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MANUAL

ECONOMY SMART with IO-LINK
PC-0724-800-0I1
PM-0724-400-0I1

Multi-channel circuit breaker
IO-LINK

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1. ORDER DATA

The following table shows the ordering data for ECONOMY SMART circuit-breakers with IO-LINK.

Table 1: Order numbers

Variant	Input voltage	Channels
PC-0724-800-0I1	24 Vdc	8
PM-0724-400-0I1	24 Vdc	4

2. GENERAL INFORMATION

2.1 Safety instructions

Please read these warnings and safety instructions carefully before operating the appliance. The appliance may only be installed by skilled and qualified personnel. In the event of malfunctions or damage, switch off the supply voltage immediately and send the device to BLOCK Transformatoren-Elektronik GmbH for inspection. The device does not contain any service parts. If an internal fuse blows, there is most likely an internal defect in the appliance. The data provided is for product description purposes only and should not be construed as guaranteed characteristics in the legal sense.

2.2 Qualified personnel

The product associated with this documentation may only be handled by qualified personnel in compliance with the documentation associated with the respective task, in particular the safety instructions and warnings contained therein. Qualified personnel can ensure, on the basis of their training and experience, that the use of the described product complies with all safety requirements and the applicable provisions, regulations, standards and laws.

2.3 Intended use

This device is designed for installation in a housing and is suitable for use in general electronic devices, such as industrial control systems, office equipment, communication devices or measuring devices. Do not use this device in control systems of airplanes, trains or nuclear facilities, where a malfunction could lead to serious injury or danger to life.

2.4 Disclaimer

The content of this publication has been checked with the utmost care to ensure that it corresponds to the hardware and software described. Nevertheless, there may be discrepancies between the product and the documentation. Deviations may also occur due to the continuous further development of the product.
For this reason, we cannot guarantee complete conformity. Should this documentation contain errors, we reserve the right to make any necessary corrections without prior notice.

CAUTION
Switch off the input voltage before carrying out installation, maintenance or modification work and secure it against unintentional reconnection.

CAUTION
Do not modify or attempt to repair the appliance. Do not open the device!

CAUTION
Prevent the ingress of foreign objects such as paper clips and metal parts.

CAUTION
Do not operate the appliance in a damp environment or in an environment where condensation or condensation is to be expected.

CAUTION
Do not touch the housing during operation or shortly after switching off. Hot surfaces can cause injuries.

3. Product description

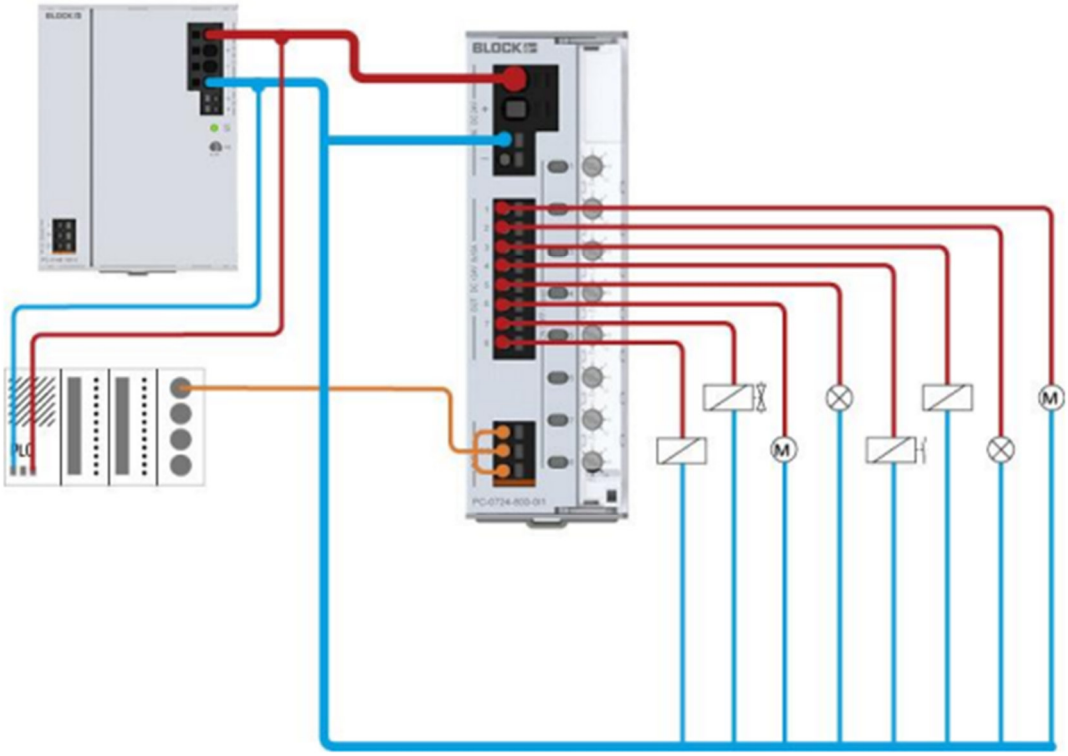
The electronic circuit breaker splits the load current between several 24 V feeders and reliably monitors them for overloads and short circuits. Short-term current peaks, e.g. due to a high inrush current, are allowed by the electronics; branches with longer overloads are de-energized. The tripping current of each output can be set individually using a current selector switch accessible from the front or via the IO-LINK interface. The outputs are switched on with a time delay and load-dependent in order to reduce peak inrush currents. If the rated current is exceeded, the output is automatically switched off after a defined tripping time and can be switched on again after a short waiting time (thermal relaxation) using a push-button or IO-LINK interface. The push-button is also used to switch off the respective output manually. Operation-relevant information can be read out via the IO-LINK interface and individual outputs can be specifically switched on or off. The status of the respective output is displayed via a multi-colored LED.

