NGRM700 (HRG)
NGRM750 (LRG)

Neutral Grounding Resistor Monitor

NGRM7xx_D00292_09_D_XXEN/07.2023

BENDER

NGRM700 (HRG)
NGRM750 (LRG)

Certifications

UL File number: E493737, E173157

Device features

- Determination of R_{NGR} with passive and active measurement methods
- Continuous monitoring of the R_{NGR} even if the installation is de-energized;
- Alarm or trip on ground fault
- Monitoring of the current I_{NGR}
- Monitoring of the voltage U_{NGR}
- Faulted phase 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 neutral current and voltage
- Pulser control for manual ground fault location
- Relay outputs for detection of ground faults and resistor faults
- Relay output for shutdown of the installation after a configurable time
- Can be combined with RCMS… for automatic shutdown of feeders
- Graphical user interface
- Integrated wide-range power supply unit for operating the NGR monitor (AC/DC 24…240 V)
- Range of use up to 5000 m AMSL
- Fault/History memory
- Analogue output of measured values (0…10 V, 4…20 mA, etc., selectable parameter)
- Detachable HMI for door mounting
- Password protection
- Tripping on RMS, fundamental component signal or harmonics
- Detection of AC and DC ground faults
- Variants High Resistance Grounded (HRG), Low Resistance Grounded (LRG)

	HRG		LRG	
	NGRM500	NGRM700	NGRM550	NGRM750
$U_{sys\,LL}$	400…25000V			
$I_{NGR\,nom}$	0…100 A		10…2000 A	
$R_{NGR\,nom}$	15…5000 Ω		0,1…200 Ω	

Product description

The NGRM700 is only intended for use in high-resistance grounded systems.
The NGRM750 is only intended for use in low-resistance grounded systems.
In these systems, the NGRM7… monitors

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

i *Systems with a 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 ground 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, customised parameter settings must be made on the equipment in order to adapt it to local equipment and operating conditions. Please heed the limits of the range of application indicated in the technical data.

Function

The NGRM7… 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 effective when installation is energized: 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 current or voltage value exceeds or falls below the internal threshold. The threshold is 15 % of the nominal value and can be adjusted by Bender if required.

A shorted or open NGR is reliably detected in an energized as well as a de-energized 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-energized.

The measurement method can be selected as a set point or via the configurable digital input I1 if the NGR method “external” has been selected (for software versions from July 2021).

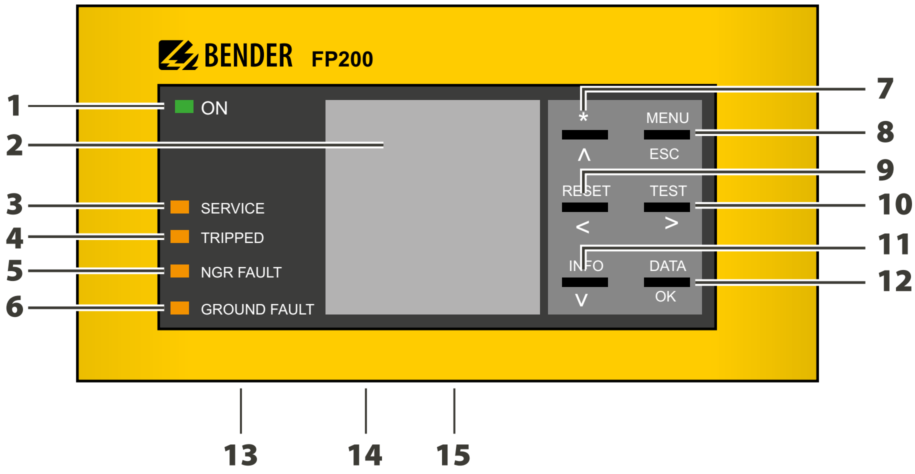
Should the use of frequency inverters lead to interferences with the R_{NGR} measured value during the active measurement, a filter for active resistance measurement can be added. To this end, 3 pre-defined filters (weak, medium, strong) have been implemented. In addition, the filter parameters can be adapted individually in the setting “Customer-specific”.

The NGR-fault relay switches from the operating state (selectable as fail-safe or non-failsafe) to the alarm state when the measured resistance RNGR is outside of 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 time delay has elapsed, the trip relay operates.
A connection to installations ranging from 400 V…25 kV is possible via the appropriate CD-series coupling device. I_{NGR} is measured with (universal) **measuring current transformers** with a 5 A or 50 mA secondary rating. The ratio of the used measuring current transformer can be set internally for best measurement performance of 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 ratio is an NGRM7… setting.

