

0247/885

- According to
 - Performance Level (PL) e and category 4 to EN ISO 13849-1: 2008
 - SIL Claimed Level (SIL CL) 3 to IEC/EN 62061
 - Safety Integrity Level (SIL 3) to IEC/EN 61508

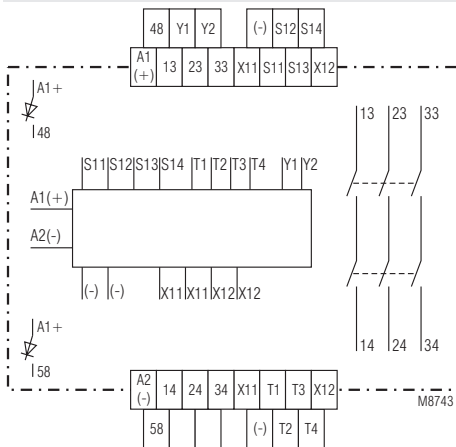
• For emergency stop function, the following inputs and outputs are available:

Inputs: 4 monitored start inputs, or
3 start inputs and 1 stop input and
2 Emergency stop inputs

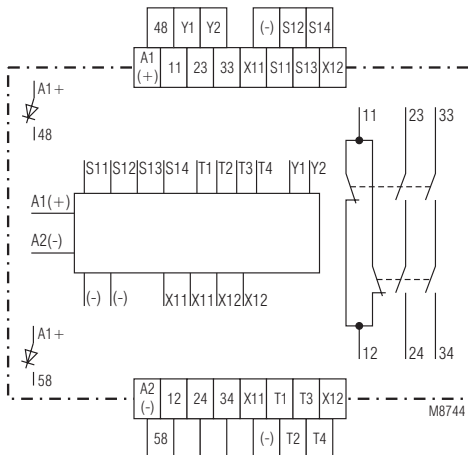
Outputs: 3 NO contacts, or
2 NO contacts/1 NC monitoring contact

- Parallel connection of several SAFEMASTER M-systems possible
- The functions are selected via rotary switch
 - 1 Emergency stop circuit, 2-channel
 - 2 Emergency stop circuits, single-channel
 - 1 Emergency stop circuit, 2-channel + 1 stop single channel
- Auto or manual start
- 2 semiconductor outputs for status indication
- LEDs for status indication
- Overvoltage and undervoltage monitoring function with error indication
- Permanently monitored feedback loop to connect external contactors
- Broken wire and short circuit monitoring function with error indication
- Width: 45 mm

Circuit Diagrams



BH 5911.03



BH 5911.22

Approvals and Markings



Applications

Realization of fail-safe control circuits for protection of people and machinery

Input Terminal Assignment

Terminal	Signal
S11	Emergency stop button 1
S12	
S13	Emergency stop button 2
S14	
X11-T1	Start button 1
X11-T2	Start button 2
X12-T3	Start button 3
X12-T4	Start button 4 or stop
Y1-Y2	Feedback loop for external contact extensions

General Information SAFEMASTER M

The maximum configuration of the SAFEMASTER M multi-function safety system is as follows:

- the control unit BH 5911
- up to 3 input modules BG/BH 5913, or BG/BH 5914, BH/BH 5915
- up to 3 output modules BG 5912
- 1 diagnostic module BG 5551 for CANopen, or
- 1 diagnostic module BG 5552 for Profibus-DP

The BH 5911 controls the whole system.

The input/output modules can be used to expand the control unit in a modular way into a multi-functional safety system.

To transmit status messages of the individual modules to a monitoring or control unit, one of the following diagnostic modules may be connected:

- BG 5551 for CANopen
- BH 5552 for Profibus-DP

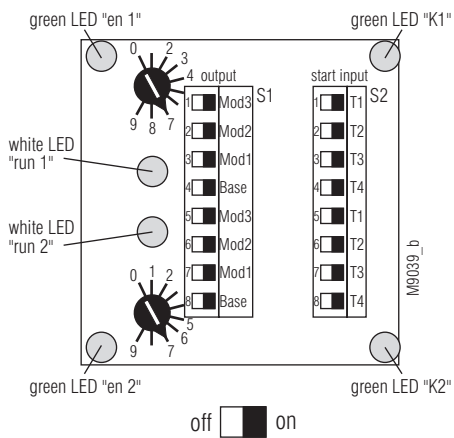
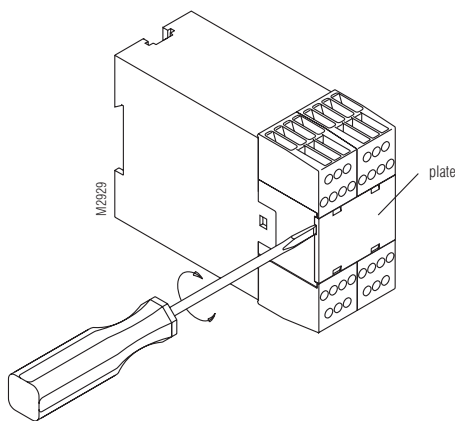
Indication

