Residual Current Monitoring

acc. IEC 62020

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the future for you
TODAY !

Highly flexible Residual Current Monitor of Type B/B+ for measuring DC and AC residual currents up to 100 kHz, with analog 4-20 mA and relay output.
User selectable Frequency range, Integration time and Rated residual operating current.

Features & Highlights:

70 mm primary cable / busbar apperture

DC and AC residual current measurement of Type B/B+ in the range 0-2 Arms up to 100 kHz

User selectable:

- Frequency range
- Integration time
- Rated residual operating current

Analog 4-20 mA and relay output

Fluxgate current measurement technology with fixed excitation frequency for enhanced accuracy and stability

Applications:

Residual current monitoring in industry

Condition-based monitoring of insulation health

Replacement of / supplement to compulsory High voltage insulation testing

Scheduling of planned factory maintenance

DC power systems (UPS, PV, LED lighting...)

High frequency loads (SMPS, Motor drives…)

Mission critical (Data centers, Medical ...)

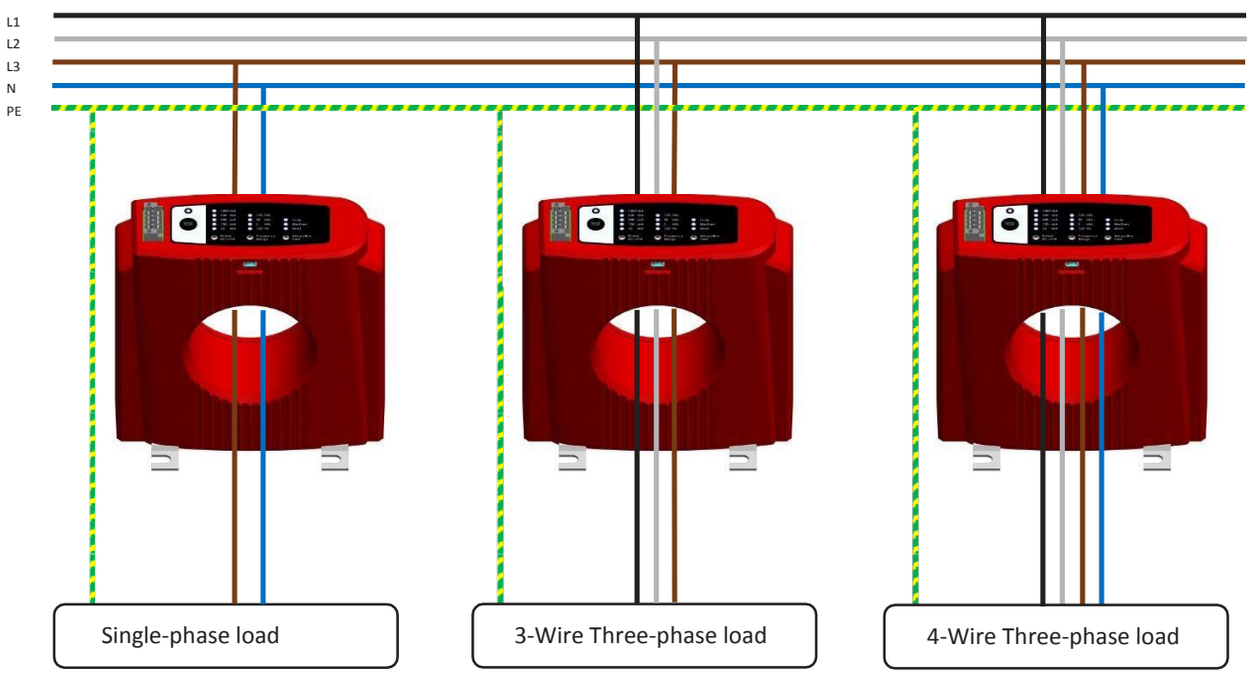
Background

Residual currents (aka Earth fault currents, Insulation leakage currents) are unique measure for the state of the insulation of the electrical power system and its need for maintenance & repair to avoid nuisance shutdowns. Monitoring of the residual currents in real-time in a power system gives the possibility to evaluate the health of the electrical insulation based on the actual value measured, while the long-term development of the residual current value can be used for planning maintenance to avoid significant insulation deterioration. In this way, Residual Current Monitors (RCMs) used in a Condition-based Monitoring scheme as per Industry 4.0 standards can ensure early fault detection and increase the availability of the power system at much lower cost than regular, expensive and time consuming high voltage insulation testing.
This fact is set out in the standard IEC 60365-6 (2016-04):
Where a circuit is permanently monitored by an RCM in accordance with IEC 62020 …it is not necessary to measure the insulation resistance if the function of the … RCM is correct.
Residual currents in electrical power systems can have multiple sources: insulation faults, insulation leakage currents, capacitive displacement currents, EMC filter leakage currents etc. While some of these contributing residual currents are normally present due to material physics when subjected to high or alternating voltages, other contributors are sign of deteriorating insulation which can produce abnormal heat dissipation, short-circuits and in worst case fire and danger to personal safety. Proliferation of DC loads (e.g. LED lighting, DC motor drives, 48Vdc bus systems etc.), DC distributed generation (e.g. PV systems, UPS, batteries etc.) as well as high-frequency converters (e.g. SMPS, motor drives etc.) in industrial environments makes it increasingly