

## Electronic Circuit Breaker **BASIC SMART**



- Number of available output channels: 2 / 4 / 8
- Adjustable rated current via channel
- High capacitive loads start up reliably
- The channels switch on sequentially and load-dependent
- Status query and remote switching of the outputs via two lines
- Faulty circuits switch off when the supply voltage is critical
- Expanded remote- transfer of input voltage, set rated currents and actual output currents
- Group signal contact for easy remote diagnosis
- Push-in-direct or pluggable connection technology
- LED signaling and on/off/reset button via channel

### Description

The circuit breakers of the **BASIC SMART** equipment guarantee the highest system availability. In the event of overload of a circuit, only the faulty current path is reliably disconnected due to active current limiting on the 1.7x of the rated current with no retroactive effect on the remaining circuits. Voltage dips on unaffected circuits are reliably prevented.

The trip current of each output can be individually adjusted using the selector switch accessible from the front. The outputs are switched on with a time delay and load-dependent in order to prevent peak inrush currents. If the rated current is exceeded, the output automatically switches off after a defined tripping time and can be switched back on after a short waiting period (thermal rebound) with a button or via signal contact. The button also manually switches the respective output.

Information relevant to operation can be read out and individual outputs can be switched on or off by way of signal contacts. A 24 V group error signal for tripped outputs is also available. A multicolored LED displays the respective output status.

### Approvals



UL 2367



UL 508



Germanischer Lloyd









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## Product overview

### BASIC SMART

<b>POWER COMPACT</b> 8-channel	<b>POWER MINI</b> 4-channel	<b>POWER MINI</b> 2-channel																						
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Rated currents adjustable in stages

**0.5-6A** = 0.5/1/2/3/4/6A

**2-12A** = 2/4/6/8/10/12A

with pluggable spring-type terminal

**Safety notices**

Please read these warnings and safety notices carefully before operating the device. Installation of the device is reserved for competent and qualified personnel. In the event of malfunctions or damage to the device, switch off the supply voltage immediately and send to the production plant for inspection. The device does not contain any service parts. If an internal fuse is tripped, an internal defect in the device is highly likely. The specified data serve the product description alone and are not understood as warranted characteristics in the legal sense.

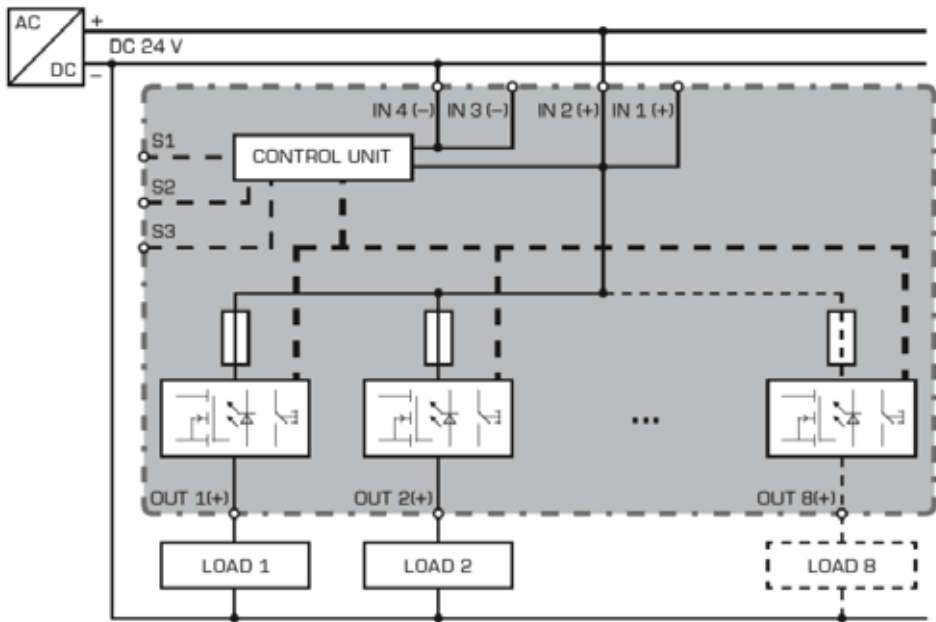
**Proper use**

This device is designed for installation in a housing and for use with all electronic devices, such as industrial control systems, office equipment, communication devices, and measuring instruments, for example. Do not use this device in the control systems of aircraft, trains, or nuclear facilities where malfunction may result in severe injury or death.

**Installation**

Installation should be performed in accordance with local conditions, relevant provisions, national accident prevention regulations and the accepted rules of engineering. This electrical equipment is a component designed for installation in electrical systems or machines and it satisfies the requirements of the Low Voltage Directive (2014/35/EU). The required minimum distance from the adjacent parts must be maintained in order to prevent the cooling system from being impeded!

