Manual

ECONOMY SMART
with IO-LINK

PC-0724-800-0I1
PM-0724-400-0I1

BLOCK Transformatoren-Elektronik GmbH
Max-Planck-Strasse 36–46 • 27283 Verden • Germany
Tel. +49 (0) 4231 678-0 • Fax +49 (0) 4231 678-177
info@block.eu • block.eu

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1. General Information

1.1 Safety Instructions

Please read these warnings and safety instructions carefully before operating the device. The device may only be installed by qualified competent personnel. In the event of malfunctions or damage, switch off the supply voltage immediately and send the device to BLOCK Transformatoren-Elektronik GmbH to be checked. The device does not contain any service components. When an internal fuse is triggered, there is most likely an internal defect in the device. The data provided are for product description purposes only and should not be construed as legally guaranteed properties.

1.2 Qualified Personnel

The product referred to in this documentation may only be operated by qualified personnel, in compliance with the specific documentation pertinent to the respective task, in particular the safety instructions and warnings contained therein. Qualified personnel can, as a result of their training and experience, help to ensure that the use of the described product meets all safety requirements as well as applicable regulations, provisions, standards, and laws.

1.3 Intended Use

This device is designed for installation within an enclosure and is suitable for use with general electronic devices, such as industrial controls, office equipment, communications equipment, and gages. Do not use this device in control systems for airplanes, trains, or nuclear facilities where a malfunction can result in serious injury or death.

1.4 Disclaimer

The contents of this publication have been checked with great care for concordance with the described hardware and software. Nevertheless, there may be differences between the product and the documentation. Deviations may also arise due to the further development of the product.
For this reason, we cannot guarantee full concordance. Should this documentation contain any errors, we reserve the right to make necessary corrections without prior notice.

2. Product Description

The electronic circuit breaker divides the load current to several 24 V branches and reliably monitors overload and short-circuiting. The electronics permits short-term current peaks, e.g. due to a high inrush current, while branches with a longer overload are disconnected from the power.
The tripping current for each output can be individually adjusted with a current selector switch accessible from the front or via the IO-LINK interface.
The outputs are activated in a time-delayed and load-dependent manner 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 this can be switched on again after a short waiting time (thermal release) via a button or the IO-LINK interface.
The button is also used to switch off the relevant output manually. The IO-LINK interface can be used for reading out operating information and for switching individual outputs on or off in a targeted manner. The status for the relevant output is displayed via a multi-colored LED.

Figure 1: Electronic Circuit Breaker

2.1 System Design

Up to eight channels from the breaker can be used to connect loads and lines to protect them from overload and short circuits.Figure 2 shows an example structure.