- Green LEDs (left): on, when all inputs are present and start button activated.
- Green LEDs (right): on, when the safety outputs of the control unit are activated.
- White LEDs Run 1 and Run 2 and semiconductor outputs 48 and 58: Indicate the current status of the control unit.

Setting of Functions

The control unit is assigned to the start inputs T1...T4 and the safety outputs via the DIP switches. The input function is set by means of the rotary switches. To prevent accidentally adjustments the setting switches are covered by a front plate and are redundant.

The control unit is supplied with two fitted terminating connectors. When the control unit is equipped with extension modules, remove these terminating connectors and plug them to the last interconnected device. When a diagnostic module is used, it is connected instead of the terminating connector.



base = Output of control Unit
mod = Output of output module

Notes:

- Settings to the unit must be performed by skilled personnel while the unit is disconnected.
- Before the front cover is removed, antistatic precautions must be observed.

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Sw	Function	Start input selection	Start function setting conditions
0	1 E-stop or 1 LC* 2 channel	4 start inputs	Automatic start lock-out following undervoltage
1	2 E-stop 1 channel	4 start inputs	
2	1 E-stop or 1 LC* 2 channel	3 start inputs 1 Stop	
3	not permitted (error 5)		
4	1 E-stop or 1 LC* 2 channel	4 start inputs	Manual start
5	2 E-stop 1 channel	4 start inputs	
6	1 E-stop or 1 LC* 2 channel	3 start inputs 1 Stop	
7	1 E-stop or 1 LC* 2 channel	3 start inputs 1 Stop	Automatic start following undervoltage, restart after the voltage has returned to the permissible value
8	1 E-stop or 1 LC* 2 channel	4 start inputs	
9	2 E-stop 1 channel	4 start inputs	

* LC = light curtain

Automatic Start

Automatic start is only performed when the supply voltage is switched on or when the Emergency stop or stop function has been reset (with switch positions 7 to 9, also after undervoltage). All other errors nevertheless require confirmation by a start input.

Manual Start

The start input must not be pressed for more than 3 seconds to start the system. Alternatively, several start inputs may be assigned to one module.

Stop

Instead of the fourth start button, an additional stop input (NC contact) can be connected. It is assigned only to the control unit and treated like an additional single-channel emergency stop button.

This means that the safety outputs assigned to the control unit can only be activated if neither the emergency stop or the stop button are activated.

If operating function 2, 6 or 7 is selected, an assignment to the start input 4 will remain ineffective in all connected modules.

Lock-Out after Undervoltage

When an undervoltage is detected, the whole system (including any extension modules) turns off (auto reset). There are two different options of auto restart:

- The system de-energises the safety outputs as soon as undervoltage has been detected. There after the system will only reset after complete removal of voltage.
- The system de-energises the safety outputs and remains de-energized until supply voltage is back to a permissible value. Then, the system is restarted.

Shortcircuit and Crossfault Detection

The control unit has an integrated dynamic shortcircuit and crossfault detection. This feature can only be used when the inputs are switched by contacts and if they are only connected to one safemaster input. To connect light curtains of type 4 or to operate several safemaster M units from common sensors a special wiring has to be chosen.

Indication of System Errors

These errors are indicated by flashing codes of the white LEDs Run 1 and/or Run 2. The green LEDs and all outputs turn inactive. The system will only restart after the supply voltage has been switched off and on again.

