



MRCDB300 series

AC/DC sensitive residual current monitoring module
for MRCD applications



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1 General information

1.1 How to use the manual

**ADVICE**

This manual is intended for qualified personnel working in electrical engineering and electronics! Part of the device documentation in addition to this manual is the enclosed supplement "Safety instructions for Bender products".

**ADVICE**

Read the operating manual before mounting, connecting and commissioning the device. Keep the manual within easy reach for future reference.

1.2 Indication of important instructions and information

**DANGER**

Indicates a high risk of danger that will result in death or serious injury if not avoided.

**WARNING**

Indicates a medium risk of danger that can lead to death or serious injury if not avoided.

**CAUTION**

Indicates a low-level risk that can result in minor or moderate injury or damage to property if not avoided.

**ADVICE**

Indicates important facts that do not result in immediate injuries. They can lead to malfunctions if the device is handled incorrectly.



Information can help to optimise the use of the product.

1.3 Signs and symbols



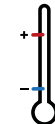
Disposal



Protect from moisture



Protect from dust



Temperature range



Recycling



RoHS directives

1.4 Service and Support

Information and contact details about customer service, repair service or field service for Bender devices are available on the following website: Fast assistance | Bender GmbH & Co. KG.

1.5 Training courses and seminars

Regular face-to-face or online seminars for customers and other interested parties:

www.bender.de > know-how > seminars.

1.6 Delivery conditions

The conditions of sale and delivery set out by Bender GmbH & Co. KG apply. These can be obtained in printed or electronic format.

The following applies to software products:

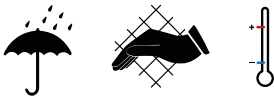


"Software clause in respect of the licensing of standard software as part of deliveries, modifications and changes to general delivery conditions for products and services in the electrical industry"

1.7 Inspection, transport and storage

Check the shipping and device packaging for transport damage and scope of delivery. In the event of complaints, the company must be notified immediately, see "www.bender.de > service & support".

The following must be observed when storing the devices:



1.8 Warranty and liability

Warranty and liability claims for personal injury and property damage are excluded in the case of:

- 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.
- The use of accessories or spare parts that are not provided, approved or recommended by the manufacturer.
- Catastrophes caused by external influences and force majeure.
- Mounting and installation with device combinations not approved or recommended by the manufacturer.

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

1.9 Disposal of Bender devices

Abide by the national regulations and laws governing the disposal of this device.



For more information on the disposal of Bender devices, refer to www.bender.de > service & support.

1.10 Safety

If the device is used outside the Federal Republic of Germany, the applicable local standards and regulations must be complied with. In Europe, the European standard EN 50110 applies.



DANGER *Risk of fatal injury due to electric shock!*

Touching live parts of the system carries the risk of:

- Risk of electrocution due to electric shock
- Damage to the electrical installation
- Destruction of the device

Before installing the device and before working on its connections, make sure that the installation has been de-energised. The rules for working on electrical systems must be observed.

2 Safety instructions



ADVICE

This manual is intended for qualified personnel working in electrical engineering and electronics! Part of the device documentation in addition to this manual is the enclosed supplement "Safety instructions for Bender products".



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Before installing the device and before working on its connections, make sure that the installation has been de-energised. The rules for working on electrical systems must be observed.

3 Product description

3.1 Intended use

The AC/DC sensitive residual current monitors of type MRCDB300 series are used in combination with a CTBC... measuring current transformer and a circuit breaker according to IEC 60947-2 as additional protection in industrial power supplies. According to IEC 60364-5-53, the use in earthed power supplies (TN and TT systems) up to 800 V is possible. These devices are suitable for monitoring AC and DC fault currents (type B).

Any other use than that described in this document is regarded as improper.

3.2 Area of application

The AC/DC sensitive device series MRCDB300 series is used in combination with a CTBC... as additional protection (protection against indirect contact) in earthed systems (TN and TT systems) in which AC or DC fault currents may occur.

Part of these systems are particularly loads containing six-pulse rectifiers or one-way rectifiers with smoothing, such as converters, battery chargers, construction site equipment with frequency-controlled drives. When the response value $I_{\Delta n1}$ (prewarning) is reached, the output relay K1 switches. When the response value $I_{\Delta n2}$ (alarm) is reached, the output relay K2 also switches.

By using an MRCDB300 series module and a switching element with isolating properties, the device combination fulfils the requirements of IEC 60947-2 Annex M for an MRCD protective device.

The application is specifically intended for protection goals such as protection of persons, fire protection and plant protection. The switching element must not exceed a switch-off time of 20 ms.

The CTBC...P series measuring current transformers feature an integrated magnetic shield and are suitable for applications with high load currents or inrush currents.

3.3 Device features

- Structure of a protective device in accordance with IEC 60947-2 Annex M in combination with a circuit breaker providing isolating properties
- Monitoring of the connected circuit breaker by means of contact feedback
- RS-485 interface with Modbus RTU (reading out measured values/setting parameters)
- Integrated switching outputs with two changeover contacts K1 and K2 (galvanically isolated)
- Fulfils the protection goals protection of persons, fire protection and plant protection (depending on the variant)
- Frequency range (depending on the variant) DC...100 kHz
- Combined test and reset button
- Multicolour LED indicating operation, exceeded response value, disturbances and status messages
- AC/DC sensitive type B measured value acquisition acc. to IEC 60755 (depending on the variant)
- AC/DC sensitive type B+ measured value acquisition acc. to VDE 0664-400 (depending on variant)
- Exchangeable electronic enclosure without mechanical separation of the primary conductors
- Extension/retrofitting or modification of functionalities in case of changed monitoring requirements
- Insensitive to load currents due to full magnetic shield (CTBC...P only)
- Connection monitoring of the measuring current transformer with cyclical test current
- Use of all MRCDB30... for all CTBC... measuring current transformer sizes
- Supply voltage DC 24 V

3.4 Variants

Electronic modules

- **MRCDB301**

Type B modular residual current protective device acc. to IEC 60755 for the protection of persons in case of indirect contact, response value 30 mA

- **MRCDB302**

Type B+ modular residual current protective device acc. to VDE 0664-100 for fire protection, response value 300 mA

- **MRCDB303**

Modular residual current protective device for plant protection (N/C operation), freely configurable

- **MRCDB304** (only on request)

Modular residual current protective device for plant protection (N/O operation), freely configurable

- **MRCDB305**

Modular residual current protective device type B acc. to IEC 60755 for the protection of persons in case of indirect contact; for applications with pulse-shaped, very high peak load currents (> 1 kA for < 1 s), e.g. welding applications, response value 30 mA

Measuring current transformers (P = shielded)

- **CTBC20(P)**

Measuring current transformer, internal diameter 20 mm

- **CTBC35(P)**

Measuring current transformer, internal diameter 35 mm

- **CTBC60(P)**

Measuring current transformer, internal diameter 60 mm

- **CTBC120(P)**

Measuring current transformer, internal diameter 120 mm

- **CTBC210(P)**

Measuring current transformer, internal diameter 210 mm

3.5 Functions

3.5.1 Functional description

Residual current $I_{\Delta n}$

The residual current monitoring module measures both AC and DC currents. Tripping takes place based on the determined r.m.s. value. When the response value set for $I_{\Delta n2}$ (main alarm) is exceeded by a residual current, the output relay K2 switches an undervoltage release (recommended) or a shunt release (N/O operation) within the required tripping time and the LED lights up red. If the fault memory behaviour of relay K1 or K2 is activated, the device must be reset by pressing the "T" button. The MRCD module automatically checks the measuring current transformer and the function of the residual current measurement cyclically.

Measuring range	Response values	Maximum value
Measuring range 1	30...126 mA	450 mA
Measuring range 2	127...495 mA	1750 mA
Measuring range 3	496 mA...3 A	14 A

Offset calibration

When the device has been installed, an offset calibration must first be carried out (see "Offset calibration",

page 24). After successful offset calibration, the multicolour LED lights up green and the device is ready for operation.

Test

Press the "T" button or the external test button for 5...10 s to start the manual self test of the device.

Reset

Press the "T" button or the external test button for 1.5...5 s to reset the device.

Contact feedback

The contact feedback ensures that the circuit breaker is in the desired switching state.

RS-485 interface

The RS-485 interface enables both reading out the measured values and setting the parameters of the device via Modbus RTU. Furthermore, a test or a reset can be triggered via the bus.

Switch-off control

After a main alarm, the measured I_{Δ} (r.m.s.) must be lower than $0.5 \times I_{\Delta n}$ of the smallest alarm limit value active via alarm assignment, so that K2 switches on again. If the residual current is permanently higher, this is a sign of a welded contactor or incorrect wiring. The device displays an error (error code: 0.56).

3.5.2 Delay times t_b , t , t_{on} and t_{off}

The times t_b , t , t_{on} and t_{off} described below delay the output of alarms via LEDs, relays and Modbus RTU.

Recovery time t_b

The recovery time is the time the device needs to be ready for measurement after connecting the supply voltage U_S .

Start-up delay t

After connecting the supply voltage U_S , the measuring function is delayed by the set time t (0...999 s) plus the recovery time t_b .

Response delay t_{on}

If a residual operating current is exceeded, the residual current monitor requires the response time t_{an} to output the alarm. A set response delay t_{on} (0...10 s) is added to the device-specific operating time t_{ae} and delays signalling:

$$\text{Response time } t_{an} = t_{ae} + t_{on}$$

If the fault does not persist during the response delay, the alarm is not signalled.

