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samos®

Manual

Multifunctional Safety Switching Device

Modular Electronic Safety System with coding

BA000256 1/2009 (Rev. F)

Contents

Validity of the manual as from module revision:

- SA-BM : D-01
- SA-BS : D-01
- SA-IN : D-01
- SA-OR : D-01

About this manual

What Does This Manual Describe?

This manual provides an overview of the functionalities of the modular ***samos*** safety system as a safety processing unit for plant and machines. It describes the individual modules and the way they function together in the system as a whole with safety sensors, switches and actuators.. As well as the specific configurations of switches and terminals, the fundamental methods by which the functions work are also explained in detail. Relevant application examples help you to use ***samos*** in practice, especially in hierarchical safety zones. The manual also includes installation information, instructions and rules that must be observed, technical data and interface descriptions, error information, error handling and instructions for risk analysis.

Who Is This Manual For?

This manual contains the information required for proper use of the devices described in it. The system and its modules must only be installed by properly qualified personnel. The applicable national norms and regulations must be observed (in Germany VDE). For that reason this manual is aimed at technically qualified personnel such as mechanical and electrical engineers, safety reps, PLC programmers, enclosure makers, electrical fitters, machine and plant operators, setup staff, and service and maintenance personnel.

Safety-related Information

The "Caution" symbol is used at various places in this manual.

"Caution" indicates a potentially dangerous situation or state that **could** – if not avoided – lead to minor or medium injury. "Caution" is also used to warn against uncertain operation and potential misuse. "Caution" is also used to indicate situations where property damage **could** occur without causing personal injury.

Please observe the following safety rules:

- Only trained professional electricians may install, startup, modify, and retrofit this equipment!
- Disconnect supply voltage to the equipment / system prior to starting any work! If installation or system errors occur, line voltage may be present at the control circuit in devices without DC isolation!
- Observe all electrical safety regulations issued by the appropriate technical authorities or the trade association.
- Opening the housing or any other manipulation will void the warranty.
- If the device has been subjected to improper or incorrect use it must no longer be used, and the guarantee loses its validity. Impermissible conditions include: strong mechanical stress, for example through a fall, or voltages, currents, temperatures or humidity outside of the specifications.
- Before starting up your machine/plant for the first time, please be sure to check all the safety functions according to valid regulations, and observe the specified test cycles for safety equipment.
- Take the following safety measures prior to installation, assembly, or disassembly:
  - Disconnect supply voltage to the equipment / system prior to starting any work!
  - Lockout/tag the equipment/system to prevent accidental activation!
  - Confirm that no voltage is present!
  - Ground the phases and short to ground!
  - Protect against adjacent live components using guards and barriers!

Protection type according to EN 60529.
Limited contact protection!
Housing/terminals: IP 40 / IP 20.
Finger-proof (DIN EN 50274).

Proper Use

The ***samos*** safety system described in this manual serves to protect people, the environment, the machine and the material according to the valid EU occupational health and safety directive 89/391/EEC, the machinery directive 98/37/EC, the use of work equipment directive 89/655/EEC as well as the statutory regulations and standards applicable in other countries (e.g. USA with OSHA 29 CFR 1910.xxx safety standards, OSHA 3067 concepts and technologies for machine safety and NPFA 70, NFPA 79, ANSI B11 product liability).

If the safety system is properly maintained and used for its intended purpose it will not normally cause damage to property or present health hazards. However, improper configuration, installation, maintenance or operation of the system or machine, ignoring the instructions in this manual, or intervention by insufficiently qualified personnel may result in connected actuators (such as motors, hydraulic units, etc.) becoming a source of danger.

The safety system is a state-of-the-art product and is manufactured to recognized safety requirements. All the same, its use can cause danger to the health and safety of operators and others, or damage machines, systems or other property.

The safety system must only be used in perfect technical condition for its intended purpose, with attention given to safety and danger, and observing the information and instructions given in this manual and the operating instructions supplied with the devices. Correct transport, storage, installation, operation and maintenance of the system are all prerequisites for smooth and safe operation of the control system. Malfunctions, in particular those which may affect safety, must be immediately resolved.

Conditions of Installation

- The devices must be installed in an enclosure with at least IP54 protection.
- The devices must be installed on a mounting rail (EN 50022-35).
- The mounting rail must be connected to protective earth (PE).
- The system and the system inputs must always be powered by a common power supply unit.
- The external power supply unit must comply with the regulations for safety and protection extra low voltage systems (SELV, PELV acc. to IEC 60536) and DIN EN 50178 (Electronic Equipment for Use in Power Installations).

Exclusion of Liability

The application examples and circuitry suggestions have been developed to the state of the art and our best knowledge. Nonetheless, Wieland cannot accept liability for the correctness and completeness of the information. The information does not have the legal status of guarantees or guaranteed qualities.

Safety Function Blocks

The ***samos*** safety system consists of a small number of multifunctional modules and an optional field bus coupler. This ***sa***fety ***mo***dular ***s***ystem is, as the name suggests, modular – you add modules as the safety task grows. Sensibly coordinated, combinable function blocks take the place of singular solutions and isolated specialists.

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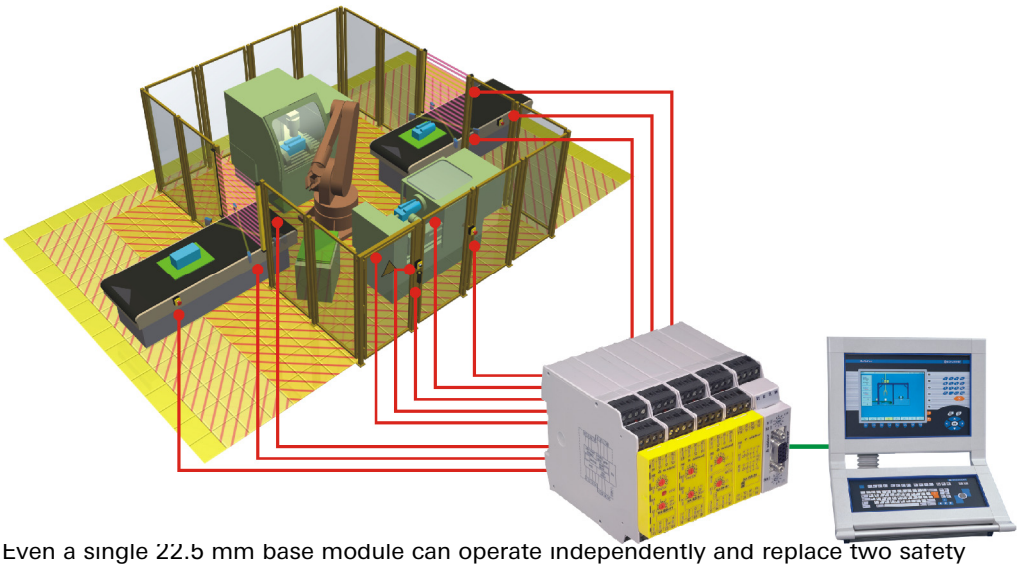
- combines all the safety sensors that monitor your machine/plant safety singly, in combination or all together.
- replaces special devices for monitoring – for example – emergency stop, position switches, two-hand switches and light barriers.
- allows you to create dependent/independent safety zones.



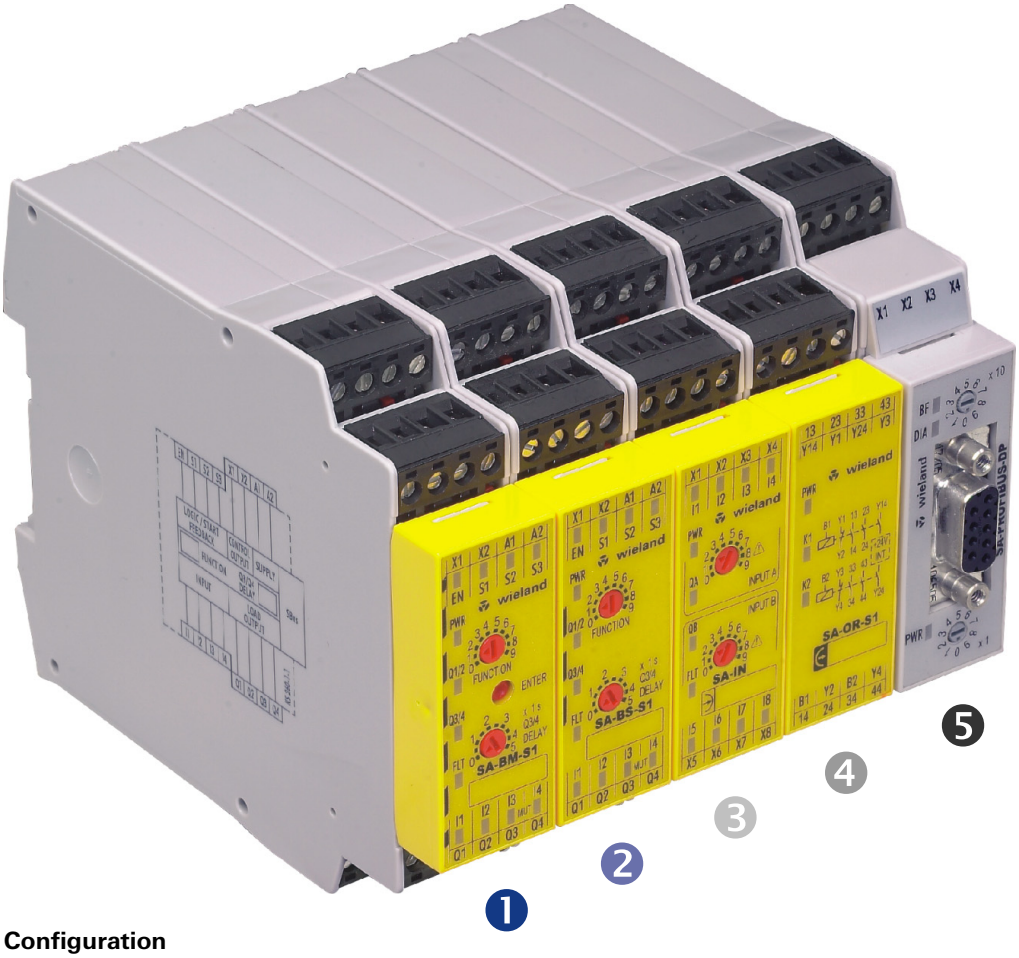
Even a single 22.5 mm base module can operate independently and replace two safety switching devices. Two ***samos*** modules replace up to 6 safety switching devices. In the maximum configuration you can monitor up to 50 dual-channel safety sensors – up to EN 954-1 category 4 or EN 61508 SIL 3.

Handling and function will be familiar from conventional safety switching devices. You can set all the safety functions simply using a screwdriver – no programming software – and read them off on the device. If required, you can expand the inputs or outputs using additional modules.

Functions

- Emergency stop, with or without cross-circuit monitoring
- Safety door monitoring, also with coded electromagnetic switches
- Controlled stopping with settable off delay up to 5 minutes, with or without retriggering
- Light barrier monitoring with testable/self-testing sensors (non-contact safety device type 2 and 4)
- Position monitoring with testable inductive sensors (PDF)
- Static valve monitoring
- Two-hand applications to EN 574, type IIIA and IIIC
- Jog mode
- 4-wire switching mat monitoring
- Muting and bypass
- Enabling function for cascading and grouping
- Automatic or manual Reset, starting and restarting inhibit

The *samos* System



Minimum configuration: SA-BM master base module as stand-alone.

Configuration

The ***samos*** modular safety system is a programmable electronics PE) element of an electrical/ electronic/programmable electronic system (E/E/PES) as described in IEC/EN 61508. The system comprises base modules, input and output modules, and bus coupler modules.

The minimum configuration is one SA-BM master base module. You can connect other active safety modules, passive safety modules and bus coupler modules to the master to create a system.

- Up to 12 active safety modules (SA-BS slave base modules, SA-IN input modules)
- Additionally up to 4 SA-OR passive relay output modules
- Additionally 1 bus coupler module

SA-BS slave base modules are functionally independent safety function modules that can be connected (wired) to the master. All SA-BM and SA-BS base modules can be expanded with SA-IN inputs and SA-OR relay outputs. The subsystems formed in this way are functionally autonomous and can be wired together as required. Slave base modules and input modules only function if a master is present.

Structure

In a system the master base module is at the left-hand end, the optional bus coupler module at the right-hand end. Input modules are always assigned functionally to the next connected base module to the left. The modules are connected by means of a connector integrated in the housing. The 24 V power supply is fed in through the master base module and all slave base modules.

Components of the *samos* system

A complete ***samos*** system is constituted by one or more subsystems with at least one base module (see following illustration in the 'example for a configuration with subsystems'.

To avoid inadvertent mixing of modules e.g. in case of maintenance, base and input modules of each subsystem are coded uniquely. This implies that base and input modules of a certain subsystem cannot be used in another subsystem (which has a different coding).

Note

The respective coding is to be taken into account when ordering the ***samos*** input modules (base modules can be re-coded according to their subsystem). Output modules and gateways are not coded and can be inserted anywhere in a ***samos*** system.

❶ Master base module

The master base module is the obligatory basic element of the ***samos*** system. On its own it functions as a complete safety switching device for monitoring up to 2 safety circuits. It offers 8 function blocks for inputs and logic functions (set on rotary switch on front), 8 inputs and 4 wear-free semiconductor safety outputs. The system configuration is saved in the master. Errors and unauthorized alterations cause safety shutdown of the whole system.

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❷ Slave base module

Apart from the enter key for accepting the system configuration, the slave module functionality is identical to the functionality of the master module. With input modules on its right or alone the slave module is al subsystem like the master module.

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❸ Input module

The input module adds additional input circuits or logic functions to a base module on its left. The module has two function groups, *A* and *B*, each with 4 inputs. You have to set one of 10 functions for each group using the rotary switch.

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❹ Relay output module

The output module adds potential-free output safety circuits with positively driven relay contacts to expand the base module outputs. The module does not function as a slave on the internal safety bus of the ***samos*** system. Instead it is integrated in the functions via external wiring. It can therefore be positioned anywhere between the master base module and the (optional) bus coupler module.

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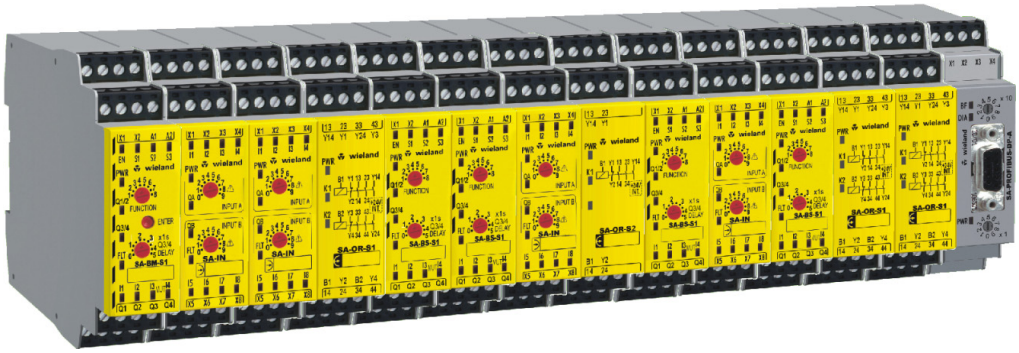
❺ Bus coupler module

The bus coupler module for the Profibus-DP field bus allows system information for diagnosis purposes (input levels, error and status information) to be sent to other bus stations (e.g. higher-order controller). There is a separate manual for the bus coupler modules (see page 71).

Example of a configuration with subsystems



Base module master	Input module SA-IN-S1	Input module SA-IN-S1	Output module	Base module slave	Base module slave	Input module SA-IN-S3	Output module	Base module slave	Input module SA-IN-S4	Base module slave	Output module	Output module	Bus coupler module
Subsystem 1				Sub-sys. 2	Subsys. 3			Subsys. 4		Subsys. 5			

Summary Analysis

Risk assessment and risk minimization for plant and machines

This simplified description outlines the basics of risk analysis for planners and designers.
For more detailed information please consult the relevant norms.

1 Determining the limits of a machine

- Proper use
- Spatial limits (transport, assembly, installation, power supply, material feed)
- Temporal limits (working life, servicing intervals, ...)

2 Identifying dangers

- Crushing, shearing, electric shock, poisoning, burns, ...

3 Assessment of all danger situations

- Operator-machine relationship
- Operating states
- Servicing, maintenance, disassembly, disposal
- Wear
- Predictable misuse, ...

4 Risk assessment

- Extent of damage
- Persons in danger zone
- Probability of danger occurring
- Possibilities of avoiding/limiting damage

5 Select measures for risk minimization

- Design measures
- Technical measures
- User information, warnings, operating hints, ...

6 Determine residual risks

- Test effectiveness of safety measures
- Validate acc. to EN 954-2

7 If necessary introduce additional measures to reduce residual risk to an acceptable level.

Risk analysis e.g. as per EN 292 (new EN ISO 12100)

Risk assessment and minimization e.g. as per EN 1050 (new EN ISO 14121)

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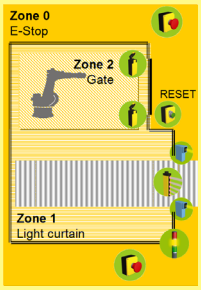
The technical measures for reducing the risk of dangerous states and damage to the machine or material include the electrical equipment. The required level of risk minimization and consequently the requirements of the safety-related parts on the controller are determined for example according to EN 954-1 (here controller category.

You can find examples for logic functions on page 53ff.

Creating safety zones
In risk analysis the machine is often divided into different safety zones, which may have different risk potentials. The zones are linked by safety logic functions so that only the necessary parts of the machine are shut down when a safety event occurs.



You can find an overview of applications on page 20 and 38.

Selecting safety devices and safety functions
for monitoring the safety equipment and safety zones. Selection of stop category 0 and/or 1 (EN 60204-1).

- Select function blocks and input circuit functions for the application on the ***samos*** base module.

You can find descriptions of input modules on page 34ff.

How many safety sensors and safety circuits must also be monitored?

- Select input expansions.

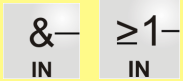
You can find descriptions of base modules on page 13ff, relay output modules on page 44ff.

How many additional safety outputs are needed?

- Select outputs on base module (semiconductor) or output expansion (relay contacts)

You can find examples for logic functions on page 53ff.

Link safety zones
and function blocks in the ***samos*** system.



You can find the descriptions of reset behavior on page 25ff.

Select Reset behavior
for powering up and after safety event.