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-fault 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-fault 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

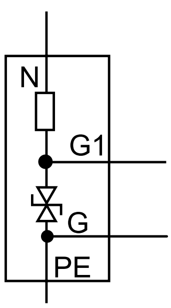
7 -	**Λ**	Navigates up in a list or increases a value.
8 -	**MENU**	Opens the device menu.
	ESC	Cancels the current process or navigates one step back in the device menu.
9 -	**RESET**	Resets alarms.
	<	Navigates backwards (e.g. to the previous setting step) or selects parameter.
10 -	**TEST**	Starts the device self test.
	>	Navigates forwards (e.g. to the next setting step) or selects parameter.
11 -	**INFO**	Shows information.
	V	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

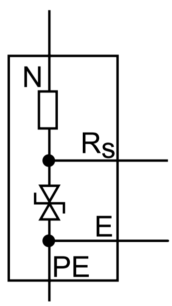
REMOTE	RJ45 port for connection of FP200-NGRM to enclosure
X3	Without function

Connectors CD…

CD1000
CD5000



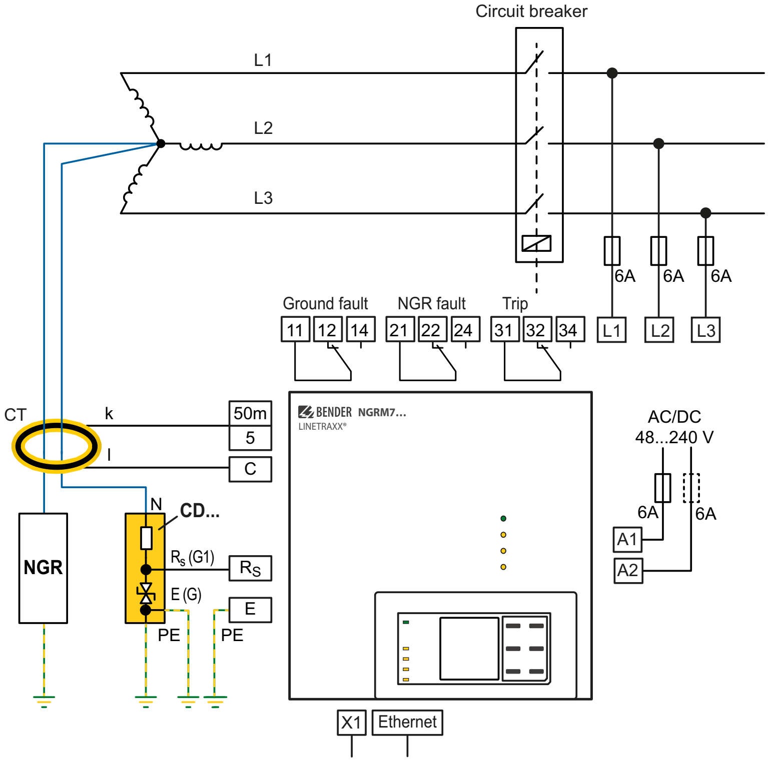
CD1000-2
CD14400
CD25000



N	Connection to star point
G1, RS	Connection to R_S of the NGRM7…
G, E	Connection to E of the NGRM7… and to the protective earth conductor of the installation (PE)

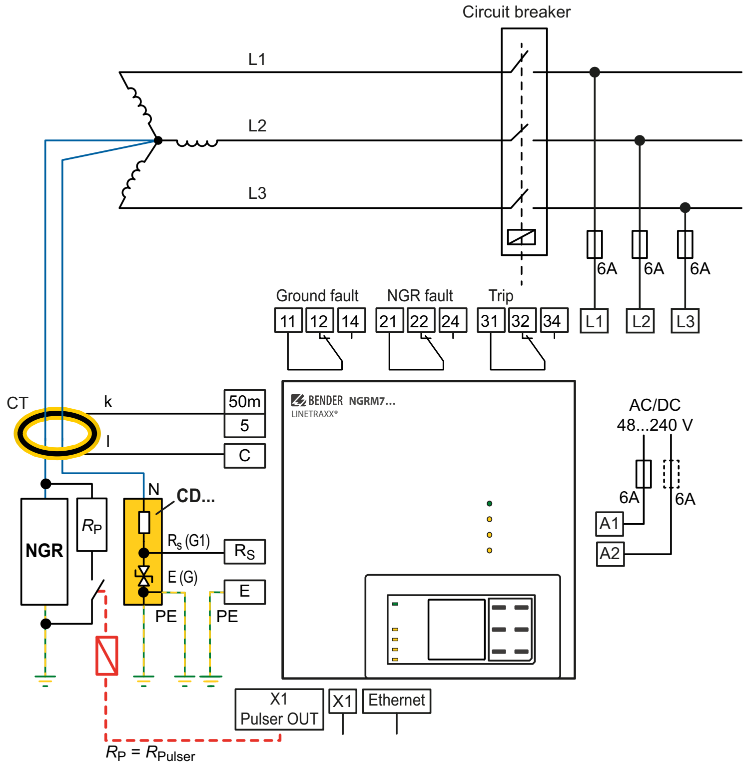
Connection star connection: $U_{sys} \leq 690$ V