Delay on release t_{off}

If the alarm no longer exists and the fault memory is disabled, the alarm LEDs go out and the alarm relays switch back to their initial position. By means of the delay on release (0...999 s), the alarm state is maintained for the selected period.

4 Mounting



Only skilled persons are permitted to carry out the work necessary to install, put into service and run a device or system.



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- Damage to the electrical installation
- Destruction of the device

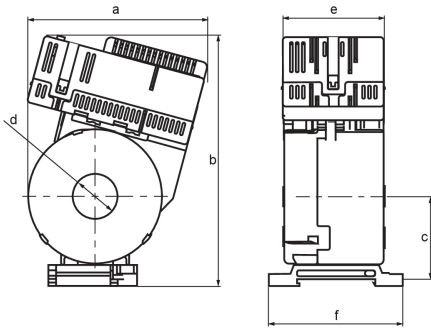
Before installing the device and before working on its connections, make sure that the installation has been de-energised. The rules for working on electrical systems must be observed.

Refer to the rated and supply voltage values as specified in the technical data!

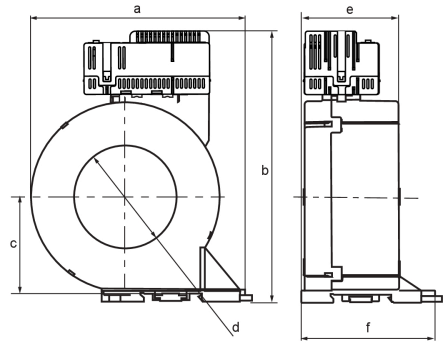
4.1 Composition of an MRCD module

Any combination of electronic modules (MRCDB30...) and measuring current transformers (CTBC...) is possible to enable individual adaptation to every installation situation.

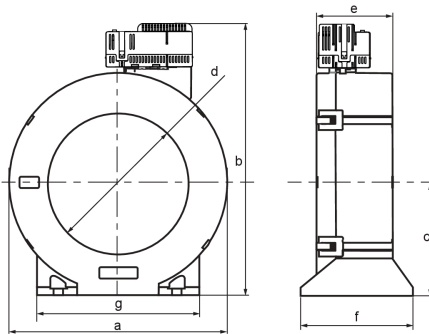
4.2 Dimension diagrams



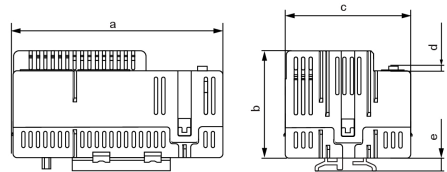
CTBC20(P) / CTBC35(P)



CTBC60(P)



CTBC120(P) / CTBC210(P)

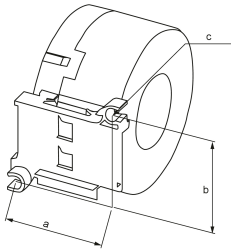


MRADB30...

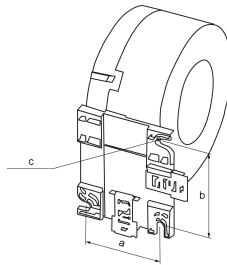
Type	a	b	c	d	e	f	g
MRADB30...-CTBC20(P)	81	112	37	∅ 20	46	60	
MRADB30...-CTBC35(P)	97	130	47	∅ 35	49	61	
MRADB30...-CTBC60(P)	126	158	57	∅ 60	56	78	
MRADB30...-CTBC120(P)	188	232	96	∅ 120	65	96	139
MRADB30...-CTBC210(P)	302	346	153	∅ 210	67	113	277
MRADB30...	74	37	44	2	4.6		

all dimensions in mm, tolerance ± 0.5 mm

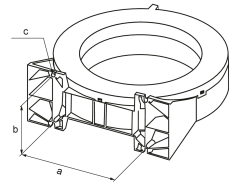
4.3 Mountings



CTBC20(P) / CTBC35(P)



CTBC60(P)



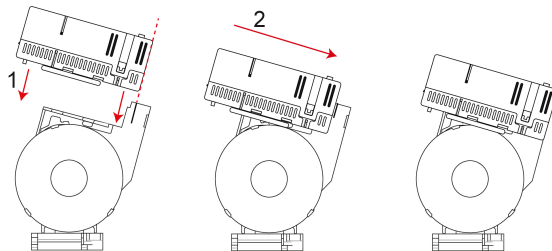
CTBC120(P) / CTBC210(P)

Type	a	b	c
CTBC20(P)	31.4	49	2 x \varnothing 5.5
CTBC35(P)	49.8	49	2 x \varnothing 5.5
CTBC60(P)	56	66	2 x \varnothing 6.5
CTBC120(P)	103	81	4 x \varnothing 6.5
CTBC210(P)	180	98	4 x \varnothing 6.5

all dimensions in mm, tolerance ± 0.5 mm

4.4 Assembly

Slide the electronic module onto the plug contacts of the measuring current transformer.



Avoid repeated plugging and unplugging of the electronics (10 plugging cycles).

5 Connection

5.1 Connecting the device



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- Damage to the electrical installation
- Destruction of the device

Before installing the device and before working on its connections, make sure that the installation has been de-energised. The rules for working on electrical systems must be observed.

Refer to the rated and supply voltage values as specified in the technical data!



For UL applications:

Use 60/75 °C copper wires only!

5.2 Device view

	1	D1	Contact feedback
	2	DG	
	3	A	RS-485 interface
	4	B	
	5	X1	Terminals for cable bridge for connection of the integrated terminating resistor of the RS-485 interface
	6	X2	
	7	GND	Connection external test/reset
	8	T/R	
	9	GND	Supply voltage U_s
	10	24 V	
	11	11, 12, 14	Relay K1 (prewarning)
	12	21, 22, 24	Relay K2 (main alarm)
	13	ON/AL	Combined LED; see System states: LED and output relays
	14	T	Test and reset button "T"

5.3 Wiring diagrams

The following applies to all wiring diagrams:

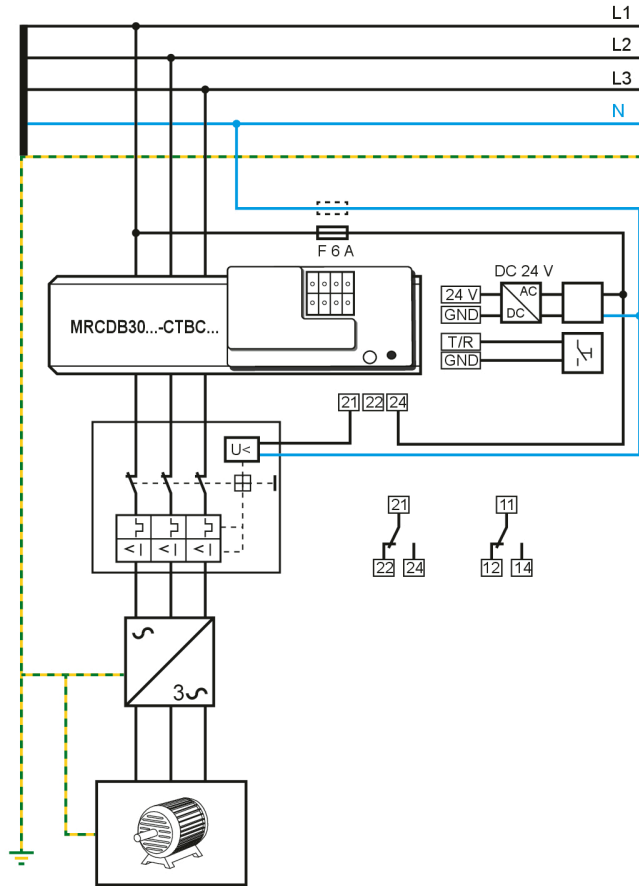
- The use of a type 2 surge protection device (SPD) is mandatory due to possible impulse voltages and in order to comply with normative requirements.
- The surge protection device must be connected upstream of the power supply unit on the supply side.
- Features of the surge protection device
 - Nominal discharge current I_n (8/20 μ s): 20 kA
 - Response time: 25 ns
 - Two-stage: 1 varistor + 1 spark gap

Alternatively, the power supply unit can be connected to a CAT II supply without a surge protection device.

The power supply unit must be connected before the switch.