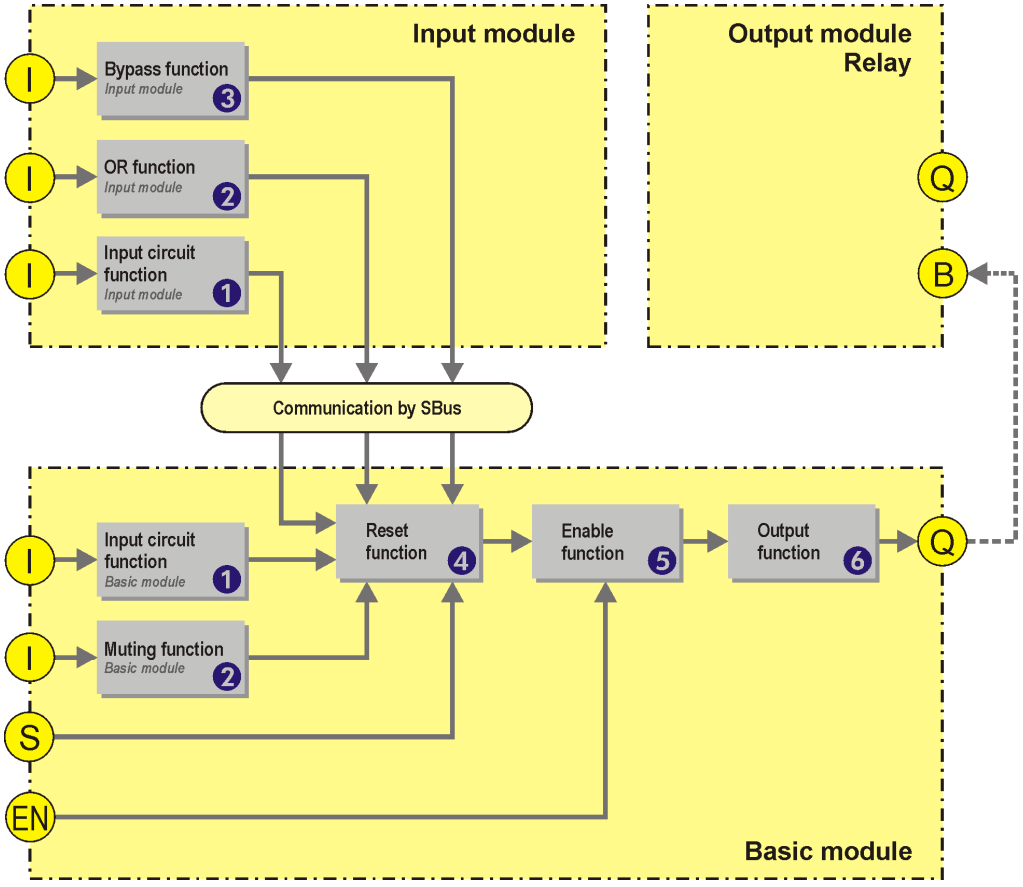
Bus coupler modules are described in a separate manual. You can find the order numbers on page 71.

Select optional field bus function as diagnosis function.

System Functions

The ***samos*** safety system is for monitoring sensors as part of the safety equipment of machines. The safety function (e.g. an emergency stop function) is implemented by switching outputs *Q* on or off safely in relation to the state of the sensors on inputs *I*, *EN* (enable) and *S* (Reset condition). Switching these outputs on/off prevents dangerous states occurring in the plant/ machine.

The safety function is made up of a chain of logically linked functions. The input modules communicate with the associated base module (on the left) via the internal safety bus (SBus). The relay output modules are not integrated directly via the SBus in the ***samos*** safety communication system. However, indirect monitoring is possible via the feedback circuits.



1 Input circuit function

The input circuit function logically links input signals for further processing. There are different methods for activation:

- Input circuit function single-channel via NC contact
- Input circuit function with dual-channel equivalent activation, with/without cross-circuit monitoring, with/without synchronous time monitoring
- Input circuit function with dual-channel non-equivalent activation, with/without cross-circuit monitoring, with/without synchronous time monitoring
- Two-hand function with activation by one NO contact per hand (EN 574, IIIA)
- Two-hand function with activation by NO/NC combination for each hand (EN 574, IIIC)
- Dual-channel equivalent activation by semiconductor

OR

Muting

2 OR function and muting function

The off signal of an input function can be bridged with an OR signal. For example, in setup mode a safety function can be bridged using an enabling button; an OR operation can also link two safety functions.

The muting function is a special case of the OR function. For example, muting sensors allow a conveyor belt to transport material through a light grille by briefly bridging the light grille function.

Bypass

3 Bypass function

With a bypass signal the OFF signal of a Reset function (see page 47) can be changed into an ON signal in the base module. Bypass is used when the system is to be switched on after a power shutdown but a light barrier is obstructed by material. Bypass cancels the safety function of the safety device, allowing the blockage to be cleared. In normal operation the muting function bridges automatically (see above).

Reset

4 Reset function

The Reset function defines which (Reset) conditions must be fulfilled if, for example, an ON signal is to be passed on to the Reset function output. All input and muting signals from the base module and the associated input modules, and the bypass/OR signals from the input modules are logically linked (AND/OR). The terminal configuration with bridges and feedback circuits is also evaluated.

Enable

5 Enable function

The enable function enables the ON signal in the Reset function if there is H-level on the *EN* input. The H-level for enabling can be generated, for example, by a semiconductor output Q_n on the base module for logic operations or a PLC output. For category 4 applications (EN 954-1) the module that generates the enabling signal must be in the same enclosure. If the *EN* input is open or on L-level the following Q_n semiconductor outputs are locked.

Safety outputs

6 Output function

The time behavior of the safety ON/OFF signal is defined in the output function. Depending on the function, you can set a off delay for outputs *Q3* or *Q3/Q4* between 0 and 5 minutes (depending on module version).

Diagnosis

Communication

With the communication function system data is exchanged between the different modules in a system via the internal safety bus (SBus).

Diagnosis and display function

The diagnosis function allows internal system data to be provided to external systems via a diagnosis module or bus coupler module.

NOTE

For detailed explanations of system functions and other hints and examples please refer to the glossary on page 47ff.

Base Module Data

- **SA-BM-S1**
- **SA-BS-S1**

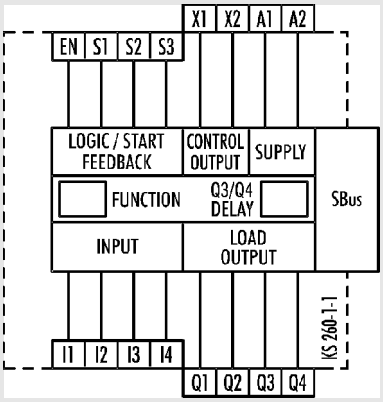
Master base module
Slave base module

SA-BM-S1 SA-BS-S1

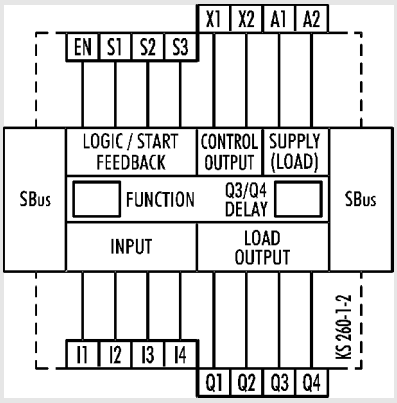
The SA-BM master base module is the obligatory module of the ***samos*** system. On its own it functions as a complete safety switching device for monitoring up to 2 safety circuits.

Apart from the enter key for accepting the system configuration, the SA-BS slave module functionality is identical to the functionality of the master module. SA-BS slave base modules function only if there is an SA-BM master base module in the system.

Connection diagram



SA-BM-S1



SA-BS-S1

Notes

- The controller category (EN 954-1) or SIL (EN 61508) depends on the external circuitry, the wiring, the choice of control devices and their location on the machine.
- In the event of single-channel control of a contact extension (e.g. SA-OR) through a base module (SA-BM/BS), category 4 according to EN 954-1 can be achieved if both devices are installed in the same enclosure and the samos system is separated from the power supply at least once a day.
- The SA-BM must be protected with a 6 A fuse (SA-BS: 4 A) of utilization category gG or a 6 A (4 A) circuit-breaker (tripping characteristic B or C).
- The rotary switches for selecting function and time must only be adjusted when power is off.
- Never connect or disconnect modules while the operating voltage is switched on.
- If external contactors or relays are connected, the feedback circuits (NC contacts) must be connected to the base module.
- When inductive loads are connected (e.g. valves, contactors) a suppressor circuit must be set up (e.g. RC combination).
- Internal ***samos*** module addresses are assigned automatically when the system starts up. Manual addressing is unnecessary (and not possible).
- The safety system must be installed in an enclosure with at least IP 54 protection.
- Each base module forms a subsystem within the overall system (sometimes together with associated input expansion modules; see diagram on page 8).

SA-BM technical data

SA-BM-S1

Function	Base module in the ***samos*** system
Function display	11 green LEDs, 1 red LED
Controls	2 10-position switches, 1 1-position button
Terminals	Plug-in terminals with screws / spring force
Max. number of modules / status in system	1 / SBus master
Max. number of parallel-connected module inputs In or S_n that can be controlled from one module output X_n or Q_n	8

Power circuitry (*A1, A2*)	**Min.**	**Typical**	**Max.**
Operating voltage U_B, DC	19.2 V	24 V	30.0 V
Residual ripple			3.0 V_{ss}
Rated power, DC			1.8 W
Peak current I_P			25 A
Ready time t_{ON} (after connecting U_B)			10 s
Device fuse		6 A (gG)	

Input circuit (I1..I4, EN, S1..S3)		**Min.**	**Typical**	**Max.**
Input voltage, U_E	(HIGH)	15.0 V		30.0 V
	(LOW)	–5.0 V		5.0 V
Input current, I_E	(HIGH)	2.3 mA	3.0 mA	
	(LOW)	–2.5 mA		0.15 mA
Cyclical peak input current, $I_{E,Peak}$			15 mA	
Input capacitance, C_{IN}			200 nF	
Input resistance, R_{IN}			8 kΩ	
ON period*, t_E		70 ms		
OFF period*, t_A		> t_{AN}		
Break time of U_E (test pulses)				1.0 ms
Break time period		20 ms		
Synchronous time t_S				
Function 2				800 ms
Functions 4, 5B				500 ms
Duration of operation Reset inuts S1, S2		50 ms		5 s

** For the times, see the function diagram at the end of the table*

Output circuit (*X1, X2*)	**Min.**	**Typical**	**Max.**
Output voltage	18.0 V		30.0 V
Output current			150 mA
Total output current**			
Wire capacitance, C_L			1000 nF
Wire resistance, R_L			100 Ω
Type of outputs / short-circuit behavior	Semiconductor / absolutely short-circuit-proof		

*** The sum of currents, which are drained from the outputs X1, X2 of all Base modules to supply external sensors, may not exceed 600 mA!*

SA-BM technical data

Output circuit (*Q1..Q4*)	**Min.**	**Typical**	**Max.**
Output voltage	18.0 V		30.0 V
Output current (with U_N = DC 24 V) res./ind.			2.0 A / 1.0 A
Total current			4.0 A
Inductive switching off energy E (E=0,5*L*I²)			220 mJ
Settable off delay	0 / 0.5 / 1 /1.5 / 2 / 2.5 / 3 / 3.5 / 4 / 5 s		
Q3/Q4 or Q4, t_{RV}	0 / 5 / 10 / 15 / 20 / 25 / 30 / 35 / 40 / 50 s		
(depending on device version)	0 / 0.5 / 1 / 1.5 / 2 / 2.5 / 3 / 3.5 / 4 / 5 min		
Test pulse width, $t_{TI,HL}$		500 µs	
Test pulse period, $t_{TP,HL}$		100 ms	
Load capacitance, C_L			500 nF
Conductor length (single, ∅ 1.5 mm²)			100 m
Type of outputs / short-circuit behavior	Semiconductor / absolutely short-circuit-proof		
Parallel connection of outputs	not allowed		

Input test	**t_{TI}, typ.**	**t_{TD}, typ.**	**t_{TP}, typ.**
Test pulse width*, t_{TI}, Test duration**, t_{TD}, Test pulse period, t_{TP}			
Function 3.2 (non-contact safety device type 2)	12 ms	20 ms	384 ms
Function 3.2 (PDF sensors)	52 ms	70 ms	384 ms
Functions 1, 2, 4, 5, 6	12 ms	22 ms	192 ms

Response times	**Min.**	**Typical**	**Max.**
Response time***, t_{AN} (normal operation)			
Functions 3.1, 7, 8			13 ms
Function 3.2 (non-contact safety device type 2)			29 ms
Function 3.2 (PDF sensors)			79 ms
Functions 1, 2, 4, 5A, 6			9 ms
Function 1 (4-wire switching mat)			130 ms
Function 5B			29 ms
DISABLE (via EN input)			13 ms
OR off			9 ms
MUTING off, dual-channel (function 3)			65 ms
MUTING off, single-channel (function 3)			165 ms

Safety parameters	**at ambient temperature T_B +55 °C**
PFD	1.7 x 10^{-5}
PFH	7.9 x 10^{-9} h^{-1}
SFF	96 %
DC	93 %

General data	**Min.**	**Typical**	**Max.**
Enter button ON period			3 s
Isolation			
Power circuitry – input circuit	no		
Power circuitry – output circuit	no		
Input circuit – output circuit	no		
Connection diagram	KS 260-1-1		
Weight	0.16 kg		
General technical data	See page 66.		
Order numbers	See page 70.		

** Signal changes are not detected during the test pulse.*

*** Signal changes from HIGH to LOW are not detected during the test pulse.*

For the times see the function diagrams at the end of the table.

**** The response time t_{AN} is the time between the OFF signal arriving at the input terminals and the outputs actually being shut down (in normal operation).*
The response times of any assigned input modules must also be taken into consideration. See input module data, page 35.

For information on safety-related parameters, see glossary p. 51

SA-BS technical data

SA-BS-S1

Function	Base module in the ***samos*** System
Function display	11 green LEDs, 1 red LED
Controls	2 10-position switches, 1 1-position button
Terminals	Plug-in terminals with screws / spring force
Max. number of modules / status in system	12 / slave on SBus
Max. number of parallel-connected module inputs I_n or S_n that can be controlled from one module output X_n or Q_n	8

Power circuitry (*A1, A2* and internal)	**Min.**	**Typical**	**Max.**
Operating voltage U_B, DC	19.2 V	24 V	30.0 V
Residual ripple			3.0 V_{ss}
Rated power, DC			1.8 W
Device fuse		6 A (gG)	

Input circuit (I1..I4, EN, S1..S3)		**Min.**	**Typical**	**Max.**
Input voltage, U_E	(HIGH) / (LOW)	15.0 V / –5.0 V		30.0 V / 5.0 V
Input current, I_E	(HIGH)	2.3 mA	3.0 mA	
	(LOW)	–2.5 mA		0.15 mA
Cyclical peak input current, $I_{E,Peak}$			15 mA	
Input capacitance, C_{IN}			200 nF	
Input resistance, R_{IN}			8 kΩ	
ON period*, t_E		70 ms		
OFF period*, t_A		> t_{AN}		
Break time of U_E (test pulses)				1.0 ms
Break time period		20 ms		
Synchronous time t_S	Function 2			800 ms
	Functions 4, 5B			500 ms
Duration of operation Reset inuts S1, S2		50 ms		5 s

** For the times see the function diagrams at the end of the table.*

Output circuit (X1, X2)	**Min.**	**Typical**	**Max.**
Output voltage	18.0 V		30.0 V
Output current			150 mA
Total output current**			
Wire capacitance, C_L			1000 nF
Wire resistance, R_L			100 Ω
Type of outputs / short-circuit behavior	Semiconductor / absolutely short-circuit-proof		

*** The sum of currents, which are drained from the outputs X1, X2 of all Base modules to supply external sensors, may not exceed 600 mA!*

Output circuit (*Q1..Q4*)	**Min.**	**Typical**	**Max.**
Output voltage	18.0 V		28.8 V
Output current (with U_N = DC 24 V) res./ind.			2.0 A / 1.0 A
Total current			4.0 A
Inductive switching off energy E (E=0,5*L*I²)			220 mJ
Settable off delay	0 / 0.5 / 1 /1.5 / 2 / 2.5 / 3 / 3.5 / 4 / 5 s		
Q3/Q4 or Q4, t_{RV}	0 / 5 / 10 / 15 / 20 / 25 / 30 / 35 / 40 / 50 s		
(depending on device version)	0 / 0.5 / 1 / 1.5 / 2 / 2.5 / 3 / 3.5 / 4 / 5 min		
Test pulse width, $t_{TI,HL}$		500 µs	
Test pulse period, $t_{TP,HL}$		100 ms	
Load capacitance, C_L			500 nF
Conductor length (single, ∅ 1.5 mm²)			100 m
Type of outputs / short-circuit behavior	Semiconductor / absolutely short-circuit-proof		
Parallel connection of outputs	not allowed		

Input test	**t_{TI}, typ.**	**t_{TD}, typ.**	**t_{TP}, typ.**
Test pulse width*, t_{TI} / Test duration**, t_{TD} / Test pulse period, t_{TP}			
Function 3.2 (non-contact safety device type 2)	12 ms	20 ms	384 ms
Function 3.2 (PDF sensors)	52 ms	70 ms	384 ms
Functions 1, 2, 4, 5, 6	12 ms	22 ms	192 ms

** Signal changes are not detected during the test pulse.*

*** Signal changes from HIGH to LOW are not detected during the test pulse.*

Response times	**Min.**	**Typical**	**Max.**
Response time***, t_{AN} (normal operation)			
Functions 3.1, 7, 8			13 ms
Function 3.2			29 ms
(non-contact safety device type 2)			79 ms
Function 3.2 (PDF sensors)			9 ms
Functions 1, 2, 4, 5A, 6			130 ms
Function 1 (4-wire switching mat)			29 ms
Function 5B			
DISABLE (via EN input)			13 ms
OR off			9 ms
MUTING off, dual-/ single-channel (funct. 3)			65 / 165 ms

For the times see the function diagrams at the end of the table.

**** The response time tAN is the time between the OFF signal arriving at the input terminals and the outputs actually being shut down (in normal operation).*
The response times of any assigned input modules must also be taken into consideration. See input module data, page 35.