Error codes*

- 0) (both white LEDs are off):
Another input module indicates a system error.
- 1) To 4): not used
- 5) Incorrect setting of function:
 - The rotary switches for channel 1 and 2 has different or incorrect positions
 - The setting of the 4 upper Dip-switches (channel 1) are not identically to the 4 lower Dip-switches (channel 2)
- 6) LED Run 1 flashes: Undervoltage
LED Run 2 flashes: Overvoltage
- 7), 8) Not used
- 9) Connection error between the input modules
 - No terminating connector available.
 - Control or input module defective
- 10), 11), 12), 13) a. 14) Internal errors

* number of short flashing impulses, followed by a longer space

Status Indicator

	Permanently OFF	Pulsing	Permanent ON
Output 48	all relays inactive due to system error	Function error	Activation of the assigned safety outputs is permissible
LED run 1	all relays inactive due to system error	Function error when LED Run 2 is ON, or system error when LED Run 2 is OFF or flashing	Activation of the assigned safety outputs is permissible
Output 58	Activation of the assigned safety outputs is permissible or system error	Waiting for start signal	Function error
LED run 2	all relays inactive due to system error	all relays inactive due to system error	No system error

Indication of Function Errors

Function errors are indicated by the white LED Run 1 and by the output 48. During this time, the white LED Run 2 remains on. Output 58 remains on as long as the error is pending; it flashes regularly while waiting for the assigned start signal.

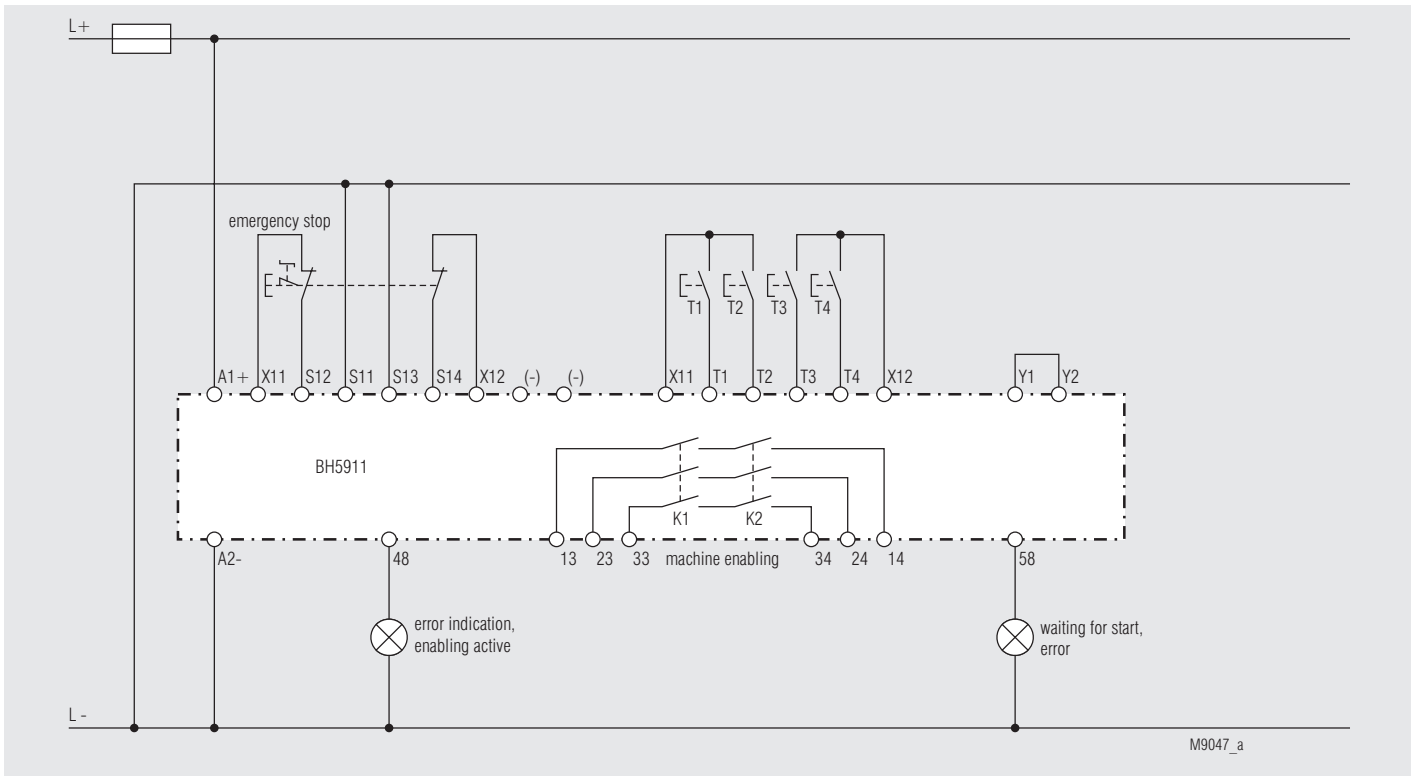
Error codes*

- 1) First Emergency stop contact open
- 2) Second Emergency stop contact open
- 3) Stop contact open
- 4) Error start input
- 5) Input error (interruption or short-circuit)
- 6) Output error at the safety output of the control unit or at the safety outputs of the extension modules (feedback loop interrupted, assigned output module does not exist).
- 7) Error at the twin contacts of the Emergency stop button