**Connection**



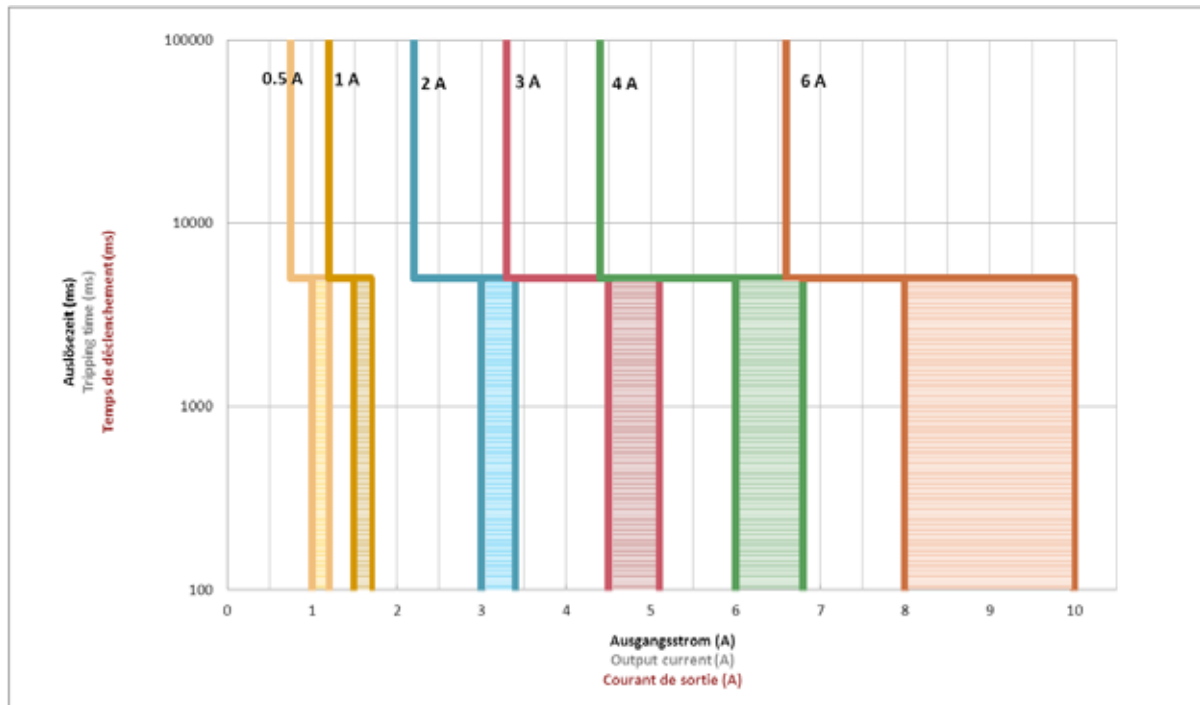
Functional circuit diagram

**Operating and display elements**



Front view with operating and display elements

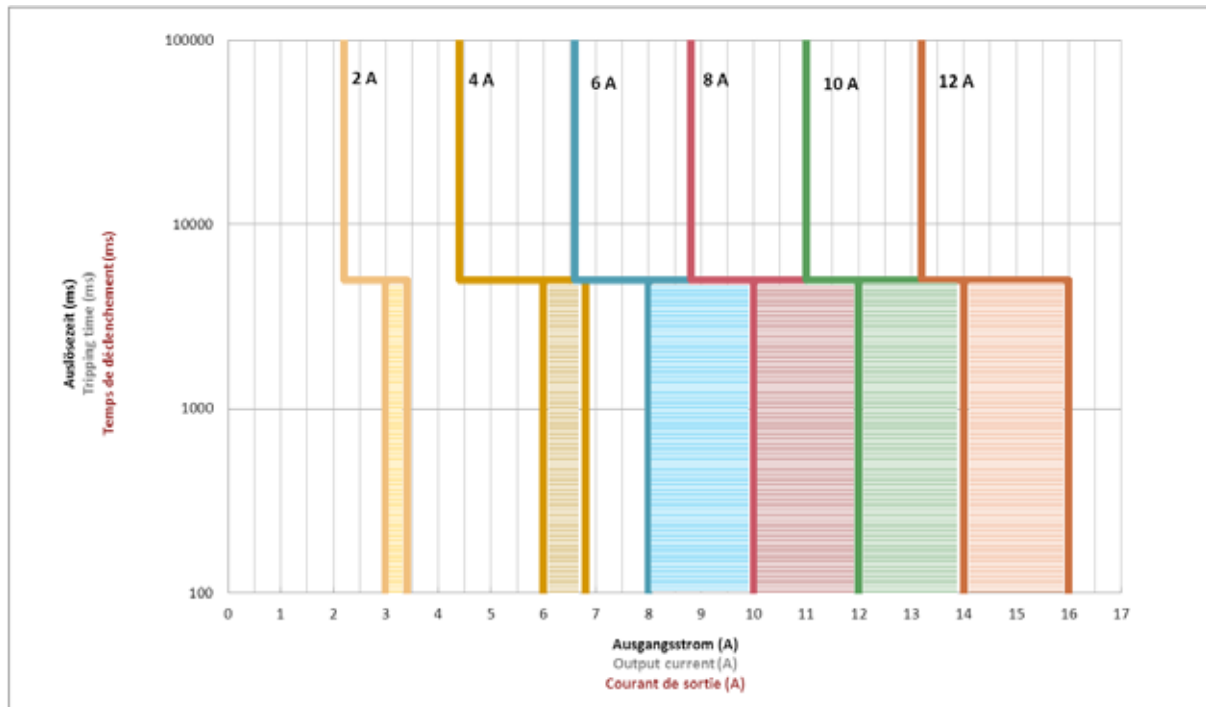
**Tripping characteristic max. 6A rated current**