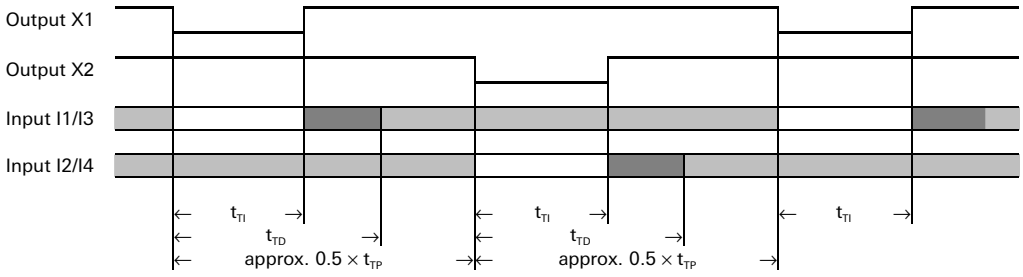
Safety parameters	**at ambient temperature T_B +55 °C**
PFD	1.7×10^{-5}
PFH	$7.9 \times 10^{-9}\ h^{-1}$
SFF	96 %
DC	93 %

Safety related characteristics are explained in the glossary, see p. 49

General data	
Isolation	
Power circuitry – input circuit	no
Power circuitry – output circuit	no
Input circuit – output circuit	no
Connection diagram	KS 260-1-2
Weight	0.16 kg
General technical data	See page 66
Order numbers	See page 70

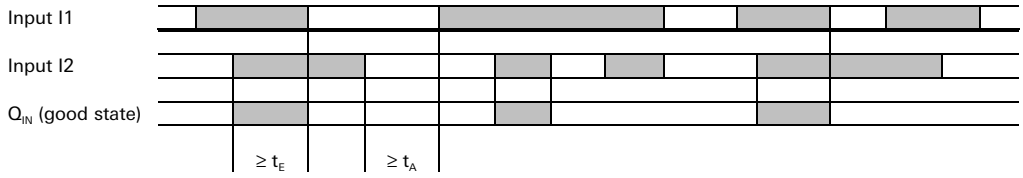
Function diagrams

Input test function diagram (with cross circuit monitoring)



t_{TI} : Test pulse width
t_{TD} : Test duration
t_{TP} : Test pulse period

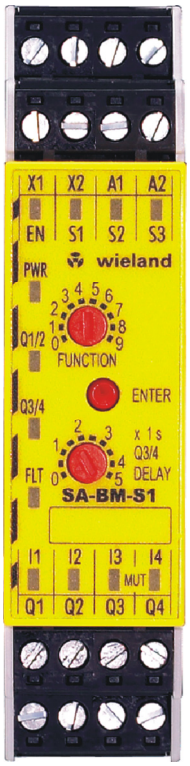
Input circuit function diagram (equivalent activation)



t_E : ON period
t_A : OFF period
Q_{IN}: see page 47

Interfaces and Operation

Interfaces



Terminals

A1, A2	Power supply for base module and connected expansion modules. (Plus potenzial to A1)
X1, X2	Outputs only for power supply to module inputs and sensor control
EN	Input for enabling outputs
S1, S2, S3	Control inputs for configuring the mode and connecting Reset buttons and feedback circuits
I1, I2, I3, I4	Inputs for connecting sensors
Q1, Q2, Q3, Q4	Outputs for controlling actuators
SBus	10-pin connector for safety bus - SA-BM: female only - SA-BS: male and female

Switches / buttons

FUNCTION	8-position rotary switch for setting an input circuit function
Q3/4 DELAY	10-position rotary switch for setting off delay time
ENTER	Button for accepting the system configuration (SA-BM only)

LEDs

EN, S1..S3, I1..I4 (green)	Display corresponding inputs
PWR (green)	Supply voltage
Q1/2, Q3/4 (green)	Control state of semiconductor outputs
FLT (red)	Display fault states (see Error Codes *FLT*, page 63)

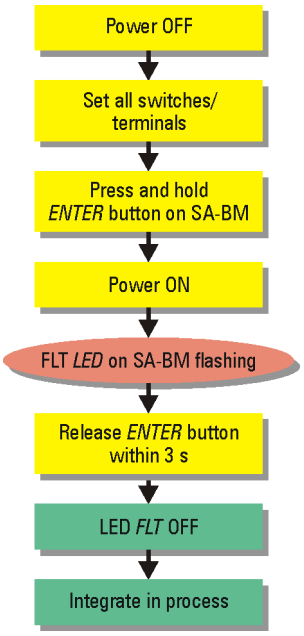
Meaning of LEDs

• *PWR* on	Power supply to module electronics is on
• *I1-I4* on	H-level on corresponding input
• *I1, I2* flash simultaneously	Cross-circuit between *I1* and *I2*
• *I3, I4* flash simultaneously	Cross-circuit between *I3* and *I4*
• *I1, I2* flash alternately	Sequence error on *I1, I2*
• *I3, I4* flash alternately	Sequence error on *I3, I4*
• *I1* oder *I2* flashes	Synchronous time error. The input that flashes is the one that achieves good state too late.
• *I3* oder *I4* flashes	Synchronous time error. The input that flashes is the one that achieves good state too late.
• *EN, S1..S3* on	H-level on corresponding input
• *S1..S3* flashes	Feedback circuit open
• *Q1/2, Q3/4* on	H-level on corresponding outputs, *Q3/4* flashes during off delay time
• *FLT* off	No fault states

Interfaces and Operation

First installation and Accepting the system configuration

Accepting configuration



Configurations can only be set or altered using the switches and terminals when the whole system is switched off, i.e. when there is no operating voltage on terminals *A1/A2* on any base module. After the required functions and control circuit functions have been set on all the modules in the system (using the rotary switches and external circuitry on terminals *S1*, *S2*, *S3* respectively), operating voltage must be connected while the *ENTER* button on the SA-BM base module is pressed and held. As soon as the *FLT* indicator starts blinking the *ENTER* button must be released within 3 seconds. Then the selected mode is saved in non-volatile form and active. If the *ENTER* button is pressed for longer than 5 seconds after the LED has started blinking, the *FLT* display will indicate a fault (blinking light).

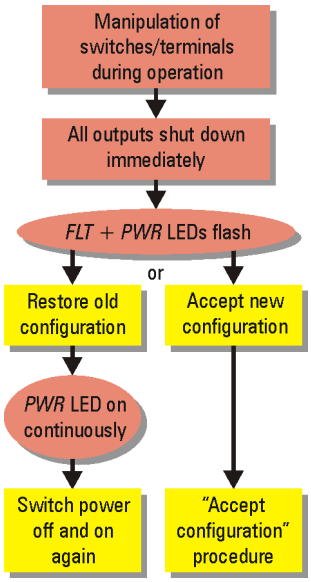
NOTES

- Terminals *S1*, *S2*, *S3* serve not only to set the mode; they can also be used for feedback-circuit monitoring of connected relays and contactors. This means that the terminal signals change during operation (opened contact). The set mode remains unaffected because it is only detected, checked and saved when the system is switched on or restarted.
- Because the relay expansion modules are not directly integrated in the communication or diagnosis of the ***samos*** system via the internal safety bus, changes in their input/output circuitry are registered only indirectly via the feedback circuits.

Manipulation, handling errors and operating errors during operation

Handling errors

NOTES



- Manipulating the system configuration (e.g. operating a rotary switch or adding or removing modules causes immediate canceling of enabling. To assist in setting the valid configuration the green *PWR* LED on the module changes from blinking to continuous when the respective switch position has been restored. A restart (switch off and on again) under the set Reset condition is possible when the former configuration has been restored. The *ENTER* key has no effect during operation.
- If the new configuration is to be adopted you have to go through the "accept configuration" procedure described above.

We recommend keeping a record of the configuration with the documentation or in a clearly visible place in the enclosure. One way to check the system configuration is to output a checksum of the configuration data via a connected bus coupler module.

There is a separate manual for the bus coupler modules (see page 71).

There is a blank configuration list for copying inside the back cover.

Notes on downloading an online version on page 75.

Input Circuit Functions

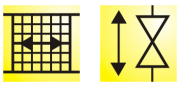
Overview of applications

** Availability of applications/sensor connections in function blocks (1 to 8) and function groups (A, B). See page 20.*

*** Maximum control category (depends on sensor, wiring and installation*

Please also note the information on page 13.

Overview of possible applications and corresponding sensor connections

Sensor connection	Application e.g.		Module/ group *	Category up to **
	**Emergency stop / safety door** *Single-channel NC*		3AB 7A/7B 8A/8B	**2**
	**Emergency stop / safety door** *Dual-channel equivalent NC* *Cross-circuit monitoring*		1AB 5A 6A/6B	**4**
	**Emergency stop / safety door** *Dual-channel three-wire equivalent NC*		3AB 7A/7B 8A/8B	**3**
	**Safety door or valve** *Dual-channel equivalent NC/NO*		2AB	**4**
	**Coded electromagnetic switch** on safety door *Dual-channel non-equivalent NC/NO*		2AB	**4**
	**Access monitoring** with self-testing sensors (e.g. outputs from light grille type 4) *dual-channel single-ended positive switching semiconductor*		3AB 7A/7B 8A/8B	**4**
	**Access monitoring** with testable sensors (e.g. type 2 light barriers) or potential-free contacts *Single-channel NC/semiconductor outputs*		3AB	**2**
	**Position monitoring** with testable inductive sensors (PDF) *Single-channel NC/semiconductor outputs*		3AB	**4**
	**Two-hand control** acc. to EN 574 IIIC or safety door *2x dual-channel non-equivalent NO/NC*		4AB	**4**
	**Two-hand control** acc. to EN 574 IIIA (not for press control) *2x single-channel NO*		5B	**2**
	**Jog mode** max. 5 s (e.g. setup mode) *2x single-channel NO*		5B	**2**
	**Access monitoring** with short-circuiting switching mats *Four-wire*		1AB	**3**
	**AND operation** Enabling input for cascading and grouping	In base module: Sensor inputs:	all function blocks input module	
	**OR operation** Muting, OR, bypass for bridging safety functions for setup mode, clearing, alternative safety function	 	Muting: 3AB OR: 1AB, 2AB, input module Bypass: input module	

Input Circuit Functions

Using the rotary *FUNCTION* switch on the front you can set 8 function blocks as single, combination or dual functions. On their own or in appropriate combinations these function blocks cover the main fields of safety application. Using terminal combinations you can set Reset behavior for manual/automatic Reset (page 25), off delay retriggering (page 26) and special functions (page 24). Switch positions 0 and 9 are without function and must not be used.

- **Single functions 1 to 4**
  The input circuits of function groups *A* and *B* act jointly on output circuits *Q1* to *Q4* (exception: function 3 with *Q3* as muting lamp / Reset required output). In functions 1 and 2 settable off delay and retriggering act jointly on outputs *Q3* and *Q4;* in function 3 only on *Q4;* in function 4 no off delay can be set.

1 SINGLE

- **Combination functions 5 to 7**
  The input circuits of function group *A* act directly on all output circuits *Q1* to *Q4*; the input circuits of function group *B* act on output circuits *Q3* and *Q4*.
  They are AND-linked via the internal logic with input circuits *A*. This allows the safety concept found on many machines (two safety zones, one group subordinate) to be reproduced within the device. With the exception of function 5 (for which no off delay is settable) the settable off delay and retriggering act only on output *Q4*.

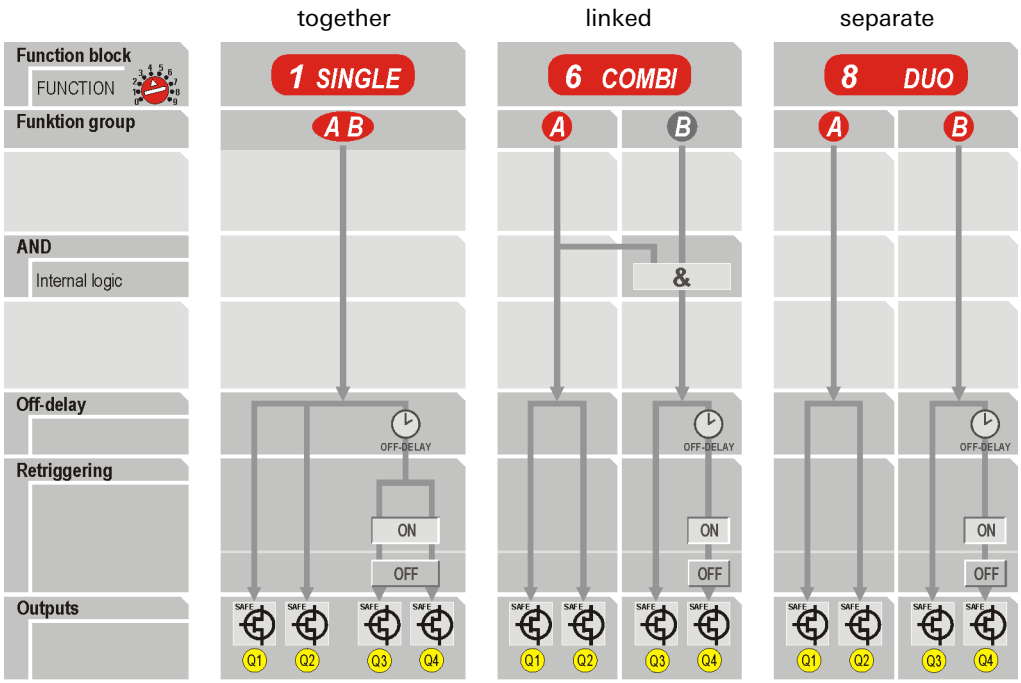
6 COMBI

- **Dual function**
  The input circuits of function groups *A* and *B* act separately on output circuits *Q1*, *Q2* or *Q3*, *Q4*. This means that with one base module you can monitor two independent safety groups on a machine or system. Settable off delay and retriggering act only on output *Q4*.

8 DUO

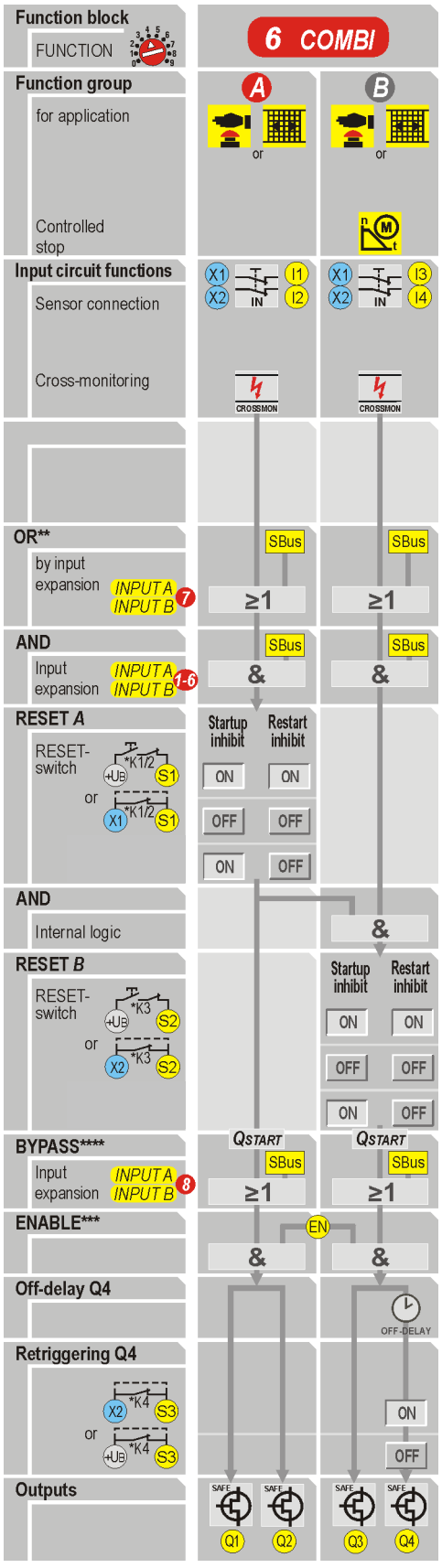
Evaluating input circuits / function blocks

The diagram shows three different types of evaluation and the signal flows between inputs and outputs for single function 1, combination function 6 and dual function 8. The diagram is an excerpt from the function overview (see page 32).



Structure and signal flow

General structure and signal flow using the example of function block 6



Select function block with *FUNCTION* switch

Function groups *A* and *B*

Applications for ... (e.g. emergency stop) +

Controlled stopping possible via off delay

Sensor connection to input terminals *I1/I2* (group *A*) or *I3/I4* (group *B*) and supply terminals (clock outputs) *X1/X2*
With cross-circuit monitoring

OR link with input expansion+ OR function via SBus

AND link with input expansion+ signals via internal safety bus (SBus)

Reset function configuring (starting/restarting inhibit) for function group *A* via terminal *S1*++ (Reset button, bridge or feedback circuit)

Internal logic module, AND link between function group *B* and function group *A*

Reset function configuring (starting/restarting inhibit) for function group *B* via terminal *S2*++ (Reset button, bridge or feedback circuit)

OR link with input expansion+ BYPASS function via SBus

AND operation with ENABLE input *EN* for external group formation and cascading

Settable off delay for output *Q4*

Configuring of retriggering via terminal *S3*++ (bridge or feedback circuit)

Safe semiconductor outputs *Q1, Q2, Q3, Q4*

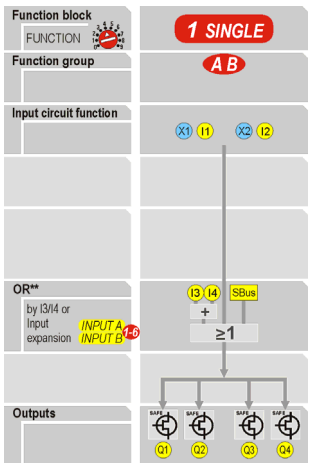
+ *For input module functions see page 34ff.*

++ *See control circuit functions, page 25.*

Input Circuit Functions

OR function of function blocks 1 and 2

OR function



The off signal of an input function can be bridged with a OR signal, for example with an enabling button for setup mode. All the function blocks offer the possibility to link OR function signals on the SA-IN input modules (function 7, see page 41) with base module input signals by logical OR via the SBus.

Additionally, the single function blocks 1 and 2 offer use of the OR function on the base module itself via the two inputs *I3* and *I4*. U_x^+ is expected as the signal. Generation of an ON signal (H-level) depends on several functions (see "System Functions", page 48).

