BENDER
The Power in Electrical Safety©

NGRM700

Neutral Grounding Resistor Monitor

NGRM700_D00292_05_D_XXEN/04.2021

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.

*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.

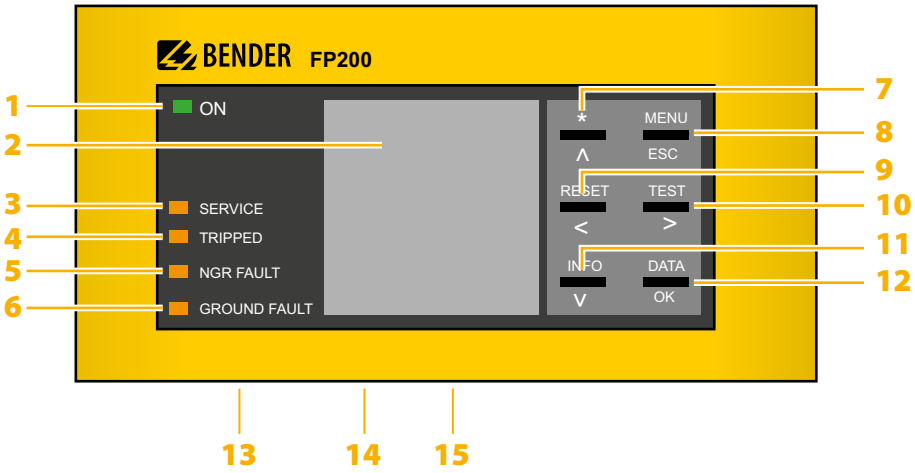
A connection to installations ranging from 400 V…25 kV is possible via the appropriate CD-series coupling device.
The I_{NGR} is measured via (universal) measuring current transformers for 5 A or 50 mA secondary. With the conversion ratio of the used measuring current transformer the current measurement 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

UL File number: E493737, E173157

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 device 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 - **∧** Navigates up in a list or increases a value.

8 - **MENU** Opens the device menu.

ESC Cancels the current process or navigates one step back in the device menu.

9 - **RESET** Resets alarms.

< Navigates backwards (e.g. to the previous setting step) or selects parameter.

10 - **TEST** Starts the device self test.

> Navigates forwards (e.g. to the next setting step) or selects parameter.

11 - **INFO** Shows information.

∨ Navigates down in a list or reduces a value.

12 - **DATA** Indicates data and values.

OK Confirms an action or a selection.

13 - **X1** Interface X1

14 - **ETH** Ethernet interface

15 - **R on/off** Terminating resistor for A/B (Modbus RTU)

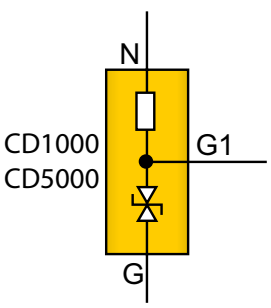
Buzzer Active in case of alarm and/or test

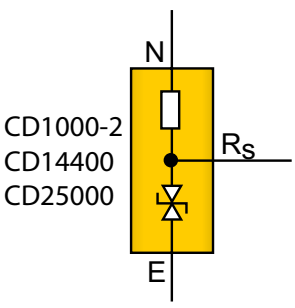
Rear side

REMOTE RJ45 port for connection of FP200-NGRM to enclosure

X3 Without function

Connectors CD...