5.3.1 N/C principle without contact feedback

Wiring diagram MRCDB300... (N/C principle without contact feedback)



Legend

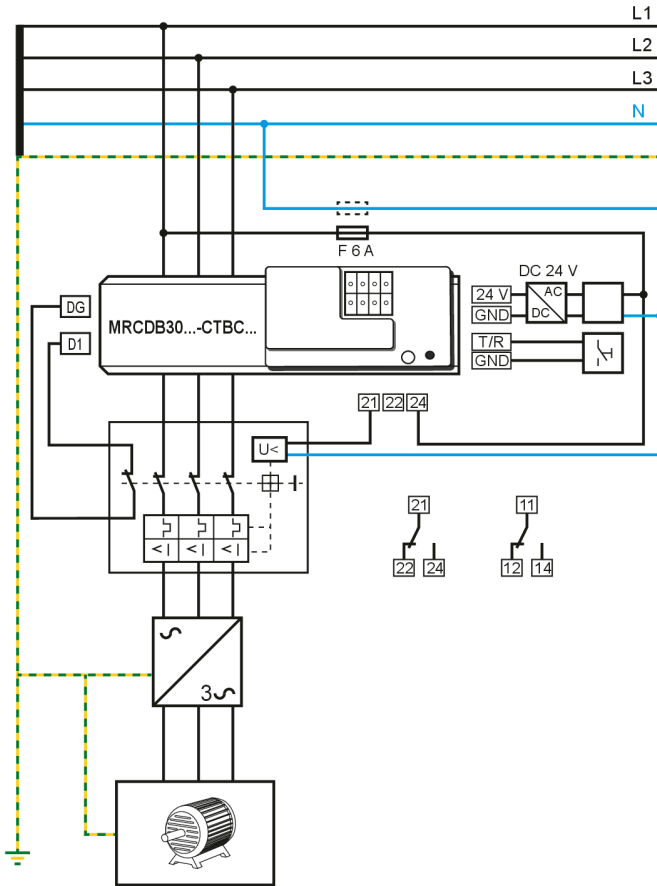
11, 12, 14 =
Relay for prewarning

21, 22, 24 =
Relay for main alarm

 =
surge protection device

5.3.2 N/C principle with contact feedback

Wiring diagram MRCDB30... (N/C principle with contact feedback)



- Legend*
- 11, 12, 14 =
Relay for prewarning
 - 21, 22, 24 =
Relay for main alarm
 - =
surge protection device

The contact feedback ensures that the trip circuit is in the desired switching state. If due to events such as

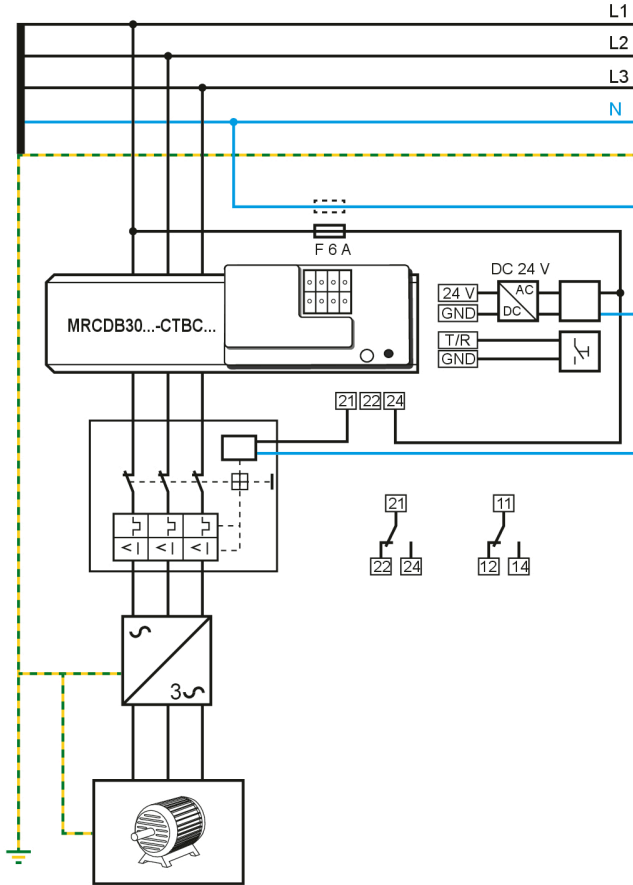
- burnt relay contacts (K2) on the MRCDB30...
- mechanical jam of the circuit breaker
- incorrect wiring

no separation at the circuit breaker takes place, the feedback signal contacts (D1/DG) cannot signal a change

of state. A failure of the trip circuit, which would otherwise go undiscovered, is detected immediately. This information can be forwarded via the RS-485 interface or relay K1 to a control centre.

5.3.3 N/O principle without contact feedback

Wiring diagram MRCDB30... (N/O principle without contact feedback)



Legend

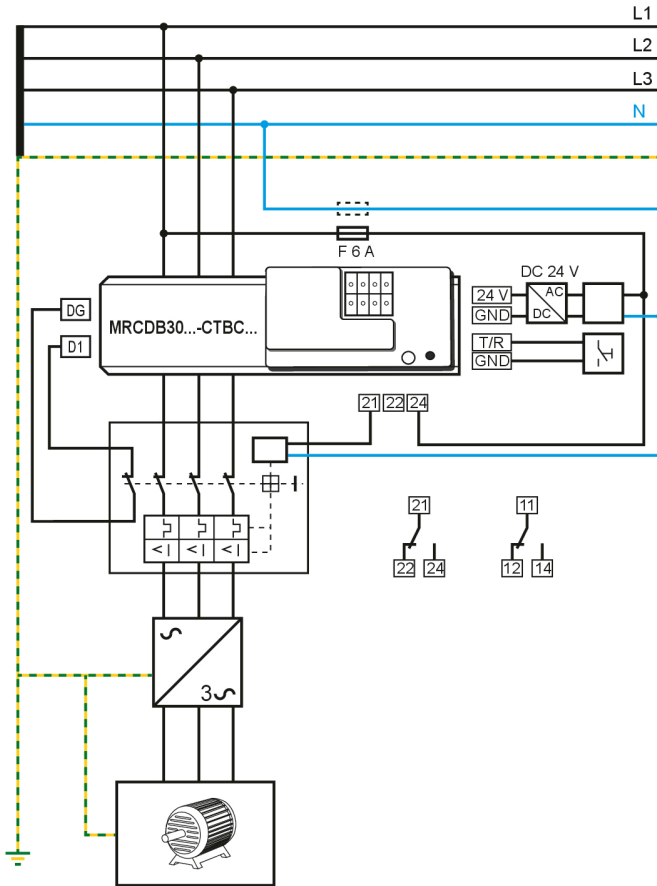
11, 12, 14 =
Relay for prewarning

21, 22, 24 =
Relay for main alarm

□ =
surge protection device

5.3.4 N/O principle with contact feedback

Wiring diagram MRCD30... (N/O principle with contact feedback)



Legend

11, 12, 14 =
Relay for prewarning

21, 22, 24 =
Relay for main alarm

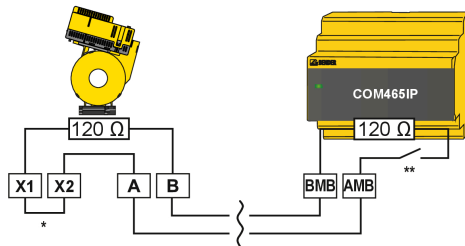
□ =
surge protection device

i We **recommend operating the alarm relay K1 according to the N/C principle**. This allows detecting and reporting the failure of the supply voltage and the internal power supply unit.

For economical installation reasons, alarm relay K2 can be operated according to the N/O principle. Due to this operating principle, the following aspects should be observed **to minimise the risks**:

1. The risk assessment intervals should be shorter.
2. Due to the **contact feedback** via the measuring inputs D1 and DG, the following fault types are detected and signalled as alarms via the alarm relay K1:
 - Interruption of the connecting line from the alarm relay K2 to the shunt release (N/O operation)
 - Mechanically defective circuit breaker
 - Defective output relay K2 for controlling the shunt release (N/O operation)

5.4 Connection RS-485 interface (Modbus RTU)



* The internal 120 Ω terminating resistor can be connected by using the **wire jumper**.

** The internal 120 Ω terminating resistor can be connected by means of the **DIP switch**.

5.5 Installation instructions for measuring current transformers



CAUTION

Device damage due to high induction currents!

High currents can be induced into the conductor loop due to the AC/DC sensitive measurement technology used. Do not route protective conductors and low-resistance conductor loops through the measuring current transformer!

Device damage due to interference pulses!

The connecting cable (supply, analogue interface...) must not be routed directly past the current transformer core.

Risk of injury due to accessible live conductors!

The measuring current transformer must be connected to the corresponding evaluator before the first use and before commissioning of the monitored system.

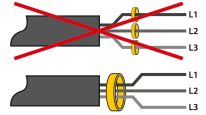
i **Application in railway vehicles / DIN EN 45545-2:2016**

If the distance to adjacent components that do not meet the requirements of DIN EN 45545-2 Table 2 is < 20 mm horizontally or < 200 mm vertically, they are to be considered grouped. Refer to DIN EN 45545-2 chapter 4.3 Grouping rules.

i Do not route any shielded cables through the measuring current transformer!

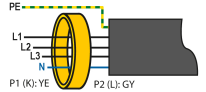
Live conductors

Ensure that **all live cables/conductors** are routed through the measuring current transformer.



Protective conductors

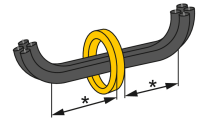
Never route an existing protective conductor through the measuring current transformer. The cable diameter should not exceed half the diameter of the measuring current transformer.



Bending of cables

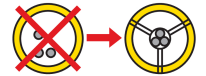
The cables/conductors should only be bent at a certain distance from the measuring current transformer.

* Distance to the 90° angle of the conductors: 2 x outer diameter of the measuring current transformer.



Route cables in the centre

The cables/conductors must be centred in the middle of the measuring current transformer.



