250 V
- Utilisation category AC-13/AC-14
- Rated operational current AC ..... 5 A/3 A
- Rated operational current AC (for UL applications) ..... 3 A/3 A
- Rated operational voltage DC ..... 220/110/24 V
- Utilisation category DC12
- Rated operational current DC ..... 0.1/0.2/1 A
- Minimum current ..... 1 mA at AC/DC > 10 V

Environment/EMC

EMC immunity (IEC 61000-6-2 / IEC 60255-26 Ed. 3.0) ..... DIN EN 61000-6-2
EMC emission (IEC 61000-6-4 / IEC 60255-26 Ed. 3.0) ..... DIN EN 61000-6-4
Operating temperature ..... –40 . . . +60 °C
..... –40 . . . +60 °C (for UL applications)
Humidity ..... ≤ 98 %
Classification of climatic conditions acc. to IEC 60721
- Stationary use (IEC 60721-3-3) ..... 3K5 (except condensation and formation of ice)
- Transport (IEC 60721-3-2) ..... 2K11 (–40 . . . +85 °C) (except condensation and formation of ice)
- Long-term storage (IEC 60721-3-1) ..... 1K22 (–40 . . . +70 °C) (except condensation and formation of ice)

Classification of mechanical conditions acc. to IEC 60721 / IEC 60255-21 / DIN EN 60068-2-6

- Stationary use 3M7
- Transport 2M4
- Long-term storage 1M12

Connection

Screw-type terminals

- Tightening torque ..... 0.5 . . . 0.6 Nm (5 . . . 7 lb-in)
- Stripping length ..... 7 mm
- Recommended connecting cables ..... see overview page 22
- rigid/flexible ..... 0.2 . . . 2.5 mm^2 (AWG 24 . . . 13)
- flexible with ferrule with/without plastic sleeve ..... 0.25 . . . 2.5 mm^2 (AWG 24 . . . 13)
- Multiple conductor rigid ..... 0.2 . . . 1 mm^2 (AWG 24 . . . 18)
- Multiple conductor flexible ..... 0.2 . . . 1.5 mm^2 (AWG 24 . . . 16)
- Multiple conductor, flexible with ferrule without plastic sleeve ..... 0.25 . . . 1 mm^2 (AWG 24 . . . 18)
- Multiple conductor, flexible with TWIN ferrule with plastic sleeve ..... 0.5 . . . 1.5 mm^2 (AWG 21 . . . 16)

Push-wire terminal X1

- Stripping length ..... 10 mm
- rigid/flexible ..... 0.2 . . . 1.5 mm^2 (AWG 24 . . . 16)
- flexible with ferrule without plastic sleeve ..... 0.25 . . . 1.5 mm^2 (AWG 24 . . . 16)
- flexible with ferrule with plastic sleeve ..... 0.25 . . . 0.75 mm^2 (AWG 24 . . . 18)

Other

- Operating mode ..... continuous operation
- Mounting ..... display-oriented
- Altitude ..... max. 2000 m AMSL
- Degree of protection, internal components (DIN EN 60529) IP30
- Flammability class ..... UL 94V-0
- Protective coating measurement equipment ..... SL1307, UL file E80315
- Weight ..... < 500 g

Standards, approvals, certifications

The specified standards take into account the edition valid until 07.2019 unless otherwise indicated.

UL File Number: E173157

13.2 Ordering details

13.2.1 NGR monitor

Type	Supply voltage/Frequency range U_S	Art. No.
NGRM500	AC 48…240 V, 40…70 Hz / DC 48…240 V	B94013500

13.2.2 Accessories

CD-series coupling device

Voltage U_{sys}	Type	Art. No.
400…690 V	CD1000	B98039010
400…1000 V	CD1000-2	B98039053
1000…4200 V	CD5000	B98039011
4300…14550 V	CD14400	B98039054
14551…25000 V	CD25000	B98039055

Measuring current transformer W…

Frequency/Ground Fault current	Type	Art. No.
AC up to 10 A	W20	B98080003
AC up to 25 A	W35	B98080010
	W60	B98080018
	W0-S20	B911787
	W1-S35	B911731
	W2-S70	B911732
AC/DC up to 10 A	W35AB	B98080016
	W60AB	B98080026
	W120AB	B98080041
	CTUB103-CTBC35	B78120030
AC/DC up to 25 A	CTUB103-CTBC60	B78120031
	CTUB103-CTBC120	B78120032

Voltage supply for
AC/DC measuring current transformers W…

Type	Supply voltage	Terminal	Art. No.
AN420	AC 100…250 V, 50/60 Hz DC 100…250 V	Push-wire terminal	B74053100
		Screw-type terminal	B94053100

Measuring current transformers CTUB103…

max. connected measuring current transformers	Type	Art. No.
2	STEP-PS/1 AC/24 DC/0.5	B94053110
7	STEP-PS/1 AC/24 DC/1.75	B94053111
17	STEP-PS/1 AC/24 DC/4.2	B94053112

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