difficult to measure reliably insulation faults with traditional RCMs designed for AC 50/60Hz with limited measurement bandwidth. It is the experience of many installers around the world that in order to make the residual current protection work not only now but also in the future with extensions of existing plants, it is necessary for the end-user to have the possibility to select from several residual current limits, different frequency bandwidths and sensitivity levels.

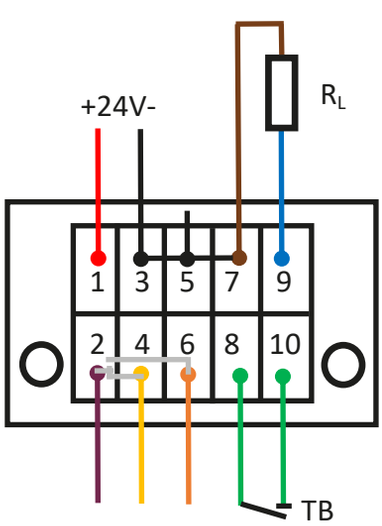
General description

Residual Current Monitors (RCMs) are used for monitoring of the residual currents in electrical power systems without the need for fast system shutdown. The RCM of Type B/B+ can measure DC and AC residual currents at frequencies of up to 100 kHz, which makes it compatible to multitude of industrial applications, loads and generation sources. With its user selectable settings, this RCM offers flexible platform for residual current measurement which fits every possible usage both at the moment the industrial plant is designed, but also in case of extensions with new modern loads operating with DC voltages or at high switching frequencies which increase the amount of leakage current in the system.
The RCM product features an analog 4-20 mA output which represents the real-time True RMS (TRMS) value of the measured residual current for interfacing to e.g. a PLC. Additionally a free potential relay output (NO / NC) with user selectable rated residual current limit can be used for warning or even system shutdown when the TRMS residual current measurement has exceeded the preset value. The status of the relay ouptut is replicated to a LED for visual indication on the device itself. Built-in test button and external test button input are provided for regular testing of the RCM as per applicable product standards. Only a single 24 Vdc power supply should be provided for powering the RCM.

Intended for use in Single-phase and 3-wire & 4-wire Three-phase systems.



Connector



Pinout:

1: 24 Vdc
2: Relay common
3: 0Vdc
4: Relais NC contact, alarm: closed
5: 0Vdc
6: Relais NO contact, alarm: open
7: 0Vdc
8: External Test button, contact 1
9: Analog 4-20mA output
10: External Test button, contact 2

Functional description

The Residual Current Monitor RCMB 70 senses the instantaneous, real-time value of both DC and AC residual current using the built-in transducer head with integrated balanced Flux-gate detector. For the purpose of functional protection and especially fire protection of the electrical power system, the RCM implements the True RMS (TRMS) value of the residual current which corresponds to the amount of heat dissipated in the insulation. In order to provide high level of flexibility in the RCM usage and fit to as many potential applications as possible, this RCM is equipped with three user-selectable parameters which affect the final TRMS value indicated at the analog 4-20mA output as well as the relay output and status LED.