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

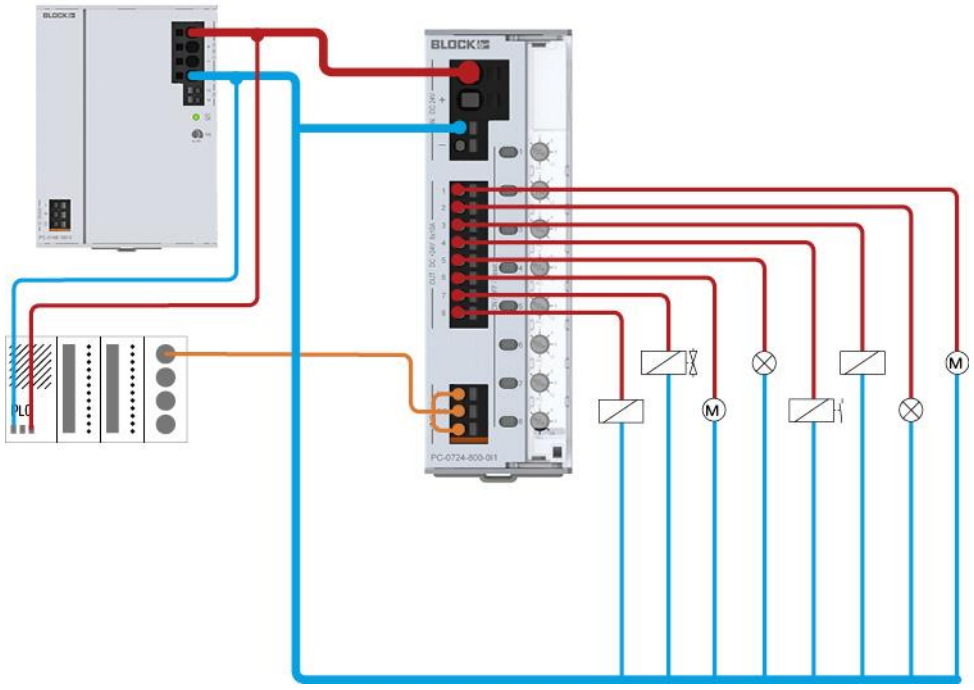

Figure 2: System Design

Note:
Deviations in the wiring can destroy the modules.
The IO-LINK cable must not exceed a maximum length of 20 m.

2.2 Tripping Characteristic

The tripping time depends on the level of overcurrent. In the case of a short circuit, the defective circuit will be shut down reliably within a few milliseconds. The level of the short circuit current depends on the current limiting of the feeding power supply as well as the line resistance. A characteristic describes this behavior in Figure 3.

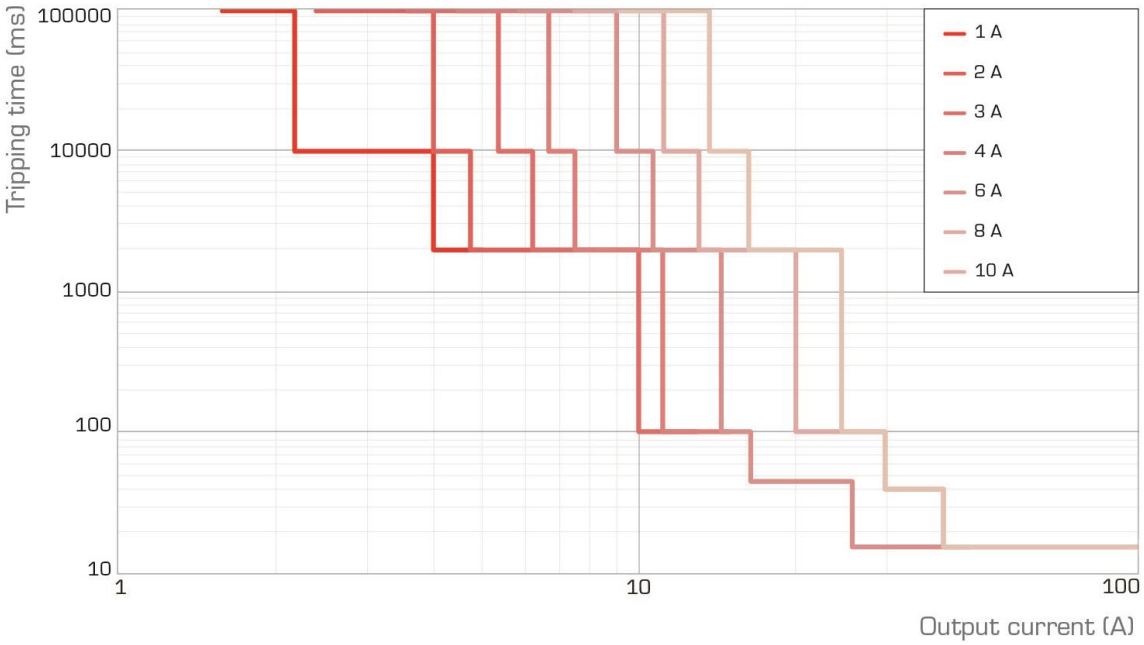

Figure 3: Tripping characteristic

2.3 Dimensions

The dimensions for the circuit breakers can be found in Figure 4.