Set rated current	Switch off occurs after max. 5 s in event of overcurrents >	Switch off occurs within 50 ms ... 5 s if the overcurrent is between:	
0.5 A	0.75 A	1.00 A	1.20 A
1 A	1.20 A	1.50 A	1.70 A
2 A	2.20 A	3.00 A	3.40 A
3 A	3.30 A	4.50 A	5.10 A
4 A	4.40 A	6.00 A	6.80 A
6 A	6.60 A	8.00 A	10.0 A

The electronic circuit breaker actively limits the overcurrent of each output channel to the type 1.7x of the set rated current; see the right hand column in the table above. The switch-off time varies between 50 ms and 5 s depending on the extent of the overcurrent. Only the faulty circuit is selective switched off in the event of an overcurrent. Voltage dips on unaffected circuits are reliably prevented.

### Tripping characteristic max. 12A rated current



Set rated current	Current limitation	Switch off occurs after max. 5 s in event of overcurrents >	Switch off occurs within 50 ms ... 5 s if the overcurrent is between:	
2 A	$1.7 \times I_{\text{rated}}$	2.2 A	3 A	3.4 A
4 A	$1.7 \times I_{\text{rated}}$	4.4 A	6 A	6.8 A
6 A	$1.7 \times I_{\text{rated}}$	6.6 A	8 A	10 A
8 A	$1.5 \times I_{\text{rated}}$	8.8 A	10 A	12 A
10 A	$1.4 \times I_{\text{rated}}$	11 A	12 A	14 A
12 A	$1.3 \times I_{\text{rated}}$	13.2 A	14 A	16 A

The electronic circuit breaker actively limits the overcurrent of each output channel to the maximum of the set rated current; see the column named "Current limitation" in the table above. The switch-off time varies between 50 ms and 5 s depending on the extent of the overcurrent. Only the faulty circuit is selective switched off in the event of an overcurrent. Voltage dips on unaffected circuits are reliably prevented.

### Selective immediate cut-off in event of undervoltage

If the power supply output voltage falls below 20 V, a selective immediate cut-off (max. 16 ms) of all outputs which at that moment lead to more than 100% of the individually set trip current is executed.

## ***Charging of capacitive loads***

The electronic circuit breaker enables especially high capacitive loads to be switched on. The following experimentally determined capacities serve as standard values.

### ***Capacities for devices with max. 6A rated current:***

#### **Line cross-section: 0.75mm<sup>2</sup>**

Line length (feed and return line)	Inrush capacity [mF] at 22V input voltage	Inrush capacity [mF] at 24V input voltage	Inrush capacity [mF] at 26V input voltage	Inrush capacity [mF] at 28V input voltage
0	80	74.3	51.5	42
2.5	82.5	72	57.8	48.8
5	100	78	63	51
10	126.8	96.8	75.3	61
20	189.3	145.2	109.8	82
40	> 620	> 620	243	167.3

#### **Line cross-section: 1.5mm<sup>2</sup>**

Line length (feed and return line)	Inrush capacity [mF] at 22V input voltage	Inrush capacity [mF] at 24V input voltage	Inrush capacity [mF] at 26V input voltage	Inrush capacity [mF] at 28V input voltage
0	80	64.8	51.5	43.3
2.5	86.8	69.3	54.3	43.8
5	91.5	78.3	61.5	45
10	99.3	86.8	66.8	50
20	131.5	102.5	89.3	62.5
40	201.5	152.5	102.5	86.8

#### **Line cross-section: 2.5mm<sup>2</sup>**

Line length (feed and return line)	Inrush capacity [mF] at 22V input voltage	Inrush capacity [mF] at 24V input voltage	Inrush capacity [mF] at 26V input voltage	Inrush capacity [mF] at 28V input voltage
0	80	64.8	51.5	42.5
2.5	83.3	67.8	52.3	43.3
5	84.3	69.3	54.3	44.3
10	89.3	71.1	56.8	46.8
20	109.3	86.8	67.8	54.3
40	136.8	107.8	82	65.3

All capacities were determined experimentally under nominal load. The indicated values are standard values. Possible line capacities depend on the installation situation. The feeding power supply must be able to supply the required current without voltage dip of the output voltage to a low 18 V.

### ***Capacities for devices with max. 12A rated current:***

Minimum capacity: **137mF @24Vdc**

The capacity was determined experimentally with a rated current of 12 A, a line length of 2.5 m and a line cross-section of 2.5 mm<sup>2</sup>.