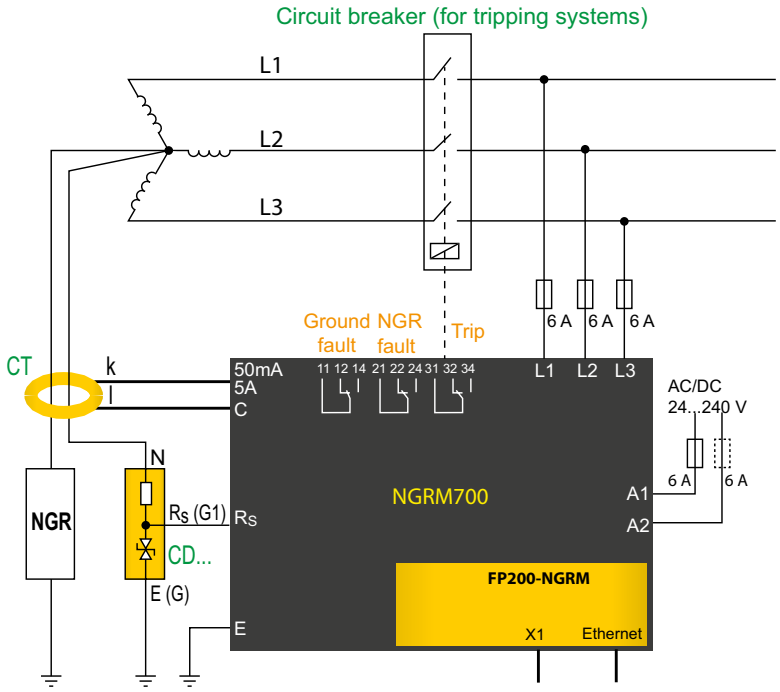
N Connection to star point

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)

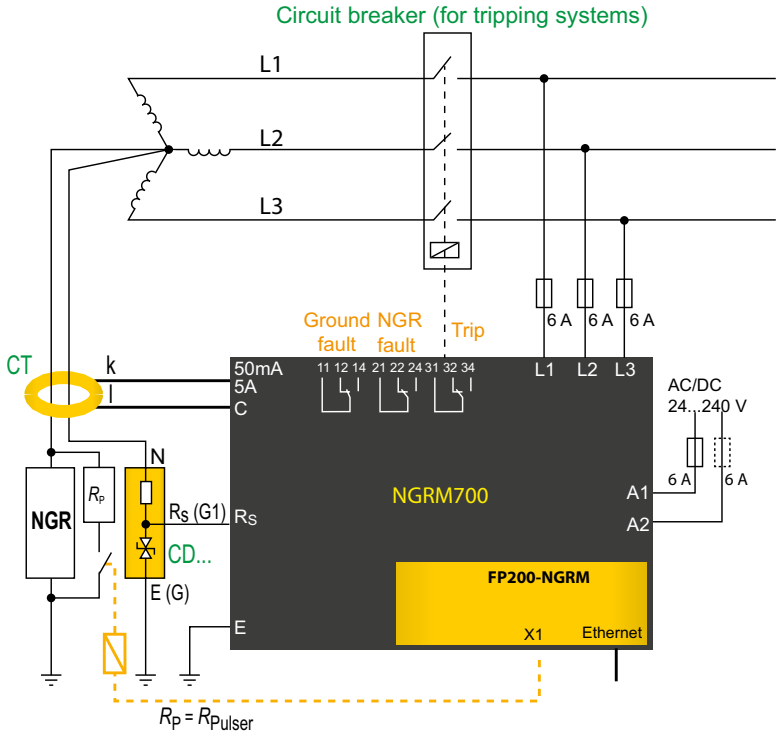
Connection star connection: $U_{sys} \leq 690$ V

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



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

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

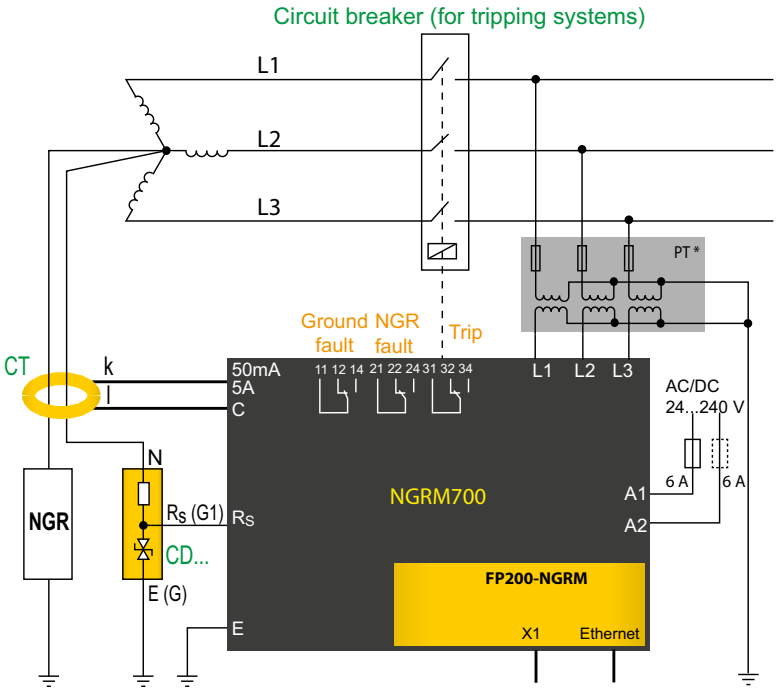


The "N" connection of the CD-series coupling device should be as close to the transformer star point as possible.

