Safety Technique

SAFEMASTER M Multi-Function Safety System
Input Module
BG 5913.08/_1_ _ _

DOLD

0247386

Block Diagram

M8752_a

- start-button assignment
- output assignment
- en1 en2 run1 run2
- function management

(-) X1 S44 S42 S34 S32 S24 S22 S14 S12 X2 (-) 48 58

Circuit Diagram

48 | X1 | (-)
S12 | S14 | S22 | S24

A1+
48

S12 | S14 | S22 | S24 | S32 | S34 | S42 | S44

(-) | X1 | X2 | (-)

A1+
58

S32 | S34 | S42 | S44
58 | X2 | (-)

M8741

- **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**
  - **Category 4 to EN 954-1**
- Input module for realization of
  - 4 mixed 2-channel inputs
  - Emergency stop circuits
  - Safety gate monitoring system
  - Two-hand control type IIIA, IIIC acc. to DIN/EN 574
  - Light curtain monitoring system (LC type 4)
- The functions are selected via rotary switch
- 8 safety inputs
- 2 semiconductor outputs for status indication
- Broken wire and short circuit monitoring function with error indication
- LEDs for status indication
- Width: 22.5 mm

Approvals and Marking

CE
1) TÜVRheinland®
Functional Safety Type Approved FS
CSA C US Canada / USA

1) The approval to EN 954 will be replaced by a TÜV-approval according to EN ISO 13849-1:2008, IEC/EN 62061, e. g. 61508

Applications

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

Note: This module is intended for applications in which mixed safety functions affect one common output.

Further input modules with other combinations of functions are provided (e.g. BG 5913.08/_0_ _ _, BG 5913.08/_2_ _ _ , BG 5913.08/_3_ _ _, BG 5914.08/_0_ _ _, BH 5914.08/_0_ _ _, BG 5914.08/_1_ _ _, BG 5915/_1_ _ _ or BH 5915.08/_1_ _ _).

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 5913, or BG/BH 5914, BG/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
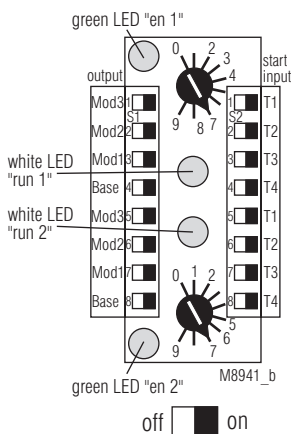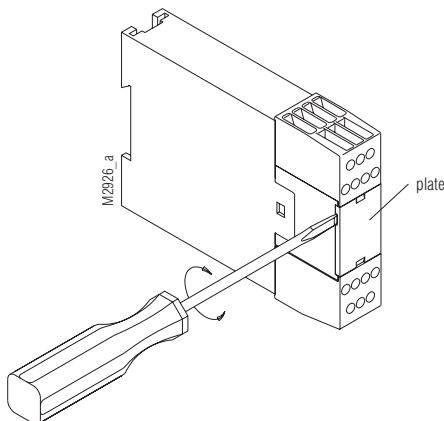- BH 5552 for Profibus-DP

Indication

Green LEDs: on, when all inputs are present and start button activated.

White LEDs Run1/ Run 2 and outputs 48 and 58: indicate the current status of the module.

Setting of the Module

The module is assigned to the start inputs and the safety outputs via the DIP switches.

The combinations of individual functions are set via the rotary switches. To prevent accidently adjustments, these elements are covered by a front plate and are redundant.

plate

green LED "en 1"

output

start input

white LED "run 1"

white LED "run 2"

green LED "en 2"

M8941_b

off ▮ on

Note:

- 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.

Setting of the Modules

Sw.	Function at Terminals				Start behavior of the LC / E-Stop
	S12-S14	S22-S24	S32-S34	S22-S24	
0	Gate	Gate	Gate	LC	Autostart
1	Gate	Gate	Gate	LC	Manual Start
2	Gate	Gate	LC	LC	Autostart
3	Gate	Gate	LC	LC	Manual Start
4	Gate	LC	Two-hand IIIC		Autostart
5	Gate	LC	Two-hand IIIC		Manual Start
6	Gate	E-stop	Two-hand IIIC		Autostart
7	Gate	E-stop	Two-hand IIIC		Manual Start
8	Gate	LC	LC	LC	Autostart
9	Gate	LC	LC	LC	Manual Start

Functional Principle of Combined Inputs

Each function activates an enabling signal in the module software. The control unit is permitted to enable the assigned safety outputs only after all 3 (for two-hands control) or 4 enablings have been given.

With the exception of two-hand control, each function works independently. The assigned safety outputs are enabled if the precondition for enabling has been met for all functions.

Function of the Two-Hand Control

This function will only work when the other two functions have already permitted enabling. To provide for enabling, the two buttons must be pressed within 0.5 s. As soon as one of the other function reacts, the two buttons must turn inactive before the others can be enabled again. Only after that, the buttons can be activated once more from an inactivated state.

The unit must be connected as specified in the application examples. When the operating contacts are connected in parallel or in series, safe functioning of the unit is cancelled.

The two-hand buttons must be designed and arranged in such a way as to ensure that they cannot be disabled with easily, or pressed unintentionally.

The safety distance between the push buttons and the place of danger must be large enough to make sure that after releasing a button, the place of danger can only be reached after the dangerous movement has stopped.