## Operational statuses, signaling, reactions

Z	Operational status	Output	LED	Signal output S3 (group signal)	Button is pressed	Signal input S1 (on/off/reset)
0	Module initialization <sup>1)</sup>	off	off	0 V	---	---
1	Outputs switched on, function OK	on	green	24 V	Switch off output Z 3	via bit pattern -->switch off output Z 3
2	Output current > rated current <sup>2)</sup>	on	green flashing	24 V	Switch off output Z 3	via bit pattern -->switch off output Z 3
3	Output is switched off manually or via signal input S1 <sup>3)</sup>	off	red	24 V	Switch on output Z 1	via bit pattern -->switch on output Z 1
4	Output is switched off on the basis of an overcurrent Thermal rebound active <sup>4)</sup>	off	red flashing	0 V	---	Z 4
5	Output is switched off on the basis of an overcurrent Thermal rebound is concluded <sup>5)</sup>	off	orange flashing	0 V	Switch on output Z 3	Long 24 V impulse (>0.5 s) --> switch on output Z 1
6	Device error (defective fuse detected)	off	red rapid flashing	0 V	---	Z 6

- 1) After initializing the module, switching on the outputs is load-dependent.
- 2) The output is switched off automatically according to the tripping characteristic
- 3) The status is saved when switching off the device.
- 4) Transition to operational status Z5 after a waiting period (thermal rebound). The remaining waiting period is saved when switching off the device and it takes effect when switching the device back on. This reliably prevents an overload of the switching elements when switching the device back on immediately.
- 5) The affected output can be switched back on by pressing the button twice or by way of an impulse (> 0.5 s) to signal input S1; transition to operational status Z1.

### Switch-on delays for individual channels

Switching on the outputs occurs sequentially after achieving a minimum input voltage (switch-on threshold). The switching on of all channels is load-dependent in order to reduce starting current spikes.

Switching on of the channels begins with the lowest channel number to be switched on, typically beginning with channel 1. The next channel is switched on as soon as the rated current in the previous channel falls below the set nominal value or the previous channel has been switched off, however, after 50 ms at the earliest.

### "ON/OFF and reset" buttons

A button is assigned to each output channel. The actual status is displayed by way of an integrated LED. The button has two functions depending on the operational status:

- Normal operation  
If the channel is switched off (button illuminates red continuously), it can be switched on by pressing the button briefly (button illuminates green). Pressing the button again switches the output back off.
- Error mode  
If the output channel is switched off due to an overcurrent (button flashes red), it can be switched back on (reset).



**Note:**

To switch the output back on, the thermal rebound must first be completed (button flashes green instead of red). After pressing the button, the output switches off initially (button illuminates red continuously). Pressing the button again switches the output back on. (button illuminates green continuously)

The outputs are switched on by default when delivered.

**Signaling and control contacts S1/S2/S3**

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



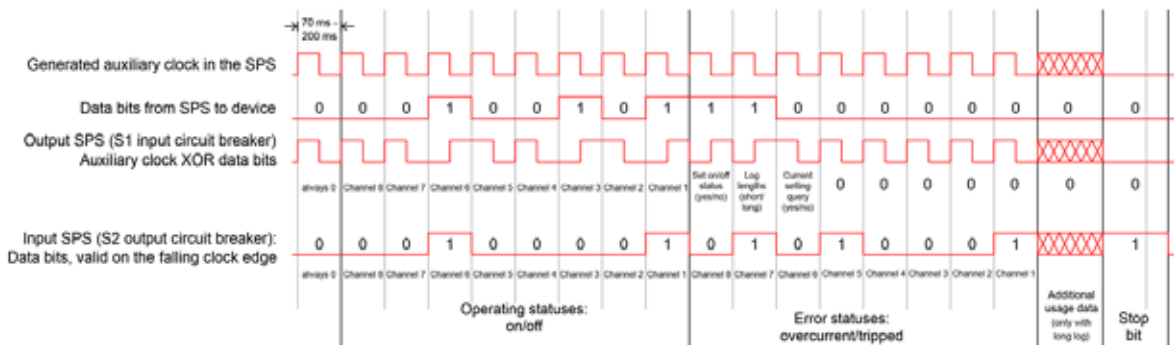
Information from the circuit breaker relevant to operation can be read out and any desired output channel can be switched on or off by way of signal contacts S1 (digital input) and S2 (digital output).

A group reset (switching back on) of all tripped outputs (outputs which have not been switched off manually) is also possible by way of signal input S1, provided a 24 V high impulse is fed in for at least 0.5 seconds.

Signal output S3 serves as an active 24 V collective fault message and signals that at least one output has been switched off due to an overcurrent. S3 also signals an internal device defect.

**Functionality of the 2-wire communication via S1/S2**

Using a higher-level control (e.g., PLC), the signal input can be controlled remotely by way of a serial bit pattern at signal input S1. The operating and error statuses, the input voltage supplied to the module, the set rated current and the actual flowing current for each circuit are provisioned simultaneously by way of signal output S2.