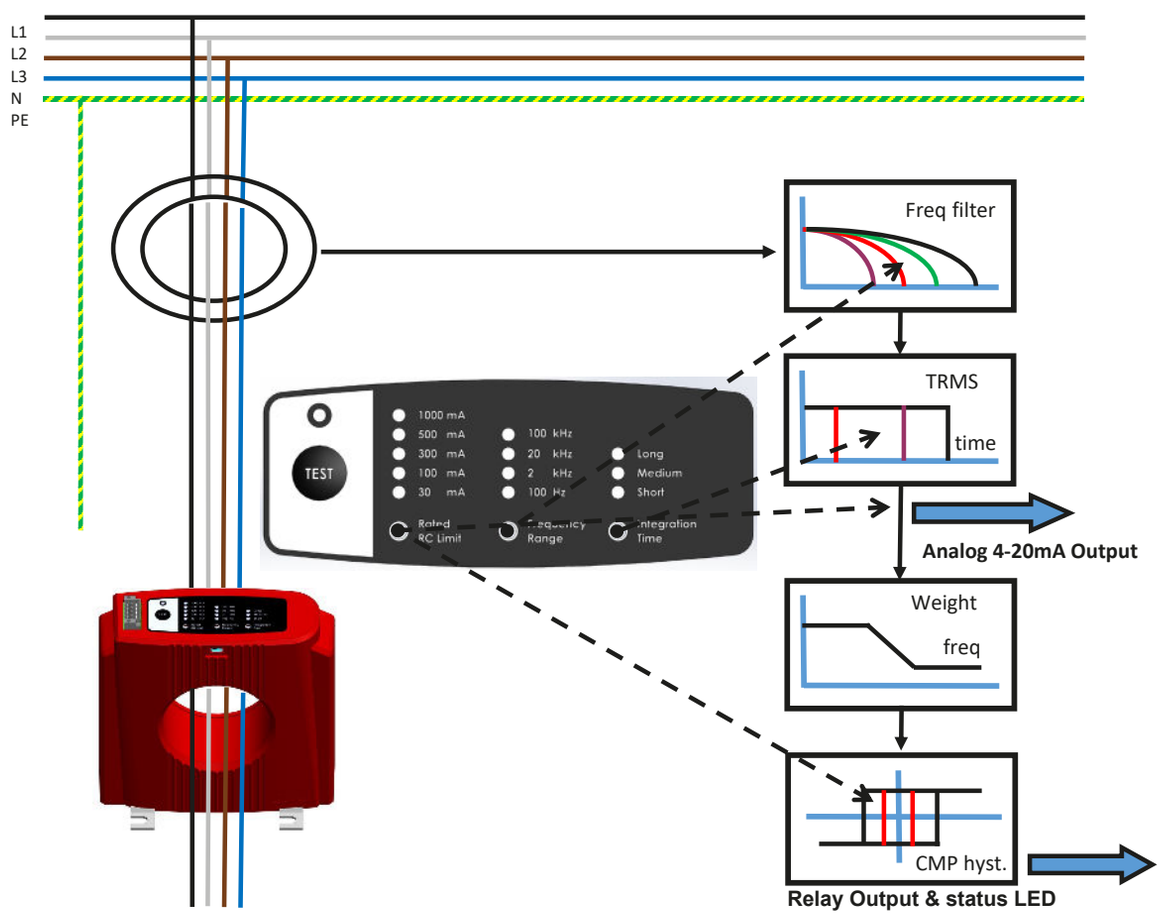
The ”Frequency range (FR)” parameter limits the frequency bandwidth of the measured residual currents. After the frequency range of interest have been selected, the ”Integration time (IT)” parameter determines the length of the integration window for the TRMS value. Finally the TRMS value is scaled according to the selected ”Rated RC limit” into two different ranges (details in the electrical specification tables). After these intermediate steps, the TRMS value of the residual current is ready to be sent out to the analog 4-20 mA output. The behavior of the relay output and status LED is though influenced by couple of extra processing blocks, as described below.

The ”Rated RC limit (RL)” sets the level at which, when violated by the Weighted TRMS, the relay output and status LED will toggle the state. Weighted TRMS is obtained from the TRMS value by applying a weighting filter which attenuates the residual currents with higher frequencies while passing entirely the low frequency residual currents, as per applicable product standards. The reason for this choice is that higher values of high-frequency residual currents appear naturally in switch-mode power converters when fast changing voltages are applied to e.g. cable insulation, output dv/dt filters, input EMC filter and Y capacitors to ground. In order to have a very precise output, the measured range of the residual current is related to the Rated RC limit.

Rated RC Limit (RL)	Measured Current RCMB70	Analog 4-20 mA DC output
30, 100 and 300 mA	0 - 4 mA	4 mA (0 A) - 20 mA (400 mA)
500 and 1,000 mA	0 - 2,000 mA	4 mA (0 A) - 20 mA (2,000 mA)

Decision on relay output status is done with a comparator having a hysteresis, meaning that after activation of the relay the residual current TRMS value needs to reduce by a certain hysteresis before the relay output is deactivated. In case of repetitive activation & deactivation of the relay, it is latched to activated state and Test button needs to be pressed for at least 3s to reset.