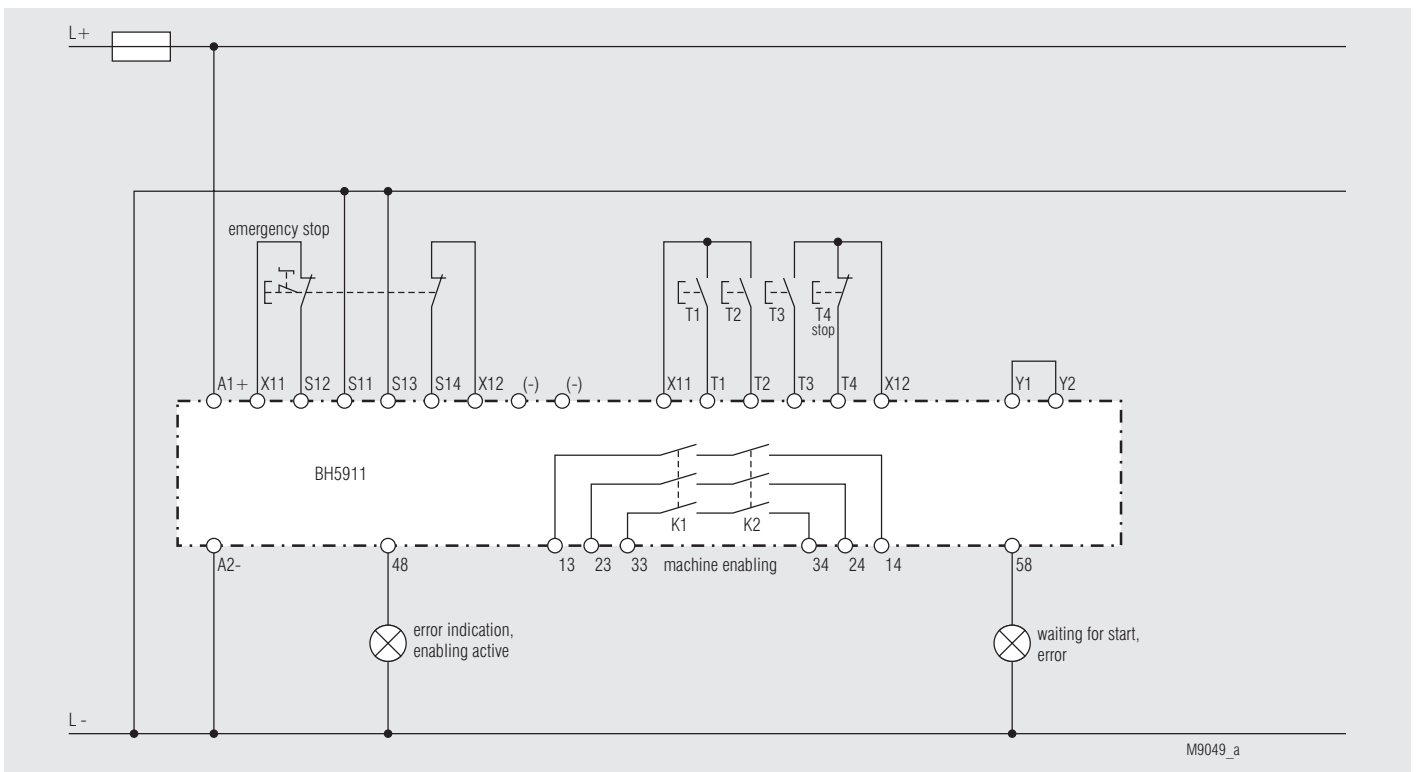
* number of short flashing impulses, followed by a longer space

In case of error 5) and 6), the LEDs Run 1 and the outputs 48 to 58 of the inputs modules which permit activation of the safety outputs flash fast and regularly until the error is remedied and acknowledged by a start signal assigned to the control unit.