**Diagnosis options via S1/S2:**

**Short log:** (17-bit data – minimal transmission duration 1.2 seconds)

*Operational statuses = on or off via channel*

*Error statuses = overcurrent or tripped via channel*

**Expanded log:** (89-bit data – minimal transmission duration 6.3 seconds)

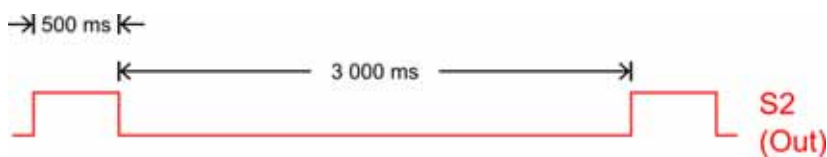
*Actual input voltage*

*Set rated currents via channel*

*Actual current via channel (applies only to BASIC SMART equipment)*

**Communication sequence via S1/S2:**

- A digital output of the control sends the Manchester coding to the circuit breaker by way of "S1." The coding determines which output channel should be switched on/off.
- The circuit breaker synchronizes internally according to this and simultaneously sends back the status (on/off and error status) of all channels by way of "S2." Optionally, in addition to the module input voltage, the momentary flowing current as well as the set current value of each circuit can be queried; see "expanded log."
- The data sent back by the circuit breaker are only high/low and not Manchester-coded. In order to avoid faulty signaling resulting from program run times or delays of the E/As in a PLC, the data import from the generated auxiliary clock occurs shortly after the edge change (from high to low).
- Once all 17 or 89 bits for the expanded log have been successfully received, the circuit breaker sends an 18- or 90- bit as a stop bit. This takes 1.5 clock cycles. The PLC can send no additional bits during this time.
- If the error status in the circuit breaker changes, for example, after an overcurrent is present on the output, then the circuit breaker generates a cyclical impulse on signal output S2 (500 ms high impulse every 3 seconds). This impulse is sent as long as the PLC has successfully queried the current status by way of a new telegram with Manchester coding.



**Coding of the status bits sent by the circuit breaker**

On/off status via channel	Error status via channel	Description
0	0	Output channel is switched off manually or via coded pulse pattern to S1
0	1	Output channel is switched off on the basis of an overcurrent
1	0	Output channel is switched on manually or via coded pulse pattern to 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 are sent back updated by the control with the next telegram. If, for example, the status of output channel 3 is changed in a telegram from "0" to "1," then the old status "0" is transmitted in the same telegram. The circuit breaker sends the updated status of the output channel only after the next query from the control.

Program examples (function) for the different PLC series are available online for free download on the product page for this device at [BASIC SMART product page](#).

## **Details on signal input S1 (ON/OFF/RESET)**


This 24 V signal input refers to the non-electrically isolated 0 V input of the module. With this input, all outputs switched off by overload are switched back on and specific individual channels can be switched on or off.

### **Reset (switching back on tripped channels)**

By applying a 24 V voltage for longer than 0.5 seconds, all outputs tripped by overload are switched back on sequentially and load-dependent.

### **Remote on/off**

Any of the outputs can be switched on or off simultaneously by way of coded pulse patterns. Specific temporary circuits, such as for example, certain lighting or auxiliary circuits can be switched off as needed.

Function	Action	Reaction	Impulse
Reset	Long impulse >= 500ms	<b>All outputs switched off due to overload are switched back on.</b> <i>Switching tripped channels back on again is only possible after 0 V detection. This prevents automatically tripped channels from being switched back on again when the signal is constant.</i>	 Switching all tripped channels on
ON/OFF	coded pulse pattern	<b>Switching untripped outputs on and off.</b> <i>Tripped outputs cannot be switched on or off. They must first be acknowledged with a reset impulse.</i>	See the pulse pattern description below

### **Pulse pattern description**

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

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

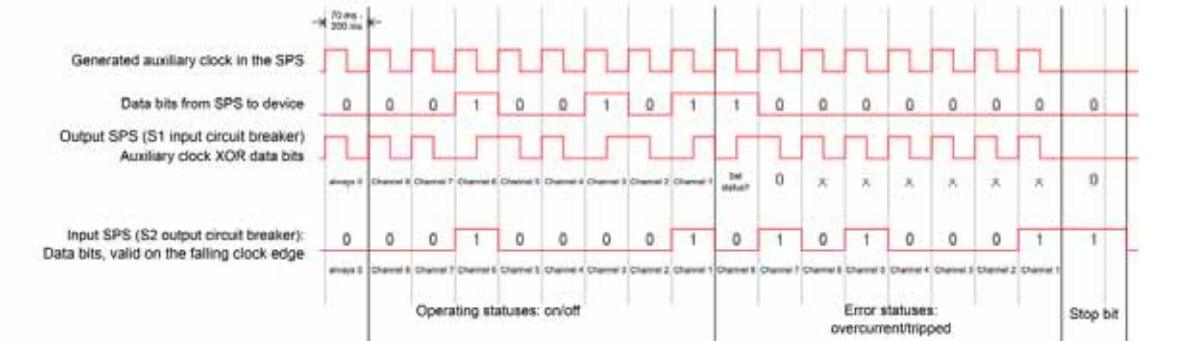
- Bit 7 = "1": the on/off status transmitted in the first 8 bits is imported
- Bit 7 = "0": the on/off status transmitted in the first 8 bits is ignored
- Bit 6 = "1": the expanded 89-bit log is used; the circuit breaker transmits additional usage data
- Bit 6 = "0": the short 17-bit log is used
- Bit 5 = "1": the rated currents set on the current selector switch and the actual input voltage are transmitted
- Bit 5 = "0": the actual input voltage and the actual output currents are transmitted for all circuit breakers in the "BASIC SMART" equipment.