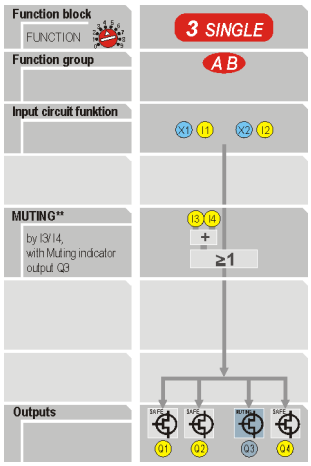
The OR function corresponds to an input circuit function with dual-channel equivalent activation without cross-circuit monitoring.

NOTE

With a constant U_x signal$^+$ on *I3* and *I4* and outputs *Q1* to *Q4* switched on, the outputs remain switched on regardless of the condition of the monitored safety sensors.

Muting function of function block 3

Muting function



The muting function is a conditional OR function, with which for example muting sensors can briefly bridge a light grille function to allow material to be transported through a light grille.

Muting is only possible on base modules with single function block 3, via inputs *I3* and *I4*. U_x^+ is expected as the signal. Generation of an ON signal (H-level) depends on several functions (see “System Functions”, page 48).

Output *Q3* controls the corresponding muting lamp. If manual Reset is configured, the Q3 output additionally indicates via periodical ON/OFF (0.5 s/0.5 s) that Reset is expected at input S1 (Reset-Required).

The muting function in the base device corresponds to an input circuit function with dual-channel equivalent activation without cross-circuit monitoring.

NOTE

With a constant U_x signal$^+$ on *I3* and *I4* and outputs *Q1*, *Q2* and *Q4* switched on, the outputs remain switched on regardless of the condition of the monitored safety sensors. Muting of a safety function must not be dependent on a single signal!

$^+$The U_x signal can come from

- supply voltage $+U_B$,
- the Q_x semiconductor outputs on the base modules,
- the OSSD outputs of muting light barriers (muting function only).

Special functions

Single function 3 and combination function 5 allow the use of special functions that are activated via a corresponding configuration on control circuit terminal *S2*.

Special function type 2

- **Single function 3**

  This function block offers the possibility of monitoring with an external test not only emergency stop, safety door and non-contact safety device type 4 applications (acc. to EN 61496-x) but also sensors (e.g. non-contact safety device type 2) and potential-free contacts. When the inputs are activated in this way the test function is activated by leaving terminal *S2* unactivated. Otherwise *S2* is bridged with the supply voltage (functions 3.1 and 3.2, see the "Control circuit functions" table on page 28 and the "Function blocks" table on page 30).

  – Testable sensors on *X1-I1* (terminal *S2* open):
  If time conditions are observed several sensors can be cascaded. Testable sensors such as non-contact safety device type 2 light barriers (EN 61496-x) have separate activation inputs on the transmitters. The activation inputs are used to test the sensor function with a low signal; the base module analyses the response signal generated by the receiver.

Special function Testable PDF

  – Testable sensors on *X2-I2* (terminal *S2* open):
  If time conditions are observed up to four sensors can be cascaded. The time conditions are matched specially for the GM 504S and GM 505S non-contact inductive sensors (PDF acc. to EN 60947-5-3) made by ifm. The connection is only available on base modules, not on input modules.

If one of the inputs *I1* or *I2* in not used a bridge must be installed to the respective control output.

Inputs *I3/I4* can be used as muting inputs specially for use with light grilles. They are AND-linked to one another and OR-linked to the other inputs. The muting inputs only act if the corresponding internal output signals of the Reset function Q_{START} on the base module were previously high (see also pages 23 and 48).

Output *Q3* functions as a muting lamp output and as sigalling output „Reset-Required". In this single function off delay for controlled stopping and retriggering act only on output *Q4*.

Special function two-hand

- **Combination function 5**

  Function group *B* can be used to monitor normal two-hand operation (synchronous operation of two buttons within 0.5 s, function 5.1*) or two-hand operation in jog mode (function 5.2*), e.g. for clearing a system. Here an output signal is only generated while the controls are being pressed. Jog mode is restricted to 5 s. Releasing both controls resets the time; repeated Reset is possible.

  To activate jog mode terminal *S2* remains unactivated. For other two-hand and safety door applications *S2* is bridged with the supply voltage $+U_B$.

** For the functions see also the "Control circuit function" table on page 28 and the "Function block overview" table on page 32).*

The two-hand function with two NO contacts cannot be used for operating presses, because the safety level usually required (category 4) is not achieved. Function block 4 should be selected for press operation (EN 574 Type IIIC).

Configuration

		Single function 3.2	Combination function 5.2
S2 and supply voltage unbridged		ON	ON

		Single function 3.1	Combination function 5.1
Bridge between *S2* and supply voltage		OFF	OFF

Control Circuit Functions

You can set the Reset behavior of the base modules by configuring terminals *S1/S2* and connecting Reset buttons, bridges or feedback circuits from external contactors/relays.

Starting lockout

- **ON**
  When power is switched on and the inputs are in safe state the base module expects a Reset (if restarting inhibit ON) or actuation on at least one input circuit (if restarting inhibit OFF).

NOTE

The enabling input does not act as an input circuit on the monitored sensors, i.e. the starting inhibit is not canceled by switching the *EN* signal off and on again. In combination functions 5, 6, 7 the starting inhibit in group *B* is not canceled by a signal change on the Reset function in group *A*; the signal change must occur in group *B*.

- **OFF**
  The outputs switch on immediately after power is switched on and the inputs are in safe state.

Restarting lockout

- **ON**
  For resetting the safety function after a safety event the base module expects the Reset button to be operated. This realizes the required manual Reset after emergency stop (or switching back on after the safety zone has been entered and left again).

NOTE

The Reset button must be operated for between 50 ms and 5 s. In combination functions 5, 6, 7 the restarting inhibit in group *B* must always be canceled by the Reset button.

In function 3, the expected Reset signal is indicated via blinking output Q3 (Reset-Required).

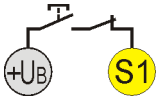
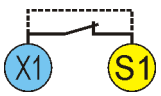
- **OFF**
  Automatic Reset after safety event and restoration of safe state of inputs.

NOTE

Elimination of a cross circuit is also immediately defined as restoration of safe state of inputs.

Reset function

The Reset function of manual and automatic Reset is defined by connecting terminals *S1/S2* with supply voltage $+U_B$ or the module's own clock output *X1*. (Here terminal *S1* is shown; in functions with separate evaluation of function groups *A* and *B* terminal *S2* and clock output *X2* are used equivalently for group *B*; see the table on page 28).

		Starting inhibit	Restarting inhibit
• **Manual reset** Reset button and feedback circuit between *S1* and supply voltage		ON	ON
• **Automatic reset** Bridge or feedback circuit between *S1* and clock output		OFF	OFF

NOTE

During the configuration phase (after power on) of manual Reset (with Reset button) the corresponding *S* output must be open or connected to a high-ohm output (e.g. a PLC). High or low potential will result in incorrect configuration.

Release delay

On the front of the base modules you can set a off delay of 0..5 s, 0..50 s or 0..5 min, depending on the device version. In position 0 release time = t_R for undelayed outputs (see Technical Data, page 15). Depending on the selected function block, the off delay acts on outputs *Q3* and *Q4*, only on *Q4*, or on none of the outputs.

NOTE

In functions without off delay (4 and 5) the delay switch must be set to 0 s, otherwise a fault will be indicated. Contactors and/or relay output modules connected to the delayed outputs are monitored separately via the feedback circuits (see "Control Circuit Functions", page 28).

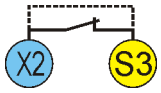
Retriggering

The behavior of off delay (retriggering) can be influenced by configuring terminal *S3*.

- **ON**

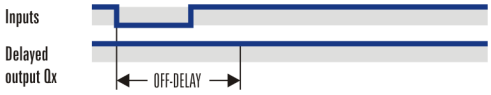
  If the safe input state ("good state") of the input circuits is reached again before the delay has expired, the delayed output circuits do not alter and the delay time is reset (❶).

  In restarting inhibit mode the Reset button has to be actuated additionally during retriggering time (❷).



Bridge or feedback circuit between *S3* and clock output *X1*

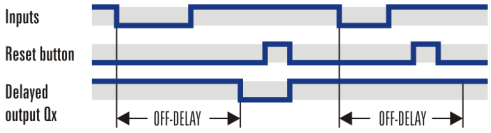
❶ Auto mode (restarting inhibit OFF)



EXAMPLE

Example: In automatic mode the safety door is opened and the off delay starts for the corresponding enabling paths. If the door is closed again before the time has expired the enabling paths do not shut down and the machine continues to operate without interruption.

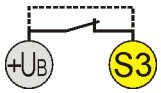
❷ Manual mode (restarting inhibit ON)



- **OFF**

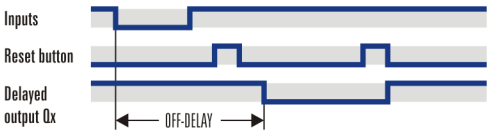
  Regardless of the state of the input circuits, the delayed output circuits open after expiry of the off delay time (❸ and ❹).

  With automatic Reset and "good state" before expiry of the off delay time, the delayed output circuits shut down for 400 ms and then switch on again (❺).



Bridge or feedback circuit between *S3* and supply voltage

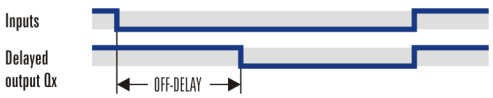
❸ Manual mode (restarting inhibit ON)



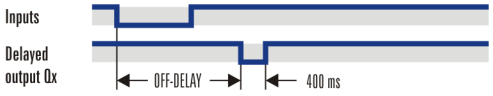
EXAMPLE

Example: In manual mode the emergency stop button is operated and the off delay starts for the corresponding enabling paths. If the emergency stop button is released before the time has expired and the Reset button operated, the enabling paths shut down anyway. The delay time must expire before enabling via the Reset input is possible again.

❹ Auto mode (restarting inhibit OFF)



❺ Auto mode (restarting inhibit OFF)



Control Circuit Functions

Control inputs

The table provides an overview of the use of control circuit terminals in connection with the selected function block:

- **S1** – Reset function (RESET), feedback circuit monitoring (FEEDBACK)
- **S2** – Reset function, special functions, feedback circuit monitoring
- **S3** – Retriggering (RETRIGGER), feedback circuit monitoring

NOTE

Control inputs *S1* and *S3* must always be connected.

Reset, feedback and retrigger

	S1		S2		S3	
FUNCTION	**RESET**	**FEEDBACK***	**RESET**	**FEEDBACK***	**RETRIGGER**	**FEEDBACK***
0	Switch position not allowed					
1	A B Man. / Auto	Q1 / Q2	unactivated		Q3 / Q4	Q3 / Q4
2	A B Man. / Auto	Q1 / Q2	unactivated		Q3 / Q4	Q3 / Q4
3	A B Man. / Auto	Q1 / Q2	$+U_B$ → FUNCTION 3.1** open → FUNCTION 3.2**		Q4	Q4
4	A B Man. / Auto	Q1 / Q2	unactivated		No function	Q3 / Q4
5	A B Man. / Auto	Q1 / Q2	B $+U_B$ → FUNCTION 5.1** open → FUNCTION 5.2**		No function	Q3 / Q4
6	A Man. / Auto	Q1 / Q2	B Man. / Auto	Q3	Q4	Q4
7	A Man. / Auto	Q1 / Q2	B Man. / Auto	Q3	Q4	Q4
8	A Man. / Auto	Q1 / Q2	B Man. / Auto	Q3	Q4	Q4
9	Switch position not allowed					

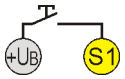
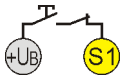
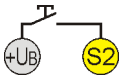
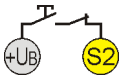
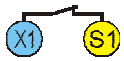
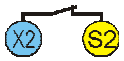
NOTE

* With off delay 0 s all the associated outputs of the group do not switch back on until all feedback circuits in the group are closed.

** For special functions see page 24.

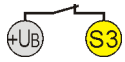
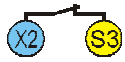
Reset and feedback – activation of control inputs *S1* and *S2*

Feedback via S1, S2

	S1		S2	
	Without FEEDBACK	**With FEEDBACK** Bridge or feedback circuit Q1/Q2	**Without FEEDBACK**	**With FEEDBACK** Bridge or feedback circuit Q3
Manual reset (restarting inhibit)				
Automatic reset without starting inhibit				

Retrigger and feedback – activation of control input *S3*

Feedback via *S3*

	S3	
	Without FEEDBACK	**With FEEDBACK** Bridge or feedback circuit Q1/Q2 resp. Q4
Retrigger OFF		
Retrigger ON		

NOTE

In functions without cross-circuit monitoring (see "Function Blocks – Overview", page 32) dynamic signals on outputs *X1* and *X2* are generated only during the configuring phase after power on.

During the configuration phase (after power on) of manual Reset (with Reset button) the corresponding *S* output must be open or connected to a high-ohm output (e.g. a PLC). High or low potential will result in incorrect configuration.

Feedback circuit monitoring

In order to monitor external contactors (FEEDBACK) that may be connected to outputs *Q1* - *Q4* the NC contacts of the respective contactors or output expansions must be connected in series with the associated control inputs (see the tables here and page 49).

Function blocks

FUNCTION	Function group	Application e.g.
		Switch position not allowed
	A B	Emergency stop, safety door, 4-wire switching mat Dual-channel NC/NC with cross monitoring, stop category 0
		OR
	A B	Safety door monitoring with electromagnetic switches, valve position monitoring Dual-channel NC/NO with cross monitoring, stop category 0 and 1
		OR
	A B	3.1* Non-contact safety device type 4, emergency stop, safety door Dual-channel NC/NC, single-channel NC, stop category 0 and 1
		3.2* PDF, Stop category 0 and 1 Non-contact safety device type 2, Stop category 0 and 1
		Muting
	A B	Two-hand function EN 574 Type IIIC, safety door 2x dual-channel NC/NO with cross monitoring
	A	Emergency stop, safety door Dual-channel NC/NC with cross monitoring
	B	5.1* Two-hand function EN 574 Type IIIA NO/NO with cross monitoring
		5.2* Jog mode with 5 s operating time restriction NO/NO with cross monitoring
	A	Emergency stop, safety door Dual-channel NC / NC with cross monitoring, stop category 0 and 1
	B	Emergency stop, safety door Dual-channel NC / NC with cross monitoring, stop category 0 and 1
	A	Emergency stop, safety door, non-contact safety device type 4 Dual-channel NC/NC, single-channel NC, stop category 0 and 1
	B	Emergency stop, safety door, non-contact safety device type 4 Dual-channel NC/NC, single-channel NC, stop category 0 and 1
	A	Emergency stop, safety door, non-contact safety device type 4 Dual-channel NC/NC, single-channel NC, stop category 0
	B	Emergency stop, safety door, non-contact safety device type 4 Dual-channel NC/NC, single-channel NC, stop category 0 and 1
		Switch position not allowed

** For special functions see page 24.*

Function block terminal assignment

Terminal assignment	Output function / off delay			
	Q1	Q2	Q3	Q4
X1 – I1 X2 – I2	NO DELAY	NO DELAY	OFF-DELAY	OFF-DELAY
U_x – I3 U_x – I4				
X1 – I1 X2 – I2	NO DELAY	NO DELAY	OFF-DELAY	OFF-DELAY
U_x – I3 U_x – I4				
U_x – I1 U_x – I2	NO DELAY	NO DELAY	NO DELAY	OFF-DELAY
(PDF) X1 – I1 (Type 2) X2 – I2			Muting lamp/ Reset-Required	
U_x – I3 U_x – I4				
**X1 – I1 (NO contact) X1 – I2 (NC contact) X2 – I3 (NO contact) X2 – I4 (NC contact)	NO DELAY	NO DELAY	NO DELAY	NO DELAY
X1 – I1 X2 – I2	NO DELAY	NO DELAY	NO DELAY	NO DELAY
X1 – I3 X2 – I4				
X1 – I3 X2 – I4				
X1 – I1 X2 – I2	NO DELAY	NO DELAY	NO DELAY	OFF-DELAY
X1 – I3 X2 – I4				
U_x – I1 U_x – I2	NO DELAY	NO DELAY	NO DELAY	OFF-DELAY
U_x – I3 U_x – I4				
U_x – I1 U_x – I2	NO DELAY	NO DELAY		
U_x – I3 U_x – I4			NO DELAY	OFF-DELAY

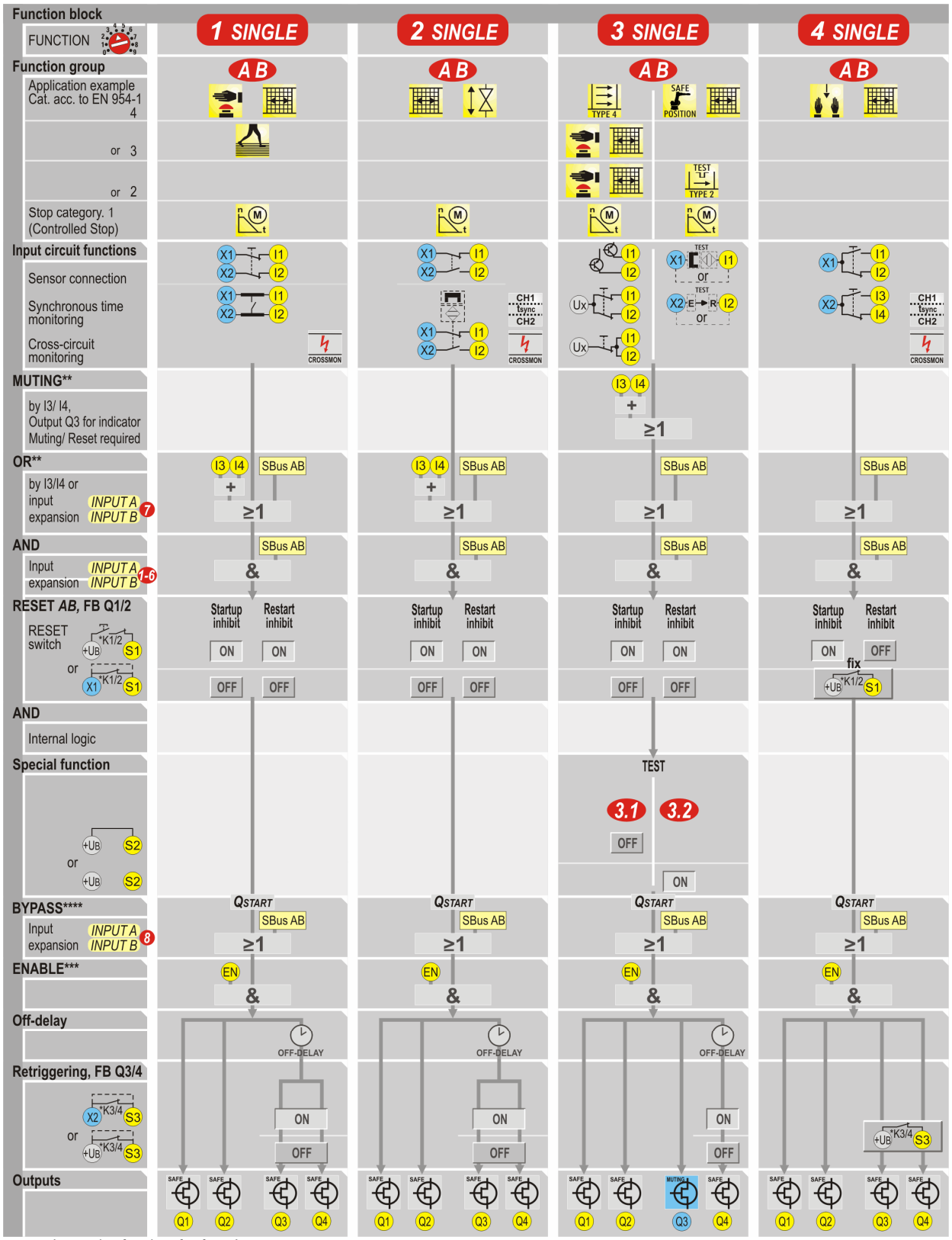
*** not actuated*

U_x – Signal from Q_x or U_B or semiconductor outputs from sensors
QE – Cross-circuit monitoring

NOTE

In combination functions 5 to 7 the signals on I1, I2 shut down all outputs Q1 to Q4, the signals on I3, I4 shut down only the outputs Q3 and Q4.