6 Commissioning

6.1 Setting addresses

Every MRCDB300 series has a factory-set Modbus address. The address is 1XX, where XX = the last two digits of the serial number.

i Example: Serial number = 12345678 --> Modbus address = 178

If the preset address is to be changed, this can be done

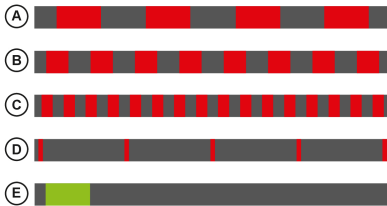
- via a COMTRAXX® gateway,
- via Modbus,
- directly on the device.

The address can be changed on the device before installation and offset calibration.

i The electronic module must not be connected to the measuring current transformer during address setting.

i Each address in the bus system may only be assigned once.

The LED has various flashing patterns, which indicate the state of the module:



Address modification procedure

Phase	Action	LED
1	Supply the electronic module with power	Flashes red (A , error: no measuring current transformer)
2	Press and hold "T" until the LED flashes red very quickly; release afterwards	Flashes red (A , error)
		Flashes red quickly (B , mode change)
		Flashes red quickly (C , ready for address setting mode)
3	Set address (address setting range: 1...247)	Flashes red very quickly (D , address setting mode)

Phase	Action		LED
3a	Units place	Press "T" repeatedly until reaching the desired digit of the units place	Each keystroke is confirmed with green (E)
		Acknowledge the entry: Press and hold "T" until the LED flashes red; release afterwards	Lights green shortly (E) LED flashes red (C)
3b	Tens place	Press "T" repeatedly until reaching the desired digit of the tens place	Each keystroke is confirmed with green (E)
		Acknowledge the entry: Press and hold "T" until the LED flashes red; release afterwards	Lights green shortly (E) LED flashes red (C)
3c	Hundreds place	Press "T" repeatedly until reaching the desired digit of the hundreds place	Each keystroke is confirmed with green (E)
		Acknowledge the entry: Press and hold "T" until the LED flashes red; release afterwards	Lights green shortly (E) LED flashes red (C)
4	Check address setting: LED indicates the address by flashing ¹⁾		
		Digit hundreds place	Flashes green for each number (E)
		Pause	off
		Digit tens place	Flashes green for each number (E)
		Pause	off
		Digit units place	Flashes green for each number (E)
	Pause	off	
5	Address set		Flashes red (A, error: no measuring current transformer)

1) Example for "Check address setting". Address "124" is to be set. Successful configuration results in the following flashing pattern:



6.2 Offset calibration

The residual current monitoring module must be calibrated to the system to be monitored so that the selected protective function can be fulfilled. Each electronic module MRCD300 series must be individually calibrated to the CTBC... **built-in measuring current transformer**. Calibration can be carried out by means of the "T" button or via the Modbus interface.

A calibration must always be performed in case of:

- New installation at the place of use after connecting the on-site cables
- A replacement of a CTBC... measuring current transformer

- A replacement of an MRCDB300 series electronic module
- A modification of the response value

In case of response values > 300 mA, no offset calibration is required.

If the device is not calibrated, the LED lights red permanently, commissioning is not possible. Note that during the offset calibration the system is switched off and no current flows through the measuring current transformer.

If a current flows through the measuring current transformer despite the system being switched off, this indicates a device error. Replace the measuring current transformer immediately.



The alarm relays switch to safe state during offset calibration (system is switched off).

Procedure of the first offset calibration

Phase	Action	LED
1	Install the measuring current transformer in the system	off
2	Plug the electronic module and the measuring current transformer together (see "Assembly", page 14)	lights red
3	Disconnect the electronic module from the supply voltage	off
4a	Press and hold the "T" button	off
4b	Press and hold the "T" button, supply the electronic module with supply voltage U_s	lights red permanently (not ready for operation)
		flashes red slowly (A) (ready for calibration)
		flashes red quickly (B) (calibration mode)
5	Start calibration: release "T"	
6	Calibration in progress	flashes red quickly (B)
7	Calibration successful, values are accepted, relay switches	lights green permanently
8	Calibration finished, normal operating status	lights green permanently

6.3 Completing and checking installation

The installation must be completed with a function test.

This is done by means of a manual self test (for details refer to "Manual self test", page 26).

7 Test, reset, function test

7.1 Periodic self test

The MRCDB300 series electronic module carries out a self diagnosis at regular intervals and thus ensures the device function. The electronic module feeds a test current into the test winding of the measuring current transformer.

i *During a periodic self test, the electronic module **does not switch off the circuit breaker**. However, if a system fault is detected, the output relay and the external circuit breaker are used to switch off.*

7.2 Manual self test

7.2.1 Integrated "T" button

Reset	Press the button for 1.5...5 s
Test	Press the button for 5...10 s

The integrated "T" button allows local performance of a function test at any time. The button is useful during commissioning, repair measures and recurring tests by the plant operator.

The "T" button can be used to delete a fault message of the tripped MRCD (reset).

The integrated "T" button is electrically decoupled from the external test/reset connection. This ensures that, of all MRCDs connected via the T/R connection, only the local MRCD acts.

7.2.2 External test/reset button

Reset	Press the button for 1.5...5 s
Test	Press the button for 5...10 s

The external test/reset button can be used to perform function tests without having to open a control cabinet or reach an installation location that is difficult to access. Another option is to carry out a collective test, i.e. a function test of several installed MRCDs at the same time.

7.3 Function test

The system operator is obliged to have the MRCD protective devices checked at regular intervals by an electrically skilled person to ensure that they are functioning properly. This requirement is deemed to be satisfied for normal and environmental conditions if the test intervals mentioned in DGUV V3 (German Social Accident Insurance Regulation 3) are adhered to. The test intervals are to be interpreted in accordance with the risk assessment.

The recurrent tests must include at least the following:

- Testing the environmental conditions for pollution, mechanical damage or insulation damage.
- To trip the circuit breaker, the integrated or the external test button is to be pressed.

8 Modbus register

This chapter provides a complete description of the Modbus register for the MRCDB300/RCMB300 series to allow access to information.

The following Modbus function codes are supported

- Holding register for reading out values (Read Holding Register; function code 0x03)
- Register for device programming (Write Multiple Registers; function code 0x10)
- Register for diagnostic functions (Diagnostic; function code 0x08)
- Register for event counter (Get Com Event Counter; function code 0x0B)
- Register for server ID (Report Server ID; function code 0x11)
- Register for device identification (Read Device Identification; function code 0x2B)

For a complete Modbus protocol specification, visit <https://www.modbus.org>.

8.1 Overview

8.1.1 Read and write accesses

RO	Read Only (read access only)
RW	Read/Write (read and write access)
WO	Write Only (write access only)

8.1.2 Formats used

Float32	IEEE754 32-bit (single precision floating point number)
INT16	Signed 16-bit integer
INT32	Signed 32-bit integer
UINT16	Unsigned 16-bit integer
UINT32	Unsigned 32-bit integer
String UTF8	ASCII character string

8.1.3 Register areas

Area	Start address	End address
Info	0	3999
Detailed measured values	4000	7999
Simple measured values	8000	11999
History	12000	15999
Parameters	16000	19999
Control commands	20000	23999
Reserved	24000	27999
Reserved	60000	60099

8.1.4 Representation of values

	Value	Description		Value	Description
Test status	0	No test	Unit	6	Hertz
	1	Internal test		7	Baud
	2	External test		8	Farad
Alarm status	0	No alarm		9	Henry
	1	Prewarning		10	Degree Celsius
	2	Error		11	Degree Fahrenheit
	3	Reserved		12	Second
	4	Warning		13	Minute
	5	Main alarm		14	Hour
Range	0	=		15	Day
	1	<		16	Month
	2	>		17	Watt
	3	Invalid		18	var
Unit	0	Invalid		19	VA
	1	None		20	Wh
	2	Ohm		21	varh
	3	Ampere		22	VAh
	4	Volt		23	Degree
	5	Percent		24	Hertz/second*

* Unit of the df/dt function

8.1.5 Alarm assignments

Bit number	Description
0	Start alarm (relay 1)
1	Device error (relay 1)
2	Manual self test (relay 1)
3	AC residual current (relay 1)
4	DC residual current (relay 1)
5	RMS residual current (relay 1)
6...15	Reserved
16	Start alarm (relay 2)

Bit number	Description
17	Device error (relay 2)
18	Manual self test (relay 2)
19	AC residual current (relay 2)
20	DC residual current (relay 2)
21	RMS residual current (relay 2)
22...31	Reserved

8.1.6 Descriptions

Description	Value
Device error	115
DC fault current	155
AC fault current	156
RMS fault current	420
"inactive"	1021
"none"	1022
"invalid"	1023

8.2 Device information

Modbus registers device information

Register	Format	Pro- perty	Description	Value/unit/comment	Factory settings
0...999	Reserved				
1000	UINT32	RO	Modbus test register	Is used to configure the interface (endianess, byte order, etc.)	0x12345678
1002	String UTF-8	RO	Device name	Maximum 32 characters (\0 = end character) Character is in the LoByte	MRCDB300 series\0
1034	String UTF-8	RO	Article number		Example: Bxxxxxxx\0
1066	String UTF-8	RO	Serial number		Example: yyyyyyyyy\0
1098	String UTF-8	RO	Manufacturer name	Maximum 96 characters (\0 = end character) Character is in the LoByte	Bender GmbH & Co. KG\0
1194	UINT16	RO	Application D-number		579
1195	UINT16	RO	Application version	Version number multiplied by 100	Example: 123 = V1.23
1196	UINT16	RO	Application Build number		
1197	UINT16	RO	Bootloader D-number		

Register	Format	Pro- perty	Description	Value/unit/comment	Factory settings
1198	UINT16	RO	Bootloader version	Version number multiplied by 100	Example: 123 = V1.23
1199	UINT16	RO	Bootloader Build number		
1200	UINT32	RO	Counter offset measurement	Counts how often complete, successful offset measurements were carried out.	
1202... 1233	String UTF-8	RO	Internet address manufacturer	Character is in the LoByte in each case. Maximum 32 characters.	www.bender.de\0
1234... 1265	String UTF-8	RO	Installation location ¹⁾	\0 = NULL character = string end	
1266	UINT16	RO	Application Modbus modul version	Version number multiplied by 100	Example: 123 = V1.23
1267... 3999	Reserved				

- 1) When writing this parameter, it must be ensured that the entire character string is structured in 8-character blocks and that one block must always be written completely with one Modbus command. This means that characters 1...8, 9...16, 17...24 and/or 25...32 must be written. If the string does not fill a block completely, it must be filled with NULL characters. The installation location is also added to the server ID (function code 17) up to the first NULL character.