The 6 or, optionally, 78 bits to follow are set to "0" and serve as a clock signal for the signal output "S2."

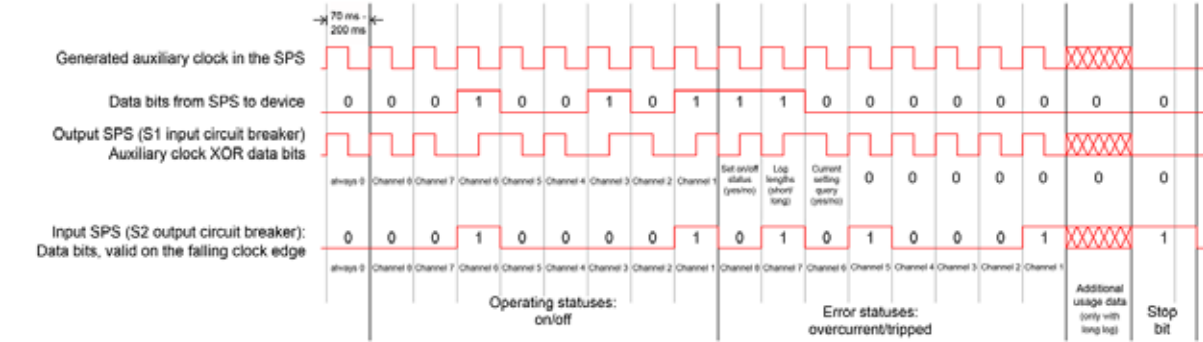
Once all 17 or 89 bits have been successfully received, the circuit breaker sends an 18- or 90-bit as a stop bit. This takes 1.5 clock cycles. The PLC can send no additional bits during this time. Once the pulse pattern has been sent, S1 and S2 are set to the low level.

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

**Standard log (17-bit)**



**Expanded log (89-bit)**



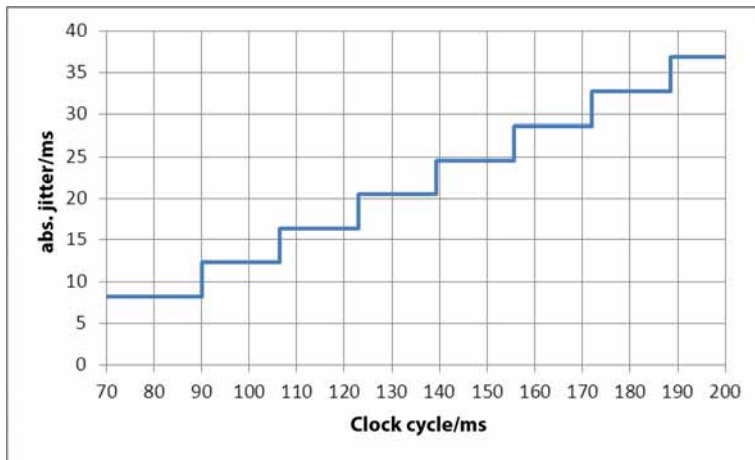
It starts with the 3rd byte of the log (additional usage data) and includes a total of 9 bytes. These are coded first with the most significant bit ("MSB first") and have the following meaning:

Depending on the significance of bit 5 in the 2nd byte, either the set rated currents or the actual 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

### Max. jitter for data transmission

The following absolute jitter is permitted depending on the selected clock cycle:



### Details on signal input S2 (status of the outputs)

This 24 V signal output refers to the non-electrically isolated 0 V input of the module. This output allows the statuses of all integrated output channels to be queried. The output is short circuit proof; the short circuit current is 25 mA.

#### Coded pulse sequence for status query, generated by the PLC

If the PLC sends the coded pulse sequence by way of signal input S1, the circuit breaker synchronizes the circuit breaker to the auxiliary clock of the PLC and sends the actual on/off status of the channels in data byte 1 by way of signal output S2. Tripped channels coded in data byte 2.

#### Cyclical impulse after status change generated by the circuit breaker

If the PLC does not execute a cyclical status query, then the circuit breaker at S2 generates a cyclical impulse, provided the error status changes and is not queried regularly within the next 3 seconds of the status. The internal error status changes by switching off or also as a result of the overcurrent of at least one output. This impulse is sent as long as the PLC has successfully queried the current status by way of a new telegram with Manchester coding.