The safety distance "S" is calculated according to the following formula:

$S = V \times T + C$, where

a) gripping velocity V = 1 600 mm/s
b) overtravel time T (s)
c) and safety factor C = 250 mm.

When any access into the danger area, with operating keys pressed, is safely prevented, e.g. by a protective cover for the keys, the safety factor C may be set to the value 0. Generally, the minimum safety distance must be 100 mm. In this respect, also see DIN/EN 574.

The two-hand control must be released when another function module which affects the same outputs does not permit enabling.
The system may comprise only one function module with two-hand control.

Safety Gate Function

The safety gate function always permits enabling if both contacts change from inactive to active state within 3 seconds. If the second contact reacts later, both changeover contacts must turn inactive before they can be enabled again.

When activating the system, press the start button to simulate the compulsory opening and re-closing of safety gates which have been kept closed since the system has started.

This simulation is possible only before enabling has been permitted for the first time, and as long as both safety gate contacts remain closed as well. As soon as a contact opens, simulation of the safety gate function is no longer possible.

E-Stop or Light Curtain (LC) Function

In the Emergency stop or LC functions, both signals have to change from inactive state into active state within 250 ms. If the second signal reacts later, both changeover contacts must turn inactive before they can be enabled again.

With manual start, all safety inputs must be active before the start button can be pressed to trigger enabling. To start the system, do not keep the start button pressed for more than 3 seconds. A module may also be assigned several start buttons.

Note:	Connect only self-testing light curtains of the type 4 acc. to EN 61496 to the module. Short-circuit monitoring of the inputs for the LC must be done in the LC.

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

Indication

	Permanently OFF	Pulsing	Permanent ON
Output 48	all relays inactive due to system error	one input function not available	Activation of the assigned safety outputs is permissible
LED run 1	Two-hand control not activated (LED run 2 ON) or all relays inactive due to system error	one input function not available (LED run 2 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	Error exists no more, waiting for Start input	one input function not available
LED run 2	all relays inactive due to system error	all relays inactive due to system error	No system error

Function Error Indication

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

Error codes*

1)   Normal interruption of function (e.g. Emergency stop)
2)   Time error: (e.g. the second two-hand button is not pressed)
3)   With gate monitoring: simulation input error (kept pressed for
     too long)
4)   Error at start input
5)   Input error (short-circuit, interruption)
6)   Error in the control unit (input or output error detected in
the control unit)

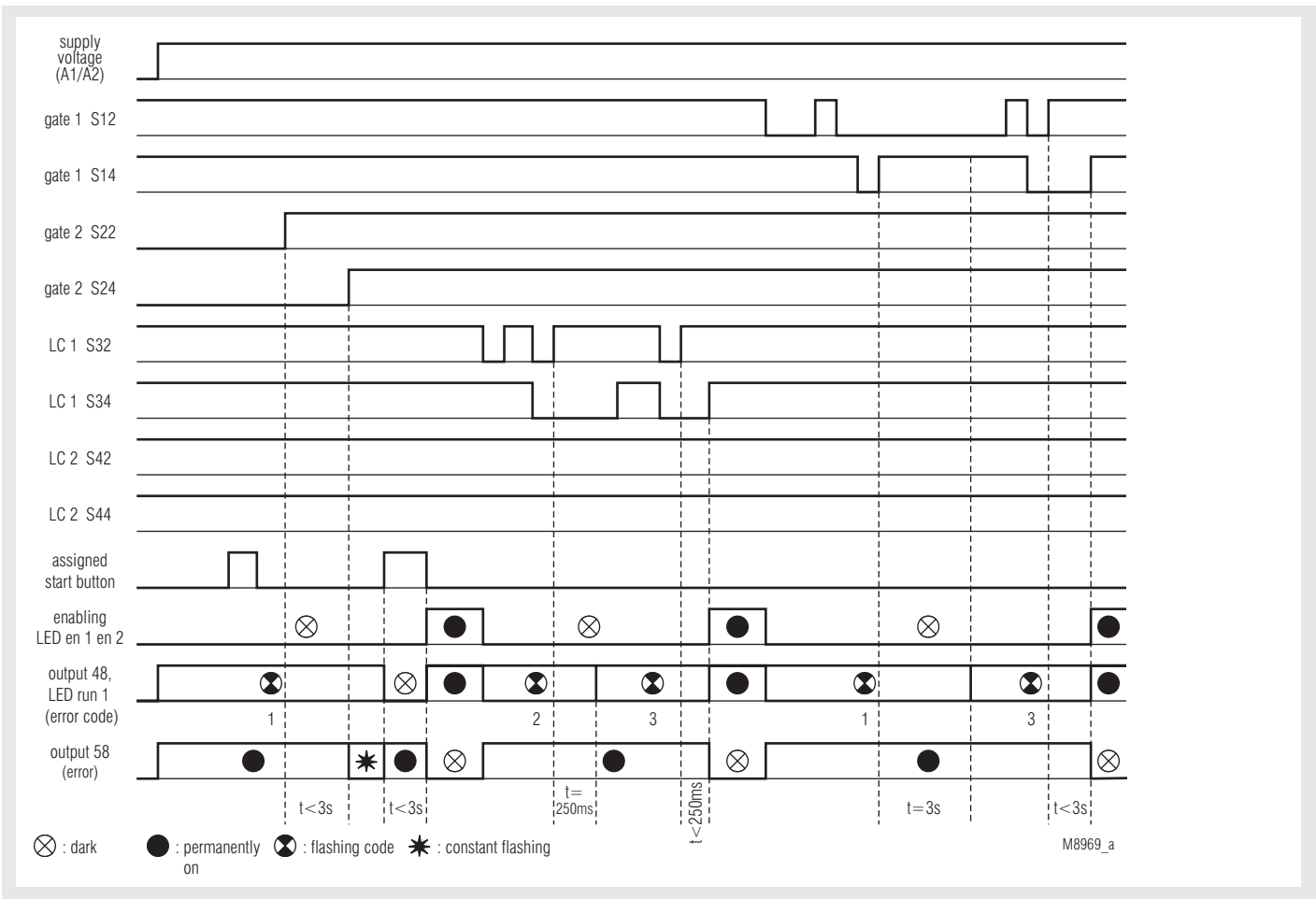* number of short flashing impulses, followed by a longer space