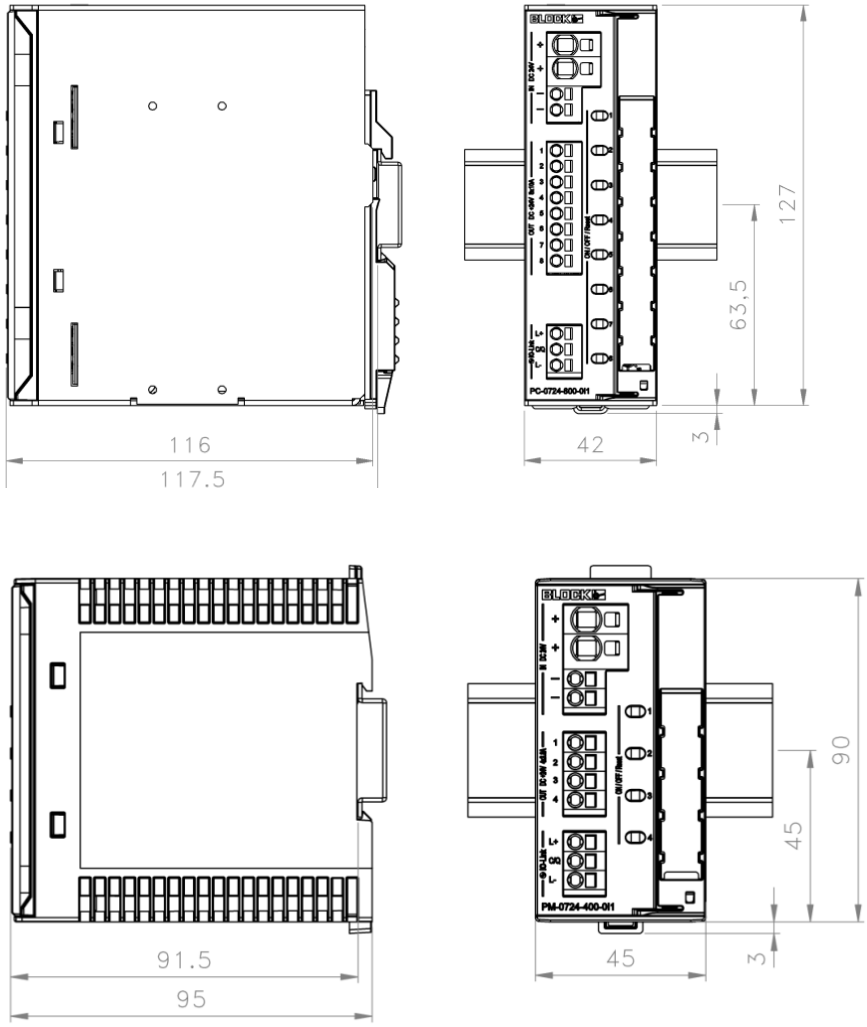

*Figure 4***:** *Dimensions and assembly*

2.4 Assembly

The circuit breaker can be assembled on the supporting rail without any tools.
First, rotate the front of the device slightly, in an upward direction, and place it on the profile rail. Note that the device slides downward as far as it will go. Once the device is sitting on the profile rail, press the underside against the mounting rail until it engages with the catch on the profile rail (followed by an audible "click"). As a further check, gently shake the device to ensure it is properly locked in place.
To remove the device, you only need an ordinary tool like a slotted screwdriver. If the attachment is pressed, the device can be released by lifting its underside from the profile rail.