An intermediate relay may be required between the power contactor of the pulser and the digital output at X1 of the FP200-NGRM.

Connection star connection: U_{sys} > 690 V

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



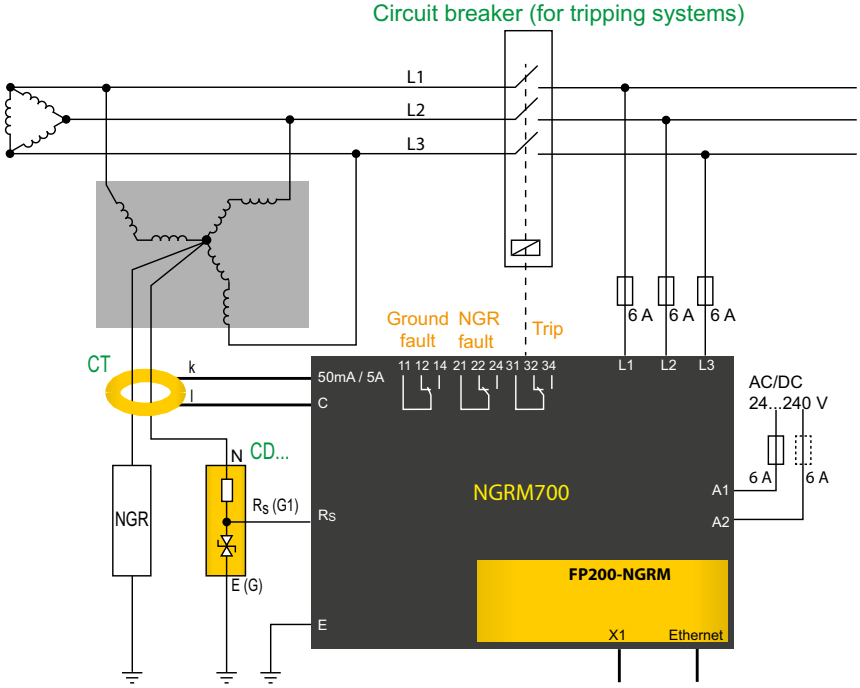
Note:

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

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

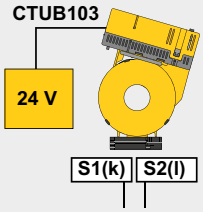
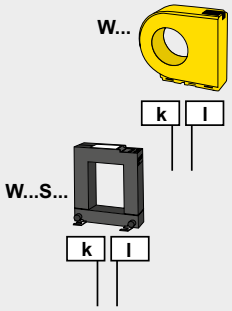
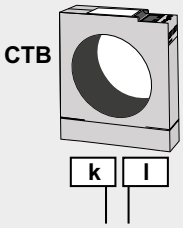
Connection artificial neutral (delta connection): zigzag transformer

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



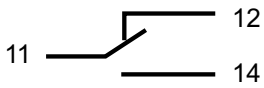
Measuring current transformer connection

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:

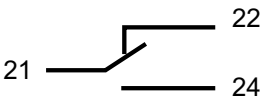
System type	AC + DC	AC	AC
I_{NGR}	1…25 A	5…25 A	5…100 A
f	0…3800 Hz	42…3800 Hz	50/60 Hz
Bender CT Ratio	600:1	600:1	60:5
Connecting cable	max. 30 m	max. 40 m	max. 25 m (4 mm²/AWG 12) max. 40 m (6 mm²/AWG 10)
	provided cable or cable of 0,75…1,5 mm²/AWG18…16		
$I_{\Delta n}$	~ ⎓	~	~
Type	CTUB103 	W20…120 W1-S35…W5-S210 	CTB31…41 
CT: Terminal k	NGRM700: **50 mA**	NGRM700: **50 mA**	NGRM700: **5 A**
CT: Terminal l	NGRM700: **C**	NGRM700: **C**	NGRM700: **C**