Special with two-hand control:
When both two-hand buttons of the module are inactive while all other functions are active and enabled either by autostart or via the start button, output 48 and the white LED Run 1 are permanently OFF, and output 58 permanently ON.
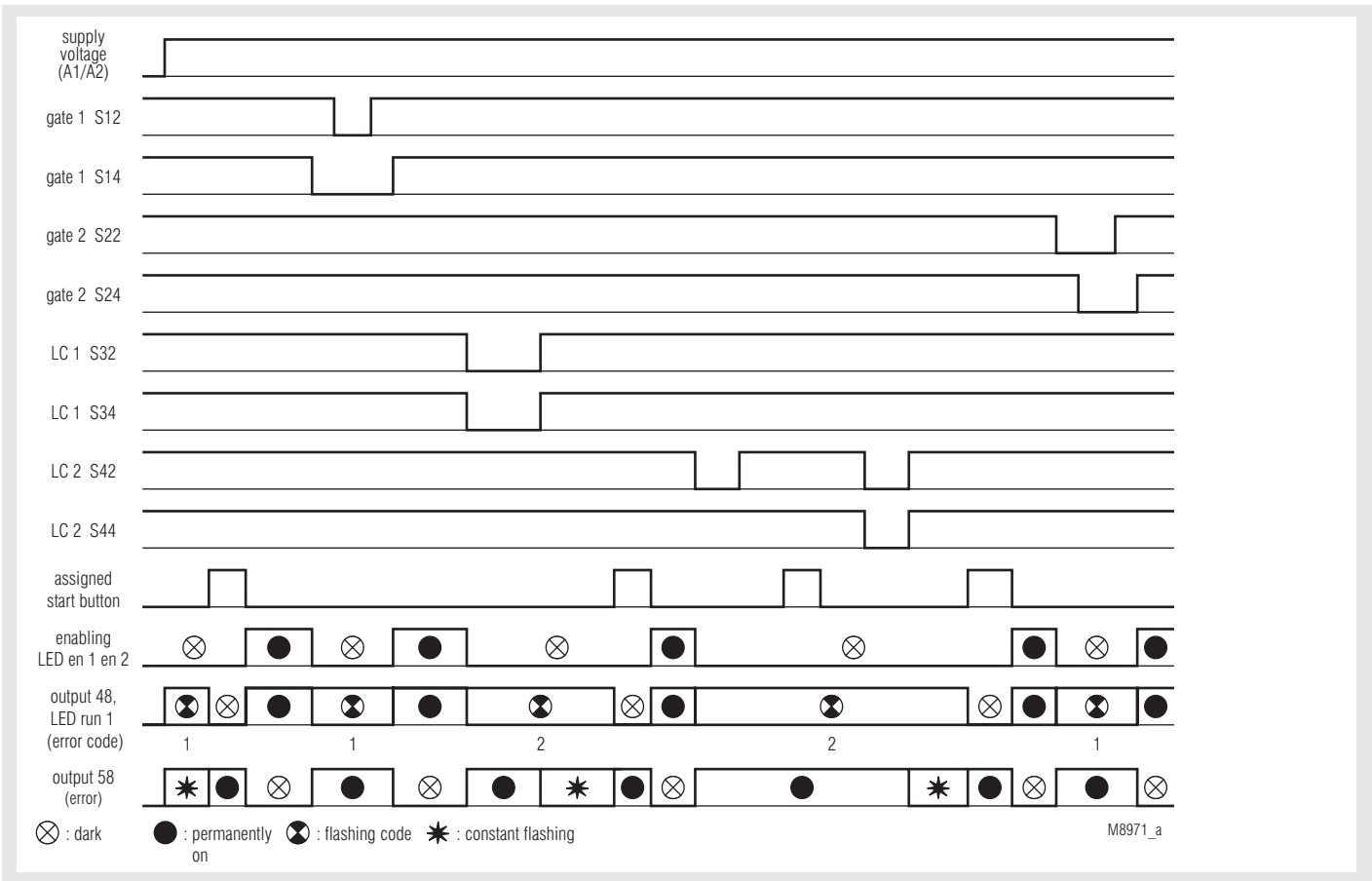
Function Diagrams