Function Blocks – Overview



SBus AB Internal safety bus for function group A or B or AB

***K1/2** Bridge or feedback circuit Q1/2

***K3/4** Bridge or feedback circuit Q3/4

***K3** Bridge or feedback circuit Q3

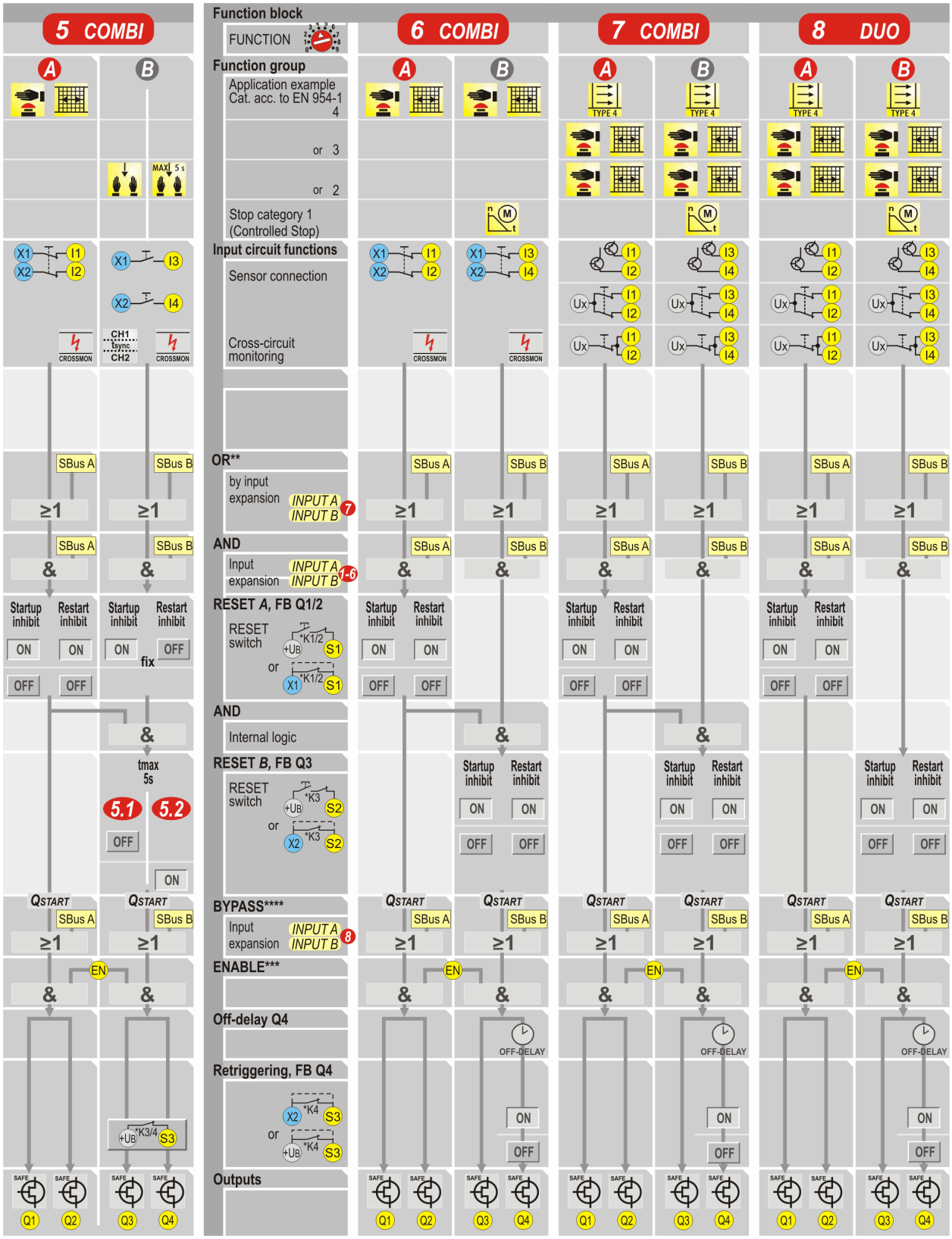
***K4** Bridge or feedback circuit Q4

****For signal supply to MUTING and OR inputs I3/I4 see page 23.**

****For signal supply to ENABLE input EN see page 50.**

*****BYPASS** limited to max. 60 s.

(Ux) Signal Ux from supply voltage +UB or the Qx semiconductor outputs on the base module or the OSSD of light barriers/light grills.



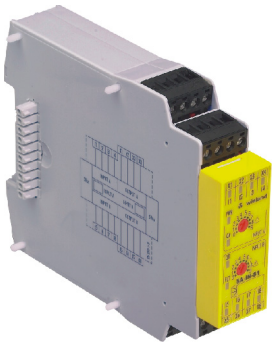
Starting inhibit ON: Manual Reset after supply ON.
Starting inhibit OFF: Automatic Reset after supply ON.
Restarting inhibit ON: Manual Reset after safety event.
Restarting inhibit OFF: Automatic Reset after safety event (see page 25).

Retriggering ON: Delayed outputs remain in ON condition if safe state of inputs has been restored when the delay has expired.
Retriggering OFF: Unconditional time delay period (see page 26).

Input Module Data

- **SA-IN**

Input Module

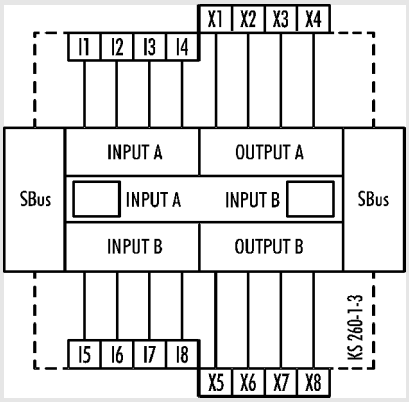


SA-IN

The input module adds additional input circuits or logic functions to a base module on its left (SA-BM master or SA-BS slave). You can operate several input modules on one base module.

There are two function groups, *A* and *B*, each with four inputs and four sensor supplies. You can set one of 10 functions for each group independently, using the rotary switches on the front. The configuration will be permanently saved in the master base module. The device operates as a slave on the internal safety bus.

Connection diagram



SA-IN

Notes

- The controller category (EN 954-1) or SIL (EN 61508) depends on the external circuitry, the wiring, the choice of control devices and their location on the machine.
- The rotary switches for selecting function must only be adjusted when power is off.
- Never connect or disconnect modules while the operating voltage is switched on.
- Internal ***samos*** module addresses are assigned automatically when the system starts up. Manual addressing is unnecessary (and not possible).
- The safety system must be installed in an enclosure with at least IP 54 protection.
- Input modules are always assigned functionally to the next connected base module to the left. Each base module forms a subsystem within the overall system (sometimes together with associated input expansion modules; see diagram on page 8).
- Base modules and input modules are uniquely coded depending on their subsystem (see diagram on page 8).

Accepting configuration

Accepting the system configuration

For accepting the system configuration see page 19.

Technical data

SA-IN

Function	Input module in the ***samos*** system
Function display	11 green LEDs, 1 red LED
Controls	2 10-position switches
Terminals	Plug-in terminals with screws / spring force
Max. number of modules / status in system	12 / slave on SBus

Power circuitry (internal)	**Min.**	**Typical**	**Max.**
Operating voltage U_B, DC	19.2 V	24.0 V	30.0 V
Residual ripple			3.0 V_{ss}
Rated power, DC			1.2 W

Input circuit (*I1..I8*)		**Min.**	**Typical**	**Max.**
Input voltage, U_E	(HIGH)	15.0 V		30.0 V
	(LOW)	-5.0 V		5.0 V
Input current, I_E	(HIGH)	2.3 mA	3.0 mA	
	(LOW)	-2.5 mA		0.15 mA
Cyclical peak input current, $I_{E,PEAK}$			15 mA	
Input capacitance, C_{IN}			200 nF	
Input resistance, R_{IN}			8 kΩ	
ON period*, t_E		70 ms		
OFF period*, t_A		> t_{AN}		
Break time of U_E (HIGH)				1.0 ms
Break time period		20 ms		
Synchronous time t_S				
Functions 3, 5				0.8 s

Output circuit (*X1.. X8*)	**Min.**	**Typical**	**Max.**
Output voltage	18.0 V		30.0 V
Output current in sum			150 mA
Wire capacitance, C_L			1000 nF
Wire resistance, R_L			100 Ω
Short-circuit behavior	Absolutely short-circuit-proof		

Input test	**t_{TI}, typ.**	**t_{TD}, typ.**	**t_{TP}, typ.**
Test pulse width*, t_{TI}			
Test duration**, t_{TD}			
Functions 1, 2, 3, 4, 5, 8	12 ms	20 ms	
Test pulse period, t_{TP}, typ.			192 ms

Response times	**Min.**	**Typical**	**Max.**
Response time***, t_{AN} (normal operation)			
– Function 1			33 ms
– Functions 6, 7			17 ms
– Functions 2, 3, 4, 5, 8			13 ms

** For the times see the function diagrams at the end of the table.*

The sum of currents, which are drained from all input modules of one system to supply external sensors, may not exceed 600 mA!

** Signal changes are not detected during the test pulse.*

*** Signal changes from HIGH to LOW are not detected during the test. For the times see the function diagrams at the end of the table.*

**** The response time t_{AN} is the time between the output signal arriving at the input terminals and the semiconductor outputs of the associated base module actually being shut down. The time is independent of the number of input modules connected to the base module.*

Input Module Data

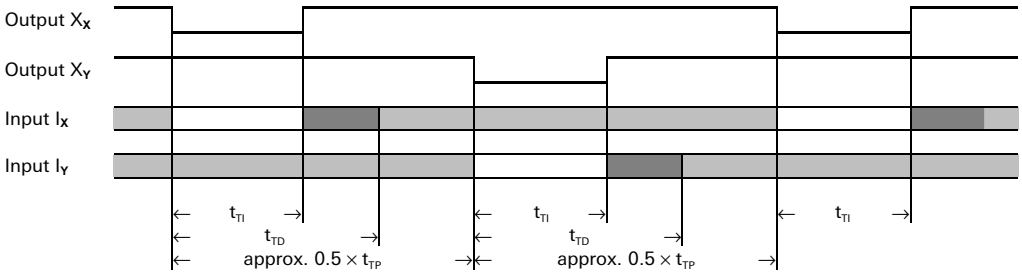
Technical data

Safety parameters	at ambient temperature T_B +55 °C
PFD	9.2×10^{-6}
PFH	$6.1 \times 10^{-9}\ h^{-1}$
SFF	96 %
DC	93 %

General data	
Isolation	
Power circuitry – input circuit	no
Power circuitry – output circuit	no
Input circuit – output circuit	no
Connection diagram	KS 260-1-3
Weight	0.13 kg
General technical data	See page 66
Order numbers	See page 70

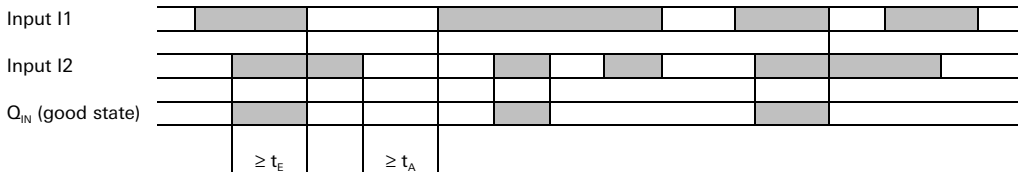
Function diagrams

Input test function diagram (with cross-circuit monitoring)



t_{TI} : Test pulse width
t_{TD} : Test duration
t_{TP} : Test pulse period

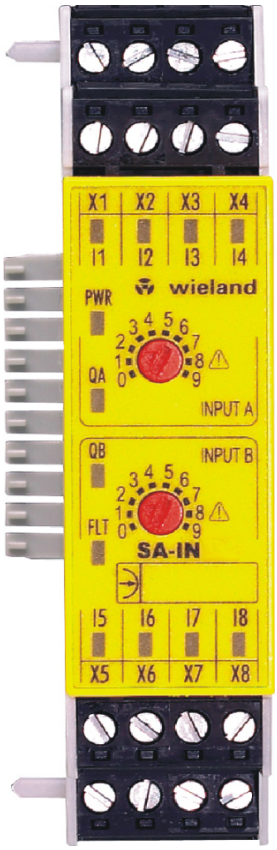
Input circuit function diagram (equivalent activation)



t_E : ON period
t_A : OFF period

Q_{IN}: see page 47

Interfaces and Operation



Terminals

- *I1, I2, I3, I4* — Inputs for connecting sensors (function group *A*)
- *X1, X2, X3, X4* — Outputs only for input circuit supply and control of the module's sensors (function group *A*)
- *I5, I6, I7, I8* — Inputs for connecting sensors (function group *B*)
- *X5, X6, X7, X8* — Outputs only for input circuit supply and control of the module's sensors (function group *B*)
- *SBus* — 10-pin connector for safety bus (male and female)

Switches / buttons

- *INPUT A* — 10-position rotary switch for setting an input circuit function (function group *A* or *B*)
- *INPUT B*

LEDs

- *I1..I8* (green) — Display corresponding inputs
- *PWR* (green) — Supply voltage
- *QA* (green) — Overall display of inputs *I1..I4* (function group *A*)
- *QB* (green) — Overall display of inputs *I5..I8* (function group *B*)
- *FLT* (red) — Display defective operating states (see *FLT* blink codes on page 63)

Meaning of LEDs

• *PWR* on	Power supply to module electronics is on
• *I1-I8* on	H-level on corresponding input
• *I1, I2* flash simultaneously	Cross-circuit between *I1* and *I2*
• *I3, I4* flash simultaneously	Cross-circuit between *I3* and *I4*
• *I5, I6* flash simultaneously	Cross-circuit between *I5* and *I6*
• *I7, I8* flash simultaneously	Cross-circuit between *I7* and *I8*
• *I1, I2* flash alternately	Sequence error on *I1, I2*
• *I3, I4* flash alternately	Sequence error on *I3, I4*
• *I5, I6* flash alternately	Sequence error on *I5*, *I6*
• *I7, I8* flash alternately	Sequence error on *I7, I8*
• *I1* or *I2* flashes	Synchronous time error. The input that flashes is the one that achieves good state too late.
• *I3* or *I4* flashes	Synchronous time error. The input that flashes is the one that achieves good state too late.
• *I5* or *I6* flashes	Synchronous time error. The input that flashes is the one that achieves good state too late.
• *I7* or *I8* flashes	Synchronous time error. The input that flashes is the one that achieves good state too late.
• *QA* on	Good state of AND-linked input pairs *I1/I2* and *I3/I4* (function group *A*)
• *QB* on	Good state of AND-linked input pairs *I5/I6* and *I7/I8* (function group *B*)
• *FLT* off	No fault states

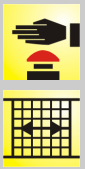
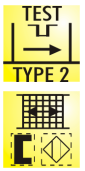
Input Circuit Functions

You can set one of 10 input functions (0–9) for each function group using the *INPUT A* and *INPUT B* rotary switches on the front. The input signals are evaluated internally (depending on switch position, for example for cross-circuit and simultaneity) and passed in groups on the safety bus to the base module to the left. There they are linked logically with the corresponding function group *A* or *B*. Several input modules can be assigned to one base module. The effect of the input module groups on the associated base module depends on the function block set there.

- F**unction blocks 1 - 4:** the inputs of both function groups on the input module (*A* + *B*) will act together on the selected base module function (AND operation).
- F**unction blocks 5 - 8:** the inputs of both function groups on the input module *A* resp. *B* will act separately on the respective group on the base module function.