Application Examples

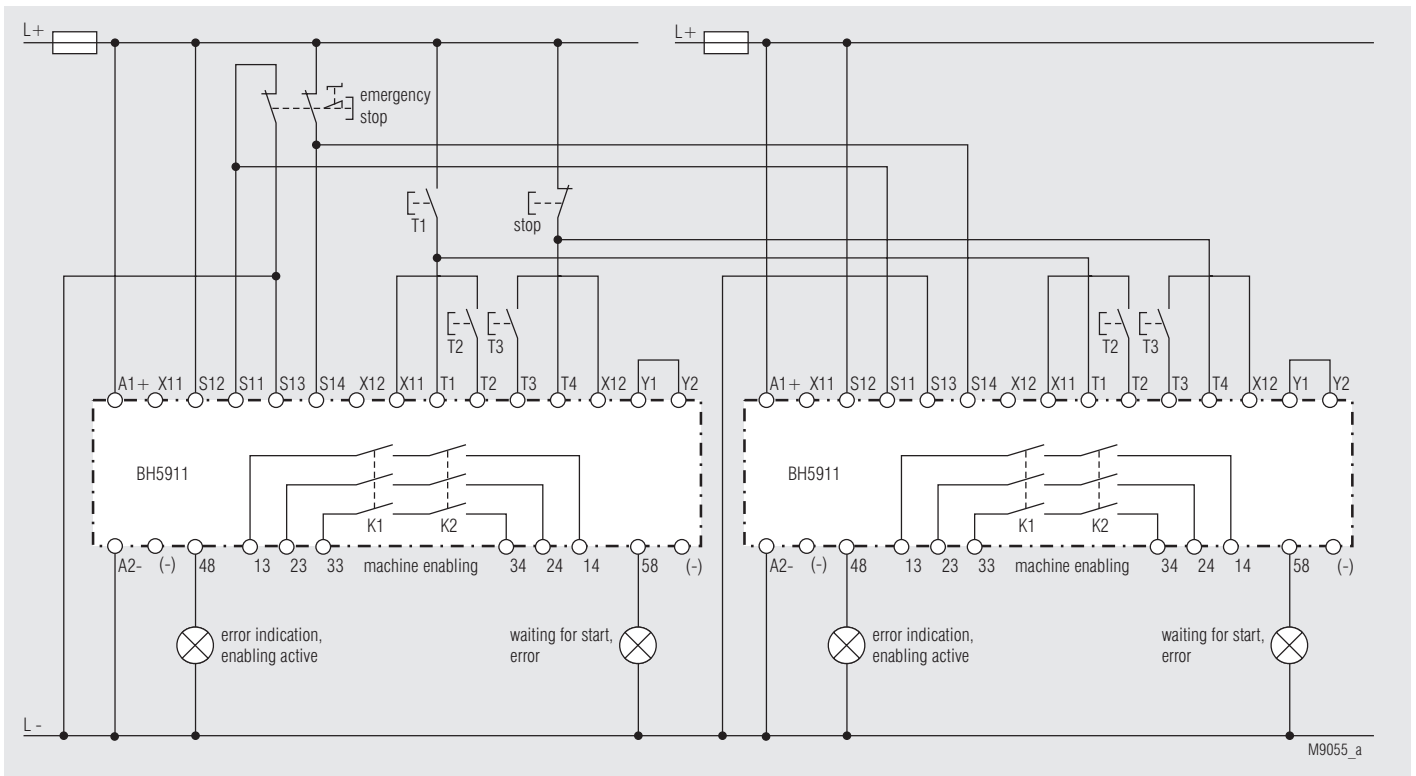


1 Emergency stop, 2-channel; setting: 0, 4 or 8

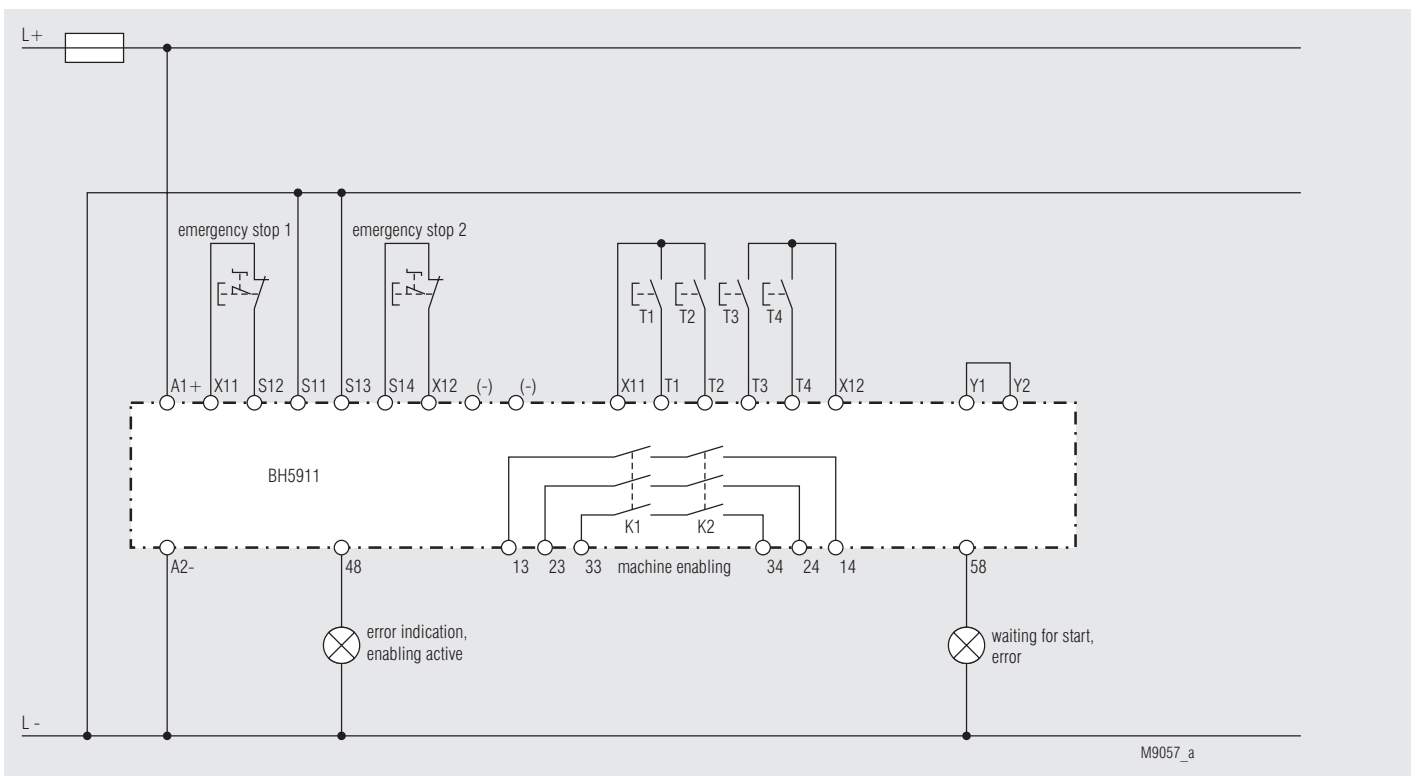


1 Emergency stop, 2-channel + stop, only 3 start inputs; setting: 2, 6 or 7

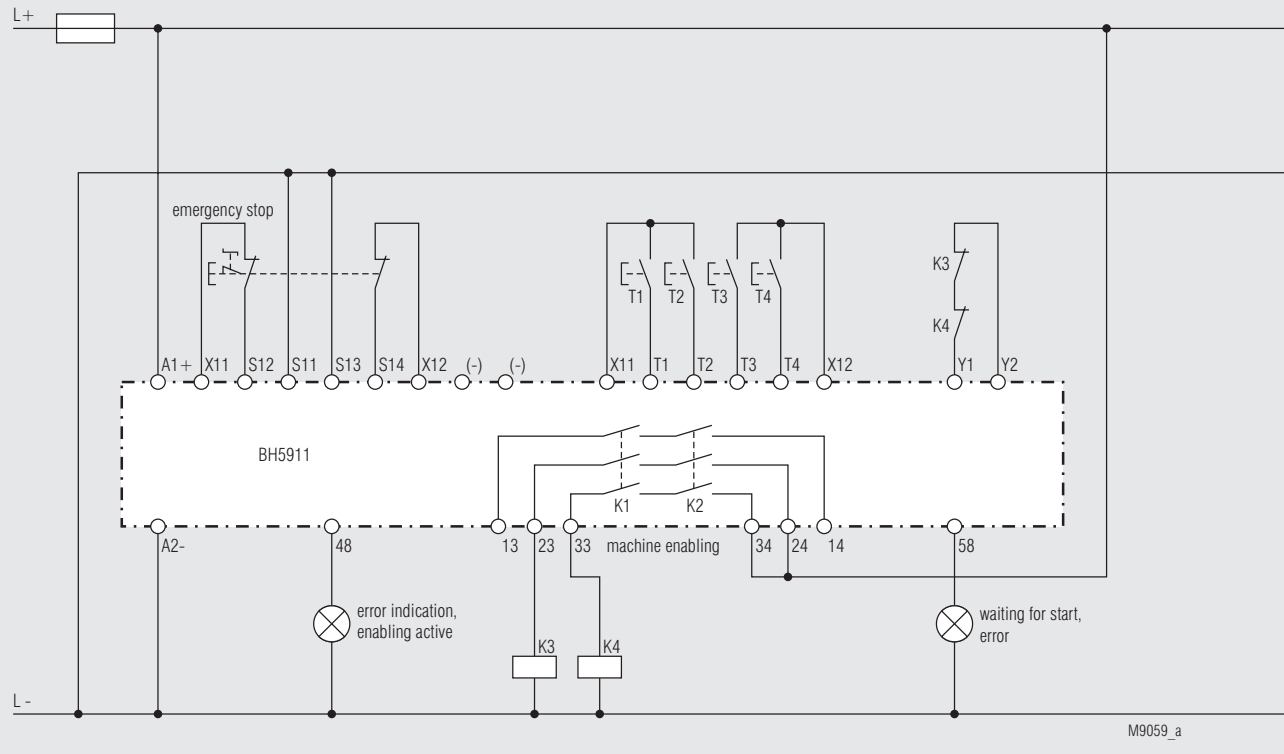
Application Examples



Emergency stop, 2-channel, 1 start button + 1 stop button operating 2 safemaster M in parallel; setting: 2, 6, or 7



2 Emergency stop, single-channel; setting: 1, 5 or 9



Emergency stop, 2-channel, 4 start inputs, contact reinforcement; setting: 0, 4 or 8

Technical Data

Nominal voltage U_N : DC 24 V
Voltage range:
 with max. 5% residual ripple: 0.85 ... 1.15 U_N
Nominal consumption
BH 5911: max. 140 mA
 (no load on semiconductor outputs)

Input

Control voltage on
X11, X12, 48, 58: DC 23 V at U_N
Control voltage on
S11, S12, S13, S14,
T1, T2, T3, T4: 4.5 mA each at U_N
 max. wire length to
 sensors with contacts: 100 m
Minimum voltage at
terminals S12, S14
T1, T2, T3, T4: DC 16 V