Note: The times specified in a pulse diagram also apply to the same function in other applications.
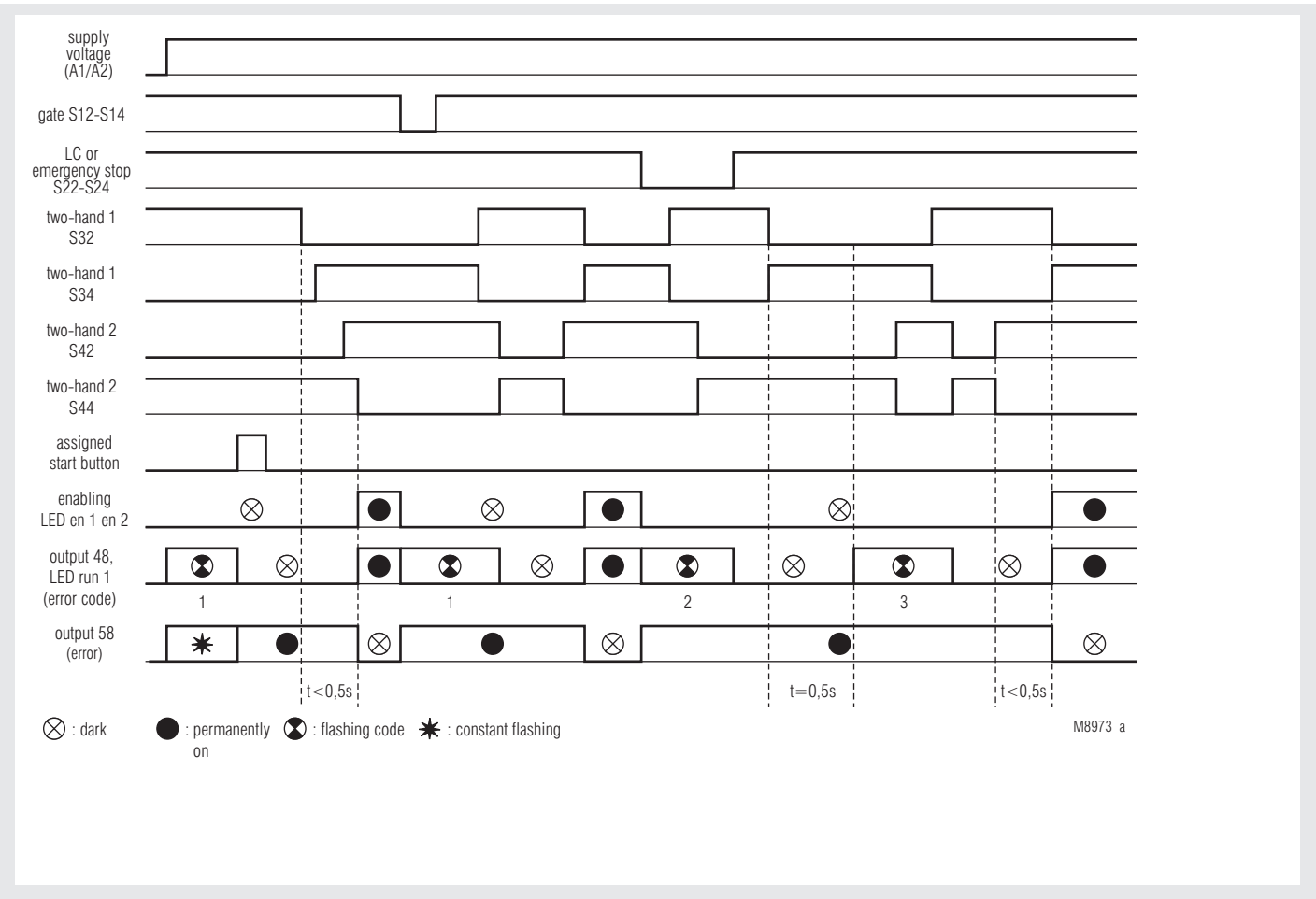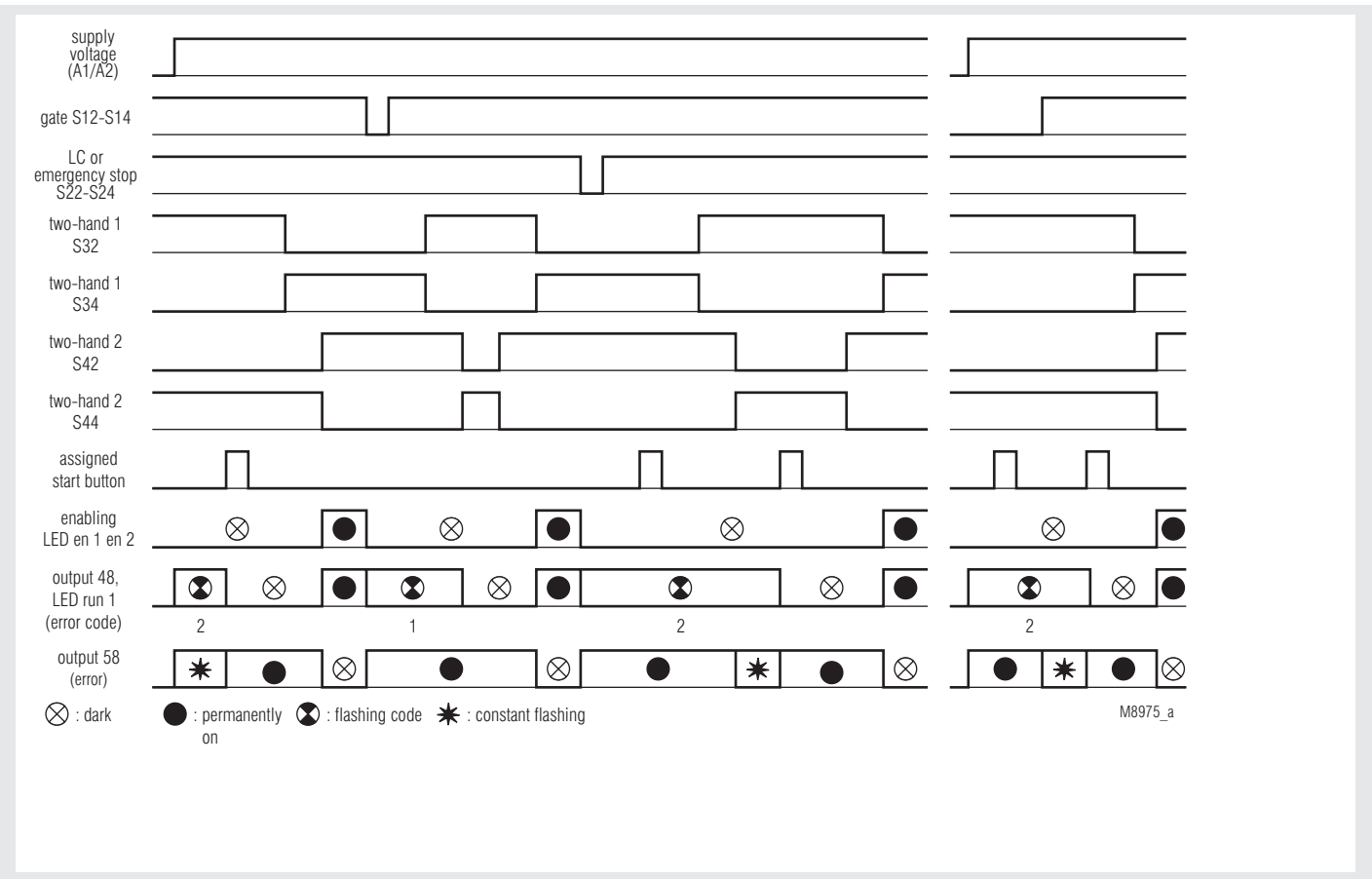

