

# NGRM700

Neutral Grounding Resistor Monitor





LINETRAXX® NGRM700

### 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  $U_{NGR}$
- Phase-to-ground fault indication (optional; up to 690 V direct coupling, otherwise via potential transformers)
- 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
- Relay for detection of ground faults and resistor faults
- Relay for shutdown of the installation after a configurable time
- Can be combined with RCMS... for automatic shutdown of feeders
- Graphical user interface
- Wide supply voltage range (24 to 240 Vac/Vdc)
- Range of use up to 5000 m AMSL
- Fault/History memory
- Analogue output of measured values (0...10 V, 4...20 mA, etc., selectable parameters)
- Detachable HMI for door mounting
- Password protection
- Tripping on RMS, fundamental component signal or harmonics
- Detection of AC and DC ground faults

### Product description

The NGRM700 is only intended for use in high-resistance grounded systems. In these systems, the NGRM700 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 NGR,
- line-to-line and line-to-earth voltages.

**i** *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 lead to a failure of the power supply in these systems. A ground fault must be detected and eliminated as quickly as possible, since the occurrence of another ground fault in a second phase would lead to a tripping of the overcurrent protective device.*

In order to meet the requirements of applicable standards, the equipment must be adjusted to local equipment and operating conditions by means of customised parameter settings. Please heed the limits of the range of application indicated in the technical data.

Any other use than that described in this manual is regarded as improper. Intended use includes following all the instructions in the operating manual.

### Function

The NGRM700 monitors NGR resistance  $R_{NGR}$ , neutral voltage  $U_{NGR}$  and current  $I_{NGR}$ . NGR resistance is monitored 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** Only for energised installations: 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  $R_{NGR}$ .

In the case of the "auto" method, monitoring switches automatically between "active" and "passive" when the measured value 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" method is selected, no switching of the monitoring takes place. No monitoring of the NGR occurs while the installation is de-energised.

The NGR relay 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 when  $I_{NGR}$  or  $U_{NGR}$  exceeds the selectable thresholds. After the adjustable delay time has elapsed, the installation can be shut down by means of the trip relay.

A connection to installations ranging from 400 V...25 kV is possible via the appropriate CD-series coupling device.

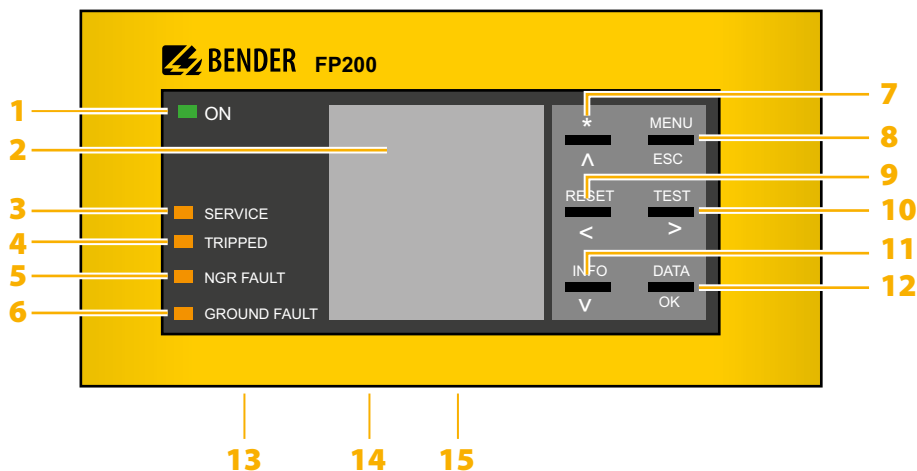
The  $I_{NGR}$  is measured via (universal) measuring current transformers for 5 A or 50 mA secondary. With the conversion ratio of the used measuring current transformer the current measurement is internally set in such a way that it adjusts best to  $I_{NGR}$ .

The phase-voltage monitoring function can be used to indicate which phase has the ground fault. Direct coupling is possible up to a system voltage of 690 V. For higher voltages use potential transformers (PT). The conversion ratio is adjustable.