Short-circuit protection
of the modules: Internally with PTC

Output

Contacts
 BH 5911.03: 3 NO contacts
 BH 5911.22: 2 NO contacts, 1 NC contact
 (The NC contact must not be used as
 a safety output!)
Contact type: Relay, forcibly guided

Typ. make time with U_N :

Control unit BH 5911	Manual start	Auto start	
		First start	Restart
Emergency stop	max. 75 ms	max. 1 s	max. 90 ms

Break time (reaction time):

Control unit BH 5911	
Emergency stop	max. 27 ms

Fault clearing
in the feed back loop: max. 600 ms
Output nominal voltage: AC 250 V
 DC: see limit curve for arc-free operation
Switching of small loads: ≥ 100 mV

Thermal current I_{th} : max. 5 A (see quadratic total current
 limit curve)
Switching capacity
 to AC 15
 NO contact: 3 A / AC 230 V IEC/EN 60 947-5-1
 NC contact: 2 A / AC 230 V IEC/EN 60 947-5-1
 to DC 13: DC8 A / DC 24 V
 at 0.1 Hz IEC/EN 60 947-5-1

Contact life
 acc. to AC 15 with 2 A, AC 230V: 10^5 switching cycles IEC/EN 60 947-5-1
Permissible switching
frequency: max. 1 200 switching cycles / h
Short circuit strenght
 max. fuse rating 6 A gL IEC/EN 60 947-5-1
 Line circuit breaker C 8 A
Mechanical life: 10×10^6 operating cycles

Semiconductor Outputs

Output (terminal 48 and 58): Transistor outputs, plus-connected
 Output nominal voltage: DC 24 V, max. 100 mA constant
 current, max. 400 mA for 0,5 s internal
 short circuit, overtemperature and
 overload protection

General Data

Operating mode: Continuous
Temperature range: $\pm 0 \dots + 50$ °C
 At an operating temperature of 50 °C
 the modules must be mounted with
 a distance of 3 - 5 mm.

Clearance and creepage
distances

rated impulse voltage /
 pollution degree: 4 kV / 2 (basis insulation) IEC 60 664-1
EMC: IEC/EN 61 326-3-1, IEC/EN 62 061
 Radio interference suppression: Limit value class A EN 55011

Remark: This device is designed for industrial ambient conditions.
When used in other environment, it is possible that wire bound or
radiated interference occurs.