Block diagram



User interface description

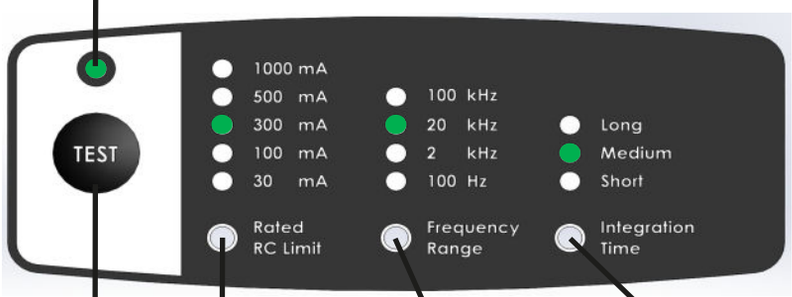
This RCM product features three user selectable parameters, each with the choice of selecting 3-5 different values. The simple and intuitive user interface can be found on the top of the RCM and is used for configuring the RCM with three buttons located below the surface level. These buttons can only be operated with a tool which prohibits unintentional and unauthorized access, as per applicable product standards. Interface features furthermore a Test button and status LED for visual indication.

Power-on / Status LED

Lights in green colour with heart-beat* during normal operation with low residual currents. Changes colour to red with heart-beat when the measured TRMS of residual current is higher than the rated RC limit.

Flashing green light during start-up. Constant red light combined with multiple flashing green LEDs from ”Rated RC limit” group indicates fault status.

*Light intensity of the status LED changes continuously in a heart-beat fashion to mark correct execution of the software. It is a mere indication of the RCM being awake and taking care of user assets.



Fault codes

●●	Input voltage out of range
●●●	Relay activated too many times
●●●●	Overtemperature
●●●●●	Internal failure
— *flashing* —	*LEDs from left group (RL)*

Test button

It is used to activate the test sequence for testing the operation of the RCM.

Succesful test will activate the relay and cause LED to turn red.

When relay is latched due to too many activations, pressing the button for 3s will reset the condition if residual current is normal.

Integration time (IT)

Refers to the time window for calculating TRMS value. Hints:

- Longer IT makes the RCM less sensitive to short peaks during startup situations; better for low frequency operation

- Shorter integration times result in faster RCM response, especially if short residual current pulses are of interest

Frequency range (FR)

Refers to the measurement bandwidth for the residual current. Hints:

- If only DC and low frequency AC (50/60Hz) are of interest, use the 100Hz setting

- If protection of switch-mode frequency converters is imperative, increase FR towards 2kHz, 20kHz or even full bandwidth 100kHz

Rated RC Limit (RL)

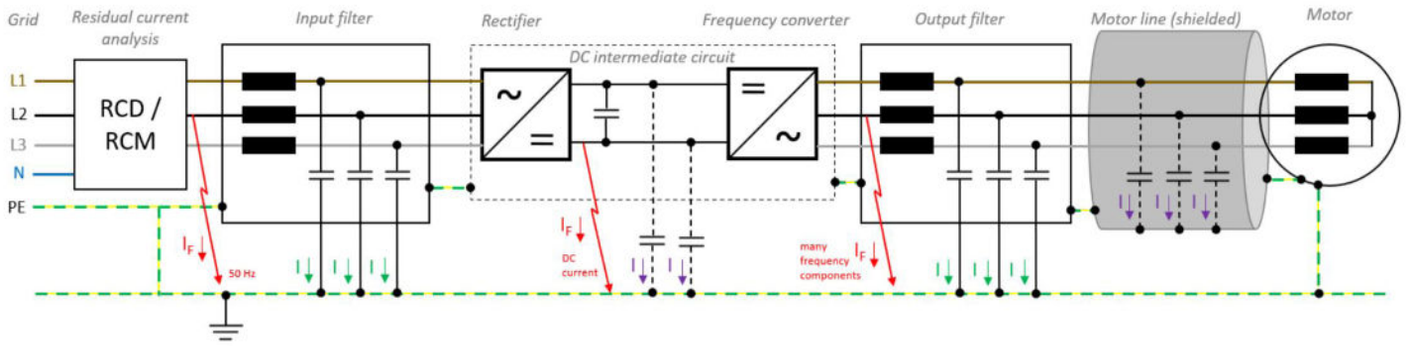
Refers to the measured TRMS value of the residual current which will trip the relay output. Additionally, selecting the three lower trip limits (30-100-300mA) changes the analog output range to 0-0.4Arms, while selecting the two higher trip limits (500-1000mA) changes the analog output range to 0-2Arms. Hints:

- Set the RL low if it is required to get early warning of increasing residual current levels

- To avoid nuissance alarms, set RL to higher values which correspond to the residual current levels the user can tolerate in the electrical power system before system check or maintenance is going to be required

Real-life examples of residual currents

Typical residual currents in a motor drive with frequency converter



= residual current due to parasitic capacitances

\+ = residual current due to capacitive filter

= constant system-related residual current

\+ = leakage current / fault current

= measured total residual current of the RCM device

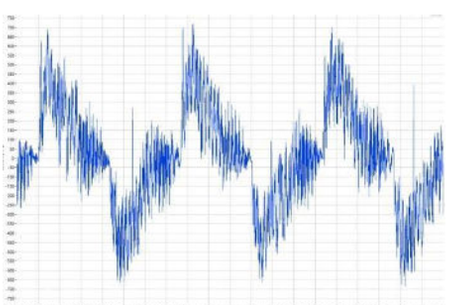
Sample:

System-related residual current of the plant 250 – 300 mA

Fire protection RCD is triggered under 300 mA

Alarm threshold 1: 400 mA (Pre-alarm)

Alarm threshold 2: 600 mA (shutdown of the plant)



Oszillogram of the residual current 60 mA TRMS (production plant MBS AG)

Frequency spectrum of the differential current at the production plant

Electrical specifications

Primary monitored circuit

Parameter	Symbol	Value
Rated voltage of monitored circuit	U_n	0-690 Vrms
Rated frequency range of monitored circuit	f_n	50 / 60 Hz
Applicable operating frequency of monitored circuit	f_{aop}	0-400 Hz
Rated primary current	I_n	100 A ($I_{\Delta n}$=30 mA) 300 A ($I_{\Delta n}$=100-1000 mA)
Max. non-tripping overcurrent	I_{max}	600 A ($I_{\Delta n}$=30 mA) 1800 A ($I_{\Delta n}$=100-1000 mA)
Thermal rated short-time (10ms) withstand residual current	$I_{\Delta th}$	200 A
Thermal rated continuous withstand residual current	$I_{\Delta cth}$	100 A
Rated impulse residual current	$I_{\Delta dyn}$	10 kA
Rated insulation voltage	U_i	700 V
Impulse withstand voltage	U_{imp}	8 kV
Overvoltage category	OVC	IV
Pollution degree	PD	3

Analog current interface 4-20mA

Parameter	Symbol	Value
Current output 0-0.4 Arms / 0-2 Arms	I_{out}	4-20 mAdc
Current output at 0% $I_{\Delta n}$	0%	4-4,2 mAdc
Current output at 0.4 Arms / 2 Arms	100%	19-21 mAdc
Peak-to-Peak noise	pk-pk	≤0,25%
Resolution	Res_{out}	0,01 mA
Short-circuit current	$I_{sc,out}$	<25 mAdc, SC-proof
Maximum total load resistance / apparent ohmic resistance with cable	$Rt,_{max}$	≤ 900 Ω
Typical load resistance	R_{typ}	250 Ω
Voltage at open terminals	$U_{oc,out}$	24 Vdc
Response time 1x $I_{\Delta n}$, step response 10-90%	$t_{10-90\%}$	≤T_i
Response time 1x $I_{\Delta n}$, step response 0-50%	$t_{0-50\%}$	≤T_i/2
Response time 5x $I_{\Delta n}$, step response 10-90%	5x $t_{10-90\%}$	≤T_i/30
Response time 5x $I_{\Delta n}$, step response 0-50%	5x $t_{0-50\%}$	≤T_i/50

External Test and Reset button

Parameter	Symbol	Value
Cable length for external Test & Reset key	L_{tk}	0-10 m
Short-circuit current	$I_{sc,tk}$	<4 mAdc, SC-proof
Voltage at open terminals	$U_{oc,tk}$	24 Vdc

CAUTION:

- PLEASE IMPERATIVELY RESPECT CONNECTION POLARITIES TO PREVENT DESTRUCTION OF THE RESIDUAL CURRENT MONITOR
- PLEASE ENSURE ADEQUATE CURRENT AND VOLTAGE RATING OF POWER SUPPLY TO AVOID MALFUNCTION