For these voltages, the phase monitor of the NGRM7… can be connected directly to the phase conductors to be monitored.



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

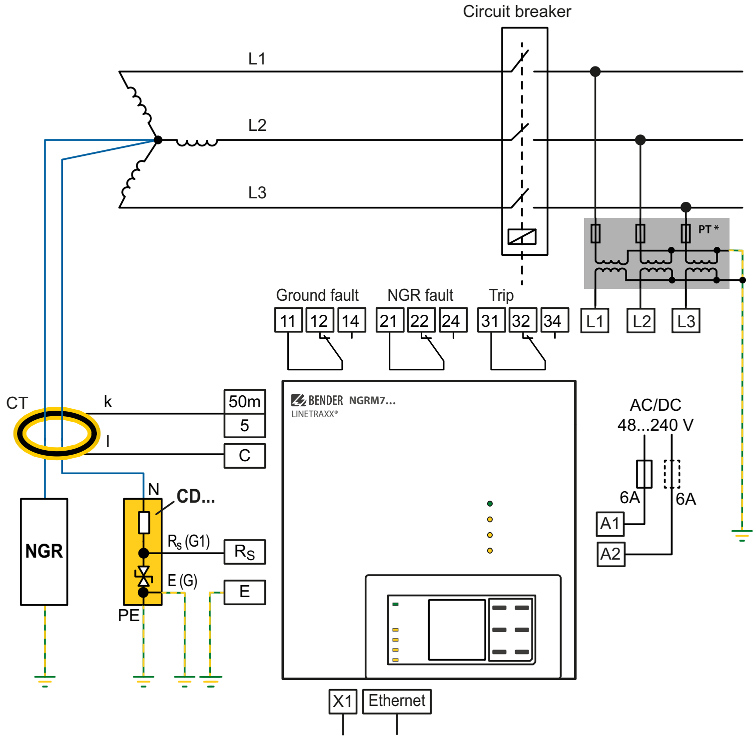
Connection Star connection: $U_{sys} \leq 690$ V with pulser



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 NGRM7… can only be connected to the conductors to be monitored via potential transformers (PT).



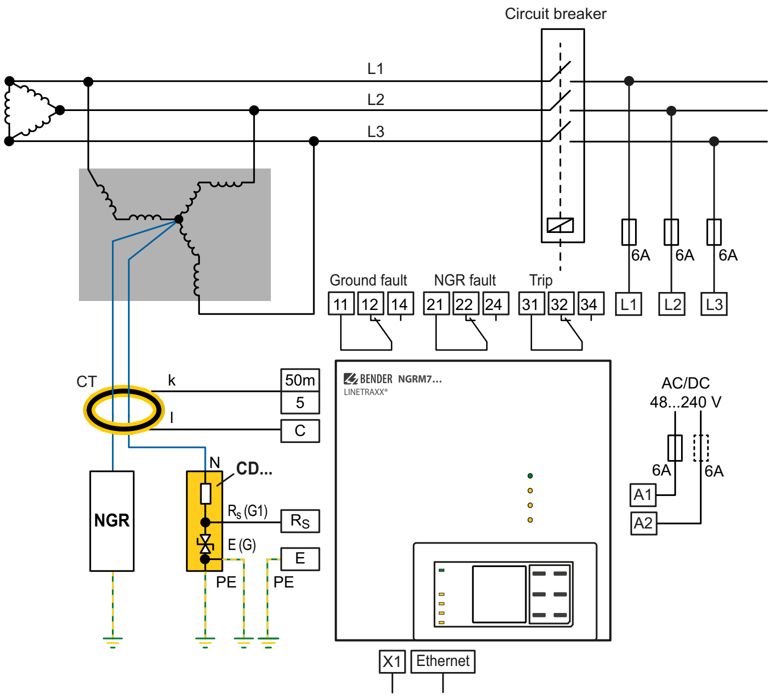
Note:

** PT ratio "primary: secondary" can be adjusted in the NGRM7….*

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

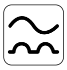
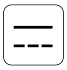
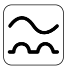
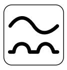
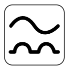
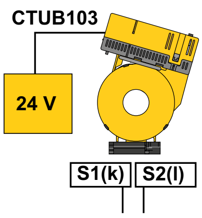
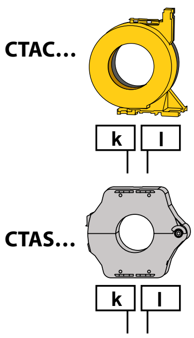
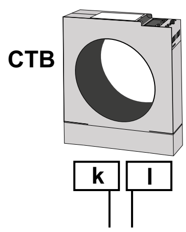
Artificial neutral (delta connection): Connection with a zigzag transformer

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



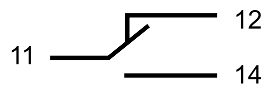
Measuring current transformer connection

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:

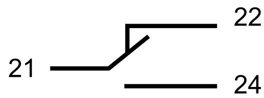
System type	AC + DC	AC	AC	AC
I_{NGR}	0,5…25 A	5…25 A	5…1000 A	10…2000 A
f	0…3800 Hz	42…3800 Hz	50/60 Hz	50/60 Hz
Transformation ratio Bender measuring current transformer	Measuring range (see CTUB103 manual) 5 A 100:1 10 A 200:1 25 A 500:1	600:1		
Connecting cable	max. 30 m provided cable or 0.75…1.5 mm²/AWG18…16	max. 40 m provided cable or 0.75…1.5 mm²/AWG18…16	max. 25 m (4 mm²/AWG12) max. 40 m (6 mm²/AWG10)	
$I_{\Delta n}$	 			
Type	CTUB103 	CTAC… / CTAS… 	CTB31…51 	Any standard current transformer can be used.
CT: Terminal k	NGRM7…: **50 mA**	NGRM7…: **50 mA**	NGRM7…: **5 A**	NGRM7…: **5 A**
CT: Terminal l	NGRM7…: **C**	NGRM7…: **C**	NGRM7…: **C**	NGRM7…: **C**

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

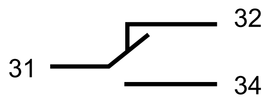
Ground-fault relay



NGR-fault relay



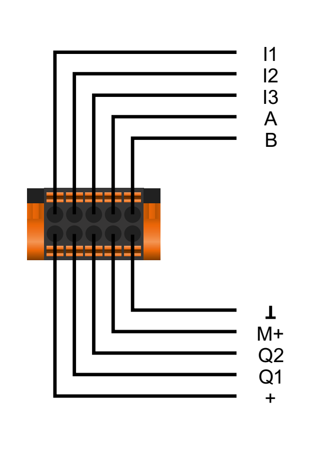
Trip relay



The delay times of the various relays are not the same. See table „Trip times relays“ in the manual.

Connection to the X1 interface

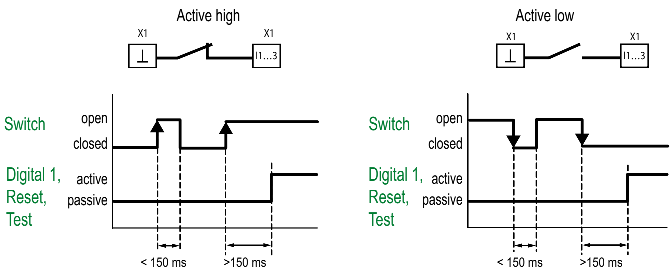
Pin assignment X1 interface



I1	Digital 1 (configurable: pulser, NGR method)
I2	Reset IN
I3	Test IN
A	Modbus RTU (A)
B	Modbus RTU (B)
⊥	Common
M+	Analogue output
Q2	Open Collector: Pulser OUT
Q1	Open Collector: Device health
+	Output for supply of external relays (+24 V, max. 100 mA)

X1: Input I1…3

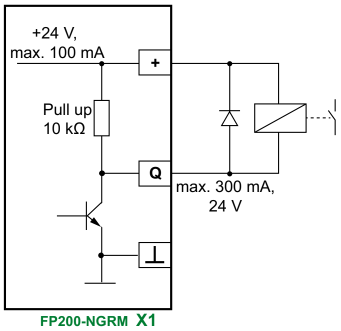
The input is only detected as “activated” after the contact has been activated for at least 150 ms. This way, short interference pulses are ignored.