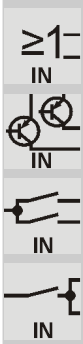
Evaluating inputs

** Maximum control category (depends on sensor, wiring and installation). Please also note the information on page 13.*

Sensor connection	Evaluation	Application e.g.	INPUT A INPUT B	Cat. up
	**Single-channel** All four inputs of each function group (*A, B*) are single-channel and linked by a logical AND. The inputs I_n expect test pulses, which are generated on the associated outputs X_n.		1	2
	**Single-channel testable sensors** **Type 2 non-contact safety devices (light barriers)** Testable sensors (e.g. type 2 non-contact safety devices) are monitored. All four inputs of each function group (*A, B*) are single-channel and linked by a logical AND. The inputs I_n expect test pulses, which are generated on the associated outputs X_n. You can also cascade several light barriers. Also observe the test pulse data for the sensors (non-contact safety device, PDF, ...) and the ***samos*** module!		1	2

*** Pairs of inputs*
Group A:
I1/I2 and I3/I4,
Group B:
I5/I6 and I7/I8.

	**Dual-channel equivalent** **(with cross-circuit monitoring, with/without synchronous time monitoring 1 s)** Two pairs are formed from the four inputs of a function group (e.g. group *A*: *I1/I2* and *I3/I4*)**. A valid ON signal is only generated if ON state is present at both inputs of a pair and both were previously in OFF state (L-level) (flipflop). Both pairs are then linked by a logical AND.		3 / 2	4
	**Dual-channel equivalent** **(without cross-circuit monitoring)** As above, but without cross-circuit monitoring. Can also be operated as dual-channel three-wire circuit.		6	3

Sensor connection	Evaluation	Application e.g.	INPUT A INPUT B	Cat. up to*
	**Dual-channel non-equivalent (with cross-circuit monitoring, with/without synchronous time monitoring 1 s)** Two pairs are formed from the four inputs of a function group (e.g. group *A*: *I1/I2* and *I3/I4*)**. A valid ON signal is only generated if ON state (H/L-level) is present at both inputs of a pair and both were previously in OFF state (L/H-level) (flipflop). Both pairs are then linked by a logical AND.		5 / 4	4
	**Dual-channel equivalent, Semiconductor activation, positive switching** Two pairs are formed from the four inputs of a function group (e.g. group *A*: *I1/I2* and *I3/I4*)**. A valid ON signal is only generated if ON state is present at both inputs of a pair and both were previously in OFF state (L-level) (flipflop). Both pairs are then linked by a logical AND.		6	4
	**OR (without cross-circuit monitoring)** Two pairs are formed from the four inputs of a function group (e.g. group *A*: *I1/I2* and *I3/I4*)**. A valid ON signal is only generated if ON state (H-level) is present at both inputs of a pair and both were previously in OFF state (L-level) (flipflop). Both pairs are then linked by a logical OR. The result of this function is used in the base module to suppress an OFF signal. For the OR function see page 48.		7	3
	**BYPASS (with cross-circuit monitoring)** A pair is formed from the first two inputs of a function group (e.g. group *A*: *I1/I2*)**. A valid ON signal is only generated if ON state (H-level) is present at both inputs of the pair and both were previously in OFF state (L-level) (flipflop). The result of this function is used in the base module to force an ON signal of duration limited to 60 s. For the BYPASS function see page 48.		8	4

When cross-circuit is detected the whole group (*A* or *B*) is shut down.

NOTE

Input Circuit Functions

Standard functions

Standard functions 1 to 6

Functions 1 to 6 allow input expansion for standard functions such as emergency stop, light grille, valve position monitoring, etc. The signals are AND-linked with the base module function blocks. The configuration of input terminals *I1* to *I4* (function group *A*) and *I5* to *I8* (function group *B*) can be set separately. In switch position 0 unused inputs do not need to be connected. In all other switch positions any unused inputs must be connected in such a way as to correspond to the indicated good state of the selected input circuit function of the respective function group on the input module.

The output signal Q_A or Q_B from function group *A* or *B* is generated from paired AND-linked inputs. The exception is function 1, where all inputs are AND-linked. See also "Evaluating inputs", page 38.

INPUT A INPUT B	0	1	2	3	4	5	6
Output signal Q_A*	*I1* **&** *I2* **&** *I3* **&** *I4*		(*I1* + *I2*) **&** (*I3* + *I4*)				
Output signal Q_B*	*I5* **&** *I6* **&** *I7* **&** *I8*		(*I5* + *I6*) **&** (*I7* + *I8*)				
Connection							
Single-channel *NC*		●					●
Single-channel Testable sensors *NC/semiconductor*		●					
Dual-channel equivalent *NC*			●	●			●
Dual-channel non-equivalent *NC/NO*					●	●	
Dual-channel Semiconductor *positive switching*							●
Dual-channel Three-wire *NC*							●
Cross-circuit monitoring			●	●	●	●	
Synchronous time monitoring				●		●	
Not used	●						

* **&** : AND-linked input pairs
+ : Combination of flipflop + AND link; see "Evaluating inputs", page 38.
Terminal assignment see page 43.

OR and bypass logic functions – functions 7 and 8

In functions 7 and 8 the signals from the input expansion are OR-linked with the base module function blocks. This makes it possible to create safety functions, e.g. for setup mode, for clearing parts of a system or for safe position monitoring. The configuration of input terminals *I1* to *I4* (function group *A*) and *I5* to *I8* (function group *B*) can be set separately.

- **OR function 7** overwrites the input circuit of the associated base module. The function prevents switching off (e.g. setup mode with enabling button for temporary bridging of safety door functions) or is used alternative to good state of the safety sensor.
- **Bypass function 8** switches the outputs on regardless of their previous control state. The function is restricted to max. 60 s. Input pairs *I3/I4* and *I7/I8* are inactive; they do not have to be connected.

NOTE

The bypass signal should be generated only by a particularly deliberate action by a person with a view into the system (e.g. by using a lockswitch). The bypass instruction is canceled by the deactivated *EN* enabling input of the associated base module. For the OR and bypass functions see page 48.

INPUT A **INPUT B**	 **OR**	 **Bypass**	 **Expansion**
Output signal Q_A*	(*I1* + *I2*) **≥1** (*I3* + *I4*)	(*I1* + *I2*)	*I1* *I2* *I3* *I4*
Output signal Q_B*	(*I5* + *I6*) **≥1** (*I7* + *I8*)	(*I5* + *I6*)	*I5* *I6* *I7* *I8*
Connection			
 Dual-channel Semiconductor *positive switching*	●		Explanation on next page
 Dual-channel Three-wire *NO*	●		
 Single-channel *NO*	●		
 Dual-channel equivalent *NO*		●	
 Cross-circuit monitoring		●	
 Input expansion			●
 Time limit 60 s		●	

* **≥1** : OR-linked input pairs
+ : Combination of flipflop + AND operation; see "Evaluating inputs", page 38.
Terminal assignment see page 43.

Input Circuit Functions

Expansion function

Input expansion – function 9

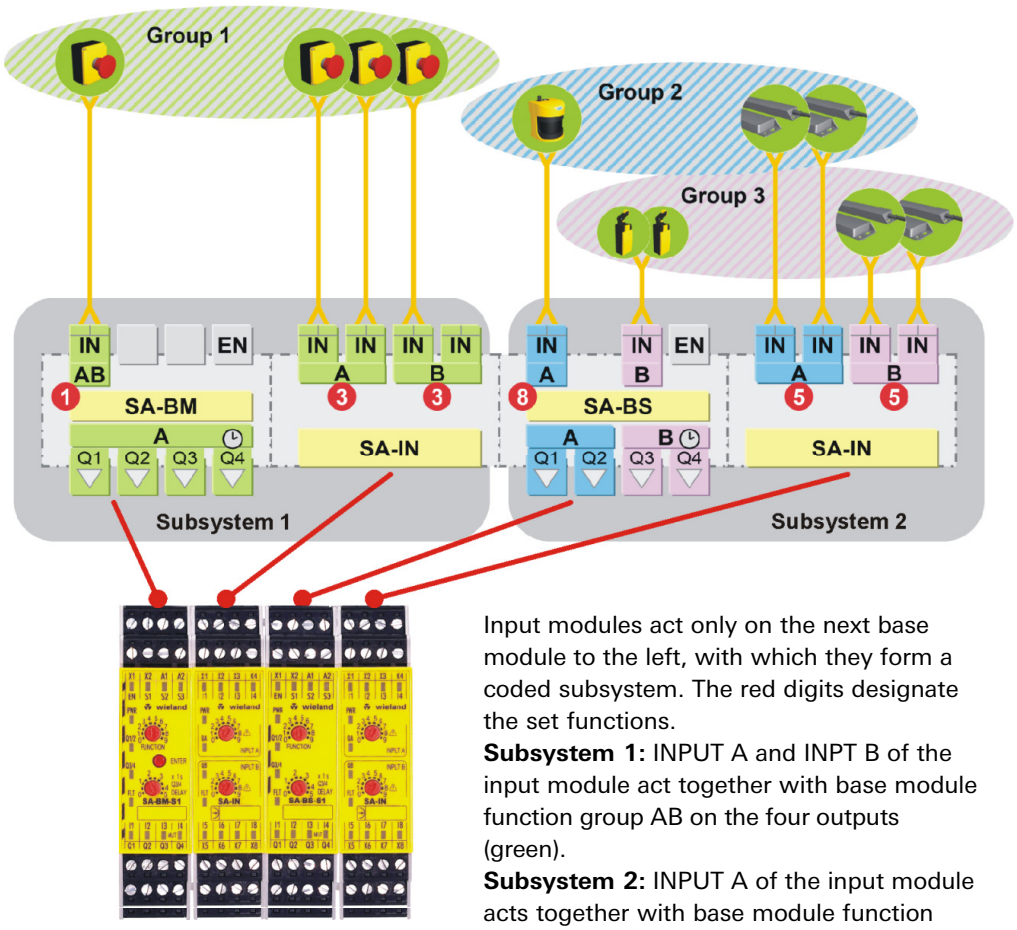
Function 9 assigns the inputs of the function group to the respective other group and takes on their input circuit function. Thus with one input module you can expand function block *A* or *B* in the base module by 8 single-channel or 4 dual-channel sensors with the same input circuit function (e.g. 8x emergency stop or 4x NC/NO electromagnetic switch. Function 9 must only be selected for one of the two function groups. Otherwise a device error will be detected and the *FLT* LED will flash.

EXAMPLE

Settings:	Input module	INPUT A	Function 9 (input expansion)
		INPUT B	Function 3 (dual-channel with cross-circuit monitoring and simultaneity monitoring)
	Base module	FUNCTION 6	
Result:	Function 6B on the base module is expanded by the 4 dual-channel inputs on the input module		

With switch positions 0 to 6 there is an AND link in the base module; for switch positions 7 (OR) and 8 (BYPASS) there is an OR link. For the effects of input module function groups *A* and *B* on the associated base module see page 38.

Example for the interaction of base and input modules



Input modules act only on the next base module to the left, with which they form a coded subsystem. The red digits designate the set functions.

Subsystem 1: INPUT A and INPT B of the input module act together with base module function group AB on the four outputs (green).

Subsystem 2: INPUT A of the input module acts together with base module function group A on output group A (blue); INPUT B acts together with function group B on output group B (pink).

Terminal Assignment

The assignment of outputs *X1* to *X8* to inputs *I1* to *I8* depends on the selected input circuit function. The functions of groups *A* and *B* can be set independently.

Unused inputs must be bridged according to the illustrated good state.

NOTE

INPUT A / INPUT B			Input terminal pairs function group A				Input terminal pairs function group B			
0	All inputs of group A / group B unused	n.c.	n.c. terminals				n.c. terminals			
1	4x single-channel with testing	IN	X1-I1	X2-I2	X3-I3	X4-I4	X5-I5	X6-I6	X7-I7	X8-I8
	4x single-channel with testable sensors*	TEST E R IN	X1-I1	X2-I2	X3-I3	X4-I4	X5-I5	X6-I6	X7-I7	X8-I8
2	2x dual-channel Cross monitoring	IN	X1-I1 X2-I2		X3-I3 X4-I4		X5-I5 X6-I6		X7-I7 X8-I8	
3	2x dual-channel Cross monitoring Synchro-check	IN	X1-I1 X2-I2		X3-I3 X4-I4		X5-I5 X6-I6		X7-I7 X8-I8	
4	2x dual-channel Cross monitoring	IN	X1-I1 X2-I2		X3-I3 X4-I4		X5-I5 X6-I6		X7-I7 X8-I8	
5	2x dual-channel Cross monitoring Synchro-check	IN	X1-I1 X2-I2		X3-I3 X4-I4		X5-I5 X6-I6		X7-I7 X8-I8	
6	2x dual-channel Semiconductor	IN	$Q1_{Sensor}$ -I1 $Q2_{Sensor}$ -I2		$Q1_{Sensor}$ -I3 $Q2_{Sensor}$ -I4		$Q1_{Sensor}$ -I5 $Q2_{Sensor}$ -I6		$Q1_{Sensor}$ -I7 $Q2_{Sensor}$ -I8	
	2x dual-channel Three-wire	IN	U_X -I1 U_X -I2		U_X -I3 U_X -I4		U_X -I5 U_X -I6		U_X -I7 U_X -I8	
	2x single-channel	IN	U_X -I1 U_X -I2		U_X -I3 U_X -I4		U_X -I5 U_X -I6		U_X -I7 U_X -I8	
7	OR 2x dual-channel semiconductor	IN	$Q1_{Sensor}$ -I1 $Q2_{Sensor}$ -I2		1 $Q1_{Sensor}$ -I3 $Q2_{Sensor}$ -I4		$Q1_{Sensor}$ -I5 $Q2_{Sensor}$ -I6		1 $Q1_{Sensor}$ -I7 $Q2_{Sensor}$ -I8	
	OR / MUTING 2x dual-channel Three-wire	IN	U_X -I1 U_X -I2		1 U_X -I3 U_X -I4		U_X -I5 U_X -I6		1 U_X -I7 U_X -I8	
	OR 2x single-channel	IN	U_X -I1 U_X -I2		1 U_X -I3 U_X -I4		U_X -I5 U_X -I6		1 U_X -I7 U_X -I8	
8	BYPASS 1x dual-channel Cross monitoring	IN	X1-I1 X2-I2		I3 n.c. I4 n.c.		X5-I5 X6-I6		I7 n.c. I8 n.c.	
9	Input expansion	ADD IN	Function as INPUT B				Function as INPUT A			

** Non-contact safety device type 2.*

For the U_x voltage see page 22.

Relay Output Module Data

- **SA-OR-S1**
- **SA-OR-S2**

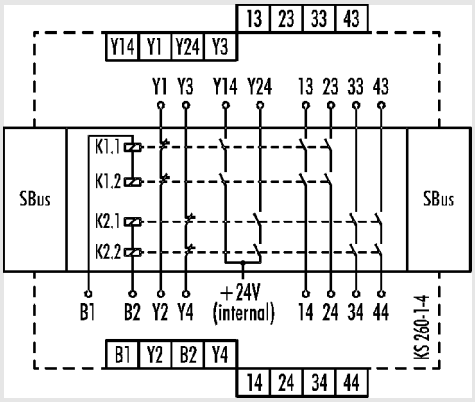
Relay output module with 2 relay groups K1, K2
Relay output module with 1 relay group K1

SA-OR-S1 **SA-OR-S2**

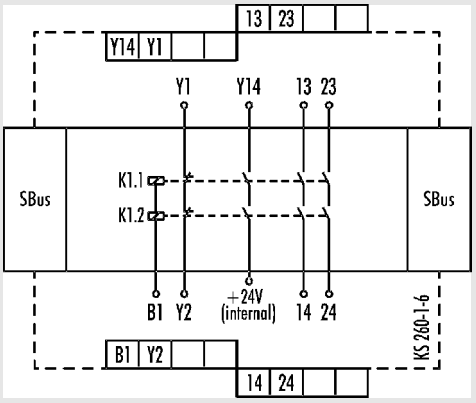
Relay output modules expand an existing base module with potential-free output circuits. Each potential-free output circuit comprises the series-connected relay contacts of two redundantly operating positively driven relays and can be used up to category 4 (EN 954-1).

The passive relay output expansions do not operate as slaves on the internal safety bus. Instead they are integrated in the functions by wiring.

Connection diagram



SA-OR-S1



SA-OR-S2

Notes

- The controller category (EN 954-1) or SIL (EN 61508) depends on the external circuitry, the wiring, the choice of control devices and their location on the machine.
- In the event of single-channel control of a contact extension (e.g. SA-OR) through a base module (SA-BM/BS), category 4 according to EN 954-1 can be achieved if both devices are installed in the same enclosure and the samos system is separated from the power supply at least once a day.
- The voltage supply of each output circuit must be protected with a 6 A fuse (utilization category gG) or a 6 A circuit-breaker (tripping characteristic B or C).
- Never connect or disconnect modules while the operating voltage is switched on.
- The safety system must be installed in an enclosure with at least IP 54 protection.
- Because the relay output modules are not directly integrated in the communication/diagnosis of the ***samos*** system via the internal safety bus, errors are registered indirectly via the base module feedback circuits.

Accepting configuration

Accepting the system configuration

For accepting the system configuration see page 19.

Relay Output Module Data

SA-OR-S1 / SA-OR-S2

Function	Relay output modules in the ***samos*** system
Function display	3 LEDs green
Controls	–
Terminals	Plug-in terminals with screws / spring force
Max. number of modules / status in system	4 / passive module

Input circuit (B1, B2)		**Min.**	**Typical**	**Max.**
Operating voltage U_B, DC		18 V		30 V
Residual ripple				3.0 V_{ss}
Rated power, DC	SA-OR-S1			2.2 W
	SA-OR-S2			1.1 W

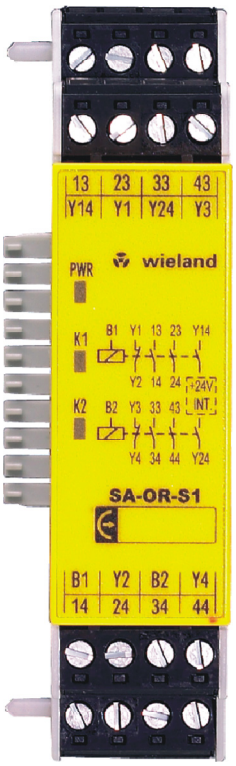
Output circuits (relay)		**Min.**	**Typical**	**Max.**
Switching voltage			AC 230 V DC 230 V	
Switching current				6 A
Total current				12 A
Off delay, t_R				30 ms
Type of outputs		positively-driven relay		
Contact type	SA-OR-S1	2 x 2 NO		
	SA-OR-S2	1 x 2 NO		
Contact material		$AgSnO_2$ with 1 µ Au		
Output circuit protection per current path		6 (gG)		
Utilization category (EN 60947-1)		AC 15: 3 A, 230 V DC 13: 3 A, 24 V		

Output circuits (Y14, Y24)	**Min.**	**Typical**	**Max.**
Output voltage	18 V	24 V	30 V
Output current			75 mA
Resulting current Y14+Y24			100 mA

Safety parameters	**at ambient temperature T_B +55°C**
PFD	1.6×10^{-7}
PFH	$1.0 \times 10^{-9}\ h^{-1}$
SFF	99.6 %
DC	99 %

General data		
Isolation		
– Power circuitry – input circuit		no
– Power circuitry – output circuit		yes
– Input circuit – output circuit		yes
Rated voltage		AC 230 V
Connection diagram	SA-OR-S1	KS 260-1-4
	SA-OR-S2	KS 260-1-6
Weight	SA-OR-S1	0.17 kg
	SA-OR-S2	0.10 kg
General technical data		See page 66
Order numbers		See page 70

Interfaces and Operation



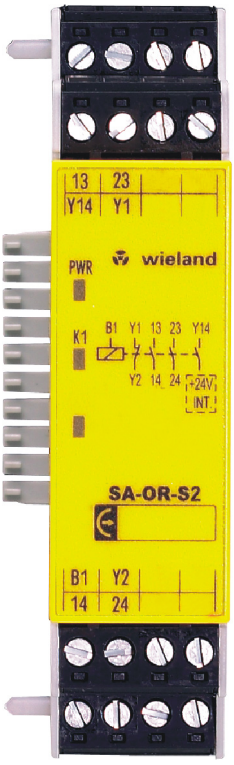
SA-OR-S1

Terminals

- *B1* — Input relay K1
- *13/14, 23/24* — Potential-free output circuits K1
- *Y14* — Single-ended output circuit K1
- *Y1/Y2* — Feedback circuit K1
- *B2* — Input relay K2
- *33/34, 43/44* — Potential-free output circuits K2
- *Y24* — Single-ended output circuit K2
- *Y3/Y4* — Feedback circuit K2
- *SBus* — 10-pin connector for safety bus (male and female)

LEDs

- *PWR* (green) — Supply voltage
- *K1* (green) — Relay K1
- *K2* (green) — Relay K2



SA-OR-S2

Terminals

- *B1* — Input relay K1
- *13/14, 23/24* — Potential-free output circuits K1
- *Y14* — Single-ended output circuit K1
- *Y1/Y2* — Feedback circuit K1
- *SBus* — 10-pin connector for safety bus (male and female)

LEDs

- *PWR* (green) — Supply voltage
- *K1* (green) — Relay K1

Meaning of LEDs

- *PWR* on — Power supply to module electronics is on
- *K1* on — Relay K1 in operated condition
- *K2* on — Relay K2 in operated condition

System Functions

Input circuit function

The input circuit function logically links input signals for further processing. In order to detect faults (e.g. in the external circuitry of safety inputs) the inputs are tested periodically in relation to function (external input dynamization).