Residual current characteristics

Parameter	Symbol	Value
Rated relay output residual current at 50/60Hz – user selectable	$I_{\Delta n}$	30 mA-100 mA - 300 mA-500mA - 1000mA
Residual current frequency range – user selectable	$f_{\Delta n}$	DC-100 Hz*, 2 kHz, 20 kHz und 100 kHz
Relay output residual operating current at 50/60 Hz	$I_{\Delta n}$	100% $I_{\Delta n}$ +0%-20%
Relay output residual non-operating current at 50/60 Hz	$I_{\Delta no}$	50% $I_{\Delta n}$ +20%-0%
Frequency dependence of residual operating current	$I_{\Delta n,\ freq}$	150 Hz: 2.4·$I_{\Delta n}$ 400 Hz: 6·$I_{\Delta n}$ 1000 Hz: 14·$I_{\Delta n}$ (or 2 Arms max)
Frequency dependence of residual non-operating current	$I_{\Delta n,\ freq}$	150 Hz: 0.5·$I_{\Delta n}$ 400 Hz: 0.5·$I_{\Delta n}$ 1000 Hz: 1·$I_{\Delta n}$
Rated analog output residual current (20 mA)	I_{an}	0.4 Arms ±6% ($I_{\Delta n}$=30-300 mA) 2 Arms ±6% ($I_{\Delta n}$=0.5-1 A)
Hysteresis on relay output (for non-latched operation)	$I_{\Delta n,hyst}$	< 30% $I_{\Delta n}$
Integration time	T_i	Short (100 ms), Medium (400 ms), Long (1000 ms)

Supply voltage

Parameter	Symbol	Value
Rated supply voltage	U_e	24 Vdc +10%/-15%
Overvoltage category	OVC_e	III
Rated impulse withstand voltage	U_{impe}	1.5 kV
Rated insulation voltage	U_{ie}	30 V
Internal consumption	P_e	<4 W

Relay output

Parameter	Symbol	Value
Contact output		NO+NC
Rated voltage	U_r	30 Vac/dc
Rated current	I_r	1 Aac/dc
Maximum Actuating time 1x $I_{\Delta n}$	t_r,1x $I_{\Delta n}$	≤T_i + 1 / (2 f_{rc})**
Maximum Actuating time 5x $I_{\Delta n}$	t_r,5x $I_{\Delta n}$	≤T_i/16 + 1 / (2 f_{rc})**
Response threshold $I_{\Delta n}$		100% +0-20%
Latching function with Reset (int/ext)		Yes
Minimum non-actuating time	t_{nr}, 1x $I_{\Delta n}$	≤T_i/2
Switching operations		>20,000