2 safety gates, 2 light curtains (Autostart)

2 safety gates, 2 light curtains (manual start)

Function Diagrams

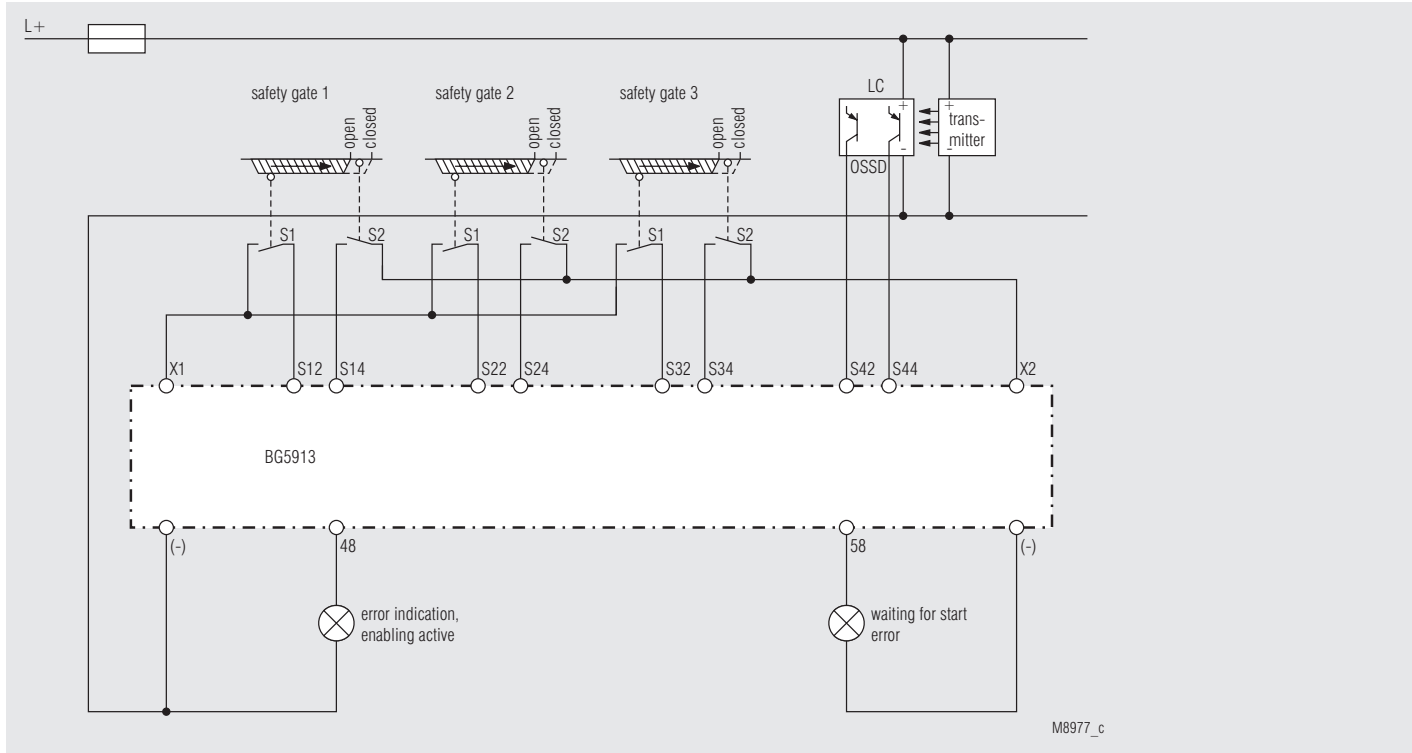**Note:** The times specified in a pulse diagram also apply to the same function in other applications.