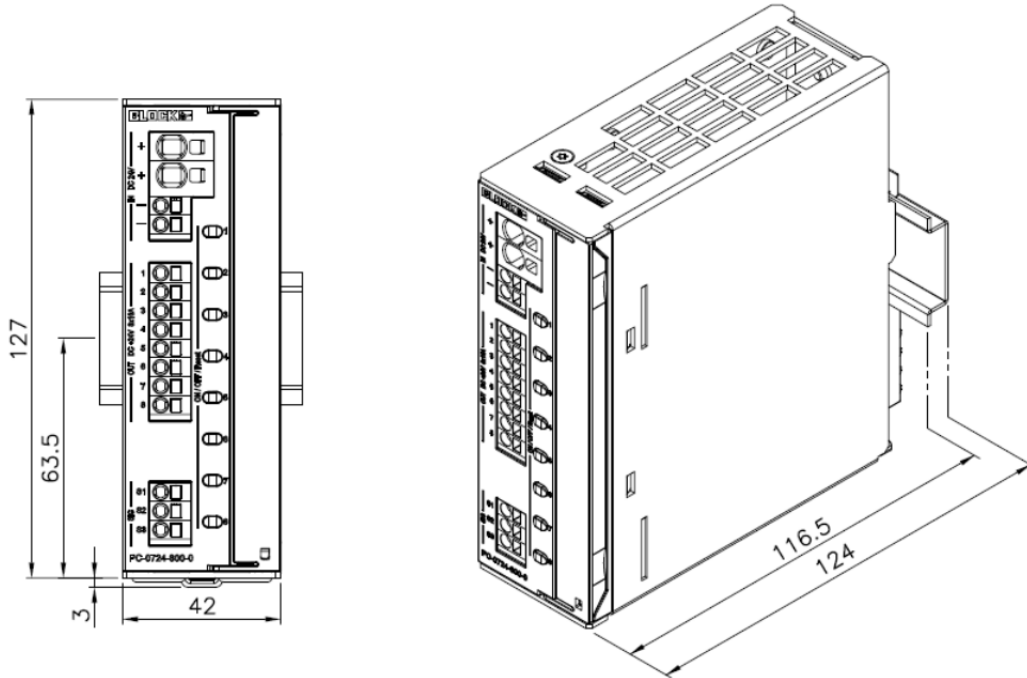
Therefore, a digital input of the control must query signal contact S2 in order to obtain information about status changes in the circuit breaker. Simultaneously, starting a telegram by way of S1 needs to be prevented programmatically in the control while the circuit breaker is generating an impulse at S2. Analyzing the respective status at S2 prior to starting the dispatch of the telegram or generating a telegram for the status query at least every 3 seconds is recommended.

### Details on signal input S3 ( $\Sigma$ for tripped outputs and device defect)

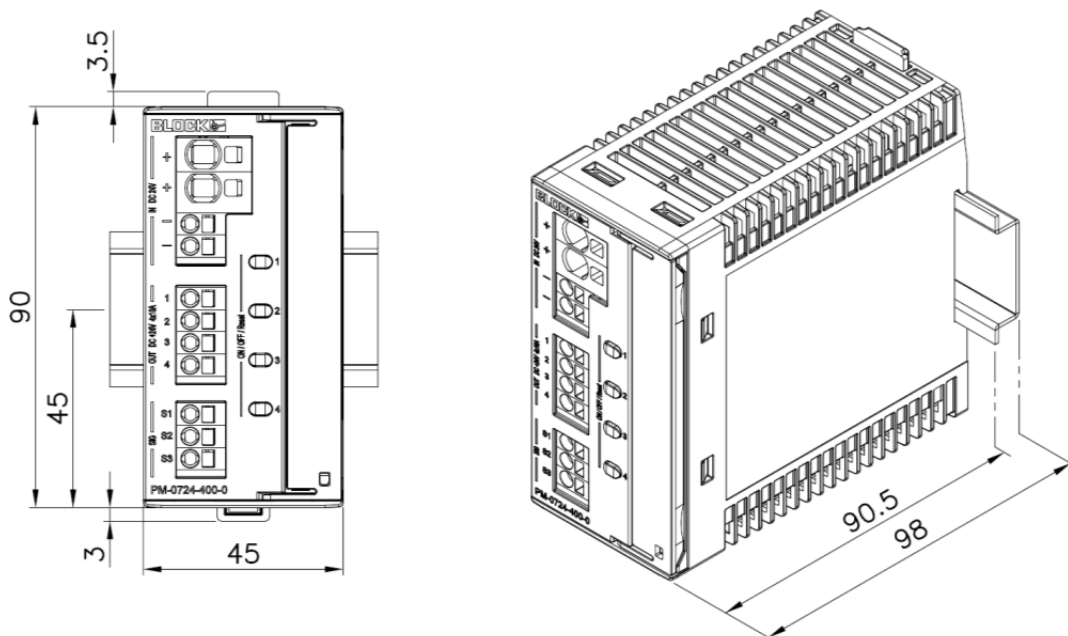
This 24 V signal output refers to the non-electrically isolated 0 V input of the module. The group message is realized through an "active high" signal output. If no output has been tripped and no internal device defect has been detected, this signal output is "active

high" (+24 V). As soon as at least one output channel has been tripped or a device defect has been detected, the signal output switches to "active low" (0 V). This signal output is short circuit proof and resilient up to max. 20 mA.

