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MANUAL

Electronic circuit breaker
ECONOMY SMART

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1. ORDERING DATA

The following table shows the ordering data for the charging and control unit and the battery modules.

Table 1: Order numbers

Variant	Input voltage	Output current	Channels
PC-0724-480-0	24 Vdc	1 – 6A	8
PC-0724-800-0	24 Vdc	2 – 10A	8
PC-0724-800-1	24 Vdc	2 – 10A	8
PM-0712-200-0	12 Vdc	2 – 10A	2
PM-0712-400-0	24 Vdc	2 – 10A	4
PM-0724-120-0	24 Vdc	1 – 6A	2
PM-0724-200-0	24 Vdc	2 – 10A	2
PM-0724-200-1	24 Vdc	2 – 10A	2
PM-0724-240-0	24 Vdc	1 – 6A	4
PM-0724-400-0	24 Vdc	2 – 10A	4
PM-0724-400-1	24 Vdc	2 – 10A	4
PM-0748-200-0	48 Vdc	2 – 10A	2
PM-0748-400-0	48 Vdc	2 – 10A	4

2. GENERAL INFORMATION

2.1 Safety instructions

Please read these warnings and safety instructions carefully before operating the appliance. The device may only be installed by specialised and qualified personnel. In the event of malfunctions or damage, switch off the supply voltage immediately and send the appliance to BLOCK Transformatoren-Elektronik GmbH for inspection. The device does not contain any service parts. If an internal fuse blows, there is most probably an internal defect in the appliance. The data provided are for product description purposes only and are not to be regarded as warranted 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, based on their training and experience, that the use of the described product fulfils all safety requirements as well as the applicable provisions, regulations, standards and laws.

2.3 Intended u

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 the control systems of aeroplanes, trains or nuclear facilities where a malfunction could result in serious injury or danger to life.

2.4 Disclaimer

The contents of this publication have been checked with the utmost care to ensure that they correspond 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.

2.5 Installation

Installation must be carried out in accordance with local conditions, relevant regulations, national accident prevention regulations and the recognised rules of technology. This electrical equipment is a component intended for installation in electrical systems or machines and fulfils the requirements of the Low Voltage Directive (2014/35/EU). The required minimum distance to neighbouring parts must be maintained in order not to impede cooling!

ATTENTION
Switch off the input voltage before carrying out installation, maintenance or modification work and secure it against unintentional switching on again.

ATTENTION
Do not make any changes or attempts to repair the appliance. Do not open the device!

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

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

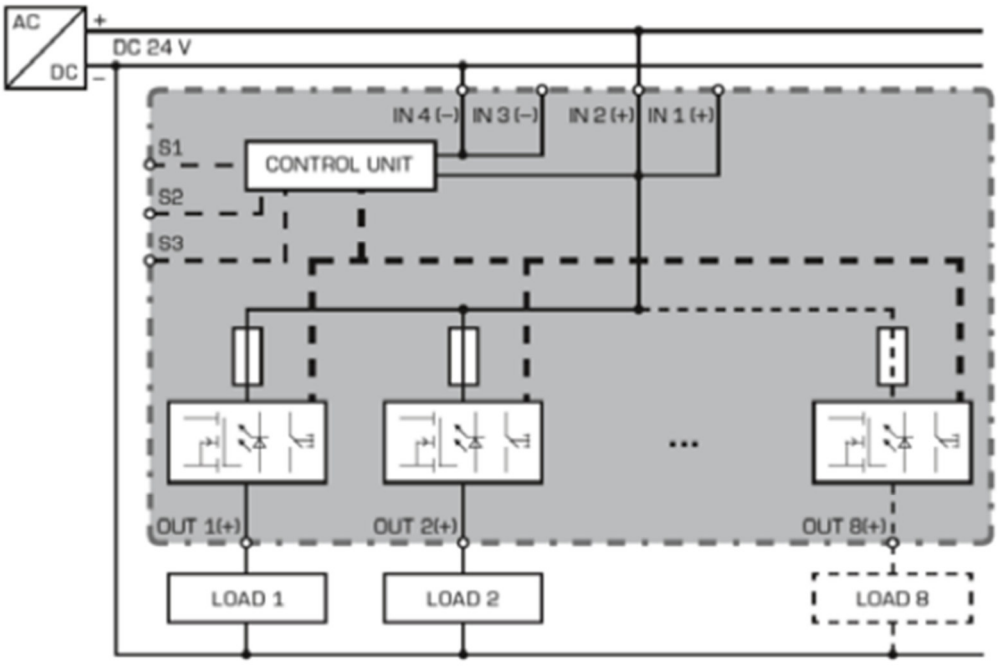
ATTENTION
Do not touch the housing during operation or shortly after switching off.
Hot surfaces can cause injuries.