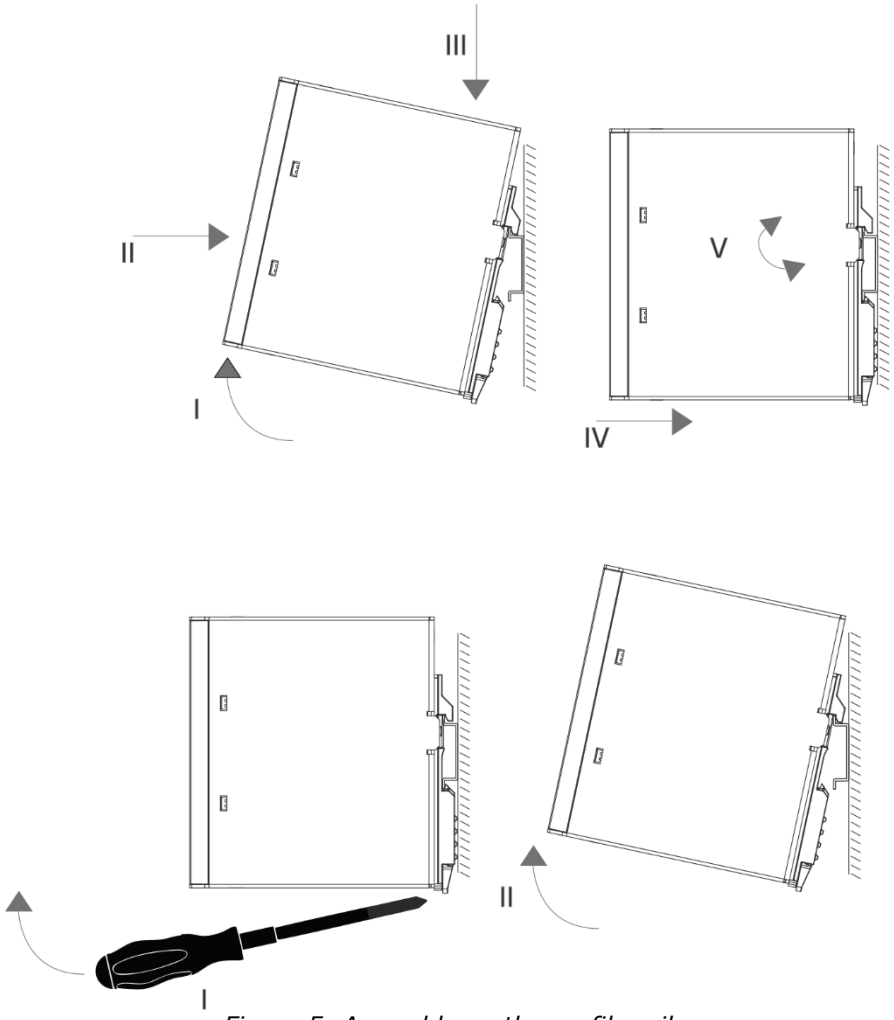

Figure 5: Assembly on the profile rail

To ensure cooling through natural convection, it is important to think about distances from any nearby equipment.