Figure 1: Electronic circuit breaker

3.1 System structure

Up to eight channels of loads and cables can be connected to the electronic circuit breaker to protect them from overloads and short circuits. An exemplary structure is shown in Figure 2.

Always ensure that there is a separate GND line between the load and the power supply unit.



Note:
Deviating wiring can lead to the destruction of the modules. The IO-LINK cable must not exceed a maximum length of 20 m.

3.2 Tripping characteristic

The tripping time depends on the level of the overcurrent. In the event of a short circuit, the faulty circuit is reliably switched off within a few milliseconds. The level of the short-circuit current depends on the current limitation of the supplying power supply unit and the line resistance. A characteristic curve describes this behavior in Figure 3.

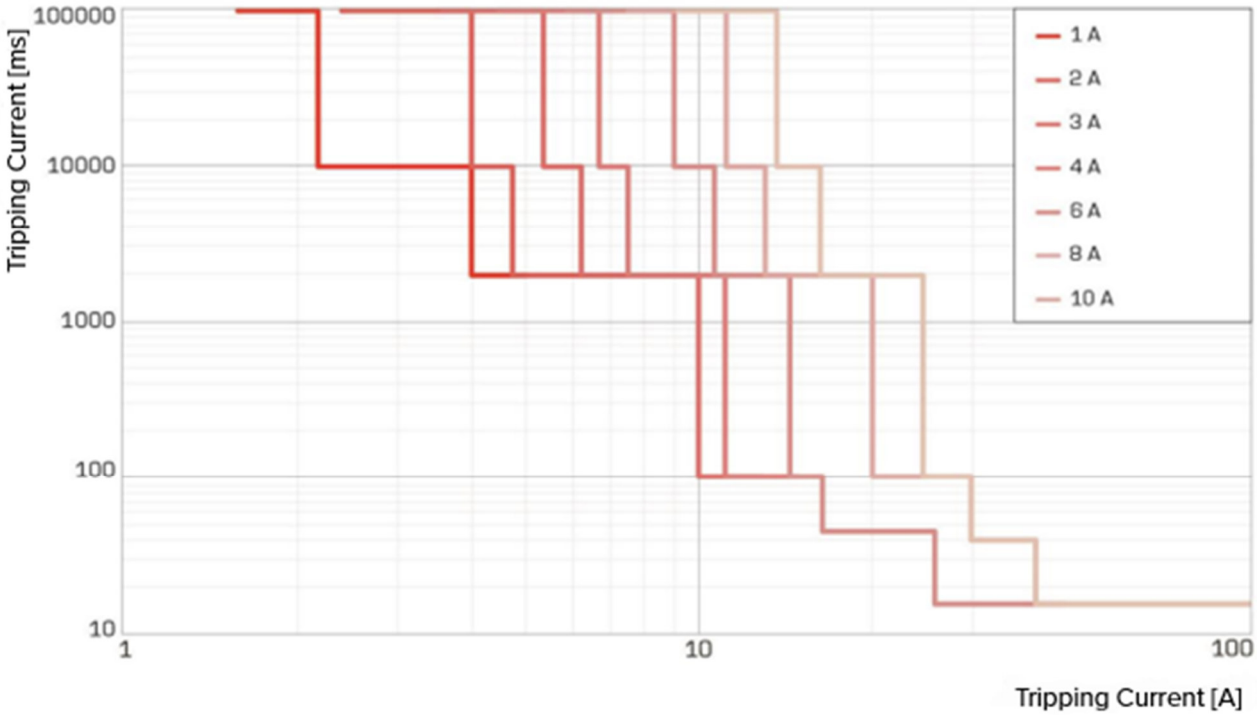


Figure 3: Tripping characteristic

3.3 Dimensioning

The dimensioning of the circuit breakers is shown in Figure 4.