3. Produktbeschreibung

Circuit-breakers with a thermomagnetic characteristic curve in the ECONOMY SMART version are an economical alternative to classic miniature circuit-breakers. They guarantee reliable tripping, even with high line resistances, and are ideal for appliance and series machine construction.

The electronic circuit breaker splits the load current between several branches and reliably monitors them for overloads and short circuits. The electronics allow short-term current peaks, e.g. due to a high inrush current, while branches with longer overloads are de-energised. This is ensured even on high-impedance cables and in the event of 'creeping' short circuits. The rated current can be set individually for each output using a selector switch. 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 remote reset. The button can also be used to switch the output manually. The status of the output is displayed via a multi-coloured LED.

- Number of available output channels: 2 / 4 / 8
- Adjustable rated current per channel
- Reliable switching on of high capacitive loads
- Sequential and load-dependent switching of the channels
- Status enquiry and remote switching of the outputs via 2 lines
- Extended remote transmission of input voltage, set rated currents and current output currents
- Sum signalling contact for simple remote diagnostics
- Push-in direct connection technology
- LED signalling and on/off/reset button per channel

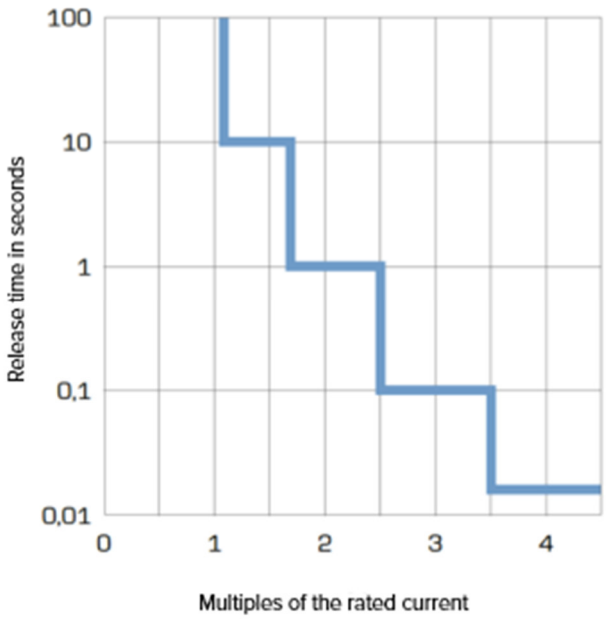


Functional diagram

4. Operating and display elements

Front view with operating and display elements

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.

5. Aufladen von kapazitiven Lasten

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

Cable cross-section: 0.75mm²

Cable length (outgoing and return line)	Switch-on capacitance [mF] at 22 V input voltage	Switch-on capacitance [mF] at 24 V input voltage	Switch-on capacitance [mF] at 26 V input voltage	Switch-on capacitance [mF] at 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

Cable cross-section: 1.5mm²

Cable length (outgoing and return line)	Switch-on capacitance [mF] at 22 V input voltage	Switch-on capacitance [mF] at 24 V input voltage	Switch-on capacitance [mF] at 26 V input voltage	Switch-on capacitance [mF] at 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	89,371,3	109,5
40	306,6	222,8	122,8	112,8

Cable cross-section: 2.5mm²

Cable length (outgoing and return line)	Switch-on capacitance [mF] at 22 V input voltage	Switch-on capacitance [mF] at 24 V input voltage	Switch-on capacitance [mF] at 26 V input voltage	Switch-on capacitance [mF] at 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 tasks are guide values, possible line capacities depend on the installation situation. The supplying power supply unit must be able to supply the required current without the output voltage dropping to less than 18V.