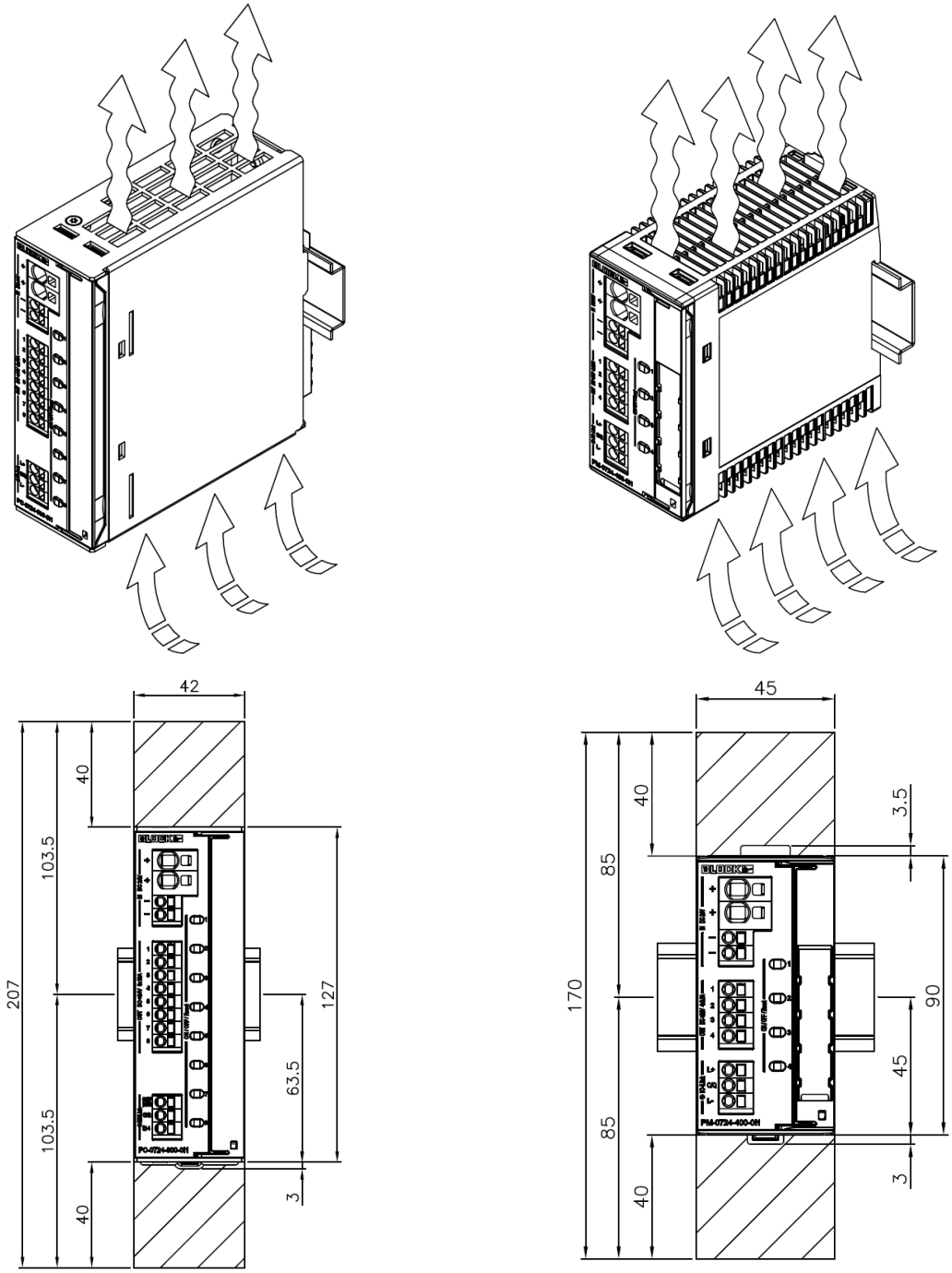

Figure 6: Convection cooling and distances

2.5 Connections and Signaling

Figure 7: *Overview of Connections and Signaling*

No.	Function	Note
1	Current selector switch cover	Can be closed using a seal
2	Input and output terminals for power supply	+ input (0.75 – 6 mm²) (20…10 AWG) - output (0.2 – 2.5 mm²) (24…12 AWG)
3	Load output terminals	0.2 – 2.5 mm² (24…12 AWG)
4	Current selector	1- 10 A
5	Button incl. status indicator	See Chapter 3.1
6	IO-LINK interface	0.2 – 2.5 mm² (24…12 AWG)

3. Initialization

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

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

Once the supply voltage has been applied, all circuit breaker channels are initialized one after the other and then selectively activated.

Note:
The delivery status of the circuit breaker is switched off locally. It cannot be switched on via the IO-LINK interface with this status. The circuit breaker must be switched on manually for this.

3.1 Operating Statuses

The circuit breaker has one LED button for each channel to indicate the operating status. The color codes for the operating statuses can be found in Table 1 below.

Table 1: Operating statuses

Operating status	LED Indicator	Comments
On	Green	Channel is switched on
Off	Red	Channel is switched off
Overload	Slowly flashes green	Channel has an overload
Tripped	Slowly flashes red	Channel has tripped
Thermal release	Slowly flashes orange	Channel is thermally released
Hardware error	Rapidly flashes red	Channel is faulty

3.1.1 Activation delay

The outputs are activated sequentially once a minimum input voltage is reached (activation threshold). All channels are activated in a load-dependent manner in order to reduce inrush current peaks.