Safety inputs

- **Input circuit function single-channel via NC contact**

One input is monitored (e.g. the NC contact of an emergency stop button). A valid input signal is only generated if ON state (H-level) is present at the input and it was previously in OFF state (L-level).

- **Input circuit function single-channel with testable sensors**

Testable sensors (e.g. type 2 non-contact safety devices) are monitored. A valid input signal is only generated if ON state (H-level) is present at the input and it was previously in OFF state (L-level).

- **Input circuit function with dual-channel equivalent activation**

Two equivalent inputs (e.g. the opening contacts of an emergency stop button or actuated N/O contact / N/C contact of two safety-door position switches) are monitored.
A valid input signal is only generated if ON state (H-level) is present at both inputs and both were previously in OFF state (L-level). The function can be used with/without cross-circuit monitoring and with/without synchronous time monitoring.

- **Input circuit function with dual-channel non-equivalent activation**

Two non-equivalent inputs are monitored. A valid input signal is only generated if ON state (H/L-level) is present at both inputs and both were previously in OFF state (L/H-level). The function can be used with/without cross-circuit monitoring and with/without synchronous time monitoring.

- **Two-hand function with activation by one NO contact per hand (EN 574, IIIA)**

Two equivalent inputs are monitored (e.g. the NO contacts of the two two-hand buttons). A valid input signal is only generated if ON state (H-level) is present at both inputs within 0.5 s (synchronous change, both two-hand buttons actuated) and both were previously in OFF state (L-level). For jog mode the ON signal can be temporarily restricted to 5 s if required.

- **Two-hand function with activation by NO/NC combination for each hand (EN 574, IIIC)**

Two pairs of non-equivalent inputs are monitored (the NO/NC contact pairs of the two two-hand buttons). A valid input signal is only generated if ON state (H/L-level) is present at both inputs within 0.5 s (synchronous change, both two-hand buttons actuated) and both were previously in OFF state (L/H-level).

- **Dual-channel equivalent activation by semiconductor**

Two equivalent inputs are monitored (e.g. the signals from a light barrier). A valid input signal is only generated if ON state (H-level) is present at both inputs and both were previously in OFF state (L-level).

System Functions

OR

For OR and muting functions see also page 23.
For the reset function see page 49.

OR function and muting function

The off signal of an input function can be bridged with an OR signal. For example, in setup mode a safety function can be bridged using an enabling button; an OR operation can also link two safety functions.

The OR function can be implemented by the base module (depending on the function) or by an input module. It corresponds to an input circuit function with dual-channel equivalent activation without cross-circuit monitoring.

Muting

The muting function is a special case of the OR function (conditional OR). For example, muting sensors allow a conveyor belt to transport material through a light grille by briefly bridging the light grille function. An ON signal (H-level) is generated only if the internal output signal of the Reset function Q_{START} has H-level at the beginning of the Muting function

The muting function in the ***samos*** base device corresponds to an input circuit function with dual-channel equivalent activation without cross-circuit monitoring. Muting of a safety function must not be dependent on a single signal! An output controls the corresponding muting lamp. This lamp additionally indicates by blinking that the Reset signal is expected at input S1.

The deactivated enabling input of the associated base module shuts down the outputs (*Q1..Q4*) switched on by OR or MUTING. The Muting lamp output Q3 stays on during the Muting function, if function block 3 is selected. When they are subsequently activated, OR or MUTING mode continues.

Bypass

Bypass function

With a bypass signal an internal OFF signal (L-level) of the Reset function Q_{START} can be overwritten in the base module. The bypass function is generated by a high-level (see also the "Reset Function" figure on page 49). It corresponds to an input function with dual-channel equivalent activation with cross-circuit monitoring.

EXAMPLE

Bypass is used when the system is to be switched on after a power shutdown but a light barrier is obstructed by material. Bypass cancels the safety function of the light barrier and the blockage can be cleared. In normal operation the muting function bridges automatically (see above).

For the input circuit functions of the input modules see page 38.

The bypass signal is limited to 60 s. After the time has expired bypass mode can be reactivated. After the bypass signal has been cancelled and respectively after 60 s the enabling outputs are switched off, if the restarting inhibit function is on and the light curtain was inerrupted. However, any set release time will run in full.

Bypass can be aborted by canceling the bypass instruction on the input module or by a low signal on the *EN* enabling input on the associated base module. This means, for example, that a higher-priority emergency stop can shut the machine down during bypass mode.

After the bypass signal has been cancelled, the internal signal Q*Start* determines the state of the outputs (see Reset Function on page 49).

NOTE

The bypass signal should be generated only by a particularly deliberate action by a person with a view into the system (e.g. by using a lockswitch that automatically returns to off position or a combination of lockswitch and enabling button).

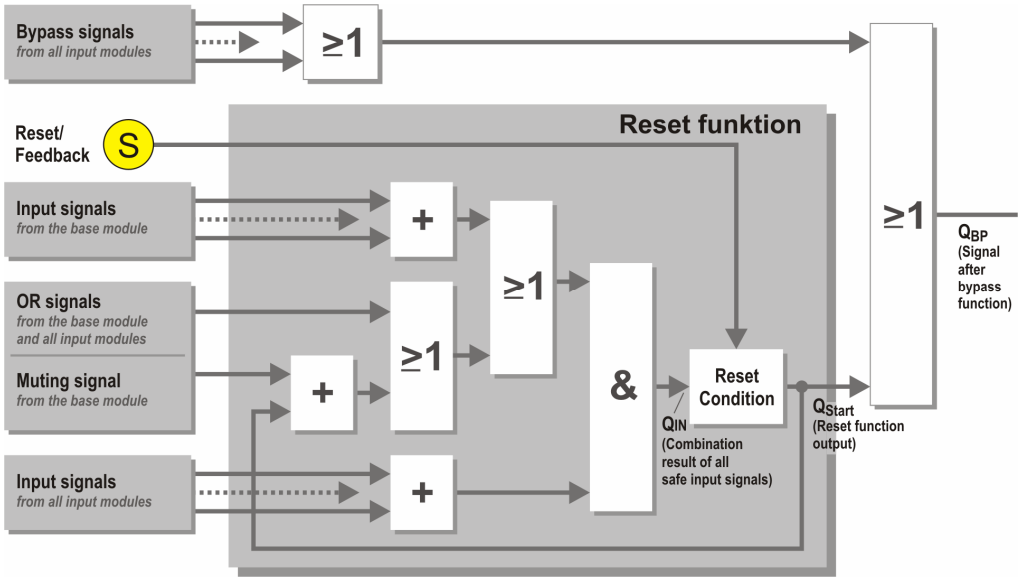
The starting inhibit on the associated base module is never on when bypass inputs are active. This means that when voltage is switched on with high potential on the *EN* ENABLE input, the outputs are enabled immediately without additional manual intervention.

Reset function

Reset

The Reset function defines which (reset) conditions must be fulfilled if, for example, an ON signal is to be passed on to output Q_{START}. All input and muting signals from the base module and the associated input modules (i.e. of a subsystem within the ***samos*** system), and the bypass/OR signals from the input modules are logically linked (AND/OR). The terminal configuration with bridges and feedback circuits is also evaluated (see below).

An ON signal from the Reset function can only be canceled by an OFF signal from an input circuit function (i.e. changed into an OFF signal), and is not influenced by enabling, muting or bypass functions or by feedback circuit monitoring.



& : AND blink **≥1** : OR link

+ : Combination of flipflop + AND link.

Muting : An ON signal is generated only if the output signal of the Reset function Q_{Start} has good state at the beginning of the muting function.

Reset condition / evaluation of feedback circuits

Feedback circuit monitoring

On the base modules there are three control inputs *S1, S2, S3* for configuring the control circuit functions. They can be used, depending on the function, to set starting inhibit, restarting inhibit, retriggering and off delay (see page 25). Depending on the application, the configuration is realized using bridges or by connecting the NC contacts of connected relays/contactors. Together with the module outputs this creates feedback circuits which allow evaluation of the control states of the respective connected relays/contactors with positively driven contacts. Evaluation uses one of two different methods depending on the function (see also page 28).

- The NC contact is connected **directly** with the respective control input. As soon as the contact closes the Reset function is activated and it is possible to switch on the outputs. The configuration is evaluated when the system is switched on. The configuration is verified before each Reset following a safety event. If a change is detected (e.g. feedback circuit not closed) the system generates an error message and cannot be switched back on until the malfunction has been rectified.
- In operation with restarting inhibit the NC contact is connected to the respective input **via a Reset button**. The required Reset condition for canceling the restarting inhibit is only fulfilled if the feedback circuit is also closed.

NOTE

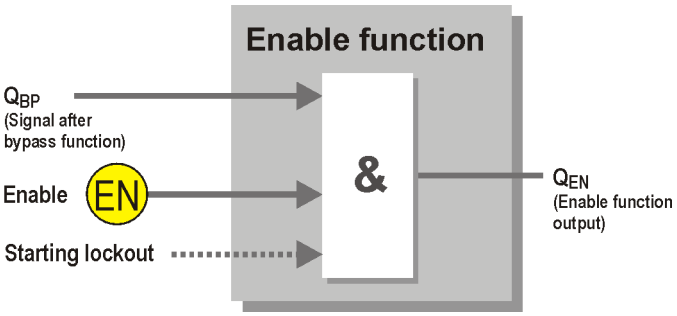
The feedback circuits that belong to the safety system must be housed in the same enclosure as the ***samos*** system in order to exclude the "Short-circuit to +24 V".

System Functions

Enable

Enable function

The enable function enables an ON signal in the Reset function if there is H-level on the *EN* input. The H-level for enabling can be generated, for example, by a semiconductor output O_n on the base module for logic operations or a PLC output. For category 4 applications (EN 954-1) the module that generates the enabling signal must be in the same enclosure. If the *EN* input is open or on L-level the following O_n semiconductor outputs are locked.



EXAMPLE

The enable function makes it easy, for example, to cascade safety circuits or form dependent safety zones. Unused *EN* inputs are connected to supply voltage $+U_B$. If the enabling input is open or on L-level all safety outputs on the base module shut down. Any set off delay will run in full. The enable function has priority over all other input signals (safety sensors, bypass, etc.).

NOTE

When voltage is switched on the starting inhibit on/off Reset condition is integrated in the enable function. During operation the Reset conditions are not checked. I.e., Reset can be prepared in disabled condition. ENABLE enables the outputs.

Output function

The time behavior of the safety ON/OFF signal is defined in the output function. In order to detect faults in the safety outputs the outputs are tested periodically (output dynamization).

Depending on the function, you can use the rotary switch to set a off delay for outputs *Q4* or *Q3/Q4* between 0 and 5 minutes (depending on module version). This does not influence switching on procedures.

Safety shutdown of drives according to stop category 1 (controlled stopping) is possible with each base module.

NOTE

Note that the delayed outputs shut down immediately if operating voltage is switched off during the off delay.

Diagnosis

Communication

With the communication function system data is exchanged between the different modules in a system via the internal safety bus (SBus).

Diagnosis and display function

The diagnosis function allows internal system data to be provided to external systems via a diagnosis module or bus coupler module. The SBus is used as the internal system communication channel.

With the display function voltage levels on terminals and particular operating states of the system are displayed via LEDs. The diagnosis and display functions are decoupled and are not safety functions. In other words, no data from external systems can enter the system via a diagnosis or bus coupler module.

samos and IEC/EN 61508

The international norm IEC/EN 61508 is the new standard for the specification, design and operation of safety systems.

The norm takes the whole system into consideration. It expands the safety requirements of single complex devices to cover the whole safety installation from sensor through control electronics and communications systems to actuators, and also includes possible errors by operators. The norm provides the framework for future developments and is decisive for manufacturers and users alike, especially as it also touches on questions of product liability.

The safety considerations concentrate on analyzing dangers and defining risks. The goal of the assessment is to reduce the risk involved in a safety system to an acceptable level of residual risk by calculating failure probabilities for components, system and design from development right through to disposal.

Safety integrity level

The safety function of the ***samos*** system is shutting down or preventing a dangerous process. All the system functions described in this manual are safety functions.

A safety integrity level defines the range for failure probability of a safety function in relation to operating mode and request frequency. IEC/EN 61508 describes two modes for safety functions:

- A **safety function in demand mode** is only executed on demand. It brings the monitored system into a defined safe state and has no influence on the system in normal operation (example: emergency stop monitoring).
- A **safety function in continuous mode** continuously maintains the monitored system in its normal safe state (example: speed monitoring).

This division means there are two different demand rates for safety functions:

- **Mode with low demand rate** when the demand rate is less than once per year;
- **Mode with high demand rate or continuous demand** when the demand rate is more than once per year.

The demand rates are considered in relation to failure probabilities:

- Low demand rate in relation to **probability of failure on demand** (PFD),
- High demand rate or continuous demand in relation to **probability of failure per hour** (PFH).

According to IEC/EN 61508, the ***samos*** safety function can be used in modes with low and high demand rates.

- With low demand rates the PFD for SIL 3 is $\geq 10^{-4}$ to $<10^{-3}$ (e.g. emergency stop components) for the whole safety chain.
- With high or continuous demand rates the PFD is $\geq 10^{-8}$ to $<10^{-7}$ (e.g. two-hand application) for the whole safety chain.

Other safety parameters used in this manual

- SFF - Safe Failure Fraction
  The percentage of the full number of errors that do not critically affect safety. Quantitative parameter from IEC 61508-2. It characterizes the safety structure and defines whether a component for executing the safety function can be single-channel or must be redundant in the safety chain of the plant/machine.
- DC - Diagnostic Coverage
  Quantitative parameter from IEC 61 508, prEN ISO 13849. Identifies the proportion of dangerous faults that will be detected.

Applications and Pictograms

Emergency stop monitoring
The emergency stop function is used to protect persons and machines by directly disconnecting the power supply.

Safety door monitoring
Safety door monitors with sensors (e.g. position switches, coded electromagnetic switches) are used for monitoring separating safety devices.

Static valve monitoring
Position monitoring with position switches.

Switching mat monitoring
Short-circuiting switching mats are access monitoring sensors that alter their control state when stood upon.

Two-hand function
Two-hand functions as per EN574 protect the operator of presses, cutting and bending machines, machining centers, etc. The two controls (two-hand buttons) must be actuated at the same time to initiate the dangerous operation. If one or both of the buttons is released the enable is canceled.

On press control systems the function must only be used in accordance with EN 574 Typ IIIC.

Two-hand operation in jog mode
In jog mode an output signal is only generated while the controls are being pressed, e.g. for motions in setup mode. Jog mode on the base modules is restricted to 5 s.

Light barrier / light grille monitoring
Access monitoring with self-testing sensors (e.g. type 4 non-contact safety devices). A non-contact safety device is a setup of devices and/or components that work together for safety shutdown and detection of persons. The non-contact safety device has at least a sensor function (e.g. safety light barrier or other secure sensors), a monitoring function (e.g. cyclical self-tests) and an output switching element (OSSD). The function is matched for modulated self-test signals or overcurrent limitation of sensor semiconductor outputs.

Light barrier / light grille monitoring
Access monitoring with testable sensors (e.g. type 2 non-contact safety devices). The sensors have separate activation inputs that are used to test the sensor function with a low signal; the base module analyses the response signal generated by the receiver. Several sensors can be cascaded.

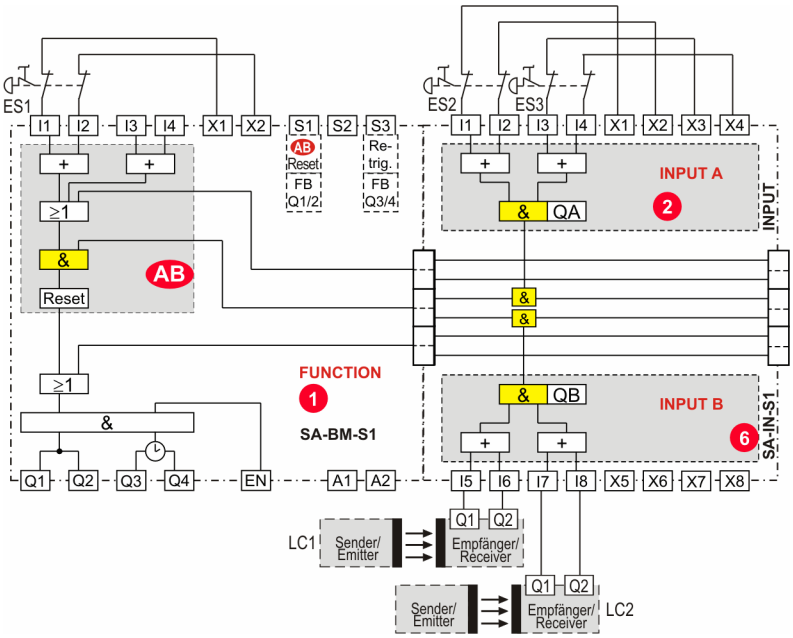
Controlled stopping
With the settable off delay a drive can be switched off after expiry of the time according to stop category 1 and EN 60204, and if required a brake can be applied.