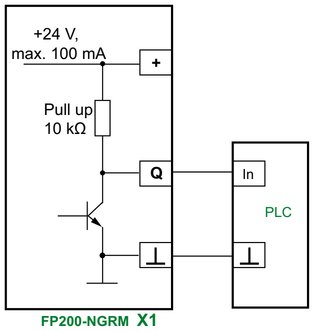
Input I1…3: Potential-free contact to common or 0 V and 24 V in conjunction with a PLC

X1: Output Q1…2

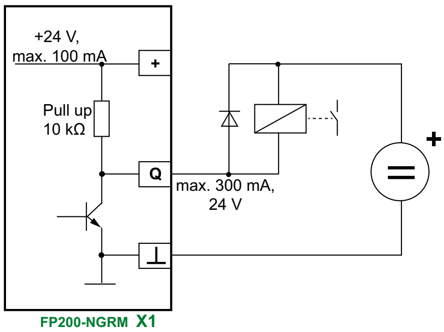
Internal 24 V



Connection to PLC



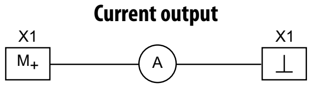
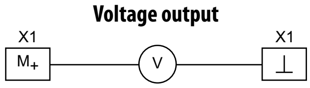
External supply e.g.12...24 V



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 50178

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 applications)	AC/DC, 48…230 V
> 2000…≤ 5000 m	AC/DC, 24…120 V
> 2000…≤ 5000 m (for UL and AS/NZS 2081 applications)	AC/DC, 48…120 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 (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
HRG	
Setting range $R_{NGR\ nom}$	15 Ω…5 kΩ
Response value <$R_{NGR\ nom}$	10…90 % $R_{NGR\ nom}$
Response value >$R_{NGR\ nom}$	110…200 % $R_{NGR\ nom}$
LRG	
Setting range $R_{NGR\ nom}$	0.1…200 Ω
Response value >$R_{NGR\ nom}$	200…500 Ω
Response delay, NGR-fault relay	7 s (±2.5 s)
Response delay, trip relay	0…48 h

Monitoring I_{NGR}

Measuring circuit 5 A	
Nominal measuring current I_n	DC / 50/60 Hz / 10…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 / 10…3200 Hz 50 mA
Maximum continuous current	2 x I_n
Overload capacity	10 x In 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…48 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 / 10…3200 Hz; (400/√3) … ≤ (4300/√3) V
U_{NGR} with R_S = 100 kΩ	DC / 50/60 Hz / 10…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 $U_{NGR\ nom} = (U_{sys\ (L-L)}/\sqrt{3})$
Voltage response value	10…90 % $U_{NGR\ nom}$
Response delay, ground-fault relay	≤ 40 ms (±10 ms)
Response delay, trip relay (configurable)	100 ms…48 h, ∞
Tolerance t_{trip} when set to	
RMS	−20…0 ms
Fundamental	0…+150 ms (filter time)
Harmonics	0…+150 ms (filter time)
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

BENDER

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 principle	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 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…+70 °C
Operating temperature for UL applications	-40…+60 °C
Transport	–40…+85 °C
Long-term storage	–40…+70 °C
Humidity	≤ 98 %
Classification of climatic conditions acc. to IEC 60721 (with respect to temperature and rel. humidity)	
Stationary use (IEC 60721-3-3)	3K22
Transport (IEC 60721-3-2)	2K11
Long-term storage (IEC 60721-3-1)	1K22
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 mm^2
flexible with ferrule with/without plastic sleeve	0.25…2.5 mm^2
Multiple conductor, rigid	0.2…1 mm^2
Multiple conductor flexible	0.2…1.5 mm^2
Multiple conductor flexible with ferrule without plastic sleeve	0.25…1 mm^2
Multiple conductor, flexible with TWIN ferrule with plastic sleeve	0.5…1.5 mm^2
Push-wire terminals X1	
Conductor sizes	AWG 24-16
Stripping length	10 mm
rigid/flexible	0.2…1.5 mm^2
flexible with ferrule without plastic sleeve	0.25…1.5 mm^2
flexible with ferrule with plastic sleeve	0.25…0.75 mm^2