The channels are switched on starting with the lowest channel number to be switched on, usually 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, although not before 50 ms has passed.

3.1.2 "ON/OFF and RESET" buttons

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

- Normal mode
  If the channel is switched off (button light is permanently red) it can be switched on by pressing it briefly (button light is green). Pressing the button again switches the output off once again.

- Error mode
  If the output channel is switched off because of an overload (button flashes red) it can be switched back on (Reset).

Note:
The thermal release must be switched off first of all before the output can be switched back on again (button flashes orange). The output is switched off first of all once the button is pressed (button light is permanently red). Pressing the button again switches the output on once again. (Button light is permanently green).

3.2 Charging Capacitive Loads

The electronic circuit breaker allows capacitive loads that are particularly high to be switched on. The following capacities determined experimentally serve as guide values.

Table 2: Line cross-section: 0.75 mm²

Line length (feed and return line)	Inrush capacity [mF] with 22 V input voltage	Inrush capacity [mF] with 24 V input voltage	Inrush capacity [mF] with 26 V input voltage	Inrush capacity [mF] with 28 V 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	130	114.8
40	> 620	> 620	> 620	> 620

Table 3: Line cross-section: 1.5 mm²

Line length (feed and return line)	Inrush capacity [mF] with 22 V input voltage	Inrush capacity [mF] with 24 V input voltage	Inrush capacity [mF] with 26 V input voltage	Inrush capacity [mF] with 28 V 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: Line cross-section: 2.5 mm²

Line length (feed and return line)	Inrush capacity [mF] with 22 V input voltage	Inrush capacity [mF] with 24 V input voltage	Inrush capacity [mF] with 26 V input voltage	Inrush capacity [mF] with 28 V input voltage
0	58	48	26.6	13.3
2.5	79.9	63.3	33.3	18.1
5	63.6	73.3	36.6	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, the potential line capacities depend on the installation circumstances. The power supply must be capable of supplying the required current without the output voltage dropping below 18V.

3.3 Communication

The PC-0724-800-0I1 and PM-0724-400-0I1 circuit breakers communicate in accordance with the IO-LINK standard V1.1.
An IO-LINK Master 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).

4. 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 that are exchanged with the Master every 2 ms. The structure and arrangement of this data is discussed in detail in Chapter 4.1 below.

The parameters and diagnostic data of each individual circuit breaker channel are transmitted in addition to the process data, see chapter 4.2 and chapter 4.3.

4.1 Process Data

4.1.1 PC-0724-800-OI1

The process data of the PC-0724-800-OI1 is exchanged with the IO-LINK Master in a cycle of 2 ms with 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: Input Voltage process data

Bytes 2 & 3	**H-byte**	**L-byte**
Description	**Data Type**	
08 Input Voltage	Unsigned Integer 16	

Table 7: Current Channel 1 process data

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

Table 8: Current Channel 2 process data

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

Table 9: Current Channel 3 process data

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

Table 10: Current Channel 4 process data

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

Table 11: Current Channel 5 process data

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

Table 12: Current Channel 6 process data

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

Table 13: Current Channel 7 process data

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

Table 14: Current Channel 8 process data

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

Table 15: Over Current process data

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: Tripped Channel process data

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

4.1.2 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 with 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: 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 18: Input Voltage process data

Bytes 2 & 3	**H-byte**	**L-byte**
Description	**Data Type**	
08 Input Voltage	Unsigned Integer 16	

Table 19: Current Channel 1 process data

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

Table 20: Current Channel 2 process data

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

Table 21: Current Channel 3 process data

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

Table 22: Current Channel 4 process data

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

Table 23: Over Current process data

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: Tripped Channel process data

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

4.2 Acyclic IO-LINK I/O Data

The acyclic I/O data shown in Table 25 depicts the indices for the basic information. In addition to the product ID this also includes manufacturer-specific information. This is identical for the PC-0724-800-OI1 and the PM-0724-400-OI1.