### Certifications



User interface FP200-NGRM



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, 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.
- 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, installation has not been shut down yet.

Device buttons

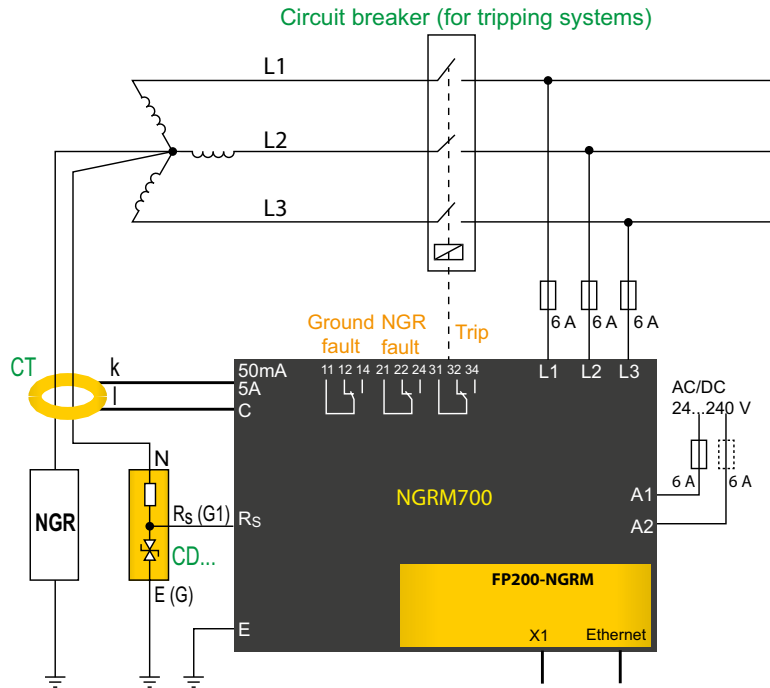
- 7 -  $\wedge$       Navigates up in a list or increases a value.
- 8 - MENU      Opens the device menu.
- ESC      Cancels the current process or navigates one step back in the device menu.
- 9 - RESET      Resets alarms.
- $<$       Navigates backwards (e.g. to the previous setting step) or selects parameter.
- 10 - TEST      Starts the device self test.
- $>$       Navigates forwards (e.g. to the next setting step) or selects parameter.
- 11 - INFO      Shows information.
- $\vee$       Navigates down in a list or reduces a value.
- 12 - DATA      Indicates data and values.
- OK      Confirms an action or a selection.
- 13 - X1      Interface X1
- 14 - ETH      Ethernet interface
- 15 - R on/off      Terminating resistor for A/B (Modbus RTU)
- Buzzer      Active in case of alarm and/or test

Rear side

- REMOTE      RJ45 port for connection of FP200-NGRM to enclosure
- X3      Without function

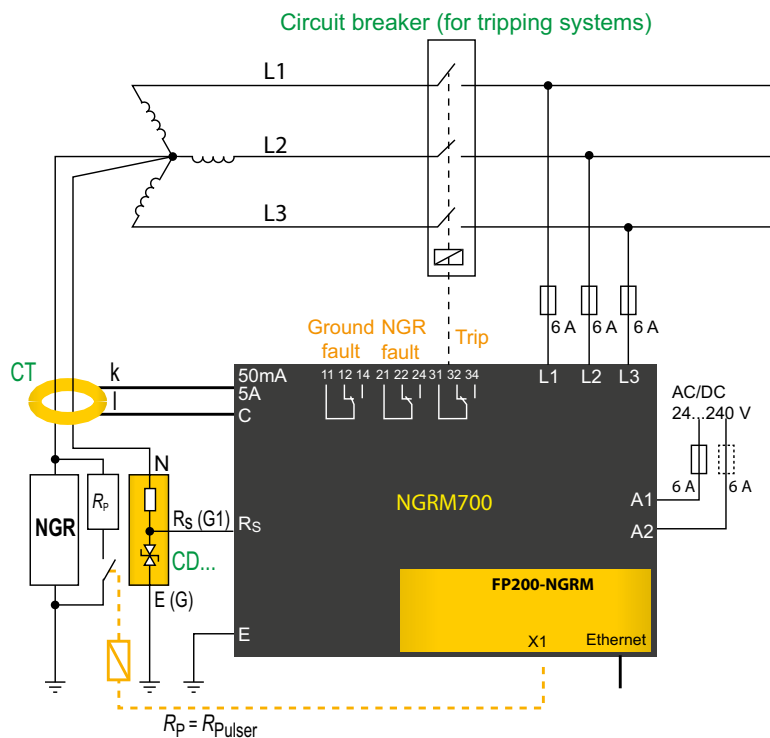
**Connection star connection:  $U_{sys} \leq 690\text{ V}$**