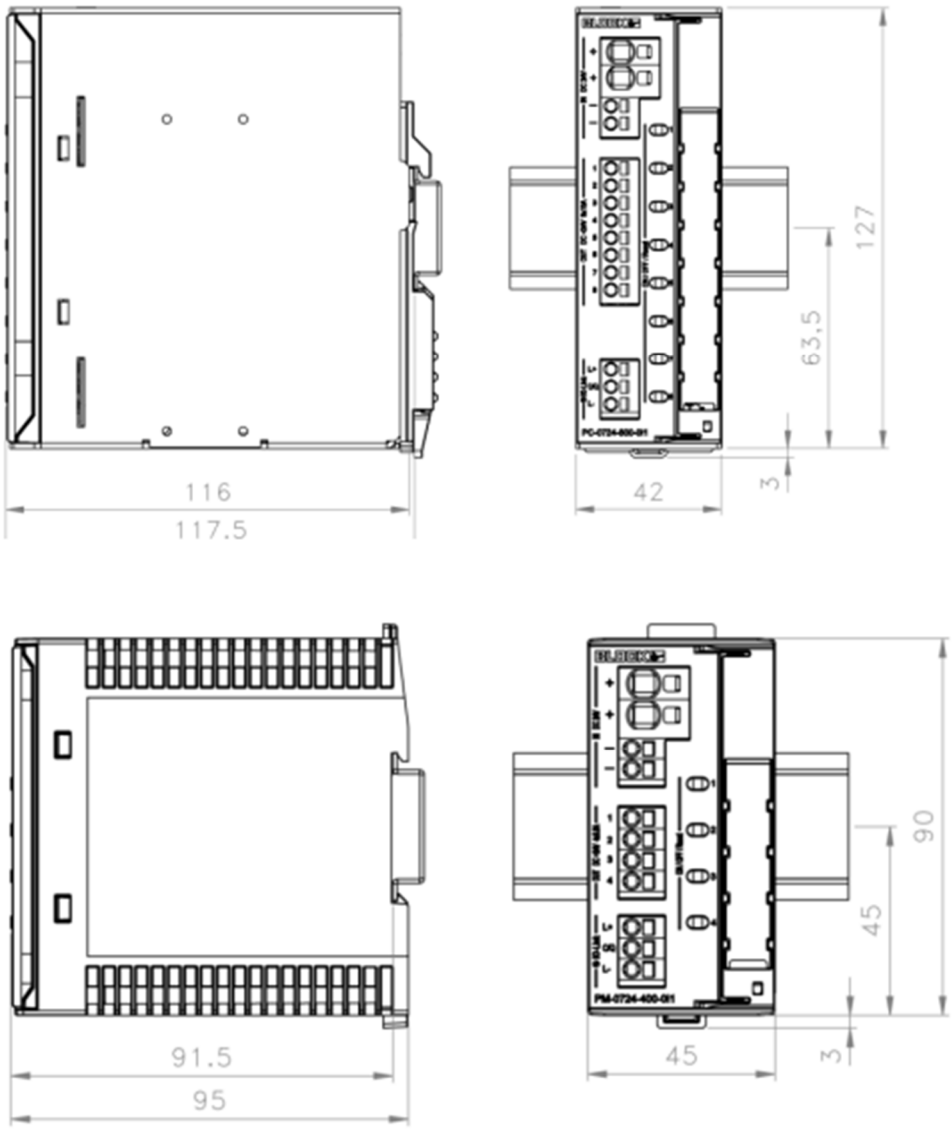


Figure 4: Dimensioning and assembly

3.4 Mounting

The circuit breaker can be mounted on the mounting rail without tools. To do this, first turn the front of the device slightly upwards and place it on the top-hat rail. Make sure that the device is pushed down as far as it will go. Once the device is seated on the top-hat rail, the underside is pressed against the mounting rail until it locks into the top-hat rail (followed by a "click" sound). To check, gently shake the device again to ensure that it is properly locked.

A standard tool, such as a slotted screwdriver, is required for removal. The device can be detached from the top-hat rail by pressing down the fastening and lifting the underside of the device.