8.3 Detailed measured values

With the detailed measured values, status information and units etc. are also transmitted in addition to the measured values. This function is mainly required for the Bender COMTRAXX® system. However, it can also be of interest for direct readout of the Modbus registers, as these registers can be used to query the measured values and associated status information all at once and in direct succession.

Register	Format	Pro- perty	Description	Value/unit	
4000	UINT16	RO	AC	Measuring channel number (1)	
4001	Float32	RO		Residual current measured value (AC)	A
4003	UINT16	RO		Test and alarm status ¹⁾	
4004	UINT16	RO		Range and unit ²⁾	
4005	UINT16	RO		Description	
4006...4015	Reserved				
4016	UINT16	RO	DC	Measuring channel number (2)	
4017	Float32	RO		Residual current measured value (DC)	A
4019	UINT16	RO		Test and alarm status ¹⁾	
4020	UINT16	RO		Range and unit ²⁾	
4021	UINT16	RO		Description	
4022...4031	Reserved				

Register	Format	Property	Description	Value/unit	
4032	UINT16	RO	RMS	Measuring channel number (3)	
4033	Float32	RO		Residual current measured value (RMS)	A
4035	UINT16	RO		Test and alarm status ¹⁾	
4036	UINT16	RO		Range and unit ²⁾	
4037	UINT16	RO		Description	
4038...4047	Reserved				
4048	UINT16	RO	Device error/ status information	Measuring channel number (4)	
4049	Float32	RO		Device error and status information ³⁾	Device/info code
4051	UINT16	RO		Test and alarm status ¹⁾	
4052	UINT16	RO		Range and unit ²⁾	
4053	UINT16	RO		Description	
4054...7999	Reserved				

- 1) HiByte: Test status
LoByte: Alarm status
- 2) HiByte: Bereich
LoByte: Einheit
- 3) see "Error codes", page 32

i *The data of the individual measured value blocks (AC, DC, RMS, device error/status information) belong together and must always be read out as a complete block. Background: While the registers are being read out, some time passes during which the data could theoretically change. To avoid this, the detailed measured values in the respective block are only updated when the measuring channel number is read.*

8.4 General measured values

Measured values AC	Only AC component of the residual current, effective value
Measured values DC	Only DC component of the residual current
Measured values RMS	Combination of AC and DC components of the residual current, effective value
Max. measured values	Maximum value of the respective measured value since the last Modbus polling of the corresponding register
Unfiltered values	Raw values without software filter (all filter settings are pure software filters), i.e. full frequency range DC...100 kHz

Register	Format	Property	Description	Value/unit/comment
8000	Float32	RO	Measured value $I_{\Delta n}$ (AC)	A
8002	Float32	RO	Measured value $I_{\Delta n}$ (DC)	A
8004	Float32	RO	Measured value $I_{\Delta n}$ (RMS)	A
8006	Float32	RO	Device error and status information ¹⁾	Device/info code
8008	UINT32	RO	Number of alarms	-
8010	Float32	RO	Measured value $I_{\Delta n}$ (AC unfiltered)	A
8012	Float32	RO	Measured value $I_{\Delta n}$ (RMS unfiltered)	A
8014	UINT32	RO	Tripping status (alarm assignment that led to tripping)	Bit, binary coded HiWord: relay 2 LoWord: relay 1
8016	Float32	RO	Measured value $I_{\Delta n \max}$ (AC) ²⁾	A
8018	Float32	RO	Measured value $I_{\Delta n \max}$ (DC) ²⁾	A
8020	Float32	RO	Measured value $I_{\Delta n \max}$ (RMS) ²⁾	A
8022	Float32	RO	Device error and status information ¹⁾²⁾	Device/info code
8024	UINT32	RO	Number of alarms ²⁾	-
8026	Float32	RO	Measured value $I_{\Delta n \max}$ (AC unfiltered) ²⁾	A
8028	Float32	RO	Measured value $I_{\Delta n \max}$ (RMS unfiltered) ²⁾	A
8030	UINT32	RO	Trigger status ²⁾	Bit, binary coded HiWord: relay 2 LoWord: relay 1
8032...11999			Reserved	

1) see "Error codes", page 32

2) Same data as register 8000...8014, but the maximum values or cumulative values are output since the last readout. In the case of the DC measured value, the highest value is stored.

8.5 Error codes

Error code	Error group	Error	Description	Action
0.10	Connection fault	Connection	CT connection faulty	Check connection between electronic box and measuring current transformer.
0.55	Connection fault	External circuit breaker	The present switching state of the external circuit breaker does not correspond to the target switching state.	Check circuit breaker and its cabling. Check contact feedback of the circuit breaker and its cabling. Parameter operating mode of the circuit breaker (Modbus register: 16056) and contact feedback.
0.56	Connection fault	Shutdown control	Although the system is switched off, a (residual) current still flows.	Check circuit breaker and its cabling. Check parameter operating mode of the circuit breaker (Modbus register: 16056).

Error code	Error group	Error	Description	Action
3.30	Component malfunction	Manual self test	The manual self test was not run without errors.	Check circuit breaker and its cabling. Check contact feedback of the circuit breaker and its cabling (if contact monitoring is active). Check parameter operating mode of the circuit breaker (Modbus register).
6.00	Calibration error			The error is deleted either by switching the device off/ on or by performing a reset. The device restarts completely (switching of relays possible). If the error persists, return the device or contact Bender service.
6.10	Calibration error	No initial offset measurement	No offset measurement has been performed in the customer installation.	Perform offset measurement.
6.20	Calibration error	Offset measurement	Measured offset is outside the limits.	Does a (DC) current still flow through the measuring current transformer? Check circuit breaker. The error is deleted either by switching the device off/on or by performing a new offset measurement (if this is successful).
7.10	Internal interface error			If error occurs frequently, return the device or contact Bender service.
8.00, 8.43 8.44, 8.46 8.47, 8.49; 8.60, 8.71	Hardware error			If error occurs frequently, return the device or contact Bender service.
9.03	µC system error			Switch the device off and on again. If error persists, return the device or contact Bender service.
9.60	µC system error	Parameter error	Parameter outside permissible limits	Switch the device off and on again. Reset device to factory settings: Modbus register 20007 or 20008. If error persists, return the device.
9.70 9.90	µC system error			Switch the device off and on again. If error persists, return the device or contact Bender service.

8.6 History

A maximum of 50 events can be stored. The events are sorted chronologically in such a way that the most recent event is number 1 and the oldest event is number 50. The history memory is buffered and is only updated by reading register 12000 so that the sequence does not change during readout (due to a new history event).

The parameter "Overwrite history memory" (register: 16089) can be used to set

- whether the history memory fills to a maximum of 50 events and then has to be cleared manually (register: 20004)
- whether the oldest event (number 50) is overwritten automatically (factory setting).

Register	Format	Pro- perty	Description	Value/unit/comment
12000	UINT16	RO	Event 1 measuring channel number	1)
12001	UINT32	RO	Event 1 start	2)
12003	UINT32	RO	Event 1 end	
12005...12006	Reserved			
12007	Float32	RO	Event 1 min. value	
12009	Float32	RO	Event 1 max. value	
12011	UINT16	RO	Event 1 unit/test status	HiByte: unit LoByte: test status
12012	UINT16	RO	Event 1 alarm status min/max	HiByte: min. value LoByte: max. value
12013	UINT16	RO	Event 1 range min/max	
12014	UINT16	RO	Event 1 description	
12015...12017	Reserved			
12018... 12035	RO		Event 2	
12036... 12899	RO		Event 3...50	
12900...15999	Reserved			

1) When register 12000 is read out, the entire history memory is updated. This way, the data remains consistent.

2) If no time has been set in register 16084: time in s from the occurrence of the event to the readout of register 12000 (indicates how long before the history memory was read out the event occurred) If a time is set in register 16084: UNIX time of the event.