For these voltages, the phase monitor of the NGRM700 can be connected directly to the conductors to be monitored.



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

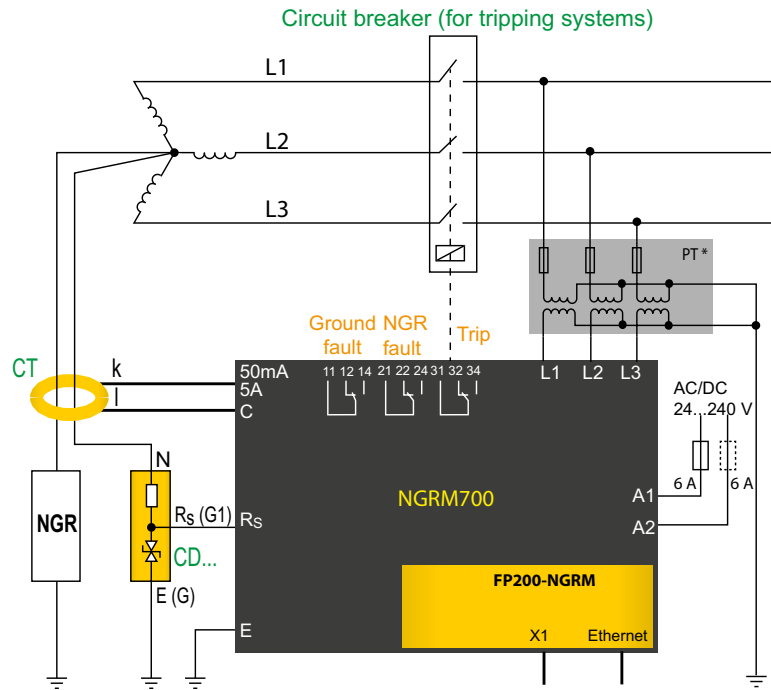
**Connection Star connection:  $U_{sys} \leq 690\text{ V}$  with pulser**



**i** 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 the digital output at X1 of the FP200-NGRM.

**Connection star connection:  $U_{sys} > 690\text{ V}$**

For these voltages, the phase monitor of the NGRM700 can only be connected to the conductors to be monitored via potential transformers (PT).



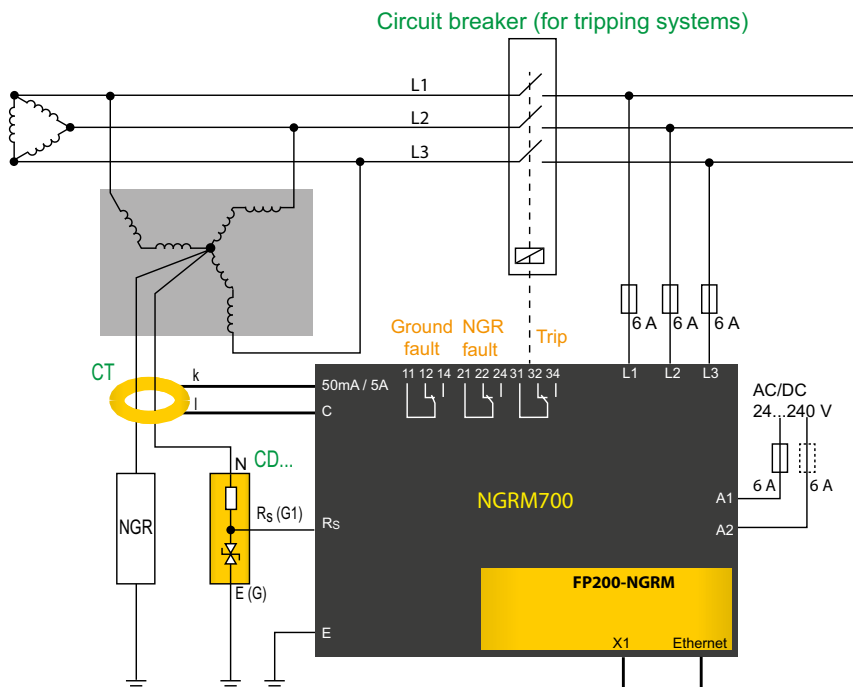
Note:

\* PT ratio "primary: secondary" can be adjusted in the NGRM700.

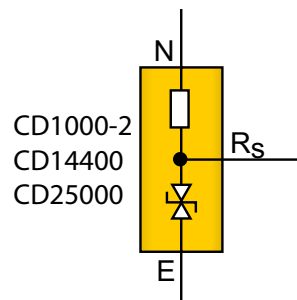
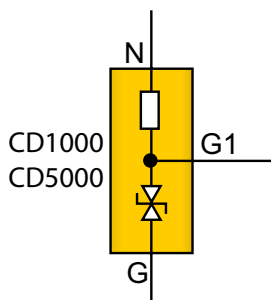
**i** The "N" connection of the CD-series coupling device should be as close to the transformer star point as possible

**Connection artificial neutral (delta connection): zigzag transformer**

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



**Connectors CD...**



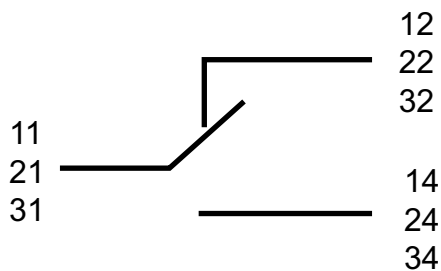
- N** Connection to star point
- G1, RS** Connection to  $R_s$  of the NGRM700
- G, E** Connection to E of the NGRM700 and to the protective earth conductor of the installation (PE)

**Measuring current transformer connection**

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:

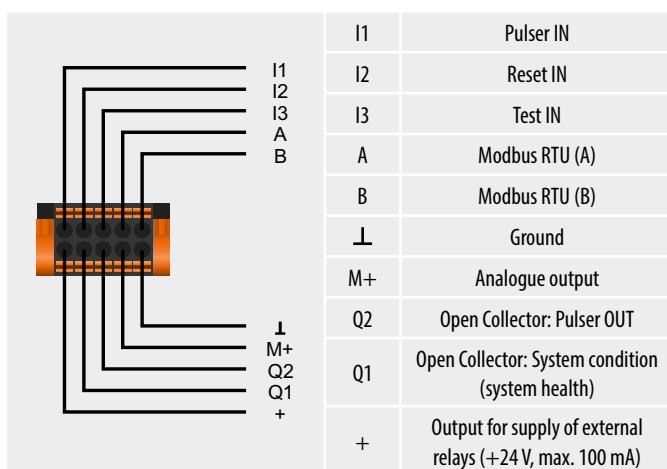
System type	AC + DC	AC	AC
$I$	1...10 A	5...25 A	5...25 A
$f$	0...3800 Hz	42...3800 Hz	50/60 Hz
Conversion ratio	600:1	600:1	60:5
Length connecting cables	max. 10 m	max. 40 m	max. 25 m (4 mm <sup>2</sup> ) max. 40 m (6 mm <sup>2</sup> )
$I_{\Delta n}$			
Type	W35...120AB  AN420	W20...120 W1-S35...W5-S210 	CTB31...41 
CT: k	NGRM700: 50 mA	NGRM700: 50 mA	NGRM700: 5 A
CT: I	NGRM700: C	NGRM700: C	NGRM700: C