Degree of protection

Housing: IP 20 IEC/EN 60 529
 Terminals: IP 20 IEC/EN 60 529
Housing: Thermoplast with V0 behavior
 according to UL Subject 94

Technical Data

Vibration resistance:	Amplitude 0.35 mm Frequency 10 ... 55 Hz, IEC/EN 60 068-2-6
Shock resistance:	
Acceleration:	10 g
Pulse duration:	16 ms
Number of shocks:	1000 per axis on three axes
Climate resistance:	0 / 050 / 04 IEC/EN 60 068-1
Terminal designation:	EN 50 005
Wire connection:	1 x 2.5 mm ² stranded wire with sleeve, or 1 x 4 mm ² massive, or 2 x 1.5 mm ² stranded wire with sleeve DIN 46 228-1/-2/-3/-4
Wire fixing:	Plus-minus terminal screws M3,5 box terminals with wire protection
Surge suppression:	When connecting inductive loads to the relay outputs (contactor coils, valves, electric brakes) surge suppressor elements like diods, capacitors, RC combinations, etc. have to be connected directly to the connection terminals of the controlled devices, keeping the connection wires as short as possible.
Mounting:	DIN rail IEC/EN 60 715

Dimensions

Width x height x depth: 45 x 84 x 121 mm

Safety Related Data for E-STOP

Values according to EN ISO 13849-1:

Category:	4	
PL:	e	
MTTF _d :	193.3	a
DC _{avg} :	98.3	%
d _{op} :	365	d/a (days/year)
h _{op} :	24	h/d (hours/day)
t _{Zyklus} :	3600	s/Zyklus
	± 1	/h (hour)

Values according to IEC EN 62061 / IEC EN 61508:

SIL CL:	3	IEC EN 62061
SIL	3	IEC EN 61508
HFT ^{*)} :	1	
DC _{avg} :	98.3	%
SFF	99.6	%
PFH _D :	4.06E-10	h ⁻¹

Safety Related Data for light curtains ,safety gates or two-hand

Values according to EN ISO 13849-1:

Category:	4	
PL:	e	
MTTF _d :	30.4	a
DC _{avg} :	99.0	%
d _{op} :	220	d/a (days/year)
h _{op} :	12	h/d (hours/day)
t _{Zyklus} :	138	s/Zyklus

Values according to IEC/EN 62061 / IEC/EN 61508:

SIL CL:	3	IEC/EN 62061
SIL	3	IEC/EN 61508
HFT ^{*)} :	1	
DC _{avg} :	99.0	%
SFF	99.6	%
PFH _D :	7.91E-09	h ⁻¹

^{*)} HFT = Hardware-Failure Tolerance



The values stated above are valid for the standard type.

Safety data for other variants are available on request.

The safety relevant data of the complete system has to be determined by the manufacturer of the system.

CSA-Data

Wire connection: 60°C / 75°C copper conductors only
AWG 20 - 12 Sol Torque 0.8 Nm
AWG 20 - 14 Str Torque 0.8 Nm



Technical data that is not stated in the CSA-Data, can be found in the technical data section.

CCC-Data

Thermal current I_{th}: 4 A

Switching capacity

to AC 15: 3 A / AC 230 V IEC/EN 60 947-5-1
to DC 13: 1 A / DC 24 V IEC/EN 60 947-5-1

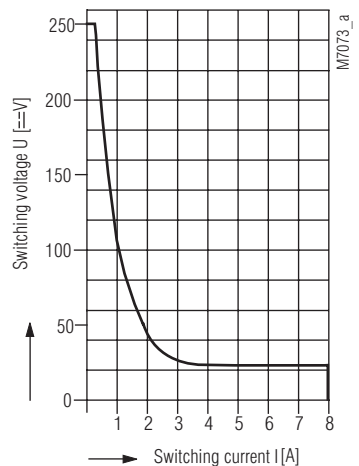


Technical data that is not stated in the CCC-Data, can be found in the technical data section.

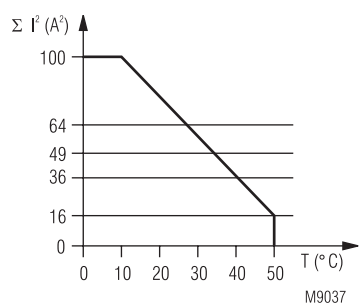
Ordering Example

BH 5911.03/00MF0 DC24V 3 NO contacts
BH 5911.22/00MF0 DC24V 2 NO contacts, 1 NC contact

Characteristics



Limit curve for arc-free operation



quadratic total current

$$\Sigma I^2 = I_1^2 + I_2^2 + I_3^2 + I_4^2$$

I₁, I₂, I₃, I₄ - current in contact paths

Quadratic total current limit curve