6. Operating states, signalling, reactions

Z	Operating state	Output	LED	Signal Output S3 (Sum Signal)	Button is pressed	Signal input S1 ON/OFF/RESET
0	Module initialisation (1)	Off	Off	0 V	---	---
1	Outputs switched on Function OK	On	Green	24 V	Switch off output Z3	Via bit pattern → Switch off output Z3
2	Output current> Rated current (2)	On	Flashing green	24 V	Switch off output Z3	Via bit pattern → Switch off output Z3
3	Output is switched off manually or via signal input S1 (3)	Off	Red	24 V	Switch on output Z1	Via bit pattern → Switch on output Z1
4	Output is switched off due to an overcurrent Thermal expansion is active (4)	Off	Flashing red	0 V	--- Z4	--- Z4
5	Output is switched off due to an overcurrent Thermal expansion has ended (5)	Off	Flashing red + green	0 V	Switch on output Z3	Long 24V pulse (>0.5s) → Switch on output Z1
6	Device error (defective fuse detected)	Off	Fast flashing red	0 V	--- Z7	--- Z7

1) Once module initialisation is complete, the outputs are switched on depending on the load.
2) The output is automatically switched off according to the tripping characteristic.
3) The status is saved when the device is switched off.
4) After a waiting time (thermal relaxation), transition to operating state Z5. When the device is switched off, the remaining waiting time is saved and waited for when the device is switched on again. This reliably prevents overloading of the switching elements even if the device is switched on again immediately.
5) The affected output can be switched on again by pressing the button twice or via a pulse (>0.5s) at signal input S1, transition to operating state Z1.

6.1 Switch-on delays of individual channels

The outputs are switched on sequentially after a minimum input voltage (switch-on threshold) is reached. 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 not before 50 ms.

6.2 Taster „ON/OFF und Reset“

A push-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 it 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 yellow instead of red). After pressing the button, the output is initially switched off (button lights up red continuously). Pressing the button again switches the output on again. (button lights up green continuously).

The outputs are switched on in the delivery state.

6.3 Signalling and control contacts S1/S2/S3

The electronic circuit breaker is equipped with three signalling and control contacts.

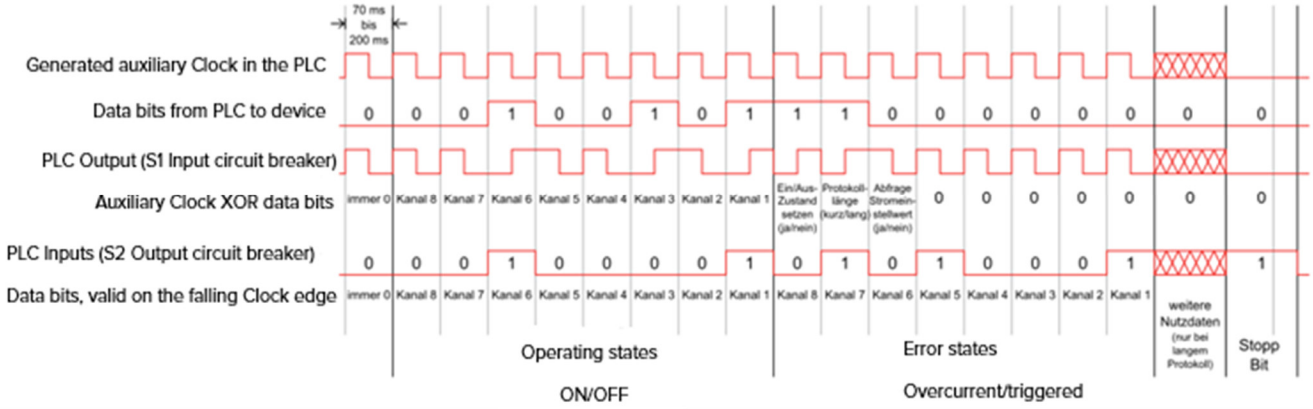
Signal contacts S1 (digital input) and S2 (digital output) can be used to read out operationally relevant information from the circuit breaker and to switch any output channels on or off.