1 safety gate, 1 light curtain or Emergency stop (Autostart), 1 two-hand control (type IIIC)

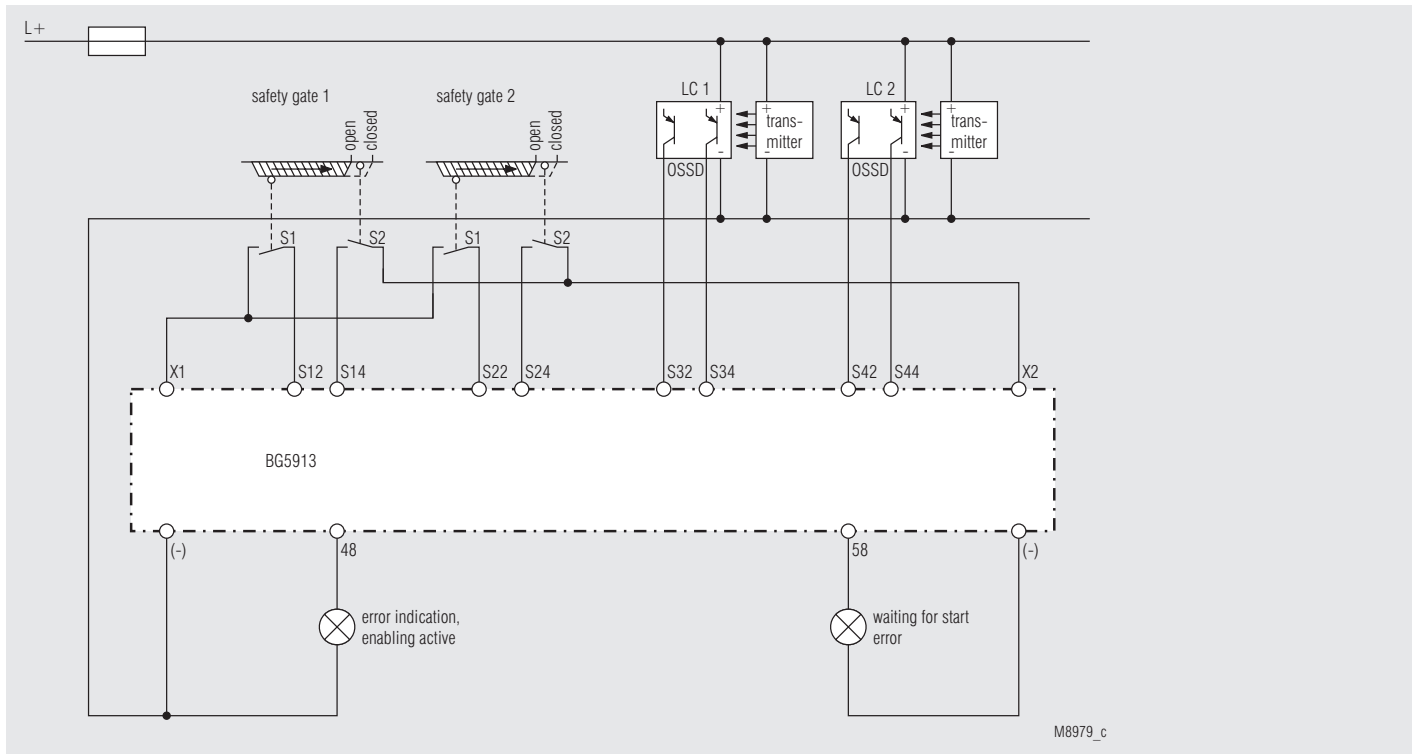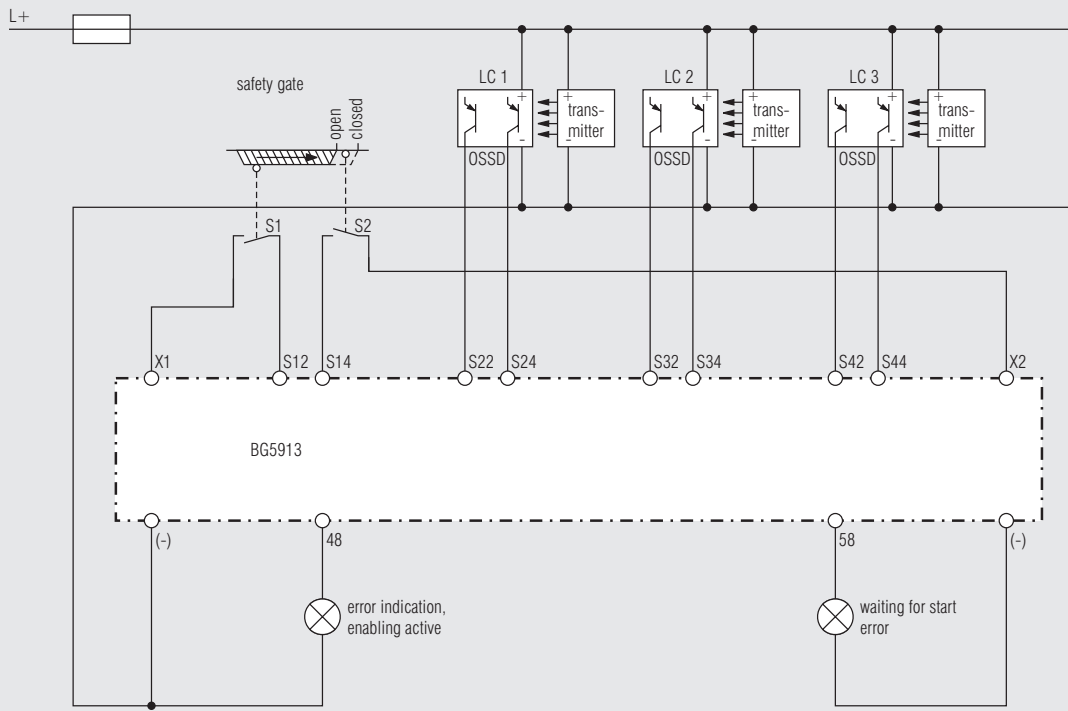1 safety gate, 1 light curtain or Emergency stop (manual start), 1 two-hand control (type IIIC)