**Connection of relays (earth-fault, NGR and trip relay)**



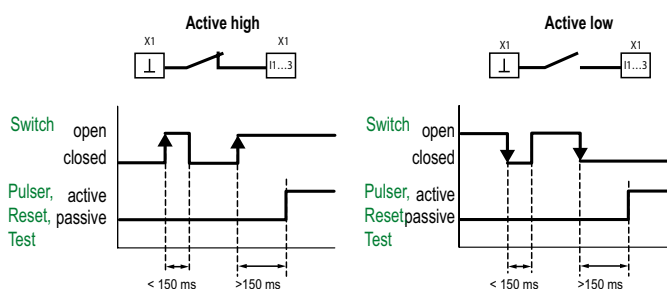
**Connection to the X1 interface**

**Pin assignment X1 interface**



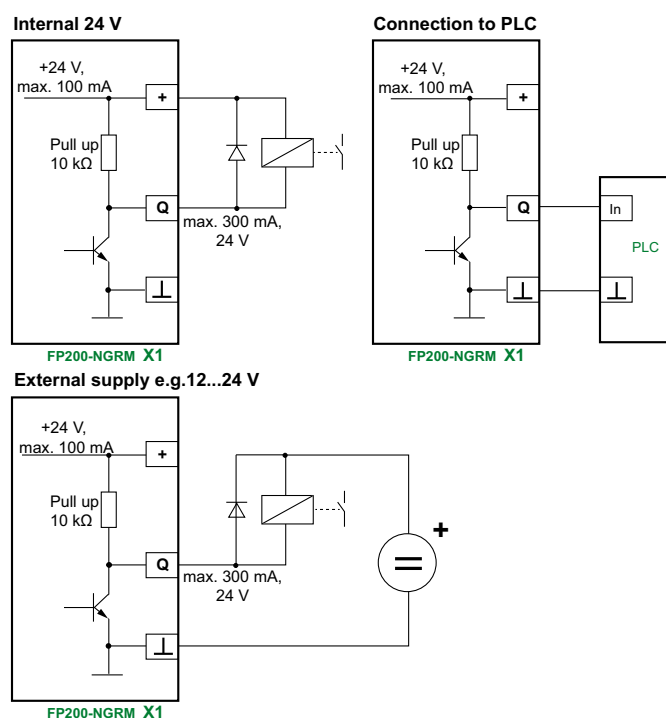
**X1: Input I1...3**

The input is only detected as "activated" after the contact 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

**X1: Output Q1...2**



Connection to Q1, Q2: external relay or PLC.

**i** **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.

**X1: Analogue output**

Analogue output	Mode	Permissible load
<b>Current output</b> 	0...20 mA	≤ 600 Ω
	4...20 mA	≤ 600 Ω
	0...400 μA	≤ 4 kΩ
<b>Voltage output</b> 	0...10V	≥ 1 kΩ
	2...10V	≥ 1 kΩ

## Technical Data

### Insulation coordination according to IEC 60664-1/IEC 60664-3/DIN EN 50187

Definitions	
Measuring circuit 1 (IC1)	(L1, L2, L3)
Supply circuit (IC2)	(A1, A2)
Measuring circuit/Control circuit (IC3)	(RS, E, CT), (X1, Ethernet)
Output circuit 1 (IC4)	(11, 12, 14)
Output circuit 2 (IC5)	(21, 22, 24)
Output circuit 3 (IC6)	(31, 32, 34)
Rated voltage	690 V
Overvoltage category	III
Rated impulse voltage	
IC1/(IC2...6)	8 kV
IC2/(IC3...6)	4 kV
IC3/(IC4...6)	4 kV
IC4/(IC5...6)	4 kV
IC5/(IC6)	4 kV
Rated insulation voltage	
IC1/(IC2...6)	800 V
IC2/(IC3...6)	250 V
IC3/(IC4...6)	250 V
IC4/(IC5...6)	250 V
IC5/(IC6)	250 V
Pollution degree exterior	3
Safe isolation (reinforced insulation) between	
IC1/(IC2...6)	overvoltage category III, 800 V
IC2/(IC3...6)	overvoltage category III, 300 V
IC3/(IC4...6)	overvoltage category III, 300 V
IC4/(IC5...6)	overvoltage category III, 300 V
IC5/(IC6)	overvoltage category III, 300 V
Voltage tests (routine test) acc. to IEC 61010-1	
IC2/(IC3...6)	AC 2.2 kV
IC3/(IC4...6)	AC 2.2 kV
IC4/(IC5...6)	AC 2.2 kV
IC5/(IC6)	AC 2.2 kV