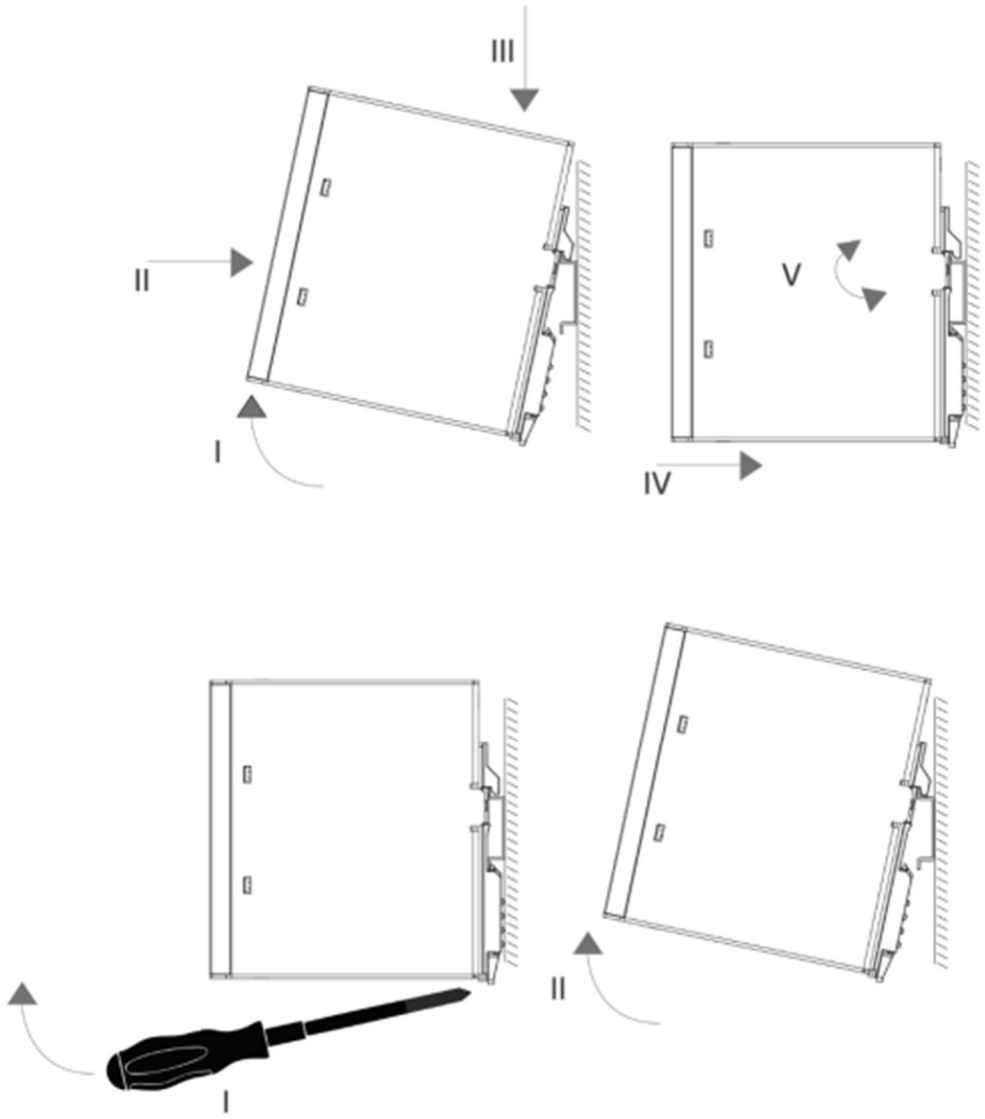


Figure 5: Mounting on the top-hat rail

To ensure cooling by natural convection, the distances to neighboring appliances must be observed.