Application Examples

BG 5913.08/_1_ _ _, 3 safety gates, 1 light curtain; functions: 0 or 1

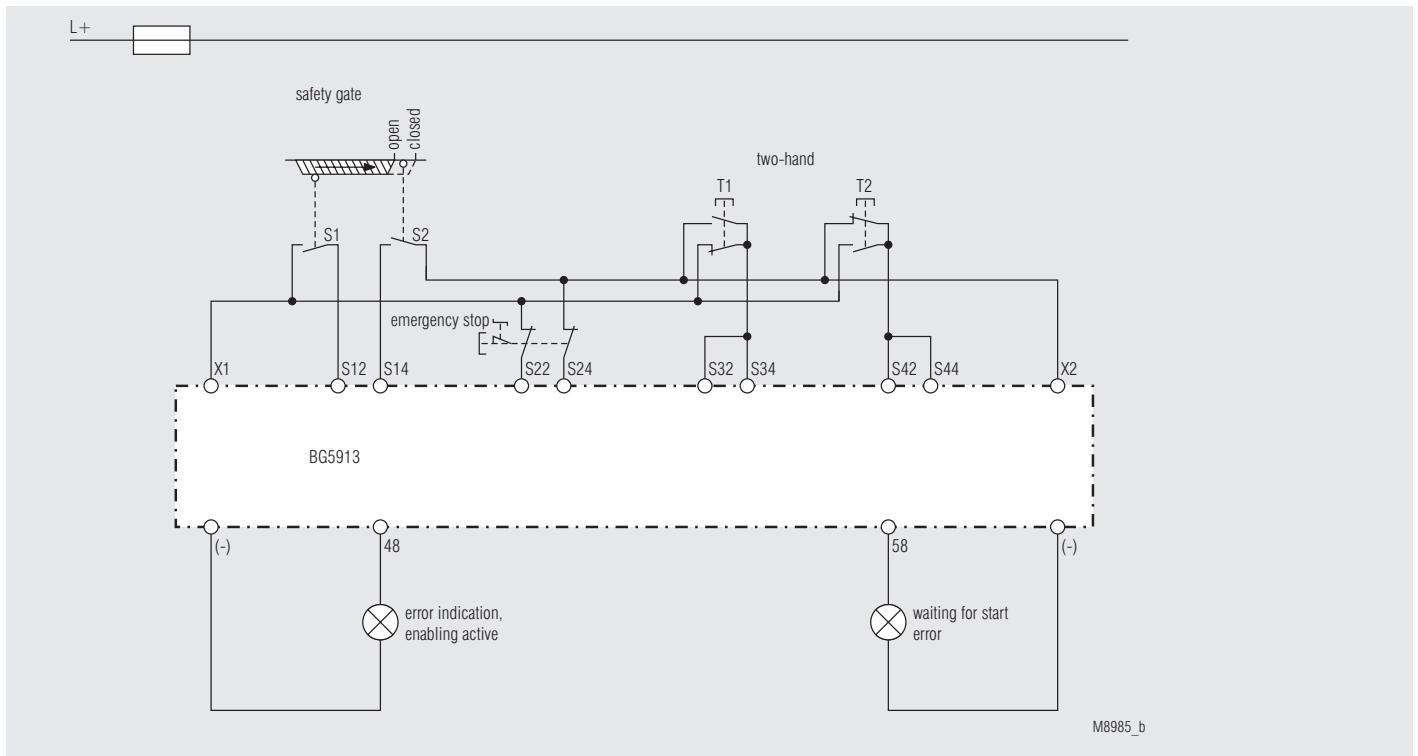

BG 5913.08/_1_ _ _, 2 safety gates, 2 light curtains; functions 2 or 3

BG 5913.08/_1_ _ _, 1 safety gate, 3 light curtains; functions: 8 or 9
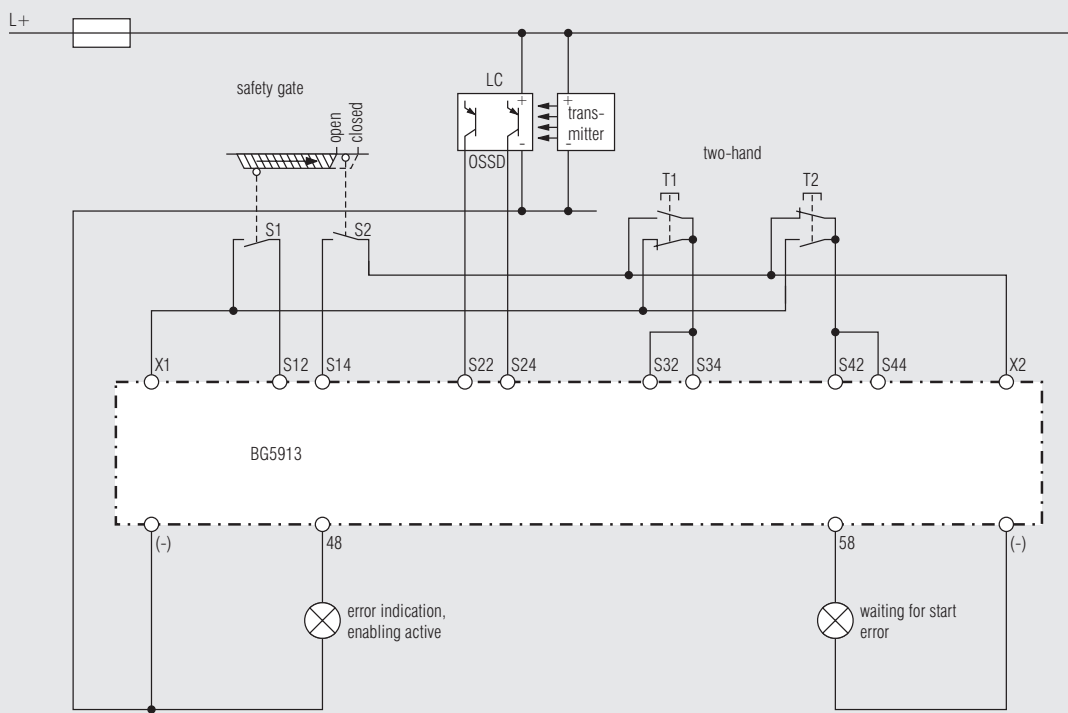
BG 5913.08/_1_ _ _, 1 safety gate, 1 light curtain, 1 two-hand control type IIIC (EN 574); functions: 4 or 5

BG 5913.08/_1_ _ _, 1 safety gate, 1 Emergency stop, 1 two-hand control type IIIC (EN 574); functions: 6 or 7

Voltage Supply

Nominal voltage U_N:	DC 24 V (coming from the basic module BH5911)
Voltage range:	
with max. 5% residual ripple:	0.85 ... 1.15 U_N
Nominal consumption:	max. 60mA (no load on semiconductor outputs)
Short-circuit protection	
of the modules:	internally with PTC

Input

Control voltage	
via X1, X2, 48.58:	DC 23 V at U_N
Control voltage	
via S12, S14, S22, S24, S32, S34, S42, S44:	4.5 mA each at U_N
Minimum voltage	
on S12, S14, S22, S24, S32, S34, S42, S44:	DC 16 V

Semiconductor Outputs

Output at 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

Reaction Times (time till reaction of the assigned output):

Typ. NO time with U_N:

Input modules BG 5913	Manual start	Automatic start	
		First start	Restart
Emergency stop	max. 80 ms	max. 1 s	max. 115 ms
Light barriers	max. 80 ms	max. 1 s	max. 115 ms
Safety gates	or simulation: max. 80 ms		Gate closing: max. 115 ms
Two-hand control	max. 85 ms		

Break time (reaction time):

Input modules BG 5913	
Emergency stop	max. 33 ms
Light barriers	max. 33 ms
Safety gates	max. 33 ms
Two-hand control	max. 33 ms

General Data

Operating mode:	Continuous operation