### Supply voltage

Nominal supply voltage $U_s$	
$\leq 2000$ m	AC/DC, 24...240 V
$\leq 2000$ m (for UL applications)	AC/DC, 48...240 V
$\leq 2000$ m (for AS/NZS 2081)	AC/DC, 48...230 V
$> 2000... \leq 5000$ m	AC/DC, 24...120 V
$> 2000... \leq 5000$ m (for UL applications, AS/NZS 2081)	AC/DC, 48...120 V
Tolerance $U_s$	$\pm 15\%$
Tolerance $U_s$ (for UL applications)	$-50...+15\%$
Tolerance $U_s$ (for AS/NZS 2081)	$-25...+20\%$
Frequency range –	DC, 40...70 Hz
Power consumption (typ. 50/60 Hz)	$\leq 6.5$ W/13 VA

### Phase monitoring

Nominal measuring voltage $U_n$	3 AC 100...690 V, CAT III
Measuring range	$1.2 \times U_n$
Measurement accuracy	$\pm 1\%$ of $U_n$
Power consumption per phase	$\leq 0.5$ W
Overload capacity	$2 \times U_n$ continuous
Input resistance	1,76 M $\Omega$
PT ratio primary	1...10,000
PT ratio secondary	1...10,000
Measuring range with PT	100 V...25 kV

### Monitoring $R_{NGR}$

Measuring input $R_S$	$< 33$ V RMS
Measuring range NGR (with $R_S = 20$ k $\Omega$ ) active	0...10 k $\Omega$
Measurement uncertainty for $T = 0...+40$ °C	$\pm 20$ $\Omega$
Measurement uncertainty for $T = -40...+70$ °C	$\pm 40$ $\Omega$
Measuring range NGR (with $R_S = 100$ k $\Omega$ ) active	0...10 k $\Omega$
Measurement uncertainty for $T = 0...+40$ °C	$\pm 30$ $\Omega$
Measurement uncertainty for $T = -40...+70$ °C	$\pm 80$ $\Omega$
Setting range $R_{NGR nom}$	15 $\Omega$ ...5 k $\Omega$
Response value $R_{NGR nom}$	10...90 % $R_{NGR nom}$
	110...200 % $R_{NGR nom}$
Response delay NGR relay	7 s ( $\pm 2.5$ 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	$2 \times I_n$
Overload capacity	$10 \times I_n$ for 2 s
Measurement accuracy	$\pm 2\%$ of $I_n$
Load	10 m $\Omega$
Measuring circuit 50 mA	
Nominal measuring current $I_n$	DC/50/60 Hz/50...3200 Hz 50 mA
Maximum continuous current	$2 \times I_n$
Overload capacity	$10 \times I_n$ for 2 s
Measurement accuracy	$\pm 2\%$ of $I_n$
Load	68 $\Omega$
Measuring circuits 5 A and 50 mA	
Response value $I_{NGR}$	10...90 % $I_{NGR nom}$
Response delay ground-fault relay	$\leq 40$ ms ( $\pm 10$ ms)
Response delay trip relay (configurable)	100 ms...24 h, $\infty$
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	$2 \times I_{NGR nom}$

### Coupling

$R_S$ for $U_{sys} \leq 4.3$ kV	CD1000, CD1000-2, CD5000 (20 k $\Omega$ )
$R_S$ for $U_{sys} > 4.3$ kV	CD14400, CD25000 (100 k $\Omega$ )