A sum reset (switching back on) of all triggered outputs (outputs not switched off manually) is also possible via signal input S1, provided a 24V high pulse is fed in for at least 0.5 seconds.

The signal output S3 serves as an active 24V collective fault signal and indicates that at least one output has been switched off due to overcurrent. An internal device fault is also signalled by S3.

6.4 Functionality of 2-wire communication via S1/S2

The circuit breaker can be remotely controlled via a higher-level control system (e.g. PLC) using a serial bit pattern at signal input S1. At the same time, the operating and fault statuses, the input voltage applied to the module, the set nominal current and the current flowing in each circuit are made available via the signal output S2.



Diagnostic options via S1/S2

Short protocol: (17 bit data – minimum transmission time 1.2 seconds)
Operating states = **On or off per channel**
Extended protocol = **Overcurrent or tripped per channel**
Extended protocol: (89 Bit Data – minimum transmission time 6.3 seconds)
Current input voltage
Set nominal currents per channel
Current current per channel (only applies to BASIC SMART equipment)

6.5 Communication process via S1/S2

- A digital output of the control unit sends the Manchester coding to the circuit breaker via "S1". This encodes which output channel is to be switched on or off.

- The circuit breaker synchronizes itself internally to this and simultaneously sends back the status (on/off and error status) of all channels via "S2". Optionally, in addition to the module input voltage, the current flowing at any time and the set current value of each circuit can be queried, see "extended protocol".

- The data sent back by the circuit breaker is only high/low and not Manchester-coded. The data should be transferred shortly after the edge change (from high to low) of the generated auxiliary clock in order to avoid false signaling due to program runtimes or delays of the I/Os in a PLC.

- Once all 17 or 89 bits for the extended protocol have been successfully received, the circuit breaker sends an 18th or 90th bit as a stop bit. This takes 1.5 clock cycles. During this time, the PLC must not send another bit.

Coding of the status bits sent by the circuit breaker

On/off status per channel	Error status per channel	Description
0	0	Output channel is switched off manually or via coded pulse pattern on S1
0	1	Output channel is switched off due to an over-current
1	0	Output channel is switched on manually or via coded pulse pattern on S1
1	1	Overcurrent (output current > rated current) (duration of the overcurrent is ≥ 1 second)

Note:
The on/off status changes sent by a higher-level control system are only sent back updated by the circuit breaker with the next telegram. If, for example, the status of output channel 3 is changed from "0" to "1" in a telegram, the old status "0" is transmitted in the same telegram. The status of the output channel is only updated by the circuit breaker the next time it is queried by the control system.

Program examples (function) for various PLC series ca be downloaded free of charge from the product page of this device on the internet at BASIC SMART (block.eu)

6.6 Details of the signal input S1 (ON/OFF/RESET)

This 24V signal input is not electrically isolated in relation to the 0V input of the module. This input can be used to switch all outputs that have been switched off due to overload back on as well as to switch individual channels on or off.

Reset (switching triggered channels back on)
By applying a 24V voltage for longer than 0.5 seconds, all outputs triggered by overload are switched back on sequentially and load-dependently.

Remote on/off
Any outputs can be switched on or off simultaneously via coded pulse patterns. Temporary circuits such as certain lighting or auxiliary circuits can be switched off as required.

Function	Action	Reaction	Pulse
Reset	Long pulse >= 500ms	**all outputs switched off due to overload are switched on again. Triggered channels are only reactivated after 0V detection. This prevents automatically triggered channels from being switched on again in the event of a continuous signal**	 Switching on all triggered channels
ON/OFF	Coded pulse pattern	**Switching non-triggered outputs on and off. Triggered outputs cannot be switched on or off. They must first be acknowledged by a reset pulse.**	See description of the pulse pattern below

Description Pulse pattern

The pulse pattern consists of 17 or optionally 89 bits, which must be sent as a Manchester code (in accordance with IEEE 802.3). The first bit to be transmitted has the value '0' and serves as the start bit. This is followed by 16 or optionally 88 bits of user data.