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

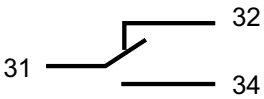
Earth-fault relay



NGR relay

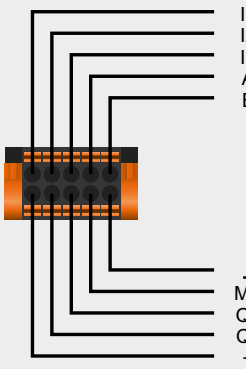


Trip relay



Connection to the X1 interface

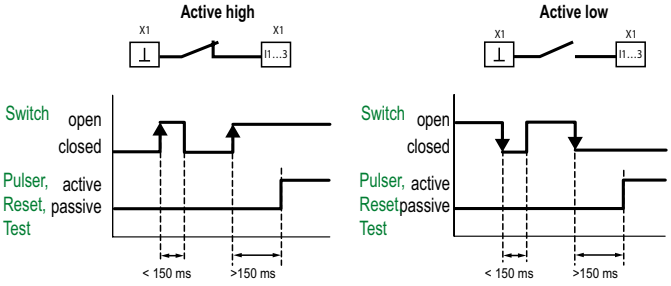
Pin assignment X1 interface



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: Device condition (Device health)
+	Output for supply of external relays (+24 V, max. 100 mA)

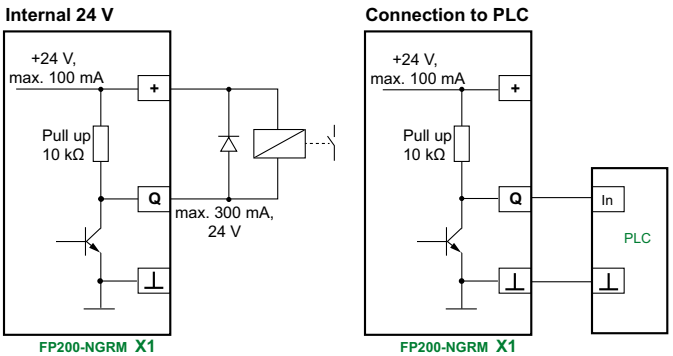
X1: Input I1…3

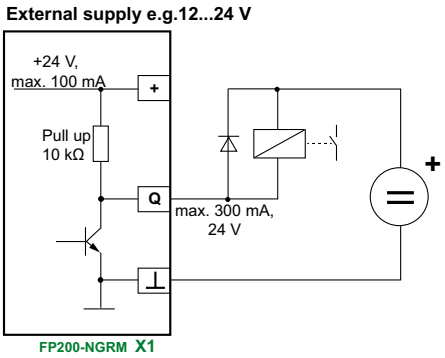
The input is only detected as “activated” after the contact has been activated for at least 150 ms. This way, short interference pulses are ignored.



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

X1: Output Q1…2

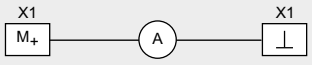
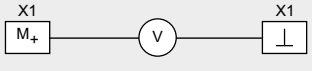




Connection to Q1, Q2: external relay or PLC.

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
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…10 V	≥ 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	
≤ 2000 m	AC/DC, 24…240 V
≤ 2000 m (for UL applications)	AC/DC, 48…240 V
≤ 2000 m (for AS/NZS 2081)	AC/DC, 48…230 V
> 2000…≤ 5000 m	AC/DC, 24…120 V
> 2000…≤ 5000 m (for UL applications, AS/NZS 2081)	AC/DC, 48…120 V
Tolerance U_s	±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)	≤ 6.5 W/13 VA

Phase monitoring

Nominal measuring voltage U_n	3 AC 100…690 V, CAT III
Measuring range	1.2 x U_n
Measurement accuracy	±1 % of U_n
Power consumption per phase	≤ 0.5 W
Overload capacity	2 x U_n continuous
Input resistance	1,76 MΩ
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 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 2 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 $U_{NGR\,nom} = (U_{sys\,(L\text{-}L)}/\sqrt{3})$
Voltage response value	10…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