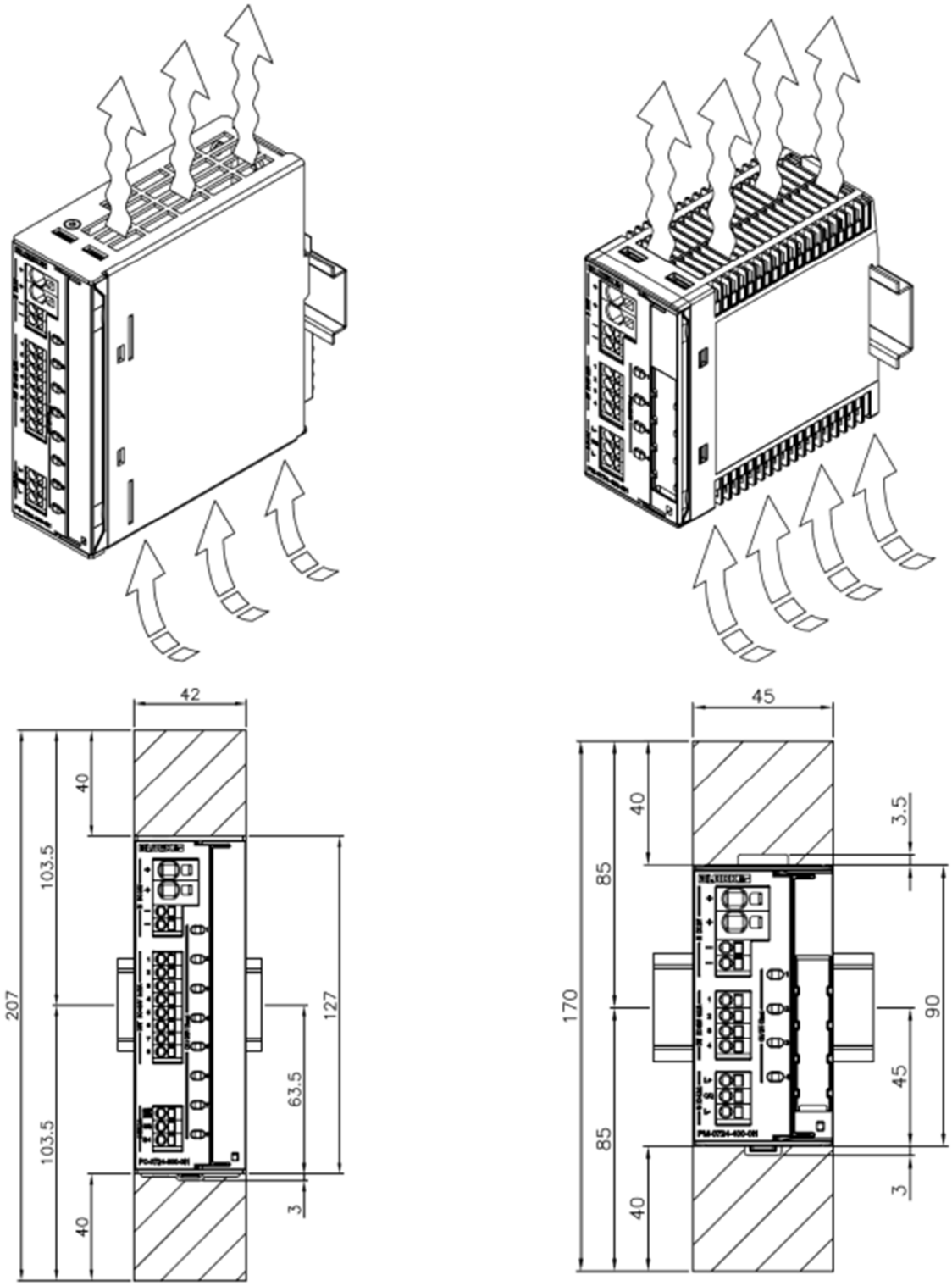


Figure 6: Convection cooling and distances

3.5 Connections and signaling

Nr.	Function	Note
1	Power selector switch cover	Lockable with a seal
2	Input and output terminals of the power supply	+ Entrance (0,75 – 6mm^2) (20...10 AWG) -Output (0,2 – 2,5 mm^2) (24...12 AWG)
3	Load output terminals	0,2 – 2,5 mm^2 (24...12 AWG)
4	Current selector switch	1 – 10A
5	Push-button incl. status display	See chapter 3.1
6	IO-LINK interface	0,2 – 2,5 mm^2 (24...12 AWG)

4. Commissioning

The PC-0724-800-0I1 and PM-0724-400-0I1 circuit breakers initialize themselves automatically by applying the supply voltage to the IN DC 24V+ terminal or by establishing the IO-LINK connection.

Functional operation is only possible by applying the 24 V supply voltage to IN+.

After the supply voltage is applied, all channels of the circuit breaker are initialized in sequence and then switched on selectively.

Note:
The delivery status of the circuit breaker is switched off locally. In this state, it cannot be switched on via the IO-LINK interface. The circuit breaker must be switched on manually.

4.1 Operating states

The circuit breaker has one LED button per channel to indicate the operating status. The color codes of the operating states can be found in Table 1 below.

Table 1: Operating states

Operating status	LED signaling	Remark
On	Green	Channel is switched on
Off	Red	Channel is switched off
Overload	Flashing green slowly	Channel has overload
Triggered	Flashing red slowly	Channel has triggered
Thermal relaxation	Flashing orange slowly	Channel is thermally relaxed
Hardware error	Flashing red quickly	Channel is defective

4.1.1 Switch-on delay

The outputs are switched on sequentially after a minimum input voltage is reached (switch-on threshold). To reduce inrush current peaks, all channels are switched on depending on the load. The channels are switched on starting with the smallest channel number to be switched on, typically starting with channel 1. The next channel is switched on as soon as the output current of the previous channel is below the set nominal value or the previous output has been switched off, but at the earliest after 50 ms.

4.1.2 ON/OFF and RESET" button

A button is assigned to each output channel. The current status is displayed via an integrated LED. The button has two functions depending on the operating status:

Normal operation When the channel is switched off (button lights up permanently red), it can be switched on by briefly pressing it (button lights up green). Pressing the button again switches the output off again.

Fault mode If the output channel is switched off due to an overcurrent (button flashes red), it can be switched on again (reset).

Note:
To switch the output back on, the thermal expansion must first be completed (button flashes orange). After pressing the button, the output is initially switched off (button lights up red continuously). Pressing it again switches the output back on.
(button lights up green continuously).

4.2 Charging capacitive loads

The electronic circuit breaker enables particularly high capacitive loads to be switched on. The following experimentally determined capacitances serve as reference values.

Table 2: Cable cross-section: 0.75 mm²

Cable length (outgoing and return cable)	Switch-on capacitance [mF] at 22V input voltage	Switch-on capacitance [mF] at 24V input voltage	Switch-on capacitance [mF] at 26V input voltage	Switch-on capacitance [mF] at 28V input voltage
0	58	48	26,6	13,3
2,5	64,8	61,5	44,8	23,3
5	89,5	83,3	70	58,1
10	156,1	130	94,8	68,1
20	222	>620	30	114,8
40	>620	>620	>620	>620

Table 3: Cable cross-section: 1.5mm²

Cable length (outgoing and return cable)	Switch-on capacitance [mF] at 22V input voltage	Switch-on capacitance [mF] at 24V input voltage	Switch-on capacitance [mF] at 26V input voltage	Switch-on capacitance [mF] at 28V input voltage
0	58	48	26,6	13,3
2,5	76,6	70	34,8	21,5
5	76,6	50	40	24,8
10	64,8	53,3	53,3	41,5
20	83,3	81,3	71,3	109,5
40	306,6	222,8	122,8	112,8

Table 4: Cable cross-section: 2.5 mm²

Cable length (outgoing and return cable)	Switch-on capacitance [mF] at 22V input voltage	Switch-on capacitance [mF] at 24V input voltage	Switch-on capacitance [mF] at 26V input voltage	Switch-on capacitance [mF] at 28V input voltage
0	58	48	26,6	13,3
2,5	79,9	63,3	33,3	18,1
5	63,6	73,3	36,3	23,3
10	70	73,3	46,6	20
20	73	63,3	56,6	50
40	100	91,5	91,5	64,8

All capacities were determined experimentally under nominal load. The specifications are guide values, possible line capacities depend on the installation situation. The power supply unit must be able to supply the required current without the output voltage dropping below 18V.