Temperature range:	± 0 ...+ 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 impuls voltage / pollution degree:	4 kV / 2 (basis insulation) IEC 60 664-1
EMC	
HF irradiation:	10 V / m	IEC/EN 61 000-4-3
Fast transients:		
on supply line A1-A2	2 kV	IEC/EN 61 000-4-4
on signal and control lines:	2 kV	IEC/EN 61 000-4-4
Surge voltages between		
wires for power supply:	1 kV	IEC/EN 61 000-4-5
wire and ground:	2 kV	IEC/EN 61 000-4-5
HF wire guided:	10 V	IEC/EN 61 000-4-6
Radio interference suppression:	Limit value class B	EN 55 011

Degree of protection

Housing:	IP 20	IEC/EN 60 529
Terminals:	IP 20	IEC/EN 60 529
Housing:	Thermoplastic with V0 behavior according to UL Subject 94	
Vibration resistance:	Amplitude 0.35 mm IEC/EN 60 068-2-6 Frequency 10…55 Hz,	

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 mm² stranded wire with sleeve, or 1 x 4 mm² massive or 2 x 1.5 mm² stranded wire with sleeve DIN 46 228-1/-2/-3/-4	
Wire fixing:	Box terminal with wire protection, removable terminal strips.	
Mounting:	DIN rail	IEC/EN 60 715
Weight:	193 g	

Dimensions

Width x height x depth:	22.5 x 84 x 121 mm

Safety Related Data for E-STOP

Values according to EN ISO 13849-1:

Category:	4	
PL:	e	
$MTTF_d$:	812.8	a
DC_{avg}:	96.0	%
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}:	96.0	%
SFF	99.2	%
PFH_D:	2.34E-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	
$MTTF_d$:	2697.1	a
DC_{avg}:	96.0	%
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}:	96.0	%
SFF	99.2	%
PFH_D:	2.34E-10	h^{-1}

[*] HFT = Hardware-Failure Tolerance

Info 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.

Standard Type

BG 5913.08/01MF0	DC 24 V
Article number:	0055530