8.7 Device parameters and factory settings

t_{on} = response delay

t_{off} = delay on release

()* = factory settings

Register	Format	Property	Description	Value range Unit (Step size)	()* MRCDB					
					301	302	303	304	305	
16000	Float32	RW	AC	Limit value main alarm	0.03... 3.00 A {1 mA}	0.03 A	0.3 A	0.03 A	0.3 A	0.03 A
16002	Float32	RW		Limit value prewarning	50...100 % {1 %}	60 %	60 %	60 %	50 %	60 %
16004	Float32	RW		Hysteresis	10...25 % {1 %}	15 %	15 %	15 %	25 %	15 %
16006	Float32	RW		t_{on} main alarm	0 s...60 min {10 ms}	0 s	0 s	0 s	0 s	0 s
16008	Float32	RW		t_{on} prewarning		1 s	1 s	1 s	2 s	1 s
16010	Float32	RW		t_{off}		1 s	1 s	1 s	1 s	1 s

Register	Format	Property	Description	Value range Unit {Step size}	(*) MRCDB					
					301	302	303	304	305	
16012	Float32	RW	DC	Limit value main alarm	0.03...3.00 A {1 mA}	0.03 A	0.3 A	0.03 A	0.3 A	0.03 A
16014	Float32	RW		Limit value prewarning	50...100 % {1 %}	60 %	60 %	50 %	50 %	60 %
16016	Float32	RW		Hysteresis	10...25 % {1 %}	15 %	15 %	15 %	25 %	15 %
16018	Float32	RW		t_{on} main alarm	0 s...60 min {10 ms}	0 s	0 s	0 s	0 s	0 s
16020	Float32	RW		t_{on} prewarning		1 s	1 s	1 s	2 s	1 s
16022	Float32	RW		t_{off}		1 s	1 s	1 s	1 s	1 s
16024	Float32	RW	RMS	Limit value main alarm	0.03...3.00 A {1 mA}	0.03 A	0.3 A	0.03 A	0.3 A	0.03 A
16026	Float32	RW		Limit value prewarning	50...100 % {1 %}	60 %	60 %	60 %	50 %	60 %
16028	Float32	RW		Hysteresis	10...25 %	15 %	15 %	15 %	25 %	15 %
16030	Float32	RW		t_{on} main alarm	0 s...60 min {10 ms}	0 s (fixed)	0 s (fixed)	0 s	0 s	0 s (fixed)
16032	Float32	RW		t_{on} prewarning		1 s	1 s	1 s	2 s	1 s
16034	Float32	RW		t_{off}		1 s	1 s	1 s	1 s	1 s
16036	Float32	RW	Start-up delay	0...3600 s {10 ms}	0 s	0 s	0 s	0 s	0 s	

Register	Format	Property	Description	Value range Unit (Step size)	()* MRCDB						
					301	302	303	304	305		
16038	UINT16	RW	Relay 1	Relay mode	1 = N/C principle 2 = N/O principle	1	1	1	1	1	
16039	UINT16	RW		Alarm assignment start alarm	1 = inactive 2 = active	2	2	2	2	2	
16040	UINT16	RW		Alarm assignment device error		2	2	2	2	2	
16041	UINT16	RW		Alarm assignment test		2 (fixed)	2 (fixed)	2 (fixed)	2 (fixed)	2 (fixed)	
16042	UINT16	RW		Alarm assignment limit value violation $I_{\Delta n}$ prewarning (AC)		1	1	1	1	1	
16043	UINT16	RW		Alarm assignment limit value violation $I_{\Delta n}$ prewarning (DC)		1	1	1	1	1	
16044	UINT16	RW		Alarm assignment limit value violation $I_{\Delta n}$ prewarning (RMS)		2	2	2	2	2	
16045...16054				—		Reserved					
16055	UINT16	RW		Fault memory mode		1 = off 2 = on 3 = permanent	1	1	1	1	1

Register	Format	Property	Description	Value range Unit {Step size}	(*) MRCDB					
					301	302	303	304	305	
16056	UINT16	RW	Relay 2	Relay mode	1 = N/C principle 2 = N/O principle	1	1	1	2	1
16057	UINT16	RW		Alarm assignment start alarm	1 = inactive 2 = active	2 (fixed)	2 (fixed)	2	2	2 (fixed)
16058	UINT16	RW		Alarm assignment device error		2 (fixed)	2 (fixed)	2	2	2 (fixed)
16059	UINT16	RW		Alarm assignment test		2 (fixed)	2 (fixed)	2 (fixed)	2 (fixed)	2 (fixed)
16060	UINT16	RW		Alarm assignment limit value violation $I_{\Delta n}$ main alarm (AC)		1 (fixed)	1 (fixed)	1	1	1 (fixed)
16061	UINT16	RW		Alarm assignment limit value violation $I_{\Delta n}$ main alarm (DC)		1 (fixed)	1 (fixed)	1	1	1 (fixed)
16062	UINT16	RW		Alarm assignment limit value violation $I_{\Delta n}$ main alarm (RMS)		2 (fixed)	2 (fixed)	2	2	2 (fixed)
16063...16072				—		Reserved				
16073	UINT16	RW	Fault memory mode	1 = off (...303 and ...304 only) 2 = on 3 = permanent		2	2	2	1	2
16074	UINT16	RW	Filter mode	see Register 16074 "Filter mode"	10	12	4	3	10	
16075	UINT16	RW	Function contact monitoring ¹⁾	1 = off 2 = N/C 3 = N/O	1	1	1	1	1	
16076	UINT16	RW	t_{off} contact monitoring ¹⁾ Time delay after which the connected relay state is monitored.	0 (= off) 0.01...3600 s {10 ms}	0	0	0	0	0	

Register	Format	Property	Description		Value range Unit (Step size)	(*) MRCDB				
						301	302	303	304	305
16078	UINT16	RW	2)	Modbus address	1...247	Last 2 digits of the serial number + 100				
16079	UINT32	RW		Baud rate	1200/2400/ 4800/9600/ 19200/38400/ 57600/19200	19200	19200	19200	19200	19200
16081	UINT16	RW		Parity/stop bit	1 = 8N2 2 = 8O1 3 = 8E1 4 = 8N1 5 = 8O2 6 = 8E2	3	3	3	3	3
16082...16083			—		Reserved					
16084	UINT32	RO	Time ³⁾	UNIX time	0	0	0	0	0	
16086	Float32	RW	Time zone ³⁾	-12...+14 {0,25}	0	0	0	0	0	
16088	UINT16	RW	Summer time ³⁾	0 = off 1 = on 2 = CEST (Automat. switchover: Central Europe) 3 = DST (Automatic switchover: USA/ CDN)	0	0	0	0	0	
16089	UINT16	RW	Overwrite history memory	1 = do not overwrite 2 = overwrite automatically	2	2	2	2	2	
16090...19999			—		Reserved					

1) Registers 16075 and 16076: If contact monitoring is active, the disconnected state is always checked after 500 ms (not configurable). If and when the connected state is checked depends on register 16076.

2) Wired interface (RS-485)

3) Is not saved when the device is switched off.

Register 16074 "Filter mode"

Register entry	Meaning	Adjustable for MRCDB				
		301	302	303	304	305
1	Normal (full bandwidth: 100 kHz)	X	X	X	X	X
2	Low pass 60 Hz	—	—	X	X	—
3	Low pass 500 Hz	—	—	X	X	—
4	Low pass 1 kHz	X	—	X	X	X
5	Low pass 2 kHz	X	—	X	X	X
6	Low pass 5 kHz	X	—	X	X	X
7	Low pass 10 kHz	X	—	X	X	X
8	Low pass 20 kHz	X	X	X	X	X
9	Low pass 50 kHz	X	X	X	X	X
10	Type B	X	—	X	X	X
11	—	Reserved				
12	Type B+ (up to 100 kHz)	—	X	X	X	—
13	—	Reserved				
14	Fire protection (up to 100 kHz)	—	—	X	X	—
15	—	Reserved				
16	—	Reserved				
17	Low pass 180 Hz	—	—	X	X	—

8.8 Control commands

Register	Format	Property	Description	Value/unit/comment	Factory setting
20000	UINT16	RW	Device test	Manual device tripping test. Same behaviour as test button. Read 1 = test inactive/completed 2 = test running Write 2 = start test	1
20001	UINT16	WO	Device reset	Deleting fault and alarm messages. Same behaviour as reset button. 1 = perform reset	
20002	UINT16	RW	Relay 1 test	1 = test inactive (normal function) 2 = relay energised	1
20003	UINT16	RW	Relay 2 test	3 = relay de-energised Switches automatically back to 1 = test inactive after one minute at the latest.	1
20004	UINT16	WO	Clear history memory	1 = perform deletion (secured via reg. 20005)	

Register	Format	Property	Description	Value/unit/comment	Factory setting
20005	UINT16	RW	Allow register write access	Flag to allow changing important registers. Is automatically deactivated after five seconds. 1 = deny 2 = allow	1
20006	UINT16	RW	Activate device signalling	Makes the LED flash quickly red and green in alternation to detect the device in its environment faster. Is automatically deactivated after one minute. 1 = inactive; 2 = active	1
20007	UINT16	WO	Load factory settings (without interface)	Loads all factory settings except the interface parameters. Secured via register 20005. 1 = restore factory settings	
20008	UINT16	WO	Load factory settings (all parameters)	Loads all factory settings including the interface parameters. Secured via register 20005. 1 = restore factory settings	
20009	UINT16	RW	Start offset measurement	Read 1 = offset measurement inactive/completed 2 = offset measurement running Write 2 = start offset measurement (secured via reg. 20005)	1
20010	UINT16	RW	Test alarm ¹⁾	0 = no test alarm 1 = test alarm channel 1 2 = test alarm channel 2 3 = test alarm channel 3 4 = test alarm channel 4	0
20011...32999				Reserved	

1) Test alarm: Output a test alarm on a measuring channel. The test alarm refers only to bus messages. No relays switch. The test alarm is deactivated after 1 minute (= 0).