4.3 Communication

The PC-0724-800-0I1 and PM-0724-400-0I1 circuit breakers communicate according to the IO-LINK standard V1.1. An IO-LINK master in version V1.1 is required for communication with the circuit breaker. The circuit breakers operate in COM 3 mode (230.4 kB) and exchange 9 bytes or 13 bytes of process data with the master per cycle (2 ms).

5. Process data and parameters

The PC-0724-800-OI1 circuit breaker has 13 bytes and the PM-0724-400-OI1 has 9 bytes of process data, which are exchanged with the master every 2 ms. The structure and organization of this data is described in detail in the following chapter 4.1. In addition to the process data, the parameter and diagnostic data of each individual circuit breaker channel are transmitted, see Chapter 4.2 and Chapter 4.3.

5.1 Process data

5.1.1 PC-0724-800-0I1

The process data of the PC-0724-800-OI1 is exchanged with the IO-LINK master in a cycle of 2 ms at 230400 baud. The process data consists of a total of 13 bytes. The coding of the individual bytes can be found in Tables 5 - 16.

Table 5: Collective message process data

Byte 1	MSB				LSB			
Description	**Bit 7**	**Bit 6**	**Bit 5**	**Bit 4**	**Bit 3**	**Bit 2**	**Bit 1**	**Bit 0**
00 Collective Message OFF	0	0	0	0	0	0	0	1
01 Collective Message Tripped	0	0	0	0	0	0	1	0
02 Collective Message >90%	0	0	0	0	0	1	0	0
03 Collective Message >100%	0	0	0	0	1	0	0	0
04 Collective Message HW-FUSE	0	0	0	1	0	0	0	0
05 Collective Message Local OFF	0	0	1	0	0	0	0	0
06 Input Voltage Alarm	0	1	0	0	0	0	0	0
07 Reserved	1	0	0	0	0	0	0	0

Table 6: Process data Input Voltage

Byte 2 & 3	H Byte	L Byte
Description	**Data type**	
08 Input Voltage	Unsigned Integer 16	

Table 7: Process data current channel 1

Byte 4	
Description	**Data type**
09 Current Channel 1	Unsigned Integer 8

Table 8: Process data current channel 2

Byte 5	
Description	**Data type**
10 Current Channel 2	Unsigned Integer 8

Table 9: Process data Current Channel 3

Byte 6	
Description	**Data type**
11 Current Channel 3	Unsigned Integer 8

Table 10: Process data Current Channel 4

Byte 7	
Description	**Data type**
12 Current Channel 4	Unsigned Integer 8

Table 11: Process data Current Channel 5

Byte 8	
Description	**Data type**
13 Current Channel 5	Unsigned Integer 8

Tabelle 12: Process data Current Channel 6

Byte 9	
Description	**Data type**
14 Current Channel 6	Unsigned Integer 8

Table 13: Process data Current Channel 7

Byte 10	
Description	**Data type**
15 Current Channel 7	Unsigned Integer 8

Table 14: Process data Current Channel 8

Byte 11	
Description	**Data type**
16 Current Channel 8	Unsigned Integer 8

Table 15: Process data Over Current

Byte 12	MSB				LSB			
Description	**Bit 7**	**Bit 6**	**Bit 5**	**Bit 4**	**Bit 3**	**Bit 2**	**Bit 1**	**Bit 0**
17 Over Current Channel 1	0	0	0	0	0	0	0	1
18 Over Current Channel 2	0	0	0	0	0	0	1	0
19 Over Current Channel 3	0	0	0	0	0	1	0	0
20 Over Current Channel 4	0	0	0	0	1	0	0	0
21 Over Current Channel 5	0	0	0	1	0	0	0	0
22 Over Current Channel 6	0	0	1	0	0	0	0	0
23 Over Current Channel 7	0	1	0	0	0	0	0	0
24 Over Current Channel 8	1	0	0	0	0	0	0	0

Table 16: Process data Tripped Channel

Byte 13	MSB				LSB			
Description	**Bit 7**	**Bit 6**	**Bit 5**	**Bit 4**	**Bit 3**	**Bit 2**	**Bit 1**	**Bit 0**
25 Tripped Channel 1	0	0	0	0	0	0	0	1
26 Tripped Channel 2	0	0	0	0	0	0	1	0
27 Tripped Channel 3	0	0	0	0	0	1	0	0
28 Tripped Channel 4	0	0	0	0	1	0	0	0
29 Tripped Channel 5	0	0	0	1	0	0	0	0
30 Tripped Channel 6	0	0	1	0	0	0	0	0
31 Tripped Channel 7	0	1	0	0	0	0	0	0
32 Tripped Channel 8	1	0	0	0	0	0	0	0

5.1.2 PM-0724-400-OI1

The process data of the PM-0724-400-OI1 is exchanged with the IO-LINK master in a cycle of 2 ms at 230400 baud. The process data consists of a total of 9 bytes. The coding of the individual bytes can be found in Tables 17 -24.