### Monitoring $U_{NGR}$

$U_{NGR}$ with $R_S = 20$ k $\Omega$	DC/50/60 Hz/50...3200 Hz; $(400/\sqrt{3}) \dots \leq (4300/\sqrt{3})$ V
$U_{NGR}$ with $R_S = 100$ k $\Omega$	DC/50/60 Hz/50...3200 Hz; $> (4.3/\sqrt{3}) \dots (25/\sqrt{3})$ kV
Measuring range	$1.2 \times U_{NGR nom}$
Overload capacity	$2 \times U_{NGR}$ for 10 s
Measurement accuracy	2 % of $U_{NGR nom}$ with $U_{NGR nom} = (U_{sys(L-L)}/\sqrt{3})$
Voltage response value	0...100 % $U_{NGR nom}$
Response delay ground-fault relay	$\leq 40$ ms ( $\pm 10$ ms)
Response delay trip relay (configurable)	100 ms...24 h, $\infty$
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 $R_S = 20$ k $\Omega$	DC $\pm 12$ V
with $R_S = 100$ k $\Omega$	DC $\pm 60$ 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

**Analogue output (M+)**

Operating mode	Linear
Functions	$I_{NGR}$ , $R_{NGR}$
Current	0...20 mA ( $\leq 600 \Omega$ ), 4...20 mA ( $\leq 600 \Omega$ ), 0...400 $\mu$ A ( $\leq 4 \text{ k}\Omega$ )
Voltage	0...10 V ( $\geq 1 \text{ k}\Omega$ ), 2...10 V ( $\geq 1 \text{ k}\Omega$ )
Tolerance related to the current/voltage end value	$\pm 20 \%$

**Ground-fault, NGR, trip relay**

Switching elements	changeover contacts
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 6100-6-2/IEC 60255-26 Ed. 3.0)	DIN EN 61000-6-2
EMC emission (IEC 6100-6-2/IEC 60255-26 Ed. 3.0)	DIN EN 61000-6-4
Operating temperature	-40...+70 °C
	-40...+60 °C (for UL applications)
Humidity	$\leq 98 \%$

**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)	2K3 (-40...+85 °C) (except condensation and formation of ice)
Long-term storage (IEC 60721-3-1)	1K4 (-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	2M2
Long-term storage	1M3

**Connection**
**Screw-type terminals**

Tightening torque	0.5...0.6 Nm (5...7 lb-in)
Conductor sizes	AWG 24-12
Stripping length	7 mm
rigid/flexible	0.2...2.5 mm <sup>2</sup>
flexible with ferrule with/without plastic sleeve	0.25...2.5 mm <sup>2</sup>
Multiple conductor, rigid	0.2...1 mm <sup>2</sup>
Multiple conductor flexible	0.2...1.5 mm <sup>2</sup>
Multiple conductor flexible with ferrule without plastic sleeve	0.25...1 mm <sup>2</sup>
Multiple conductor, flexible with TWIN ferrule with plastic sleeve	0.5...1.5 mm <sup>2</sup>

**Push-wire terminals X1**

Conductor sizes	AWG 24-16
Stripping length	10 mm
rigid/flexible	0.2...1.5 mm <sup>2</sup>
flexible with ferrule without plastic sleeve	0.25...1.5 mm <sup>2</sup>
flexible with ferrule with plastic sleeve	0.25...0.75 mm <sup>2</sup>

**Other**

Operating mode	continuous operation
Mounting	display-oriented
Altitude	5000 m AMSL
Degree of protection, internal components (DIN EN 60529)	IP30
Flammability class	UL 94V-0
Protective coating measurement equipment	SL1307, UL file E80315
Documentation number	D00292
Weight	1050 g

### Ordering information

Supply voltage $U_s$ / Frequency range Hz		Type	Art. No.
AC	DC		
24...240 V, 40...70 Hz	24...240 V	NGRM700	B94013700

### Accessories

Description	Art. No.
Accessory for FP200-NGRM: Transparent front cover 144x72 (for IP65) <sup>1)</sup>	B98060005

<sup>1)</sup> When using the "transparent front cover 144x72 (IP 65)" the cutout in the switchboard cabinet must be extended in height from 66 mm to 68 mm (+0.7/-0 mm).