8.9 Additional function codes

Diagnostic (function code 0x08)

Sub-function code name	Sub-function code number (decimal)	Error counter	Supported	Notes
Return Query Data	0		X	
Restart Communication	1		X	
Return Diagnostic Register	2		X	¹⁾
Change ASCII Input Delimiter	3			
Force Listen Only Mode	4		X	
Reserved	5...9			
Clear Counters and Diagnostic Register	10		X	

Sub-function code name	Sub-function code number (decimal)	Error counter	Supported	Notes
Return Bus Message Count	11		X	2)
Return Bus Communication Error Count	12	X	X	
Return Bus Exception Error Count	13	X	X	
Return Server Message Count	14		X	
Return Server No Response Count	15		X	
Return Server NAK Count	16	X	X	
Return Server Busy Count	17	X	X	
Return Bus Character Overrun Count	18	X	X	
Reserved	19			
Clear Overrun Counter and Flag	20		X	
Reserved	21...65535			

- 1) The diagnostic register is 0 if all error counters are 0. Otherwise it is 1.
 2) It is a 16-bit counter. This means that a maximum of 65535 is counted. There is no overflow.

Get Com Event Counter (function code 0x0B)

Response	Notes
Status	If a previously received command is still being processed, then the answer is 0xFFFF. Otherwise it is 0x0000. (Current implementation: always 0x0000).
Event Count	It is a 16-bit counter. This means that a maximum of 65535 is counted. There is no overflow

Report Server ID (function code 0x11)






Response	Notes	
Byte Count	Number of bytes from "Server ID" to "Installation location"	
Server ID	Is always 0x01.	
Run Indicator Status	Is always 0xFF.	
Manufacturer name	Same information as register 1098.	Output as ASCII string.
Device name	Same information as register 1002.	
Application D number	Same information as register 1194.	
Application version	Same information as register 1195.	
Application Build number	Same information as register 1196.	
Installation location	Same information as register 1234.	

Device Identification (function code 0x2B)

Object ID	Object name / Description	Data type	Category	Supported	Notes
0x00	Manufacturer name	ASCII-String	Basic	X	Corresponds to register 1098
0x01	Article number			X	Corresponds to register 1034
0x02	Application software, version and build number			X	Corresponds to registers 1194, 1195 and 1196
0x03	Internet address manufacturer		Regular	X	Corresponds to register 1202
0x04	Device name			X	Corresponds to register 1002
0x05	Model name				
0x06	User application name				
0x07...0x7F	Reserved				
0x80...0xFF	Non-public objects		Extended		

9 Technical data

9.1 System states: LED and output relays

Ⓐ 	A	slowly	Error
Ⓑ 	B	medium	Mode change
Ⓒ 	C	quickly	Ready for address setting mode
Ⓓ 	D	slowly flashing	Address setting mode
Ⓔ 	E	once	Confirmation

The LED indicates the system state by means of colours and lighting/flashing. The changeover contacts of relay outputs K1 and K2 have defined switching positions for each system state.

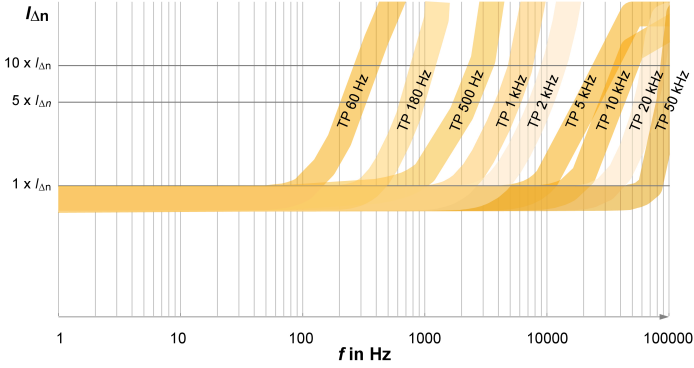
System state	LED		Notes	Changeover contact	
	ON (green)	Alarm (red)		K1	K2
Device switched off	off	off	Device is de-energised, no monitoring, no monitoring function	de-energised	de-energised
Normal operating state	lights	off	The device is supplied with the specified voltage and monitors the primary circuit. No residual current flows which would lead to tripping.	energised	energised
Prewarning	lights	flashes briefly	The device is supplied with the specified voltage and monitors the primary circuit. A fault current flows which exceeds the set limit of the prewarning.	de-energised	energised
Main alarm	off	lights	The device is supplied with the specified voltage and monitors the primary circuit. A fault current flows which exceeds the set limit of the main alarm.	de-energised	de-energised
Device error	off	flashes slowly	The device is supplied with the specified voltage and monitors the primary circuit. An error is detected by the periodic self tests.	de-energised	de-energised
Device in calibration mode	offset calibration procedure: see "Offset calibration", page 24			de-energised	de-energised
Device in address mode	for procedure, refer to "Setting addresses", page 23				
Device signalling	flash quickly in alternation		Use Modbus register 20006 = 2 to detect the device in its environment faster. Is automatically deactivated after one minute.		

System state	LED		Notes	Changeover contact	
	ON (green)	Alarm (red)		K1	K2
Reset	off	Flashes slowly	The reset status is achieved by pressing and holding the "T" button in the alarm status. To perform the reset, release the "T" button when the red LED flashes slowly (1.5...5 s).		
Test	flashes quickly	off	The test status is achieved by pressing and holding the "T" button in normal operating mode. To carry out the test, release the "T" button when the green LED flashes quickly (5...10 s).	wechselt	wechselt

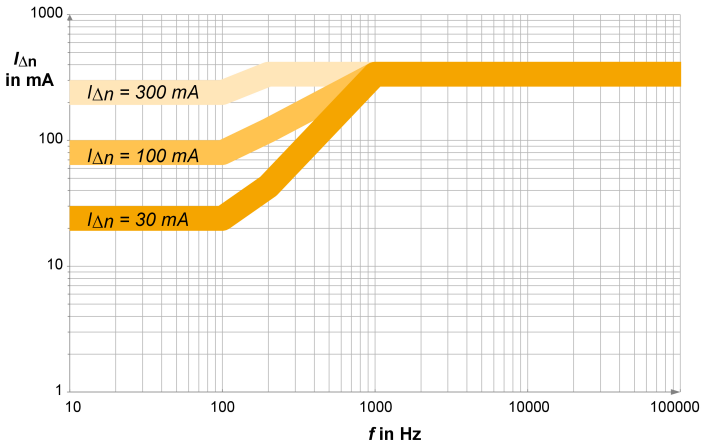
9.2 Diagrams

9.2.1 Frequency responses

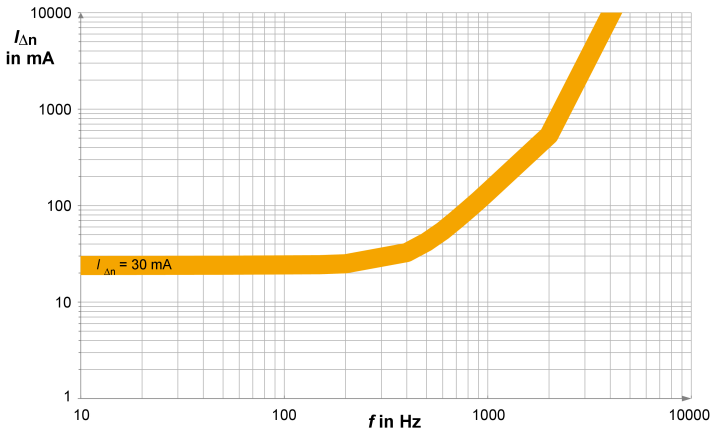
Low passes TP



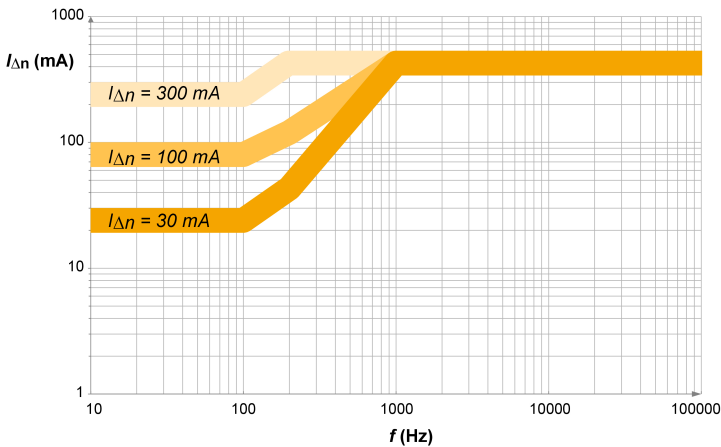
Type B+



Type B



Fire protection 100 kHz



9.3 Tabular data

(*) = factory setting

Insulation coordination acc. to IEC 60664-1/IEC 60664-3

Definitions

Measuring circuit (IC1)	Primary conductors routed through the current transformer
Secondary (IC2)	Terminal block 1 (24 V, GND, D1, DG, T/R, GND, A, B, X1, X2)
Control circuit 1 (IC3)	Terminal block 2 (11, 12, 14)
Control circuit 2 (IC4)	Terminal block 3 (21, 22, 24)
Rated insulation voltage	800 V
Overvoltage category	III
Pollution degree	2
Operating altitude	≤ 2000 m AMSL
Rated impulse voltage	
IC1/(IC2-IC4)	8 kV
IC2/(IC3-IC4)	4 kV
IC3/IC4	4 kV
Rated insulation voltage	
IC1/(IC2-IC4)	800 V
IC2/(IC3-IC4)	250 V
IC3/IC4	250 V
Safe isolation (reinforced insulation) between	
IC2/(IC3-IC4)	300 V
Basic insulation between	
IC1/(IC2-IC4)	800 V
IC3/IC4	300 V
Voltage tests (routine test) acc. to IEC 61010-1	
IC2/(IC3-IC4)	AC 2.2 kV
IC3/IC4	AC 2.2 kV