Analogue 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

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	≤ 98 %

Classification of climatic conditions acc. to IEC 60721

Stationary use (IEC 60721-3-3)	3K23 (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	3M12
Transport	2M4
Long-term storage	1M12

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 mm²
flexible with ferrule with/without plastic sleeve	0.25…2.5 mm²
Multiple conductor, rigid	0.2…1 mm²
Multiple conductor flexible	0.2…1.5 mm²
Multiple conductor flexible with ferrule without plastic sleeve	0.25…1 mm²
Multiple conductor, flexible with TWIN ferrule with plastic sleeve	0.5…1.5 mm²

Push-wire terminals X1

Conductor sizes	AWG 24-16
Stripping length	10 mm
rigid/flexible	0.2…1.5 mm²
flexible with ferrule without plastic sleeve	0.25…1.5 mm²
flexible with ferrule with plastic sleeve	0.25…0.75 mm²

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)[1)]	B98060005

1) 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.

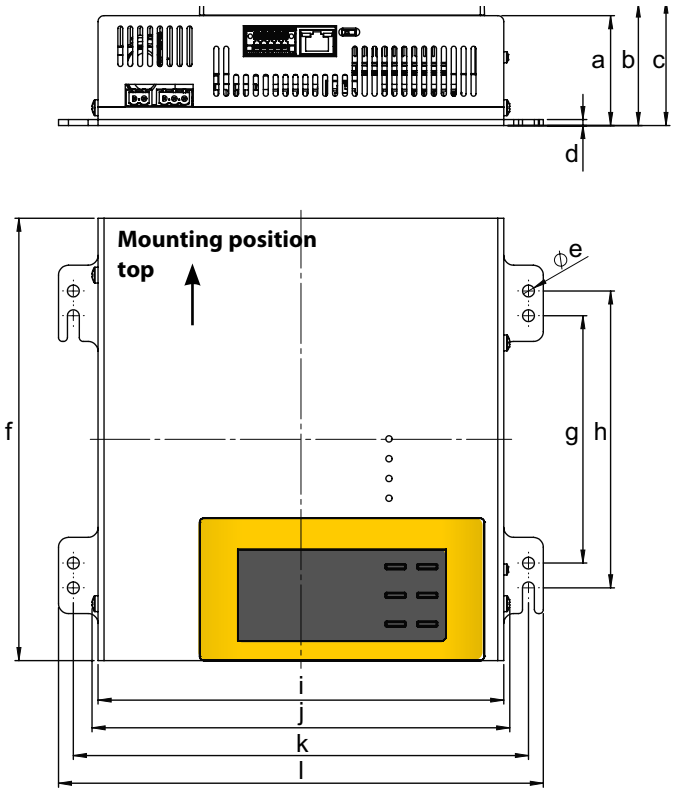
Suitable system components

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	B98039054
	14551…25000 V	CD25000	B98039055

Description	Voltage/Current	Type	Art. No.
Measuring current transformer	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	CTUB103-CTBC35	B78120030
	AC/DC up to 25 A	CTUB103-CTBC60	B78120031
		CTUB103-CTBC120	B78120032

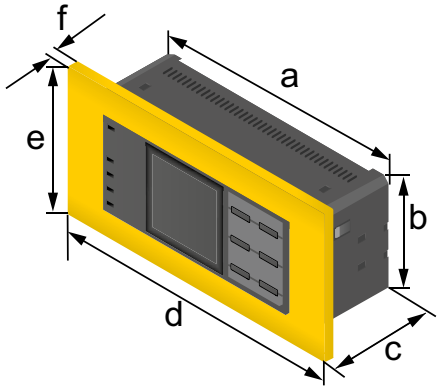
Description	max. connected measuring current transformers	Type	Art. No.
Voltage supply for AC/DC measuring current transformers CTUB103…	2	STEP-PS/1 AC/24 DC/0.5	B94053110
	7	STEP-PS/1 AC/24 DC/1.75	B94053111
	17	STEP-PS/1 AC/24 DC/4.2	B94053112

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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