The first 8 bits represent the desired on/off status of the individual channels in descending order. A value of '1' switches the corresponding channel on, a value of '0' switches it off. For the following 8 bits, only the first three most significant bits are relevant.

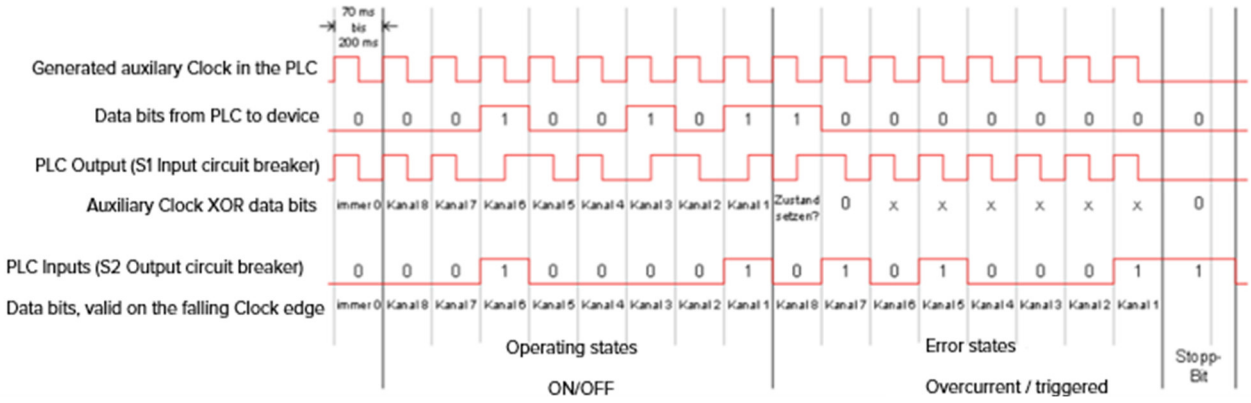
- Bit 7 = „1“: the on/off status transmitted in the first 8 bits is accepted
- Bit 7 = „0“: the on/off status transmitted in the first 8 bits is ignored
- Bit 6 = „1“: the extended 89-bit protocol is used, the circuit breaker transmits additional user data
- Bit 6 = „0“: the short 17-bit protocol is used
- Bit 5 = „1“: the rated currents set on the current selector switch and the current input voltage are transmitted
- Bit 5 = „0“: the current input voltage and, for all circuit breakers in the „**BASIC SMART**“ configuration, the current output currents are transmitted.

The following 6 or optionally 78 bits must be set to '0' and serve as a clock signal for the signal output 'S2'.

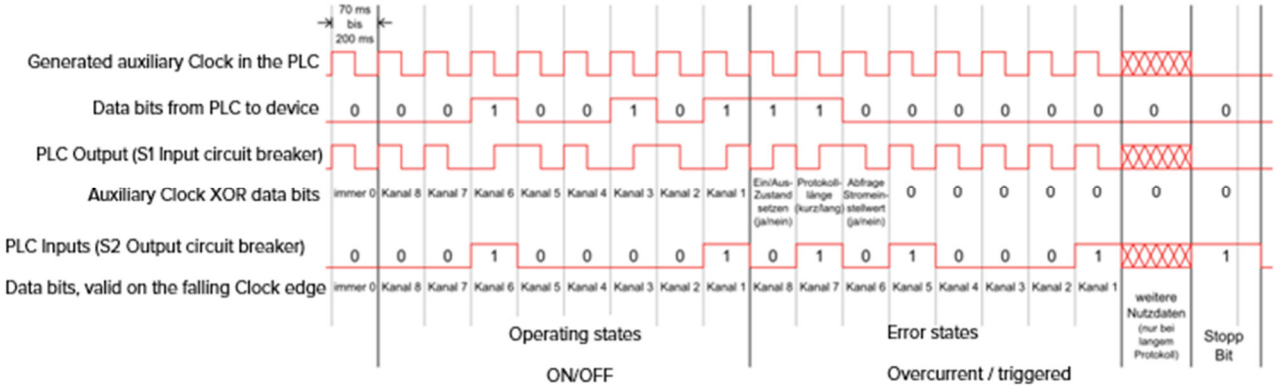
Once all 17 or 89 bits have been successfully received, the circuit breaker sends an 18th or 90th bit as a stop bit. This takes 1.5 clock cycles. During this time, the PLC must not send another bit. After the pulse pattern has been sent, S1 and S2 are set to low level again.