Table 17: Process data Collective Message

Byte 1	MSB				LSB			
Description	**Bit 7**	**Bit 6**	**Bit 5**	**Bit 4**	**Bit 3**	**Bit 2**	**Bit 1**	**Bit 0**
00 Collective Message Off	0	0	0	0	0	0	0	1
01 Collective Message Tripped	0	0	0	0	0	0	1	0
02 Collective Message >90%	0	0	0	0	0	1	0	0
03 Collective Message > 100%	0	0	0	0	1	0	0	0
04 Collective Message HW-FUSE	0	0	0	1	0	0	0	0
05 Collective Message Local Off	0	0	1	0	0	0	0	0
06 Input Voltage Alarm	0	1	0	0	0	0	0	0
07 Reserved	1	0	0	0	0	0	0	0

Table 18: Process data Input Voltage

Byte 2 & 3	H Byte	L Byte
Description	Data type	
08 Input Voltage	Unsigned Integer 16	

Table 19: Process data Current Channel 1

Byte 4	
Description	Data type
09 Current Channel 1	Unsigned Integer 8

Table 20: Process data Current Channel 2

Byte 5	
Description	Data type
10 Current Channel 2	Unsigned Integer 8

Table 21: Process data Current Channel 3

Byte 6	
Description	Data type
11Current Channel 3	Unsigned Integer 8

Tabelle 22: Process data Current Channel 4

Byte 7	
Description	Data type
12 Current Channel 4	Unsigned Integer 8

Tabelle 23: Prozessdaten Over Current

Byte 8	MSB				LSB			
Description	**Bit 7**	**Bit 6**	**Bit 5**	**Bit 4**	**Bit 3**	**Bit 2**	**Bit 1**	**Bit 0**
17 Over Current Channel 1	0	0	0	0	0	0	0	1
18 Over Current Channel 2	0	0	0	0	0	0	1	0
19 Over Current Channel 3	0	0	0	0	0	1	0	0
20 Over Current Channel 4	0	0	0	0	1	0	0	0

Table 24: Process data Tripped Channel

Byte 9	MSB				LSB			
Description	**Bit 7**	**Bit 6**	**Bit 5**	**Bit 4**	**Bit 3**	**Bit 2**	**Bit 1**	**Bit 0**
21 Tripped Channel 1	0	0	0	0	0	0	0	1
22 Tripped Channel 2	0	0	0	0	0	0	1	0
23 Tripped Channel 3	0	0	0	0	0	1	0	0
24 Tripped Channel 4	0	0	0	0	1	0	0	0

5.2 Acyclic I/O data IO-LINK

The acyclic I/O data shown in Table 25 shows the indexes of the basic information. In addition to the product ID, these also contain manufacturer-specific information. These are identical for the PC-0724-800-OI1 and the PM-0724-400-OI1.

Tabelle 25: Azyklische E/A Daten IO-LINK

Index dec	Functions	Data type	Attribute	Remark
16	Vendor Name	String	RO	IO-LINK interface and system specification
17	Vendor Text	String	RO	IO-LINK interface and system specification
18	Product Name	String	RO	IO-LINK interface and system specification
19	Product ID	String	RO	IO-LINK interface and system specification
20	Product Text	String	RO	IO-LINK interface and system specification
21	Product Serial Number	String	RO	IO-LINK interface and system specification
22	Hardware-Revision	String	RO	IO-LINK interface and system specification
23	Firmware Revision	String	RO	IO-LINK interface and system specification
24	Application Specific tag	String	R/W	IO-LINK interface and system specification
32	Error Count	16 Bit	RO	IO-LINK interface and system specification
36	Device Status	8 Bit	RO	IO-LINK interface and system specification
37	Detailed Device Status	String	RO	IO-LINK interface and system specification

5.3 Acyclical I/O data of the circuit breaker

5.3.1 PC-0724-800-0I1

The acyclic I/O data is information that can be obtained directly from the circuit breaker channels, shown below in Table 26:

Table 26: Acyclic I/O data

Index dec	Functions	Data type	Attribute	Remark
68	eBreaker Error Code	16 Bit	RO	Error code
69	eBreaker Type	16 Bit	RO	Device designation
70	eBreaker RC_Status 1-8	8 Bit	RO	Test bit for setting the current
71	eBreaker Reset Trip Counter 1-8	8 Bit	WO	Resetting the trip counter
72	Number of Channels	8 Bit	RO	Number of channels
73	Threshold Critical Input Voltage Max	16 Bit	RW	Threshold value Uln Max
74	Threshold Critical Input Voltage Min	16 Bit	RW	Threshold value Uln Min
75	Events PD0-7	8 Bit	RW	Events
81-88	eBreaker Trip Counter	8 Bit	RO	Trip counter
100	Input Voltage	16 Bit	RO	ACTUAL voltage IN
101-108	Channel Voltage 1-8	16 Bit	RO	ACTUAL voltage OUT
301-308	Channel Current 1-8	16 Bit	RO	ACTUAL current
310-317	Current Settings 1-8	16 Bit	RW	Trigger current
601-608	eBreaker Status	8 Bit	RO	Status
609-616	eBreaker Command	8 Bit	WO	ON / OFF / RESET