Supply voltage

Supply voltage U_S	DC 24 V
Operating range of U_S	$\pm 20\%$
Ripple U_S	$\leq 1\%$
Power consumption	$\leq 2.5\text{ W}$
Inrush current	1.7 A for 1 ms

Measuring circuit

Internal diameter measuring current transformer	see "Dimension diagrams", page 13
Characteristics according to IEC 62020 and IEC/TR 60755	AC/DC sensitive, type B
Response value $I_{\Delta n}$	see "Frequency responses", page 45
MRCDB301 (protection of persons)	30 mA
MRCDB302 (fire protection)	300 mA
MRCDB303 (plant protection)	30 mA...3 A (freely configurable), (30 mA)*
MRCDB304 (plant protection)	300 mA
MRCDB305 (protection of persons)	30 mA
Prewarning	50...100% $I_{\Delta n}$ (freely configurable), (60%)*
Rated current I_n	
CTBC20 at $I_{\Delta n} = 30\text{ mA}$	40 A
CTBC20 bei $I_{\Delta n} = 300\text{ mA}$	63 A
CTBC20P	80 A
CTBC35 at $I_{\Delta n} = 30\text{ mA}$	80 A
CTBC35 at $I_{\Delta n} = 300\text{ mA}$	125 A
CTBC35P	160 A
CTBC60 at $I_{\Delta n} = 30\text{ mA}$	160 A
CTBC60 at $I_{\Delta n} = 300\text{ mA}$	250 A
CTBC60P	320 A
CTBC120 at $I_{\Delta n} = 100\text{ mA}$	330 A
CTBC120P at $I_{\Delta n} = 100\text{ mA}$	630 A
CTBC210 at $I_{\Delta n} = 300\text{ mA}$	630 A
CTBC210P at $I_{\Delta n} = 100\text{ mA}$	630 A
CTBC210P at $I_{\Delta n} = 300\text{ mA}$	1000 A

Operating uncertainty	±17.5 %
Relative uncertainty	0...-35 %
Test winding	yes

Possible response values (to be set on the evaluator)

CTBC20, CTBC20P	10...500 mA
CTBC35, CTBC35P, CTUBC60, CTBC60P	30 mA...10 A
CTBC120P, CTBC210P	100 mA...10 A
CTBC120, CTBC210	300 mA...10 A

Time response

Response delay t_{on}	
MRCDB301, MRCDB302, MRCDB304, MRCDB305	0 s
MRCDB303	0 s...60 min (freely configurable), (0 s)*
Start-up delay t	0 s...60 min (freely configurable), (0 s)*
Delay on release t_{off}	2 s after reset
Operating time t_{ae}	
at $1 \times I_{\Delta n}$	≤ 180 ms
at $2 \times I_{\Delta n}$	≤ 130 ms
at $5 \times I_{\Delta n}$	≤ 20 ms
Response time	$t_{an} = t_{ae} + t_{on}$
Recovery time t_b	≤ 1 s

Indication

Multicolour LED	red/green, Refer to "System states: LED and output relays", page 43
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Inputs

Label	T/R, GND, D1, DG
Maximum length connecting cable	10 m

Outputs

Number of changeover contacts	2
Relay mode	
MRCDB301, MRCDB302, MRCDB305	N/C principle
MRCDB303	N/C principle or N/O principle, (freely configurable), (N/C principle)*
MRCDB304	N/O principle
Switching outputs (K1, K2)	250 V, 5 A
Switching capacity	1500 VA / 144 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	10 mA at DC 5 V
Electrical endurance, number of cycles	10.000

Environment/EMC

EMC	IEC 60947-2 Annex M
Operating temperature	-25...70 °C
Classification of climatic conditions acc. to IEC 60721	
Stationary use (IEC 60721-3-3)	3K23
Transport (IEC 60721-3-2)	2K11
Long-term storage (IEC 60721-3-1)	1K22
Classification of mechanical conditions acc. to IEC 60721	
Stationary use (IEC 60721-3-3)	3M11
Transport (IEC 60721-3-2)	2M4
Long-term storage (IEC 60721-3-1)	1M12

Connection

Required terminals are included in the scope of delivery (except MRCDB304).

Terminal block 1	
Manufacturer	Phoenix Contact
Type	DFMC 1,5/5-ST-3,5 BK
The connection conditions of the manufacturer apply.	
Connection properties	
rigid	0.2...1.5 mm ² (AWG 24...16)
flexible	0.2...1.5 mm ² (AWG 24...16)
with ferrules	0.25...0.75 mm ² (AWG 24...19)
Terminal block 2, 3	
Manufacturer	Phoenix Contact
Type	FKCVW 2,5/ 3-ST-5,08
The connection conditions of the manufacturer apply.	
Connection properties	
rigid	0.2...2.5 mm ² (AWG 24...13)
flexible	0.2...2.5 mm ² (AWG 24...13)
with ferrules	0.25...2.5 mm ² (AWG 24...13)

Mounting CTBC...

Screw type	
CTBC20...60(P)	DIN EN ISO 7045 - M5
CTCB120...210(P)	DIN EN ISO 7045 - M6
Washer type	
CTBC20...60(P)	DIN EN ISO 7089/7090 - 5
CTCB120...210(P)	DIN EN ISO 7089/7090 - 6
Tightening torque	
CTBC20...35 (P)	0.6 Nm
CTCB60...210(P)	1 Nm

Other

Operating mode	continuous operation
Mounting	any position
Degree of protection, internal components (DIN EN 60529)	IP40
Degree of protection, terminals (DIN EN 60529)	IP20

Flammability class	UL94 V-0
Software	D0579

Weight	
MRCDB30...	≤ 100 g
CTBC20	≤ 160 g
CTBC20P	≤ 220 g
CTBC35	≤ 240 g
CTBC35P	≤ 320 g
CTBC60	≤ 460 g
CTBC60P	≤ 620 g
CTBC120	≤ 1390 g
CTBC120P	≤ 1750 g
CTBC210	≤ 4220 g
CTBC210P	≤ 4870 g

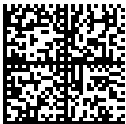
9.4 Standards and certifications



9.5 Conformity

EU Declaration of Conformity

The EU Declaration of Conformity is available at the following Internet address:



https://www.bender.de/fileadmin/content/Products/CE/CEKO_MRCDB30x.pdf

9.6 Ordering details

Electronic modules

Supply voltage	Variant	Type	Art.No.
DC 24 V (19.2...28.8 V)	Protection of persons	MRCDB301	B74043120
	Fire protection	MRCDB302	B74043121
	Protection of persons, fire protection and plant protection (freely configurable)	MRCDB303	B74043122
	Plant protection	MRCDB304	On request
	Protection of persons for applications with pulsed, very high peak load currents (> 1 kA for < 1 s), e.g. welding applications	MRCDB305	B74043125

Measuring current transformers

Type	Description	Art. No.
CTBC20	Measuring current transformer, internal diameter 20 mm	B98120001
CTBC20P	Measuring current transformer shielded, internal diameter 20 mm	B98120002
CTBC35	Measuring current transformer, internal diameter 35 mm	B98120003
CTBC35P	Measuring current transformer shielded, internal diameter 35 mm	B98120004
CTBC60	Measuring current transformer, internal diameter 60 mm	B98120005
CTBC60P	Measuring current transformer shielded, internal diameter 60 mm	B98120006
CTBC120	Measuring current transformer, internal diameter 120 mm	B98120007
CTBC120P	Measuring current transformer shielded, internal diameter 120 mm	B98120020
CTBC210	Measuring current transformer, internal diameter 210 mm	B98120008
CTBC210P	Measuring current transformer shielded, internal diameter 210 mm	B98120021

Accessories

Description	Art. No.
USB to RS-485 interface converter	B95012045
Terminal set for MRCD module *	B74043124
Snap-on mounting for CTBC20 and CTBC20P *	B91080111
Snap-on mounting for CTBC35 and CTBC35P *	B91080112

* Included in scope of delivery

Suitable system components

Description	Max. number of current transformers	Type	Art. No.
Voltage supply	14	STEP-PS/1 AC/24 DC/1.75	B94053111
	34	STEP-PS/1 AC/24 DC/4.2	B94053112

9.7 Document revision history

Date	Document version	Starte/Changes
07.2021	04	<i>Added</i> Certifications Lloyds and UKCA
04.2024	05	<i>Added</i> Note acc. to standard DIN EN 45545-2 <i>Editorial revision</i> Dimension diagrams, wiring diagrams, layout complete document
07.2024	06	<i>Corrected</i> Device view, Modbus registers 16060...16062



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