Environmental and mechanical characteristics

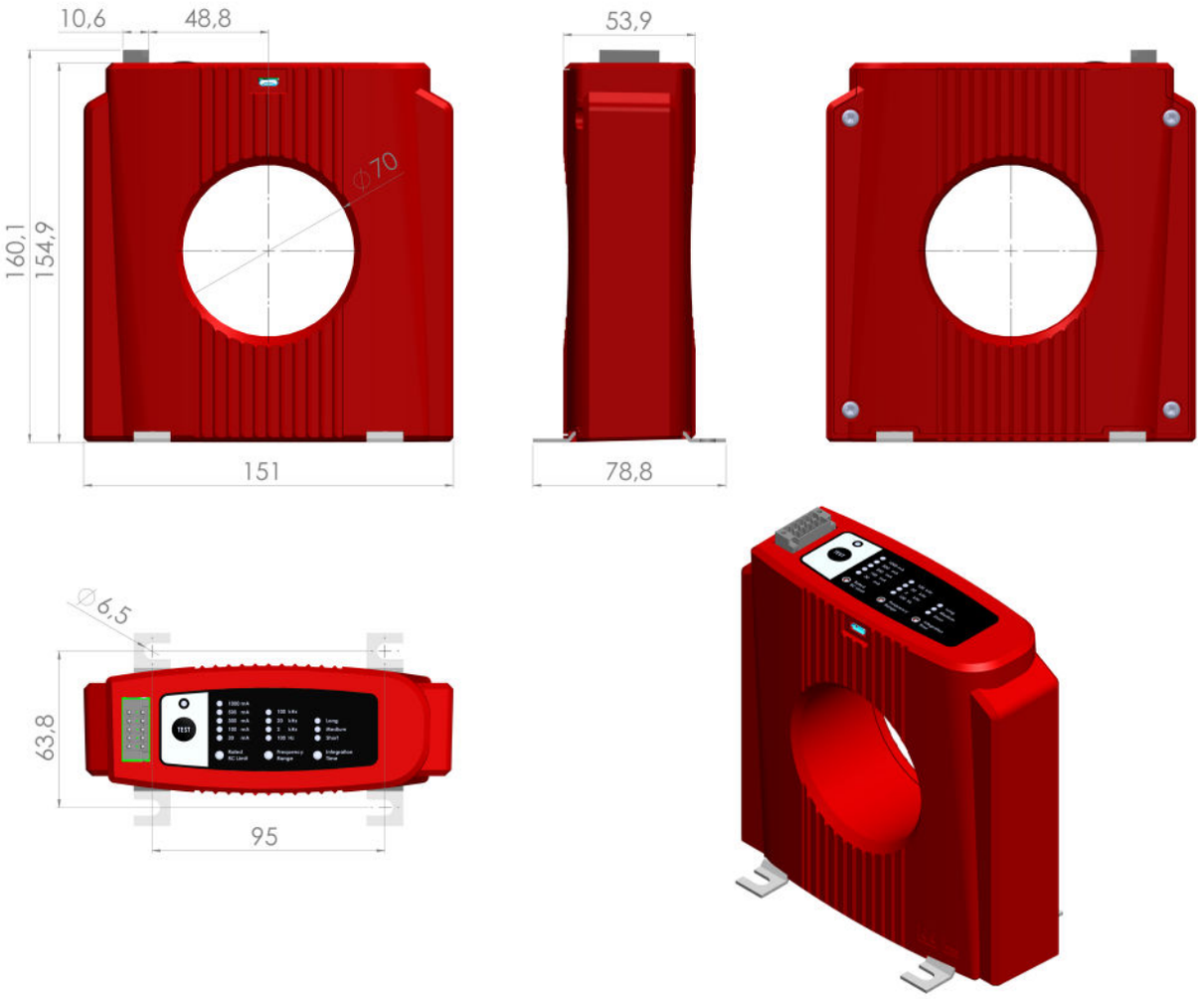
Parameter	Unit	Min	Typ	Max	Comment
Operating temperature range	°C	-20		55	
Storage temperature range	°C	-40		85	
Relative humidity	%	20		80	Non-condensing
Mass	kg		0.900		
Connector	Phoenix Contact DFMC 1,5/ 5-ST-3,5-LR — PN: 1790519 or compatible				
Standards	EN / IEC 62020-1:2020				

* DC-100 Hz frequency range makes RCMB insensitive to higher frequencies and it is not Type B compliant acc. to IEC 62020-1

** f_{rc} is the frequency of the dominant residual current component

All values are True RMS (TRMS) values

Dimensions



(general tolerance 0.3mm unless otherwise stated)

Base plate mounting with screws in the four holes of the foot angles.

Optional accessories

Power supply for DIN-rail mounting

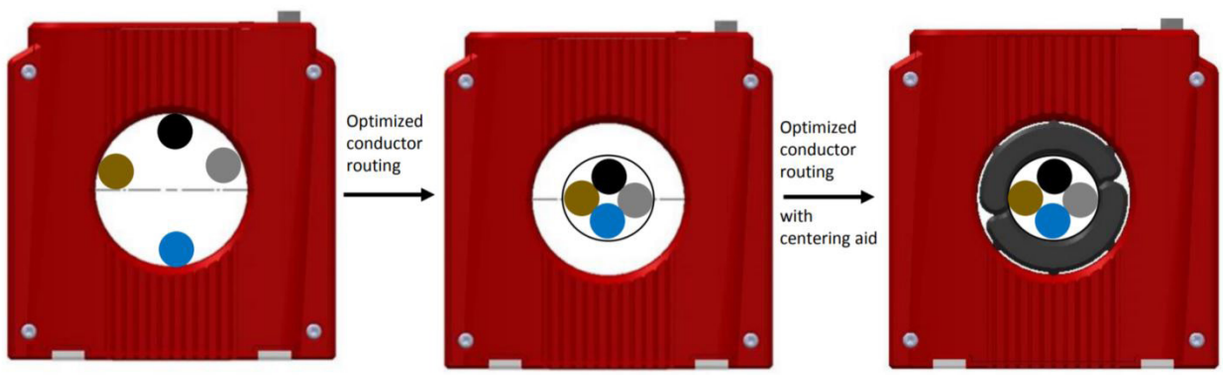
Input:
85-264V AC
120-370V DC
Output:
20W
24V DC (± 2%)