Table 25: Acyclic IO-LINK I/O Data

Index dec	Functions	Data Type	Attribute	Comments
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

4.3 Acyclic I/O Data of the Circuit Breaker

4.3.1 PC-0724-800-OI1

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	Comments
68	eBreaker Error Code	16 Bit	RO	Error Code
69	eBreaker Type	16 Bit	RO	Device Name
70	eBreaker RC_Status 1-8	8 Bit	RO	Check bit for the setting of the current
71	eBreaker Reset Trip Counter 1-8	8 Bit	WO	Reset the trip counter
72	Number of Channels	8 Bit	RO	Number of Channels
73	Threshold Critical Input Voltage Max	16 Bit	RW	Threshold UIn Max
74	Threshold Critical Input Voltage Min	16 Bit	RW	Threshold UIn 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	Tripping current
601 – 608	eBreaker Status	8 Bit	RO	Status
609 – 616	eBreaker Command	8 Bit	WO	ON / OFF / RESET

4.3.2 PM-0724-400-OI1

Acyclic I/O data is 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	Comments
68	eBreaker Error Code	16 Bit	RO	Error Code
69	eBreaker Type	16 Bit	RO	Device Name
70	eBreaker RC_Status 1-4	8 Bit	RO	Check bit for the current
71	eBreaker Reset Trip Counter 1-4	8 Bit	WO	Reset the trip counter
72	Number of Channels	8 Bit	RO	Number of Channels
73	Threshold Critical Input Voltage Max	16 Bit	RW	Threshold UIn Max
74	Threshold Critical Input Voltage Min	16 Bit	RW	Threshold UIn 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	Current Settings 1 – 4	16 Bit	RW	Tripping current
601 – 604	eBreaker Status	8 Bit	RO	Status
609 – 612	eBreaker Command	8 Bit	WO	ON / OFF / RESET

4.3.3 Coding of the Circuit Breaker Status

The coding for the status of the PC-0724-800-OI1 (Index 601-608) and PM-0724-400-OI1 (Index 601-604) is shown in Table 28.

Table 28: eBreaker Status

Dec. Value	Functions	Comments
0	N.C.	Not connected
1	Switched Off	Switched off via interface
2	Switched On	Switched on
3	Tripped	Tripped
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 release
50	Switched Off, Local	Switched off locally

4.3.4 Coding of the Circuit Breaker Currents

The coding for the tripping currents of the PC-0724-800-OI1 (Index 310-318) and PM-0724-400-OI1 (Index 310 - 313) is shown in Table 29.

Table 29: eBreaker Current

Dec. Value	Functions	Comments
0	Default	IODD DEFAULT
1000	1	Tripping current 1A
2000	2	Tripping current 2A
3000	3	Tripping current 3A
4000	4	Tripping current 4A
6000	6	Tripping current 6A
8000	8	Tripping current 8A
10000	10	Tripping current 10A

4.3.5 Coding of the Circuit Breaker Type

The coding for the type of the PC-0724-800-OI1 (Index 69) and PM-0724-400-OI1 (Index 69) is shown in Table 30.

Table 30: eBreaker Type

Dec. Value	Name	Comments
0	N/A	
47919	PC-0724-800-0I1	
43822	PM-0724-400-0I1	

4.3.6 Coding of the Circuit Breaker Commands

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

Table 31: eBreaker Commands

Dec. Value	Name	Comments
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 On
23[1)]	RESET	Channel 2 Reset
31[1)]	OFF	Channel 3 Off
32[1)]	ON	Channel 3 On
33[1)]	RESET	Channel 3 Reset
41[1)]	OFF	Channel 4 Off
42[1)]	ON	Channel 4 On
43[1)]	RESET	Channel 4 Reset
51	OFF	Channel 5 Off
52	ON	Channel 5 On
53	RESET	Channel 5 Reset
61	OFF	Channel 6 Off
62	ON	Channel 6 On
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

4.3.7 Coding to Reset the Circuit Breaker Trip Counter

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

Table 32: eBreaker Trip Counter

Dec. Value	Functions	Comments
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