5.3.2 PM-0724-400-0I1

The acyclic I/O data is the information that can be obtained directly from the circuit breaker channels, shown below in Table 27:

Table 27: Acyclic I/O data

Index dec	Functions	Data type	Attribute	Remark
68	eBreaker Error Code	16 Bit	RO	Error code
69	eBreaker Type	16 Bit	RO	Device designation
70	eBreaker RC_Status 1-4	8 Bit	RO	Check bit of the current
71	eBreaker Reset Trip Counter 1-4	8 Bit	WO	Resetting the trip counter
72	Number of Channels	8 Bit	RO	Number of channels
73	Threshold Critical Input Voltage Max	16 Bit	RW	Threshold value Uln Max
74	Threshold Critical Input Voltage Min	16 Bit	RW	Threshold value Uln Min
75	Events PD0-7	8 Bit	RW	Events
81-84	eBreaker Trip Counter	8 Bit	RO	Trip counter
100	Input Voltage	16 Bit	RO	ACTUAL voltage IN
101-104	Channel Voltage 1-4	16 Bit	RO	ACTUAL voltage OUT
301-304	Channel Current 1-4	16 Bit	RO	ACTUAL current
310-313	Channel Settings 1-4	16 Bit	RW	Trigger current
601-604	eBreaker Status	8 Bit	RO	Status
609-612	eBreaker Command	8 Bit	WO	ON / OFF / RESET

5.3.3 Coding of the circuit breaker status

The coding of the status of the PC-0724-800-0I1 (index 601-608) and the PM-0724-400-0I1 (index 601-604) is shown in Table 28.

Tabelle 28: eBreaker Status

Dec. Value	Functions	Remark
0	N.C.	Not connected
1	Switched Off	Switched off via interface
2	Switched On	Switched on
3	Tripped	Triggered
6	Current >90% Nominal	Current >90% nominal
14	Current >100% Nominal	Current >100% nominal
18	Tripped, Hardware Error	Hardware error
20	Tripped, Thermal release	Thermal relaxation
50	Switched Off, local	Switched off, local

5.3.4 Coding of the circuit breaker currents

The coding of the tripping currents of the PC-0724-800-0I1 (index 310-318) and the PM-0724-400-0I (index 310 - 313) is shown in Table 29.

Tabelle 29: eBreaker Current

Dec. Value	Functions	Remark
0	Default	IODD DEFAULT
1000	1	Trigger current 1A
2000	2	Trigger current 2A
3000	3	Trigger current 3A
4000	4	Trigger current 4A
6000	6	Trigger current 6A
A8000	8	Trigger current 8A
10000	10	Trigger current 10A

5.3.5 Coding of the circuit breaker type

The coding of the type of the Pc-0724-800-0l1 (index 69) and the PM-0724-400-0l1 (index 69) is shown in Table 30.

Table 30: eBreaker Type

Dec. Value	Description	Remark
0	N/A	
47919	PC-0724-800-0l1	
43822	PM-0724-400-0l1	

5.3.6 Coding of the circuit breaker command

The coding of the commands of the PC-0724-800-OI1 (index 609 - 616) and the PM-0724-400-OI1 (index 609 - 612) is shown in Table 31.

Tabelle 31: eBreaker Commands

Dec. Value	Description	Bemerkung
11 [1]	OFF	Channel 1 Off
12 [1]	ON	Channel 1 On
13 [1]	RESET	Channel 1 Reset
21 [1]	OFF	Channel 2 Off
22 [1]	ON	Channel 2 An
23 [1]	RESET	Channel 2 Reset
31 [1]	OFF	Channel 3 Aus
32 [1]	ON	Channel 3 On
33 [1]	RESET	Channel 3 Reset
41 [1]	OFF	Channel 4 Aus
42 [1]	ON	Channel 4 On
43 [1]	RESET	Channel 4 Reset
51	OFF	Channel 5 Aus
52	ON	Channel 5 On
53	RESET	Channel 5 Reset
61	OFF	Channel 6 Off
62	ON	Channel 6 An
63	RESET	Channel 6 Reset
71	OFF	Channel 7 Off
72	ON	Channel 7 On
73	RESET	Channel 7 Reset
81	OFF	Channel 8 Off
82	ON	Channel 8 On
83	RESET	Channel 8 Reset

1) PM-0724-400-OI1

5.3.7 Coding for resetting the circuit breaker trip counter

The coding of the reset function of the PC-0724-800-OI1 (index 81 - 88) and the PM-0724-400-OI1 (index 81 - 84) of the trip counter is shown in Table 32.

Table 32: eBreaker Trip Counter

Dec. Value	Functions	Remark
1 [1)]	RESET	Channel 1 Reset Trip Counter
2 [1)]	RESET	Channel 2 Reset Trip Counter
3 [1)]	RESET	Channel 3 Reset Trip Counter
4 [1)]	RESET	Channel 4 Reset Trip Counter
5	RESET	Channel 5 Reset Trip Counter
6	RESET	Channel 6 Reset Trip Counter
7	RESET	Channel 7 Reset Trip Counter
8	RESET	Channel 8 Reset Trip Counter

1) PM-0724-400-OI1