New pulse patterns on S1 are only permitted after a waiting time of at least 200ms.

Standard protocoll (17 Bit)



Extended protocoll (89 Bit)



It begins with the 3rd byte of the protocol (further user data) and contains a total of 9 bytes. These are coded with the most significant bit first ('MSB first') and have the following meaning:

(Depending on the value of bit 5 in the 2nd byte, either the set nominal currents or the current output currents (only 'BASIC SMART' equipment) are transmitted in addition to the current input voltage.

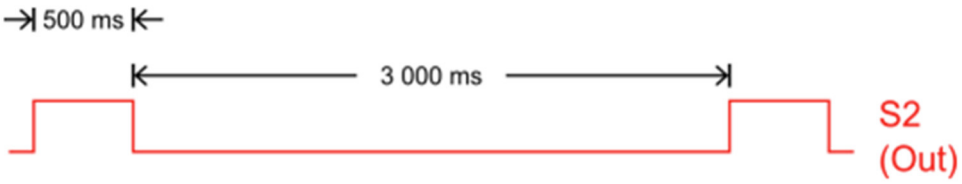
Input voltage:	((transmitted value) /16 + 16) V
Current channel 1:	(transmitted value) /16 A
Current channel 2:	(transmitted value) /16 A
Current channel 3:	(transmitted value) /16 A
Current channel 4:	(transmitted value) /16 A
Current channel 5:	(transmitted value) /16 A
Current channel 6:	(transmitted value) /16 A
Current channel 7:	(transmitted value) /16 A
Current channel 8:	(transmitted value) /16 A

6.7 Details on signal output S2 (status oft he outputs)

This 24V signal output is not electrically isolated in relation to the 0V input of the module. This output can be used to query the status of all integrated output channels. The output is short-circuit-proof, the short-circuit current is approx. 25 mA.

Coded pulse sequence for status enquiry, generated by the PLC
If the PLC sends the coded pulse sequence via signal input S1, the circuit breaker synchronises to the auxiliary clock of the PLC and sends the current on/off status of the channels in data byte 1 via signal output S2. Triggered channels are coded in data byte 2.

Cyclical pulse after status change, generated by the circuit breaker
If the PLC does not perform a cyclical status request, the circuit breaker on S2 generates a cyclical pulse if the error status changes and the status is not requested regularly within the next 3 seconds. The internal fault status changes when at least one output is switched off or overcurrent occurs. This pulse is sent until the PLC has successfully queried the updated status via a new Manchester-coded telegram.