Item No.:
120-00003

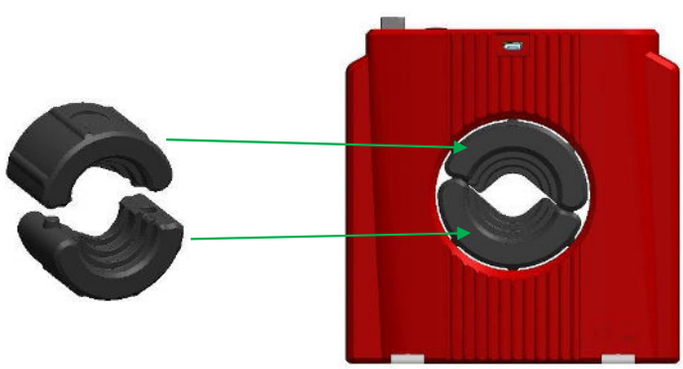
Compatible accessory

Accessory: centring aid
- Accurate measurements even with supply cables with smaller diameters -

The RCMB 70 residual current monitor must be crossed by all active conductors. The protective conductor must be led outside the device or once in each direction. When switching high loads, high currents and their magnetic fields can lead to unwanted interference or influence on the measurement results. The arrangement of the conductors must therefore be optimized as shown in the following illustrations.



When the conductors are brought together with subsequent centering in the inner diameter, disturbances and inaccuracies can be significantly reduced. A centering aid can be ordered as an accessory in order to implement this optimized conductor routing in practice. This consists of EPP foam (expanded polypropylene) and is cut to theappropriate diameter with a sharp knife. If necessary, the individual conductors can also be brought together with cable ties before and after the passage.

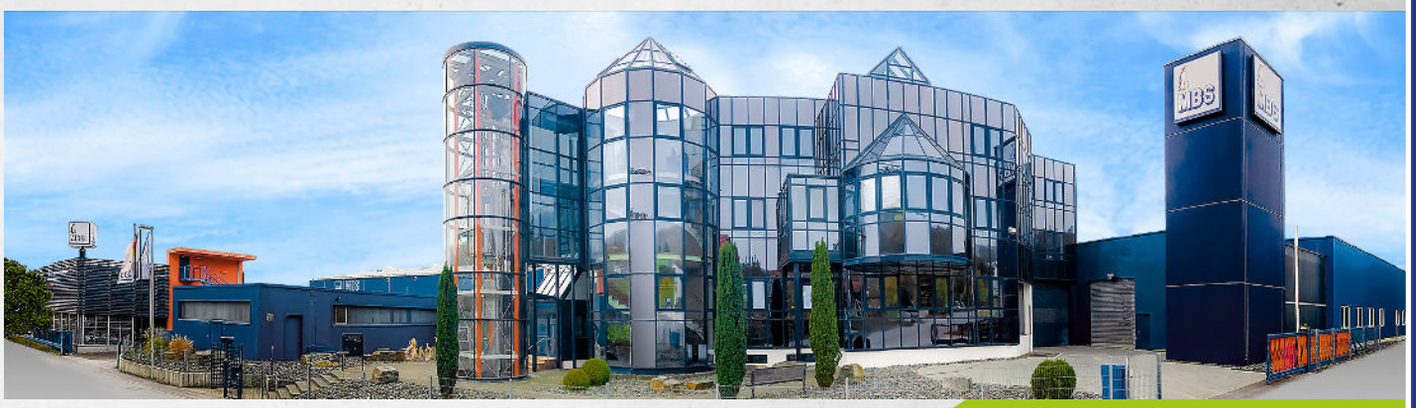


Product	Item number
Residual Current Monitor RCMB 70 (70 mm inner diameter)	DA07002B
Centring aid Compatible for the RCMB 70	55029

Notes

- Current transformers for industry
- Current transformers for tariffs
- Accessories for current transformers
- Medium-voltage transformers
- Bus bar insulators / -supports
- Shunts

- Voltage transformers
- All current sensors
- Measuring transducers
- Energy meters with or without MID approval
- Accessories for energy meters
- Panel board heaters, filter fans, roof fans and control units



www.mbs-ag.com

MBS AG
Eisbachstraße 51 74429 Sulzbach-Laufen Germany
Phone: +49 7976 9851-0 Telefax: +49 7976 9851-90
info@mbs-ag.com www.mbs-ag.com

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