The degree of protection IP65 applies only to the user interface FP200-NGRM when using the front cover. The degree of protection for the complete device is still IP30.

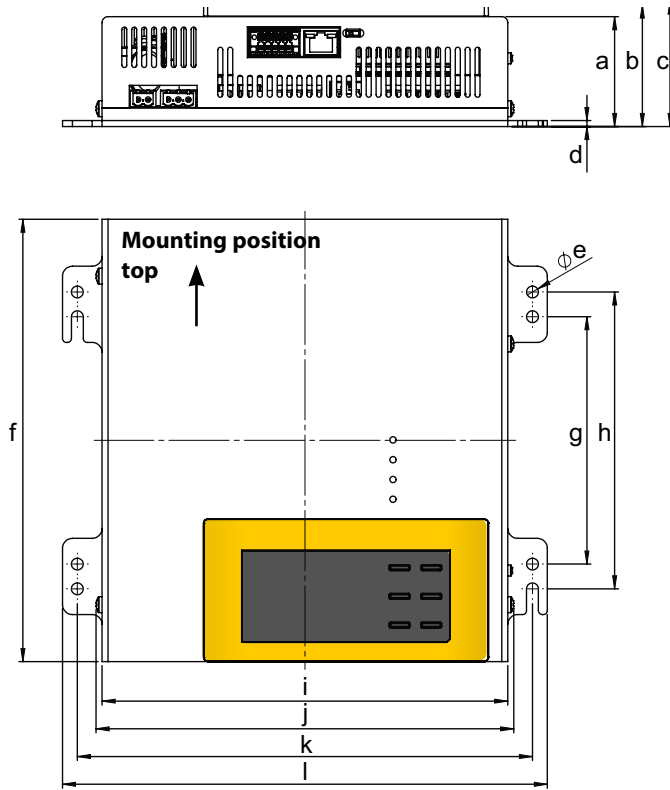
### Suitable system components

Description	Voltage $U_{sys}$	Type	Art. No.
CD-series coupling device	400...690 V	CD1000	B98039010
	400...1000 V	CD1000-2	B98039053
	1000...4200 V	CD5000	B98039011
	4300...14550 V	CD14400	On request
	14551...25000 V	CD25000	On request

Description	Voltage/Current	Type	Art. No.
Measuring current transformer	AC up to 10 A	W20	B98080003
		W35	B98080010
		W60	B98080018
	AC up to 25 A	W0-S20	B911787
		W1-S35	B911731
		W2-S70	B911732
		W35AB	B98080016
	AC/DC up to 10 A	W60AB	B98080026
		W120AB	B98039011

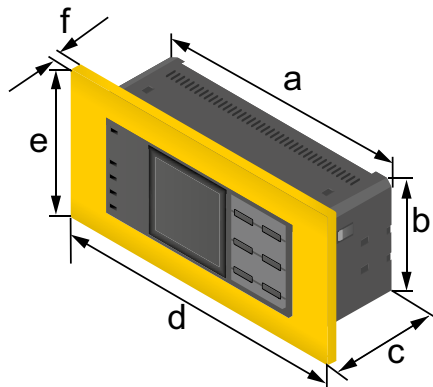
Description	Supply voltage		Type	Art. No.	
	AC	DC		Screw-type terminal	Push-wire terminal
Voltage supply for measuring current transformers	100...250 V, 50/60 Hz	100...250 V	AN420	B94053100	B74053100

**Dimension diagram NGRM700**



	mm	in
a	55.50	2.19
b	61.40	2.42
c	63.35	2.49
d	3	0.12
e	6	0.236
f	223.50	8.80
g	125	4.92
h	150	5.91
i	205	8.07
j	211	8.31
k	230	9.06
l	245	9.65

**Dimension diagram FP200-NGRM**



	mm	in
a	135.5	5.33
b	65.5	2.58
c	35.6	1.40
d	144	5.67
e	72	2.83
f	5.8	0.23



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