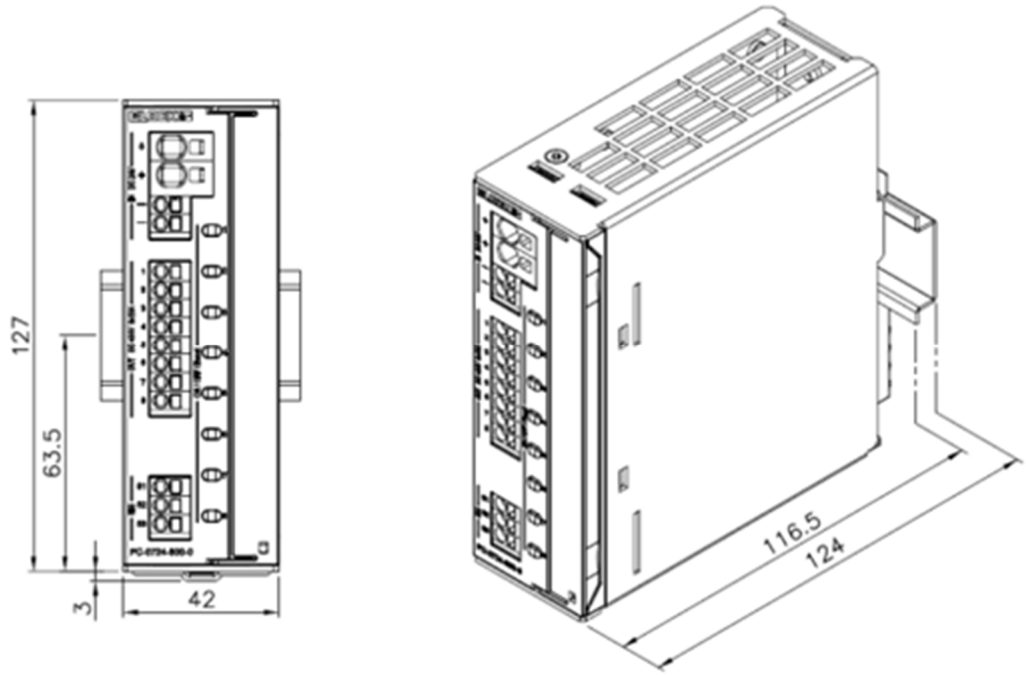


A digital input of the control system must therefore query the signal contact S2 in order to be informed of status changes in the circuit breaker. At the same time, the control system must be programmed to avoid starting a telegram via S1 while a pulse is being generated on S2 by the circuit breaker. It is recommended to evaluate the respective status on S2 before starting to send the telegram or to generate a telegram to query the status at least every 3 seconds.

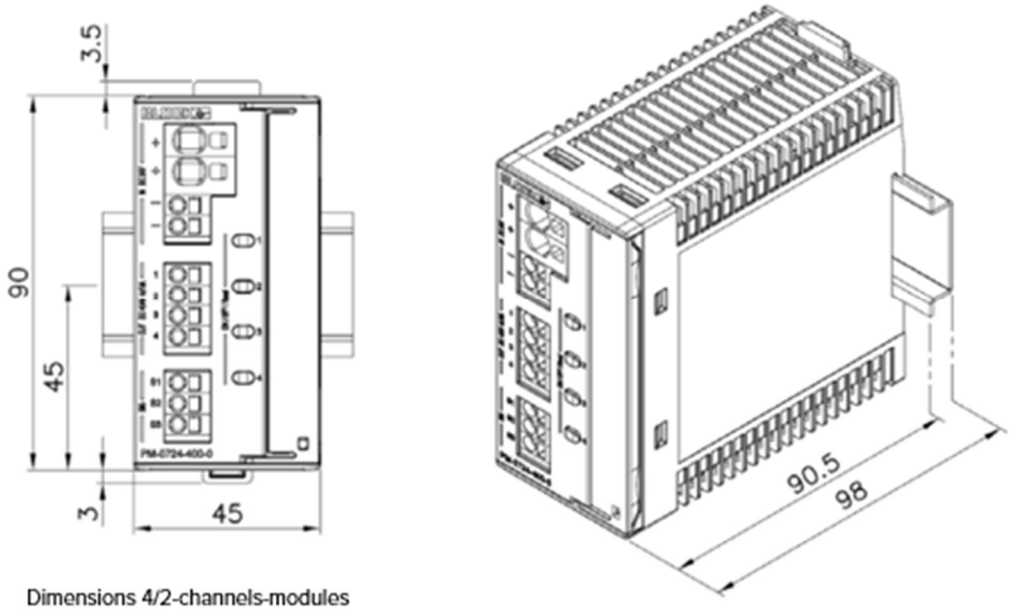
6.8 Details on signal output S3 (Σ for triggered outputs and device fault)

This 24V signal output is not electrically isolated in relation to the 0V input of the module. The sum signal is realised by an 'Active High' signal output. If no output has triggered and no internal device fault has been detected, this signal output is 'Active High' (+24V). As soon as at least one output channel has triggered or a device defect has been detected, the signal output switches to 'Active Low' (0V). This signal output is short-circuit-proof and can be loaded up to max. 20 mA.

7. Dimensions



Dimensions 8-channel-modules



Dimensions 4/2-channels-modules