### Dimensions

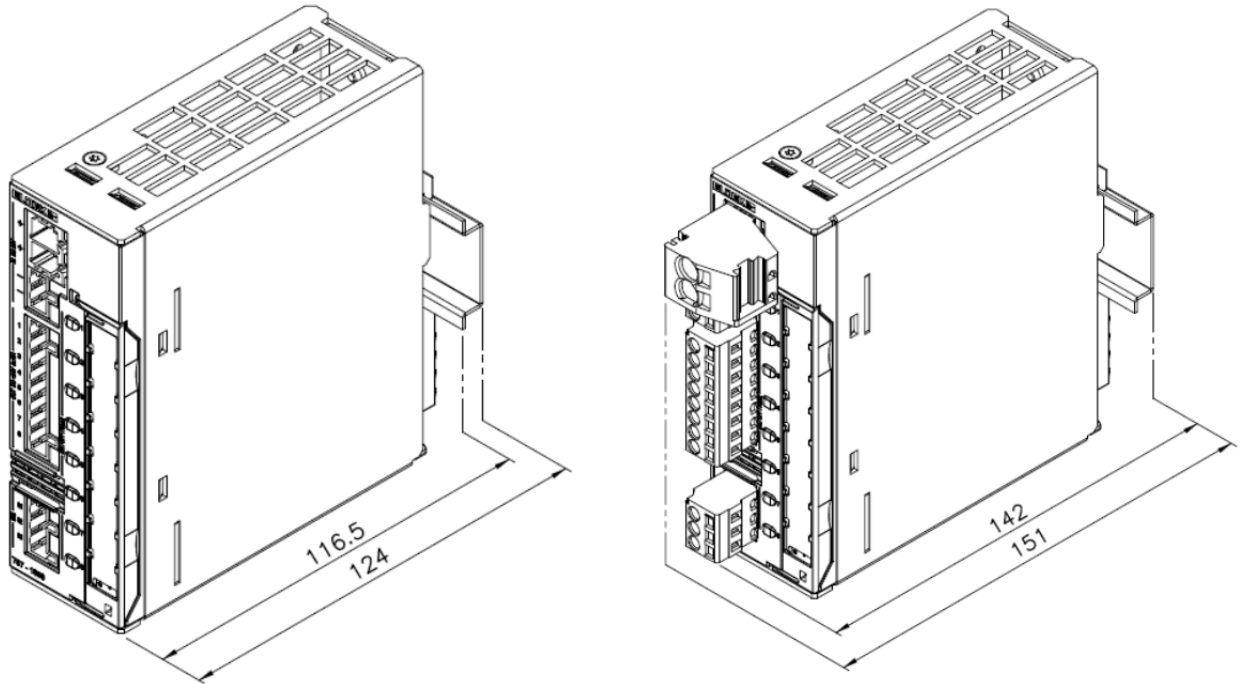


Dimensions 8-channel module

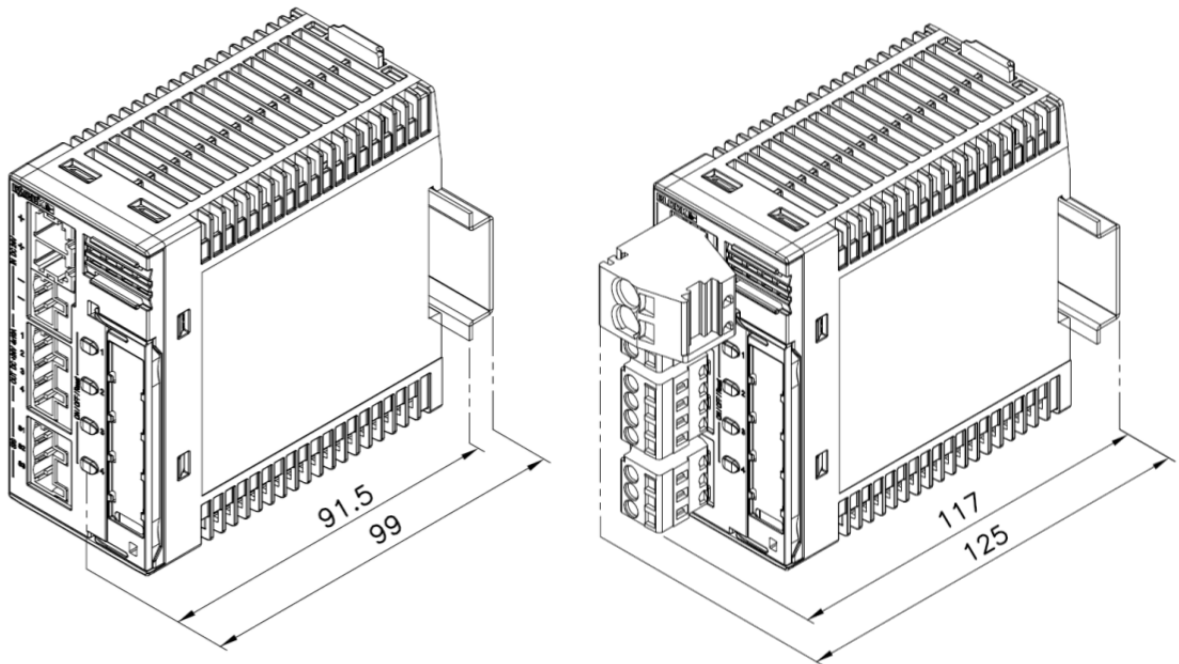


Dimensions 4/2-channel module





Dimensions 4-channel module with pluggable connection technology



Dimensions 4/2-channel module with pluggable connection technology