Other

Operating mode	continuous operation
Mounting	display-oriented
Operating 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

Type	System type	Supply voltage U_s / Frequency range Hz	Art. No.
NGRM700	HRG	AC 24…240 V, 40…70 Hz DC 24…240 V	B94013700
NGRM750	LRG		B94013750

Suitable system components

Description	Voltage/Current	Type	Art. No.
Measuring current transformer	AC up to 30 A	CTAC35	B98110007
		CTAC60	B98110017
		CTAS50	B98110009
		CTAS80	B98110010
		CTAS120	B98110011
	AC/DC up to 10 A	CTUB103-CTBC35	B78120030
	AC/DC up to 25 A	CTUB103-CTBC60	B78120031
		CTUB103-CTBC120	B78120032
	AC >30…1000 A	CTB31…CTB51	B980860xx[1]

[1] All types and ordering informations of this series are available on our website

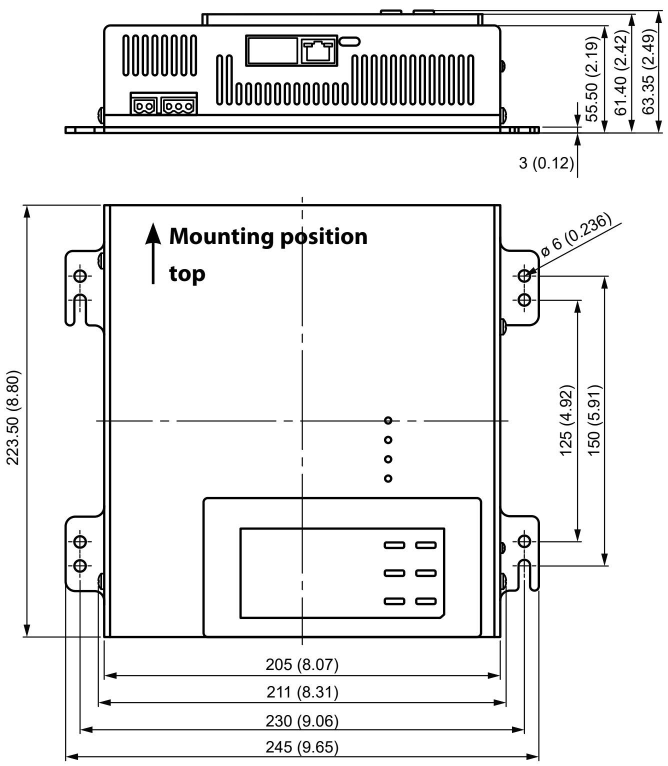
Description	Voltage U_{sys}	Type	Art. No.
CD-series coupling device	400…690 V	CD1000	B98039010
	400…1000 V	CD1000-2	B98039053
	1000…4200 V	CD5000	B98039011
	4300…14550 V	CD14400	B98039054
	14551…25000 V	CD25000	B98039055

Description	Length (m)	Type	Art. No.
Connecting cables CTUB103	1	CTXS-100	B98110090
	2,5	CTXS-250	B98110091
	5	CTXS-500	B98110092
	10	CTXS-1000	B98110093

Description	max. connected measuring current transformers	Type	Art. No.
Voltage supply for CTUB103… measuring current transformers	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

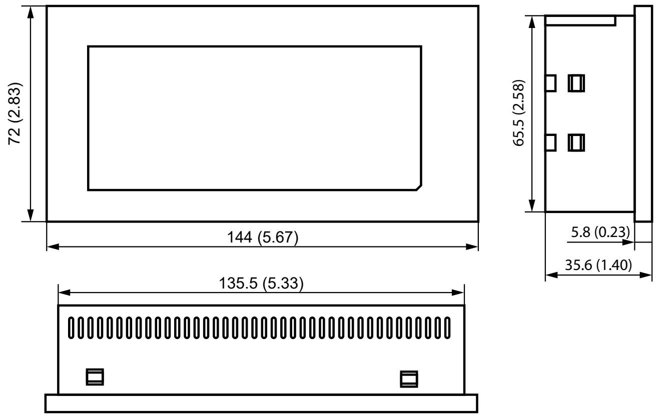
Dimension diagram NGRM7…

Dimensions in mm (in)



Dimension diagram FP200-NGRM

Dimensions in mm (in)



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