Safe Position
Safe position, e.g. of a robot, is detected by a sensor. Zone protection is lifted and an operator can enter the robot zone. If the robot leaves the position it is switched off safely.

AND-linked safety inputs (sensor inputs)

E.g. emergency stop button, position switch, electromagnetic switch, light grille, ...

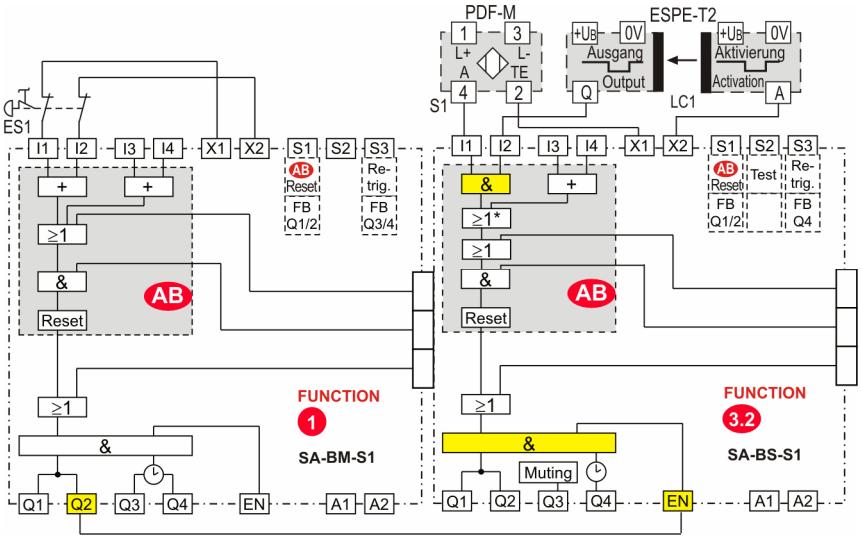
All emergency stop buttons and light grilles with FUNCTION 1 from the SA-BM and the SA-IN input expansion are **AND**-linked.



+ Combination of flipflop + AND operation

AND-linked safety inputs (sensor inputs)

The non-contact inductive safety sensor *S1* with test input (e.g. GM 504S, GM505S from ifm) and the testable light barrier *LC1* (e.g. WS27-2, WE-18-2 from Sick) are **AND**-linked. Both sensors must be actuated before a new Reset can be initiated. The emergency stop button *ES1* has priority over the enabling input on the SA-BS by **AND** operation.



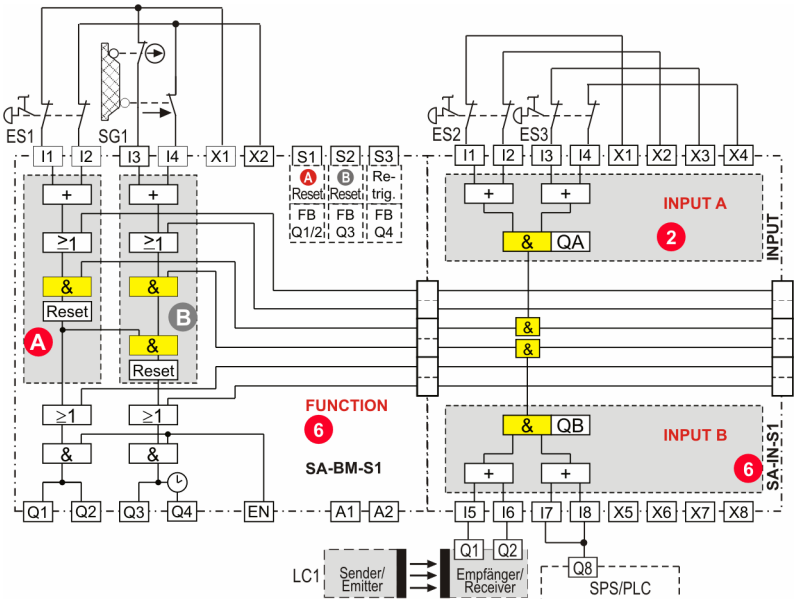
+ Combination of flipflop + AND operation

≥1 MUTING the conditional OR-combination is valid only if the result of the Reset function before was =1 (see pages 48/49).*

AND-linking of *samos* function groups A and B

The safety door switch on the base module and the light grille on the input expansion in function group *B* of the function block (FUNCTION 6) are **AND**-linked in the function block to function group *A* emergency stop circuits of base module and input expansion). Function group *A* has priority over function group *B*. Via *Q8* on the PLC *Q3* and *Q4* on the SA-BM can also be enabled or shut down.

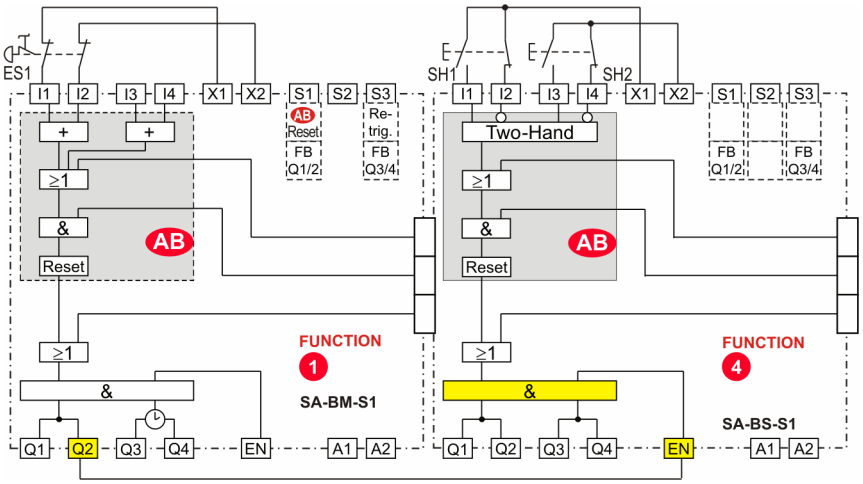
+ Combination of flipflop + AND operation



AND-linked *samos* function blocks

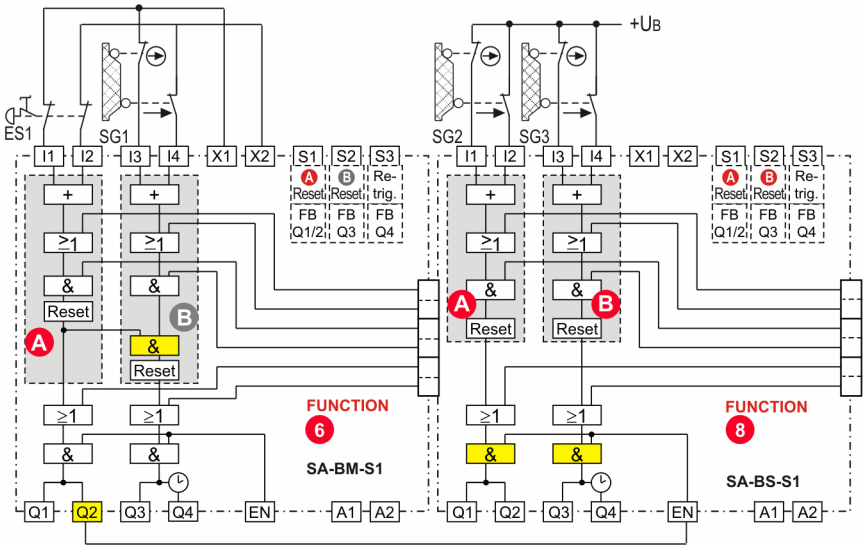
The SA-BS function block for two-hand function (FUNCTION 4) is subordinate to the SA-BM emergency stop function block (FUNCTION 1). The **AND** link is made by output *Q2* on the SA-BM and the *EN* enabling input on the SA-BS.

+ Combination of flipflop + AND operation



AND-linked *samos* function blocks

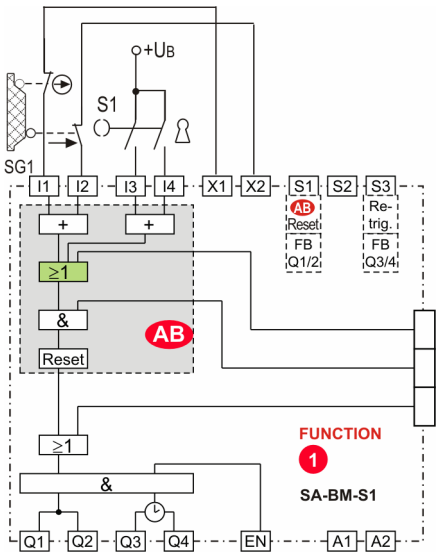
The safety door circuitry of *SG1* shuts down output *Q3,Q4* on the SA-BM. *SG2* and *SG3* shut down the independent *Q1* and *Q2* of SA-BS / *Q3, Q4* of SA-BS. When *ES1* (emergency stop) is actuated the internal **AND** link in the SA-M function block and the connection of output *Q2* on the SA-BM with the *EN* enabling input on the SA-BS ensure complete shutdown of all outputs.



+ Combination of flipflop + AND operation

OR-linked safety inputs (sensor inputs)

Actuation of lockswitch *S1* bridges the safety door function with an **OR** link; i.e. all outputs *Q1* to *Q4* remain on. Lockswitch takes effect even with safety door opened and switches all outputs on.



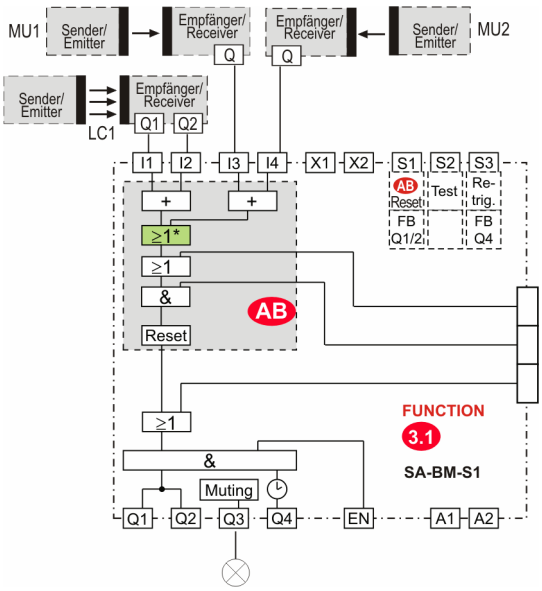
+ Combination of flipflop + AND operation

OR-linked safety inputs (sensor inputs)

Actuation of muting sensors *MU1* and *MU2* automatically bridges the safety function of light grille *LC1* by **OR** operation (**MUTING**); i.e. outputs *Q1, Q2, Q4* remain on. Light grille *LC1* must not be interrupted when the two muting sensors are actuated. Output *Q3* controls the muting lamp.

+ Combination of flipflop + AND operation

1 MUTING the conditional OR-combination is valid only if the result of the Reset function before was =1 (see pages 48/49).*

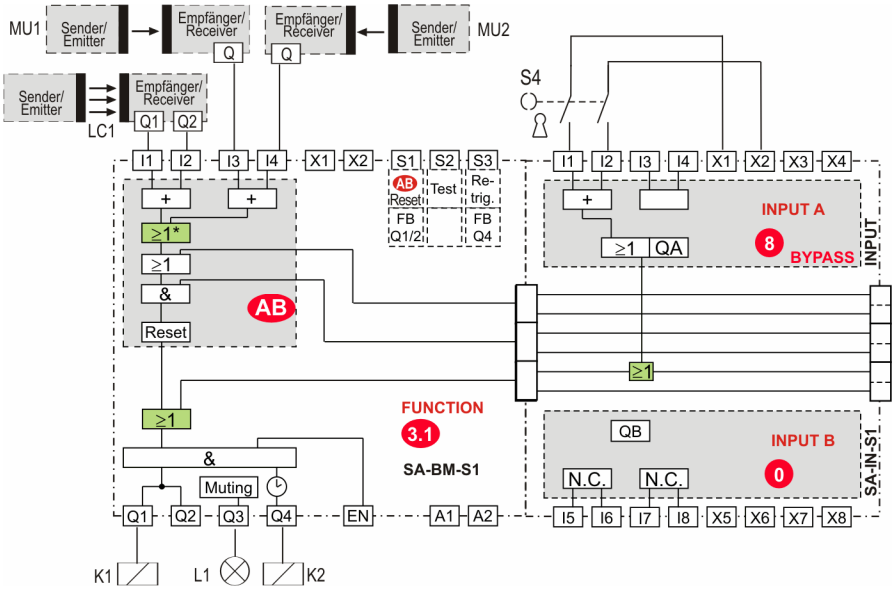


OR-linked safety inputs (sensor inputs)

Actuation of muting sensors *MU1* and *MU2* automatically bridges the safety function of light grille *LC1* by **OR** operation (**MUTING**); i.e. outputs *Q1, Q2, Q4* remain on. Light grille *LC1* must not be interrupted when the two muting sensors are actuated. Output *Q3* controls the muting lamp. Actuating lockswitch *S4* on the SA-IN activates the **BYPASS** function for clearing the light grille when power is switched on. BYPASS operates as an **OR** operation on the base module outputs via input module SA-IN.

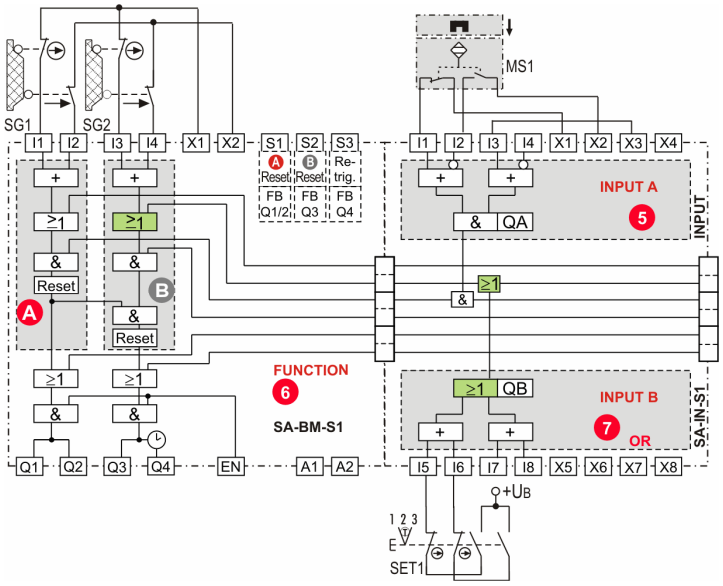
+ Combination of flipflop + AND operation

1 MUTING the conditional OR-combination is valid only if the result of the Reset function before was =1 (see pages 48/49).*



OR-linked safety inputs (sensor inputs)

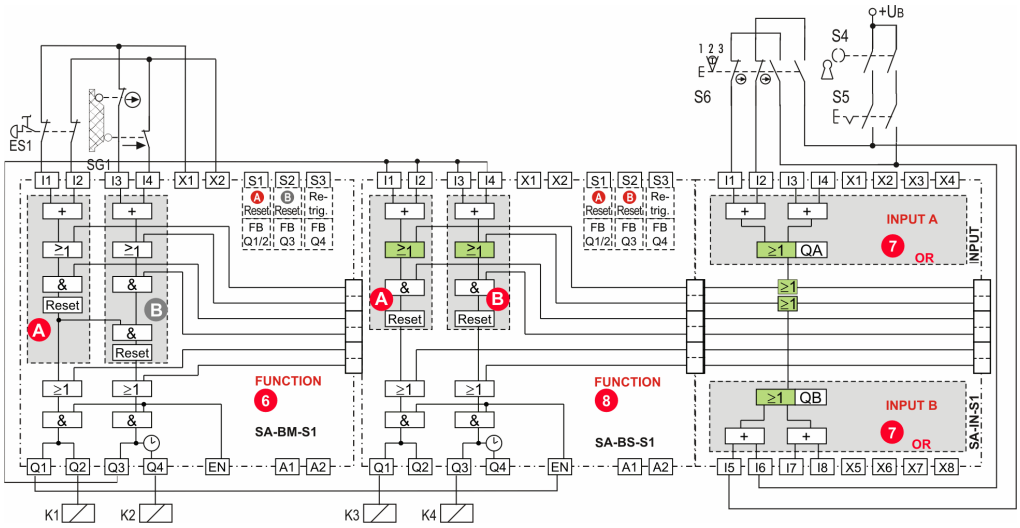
The safety door switches of *SG2* in function group *B* of the function block (FUNCTION 6) are **AND**-linked in the function block with *SG1* of function group *A*. Function group *A* has priority over function group *B*. An additional safety door circuit with an electromagnetic switch *MS1* is assigned to function group *A* via the input expansion. The sensor input of function group *B* of the SA-BM is **OR**-linked via function INPUT 7 of the SA-IN input expansion and enabling button *SET1*. If enabling button *SET1* is actuated, outputs *Q3* and *Q4* do not shut down when door *SG2* is opened.



+ Combination of flipflop + AND operation

OR-linked safety inputs (sensor inputs)

The safety door switches of *SG1* in function group *B* of the function block (FUNCTION 6) are **AND**-linked in the function block to function group *A* (ES1). Function group *A* has priority over function group *B*. The outputs of the second function block SA-BS (FUNCTION 8) are enabled by *Q1* on the SA-BM. Additionally, inputs *I1* to *I4* on the SA-BS are controlled by function group *B* (output *Q3*) on the SA-BM. In case of emergency stop via *ES1*, all contactors shut down. When the safety door *SG1* is opened only *K2, K3, K4* shut down. The **OR** link between function groups *A* and *B* on the SA-BS with the SA-IN allows shutdown of contactors *K4* or *K3* and *K4* to be prevented when safety door *SG1* is opened, by actuation of *S4* and *S5* or *S4* and *S5* and *S6*.



+ Combination of flipflop + AND operation

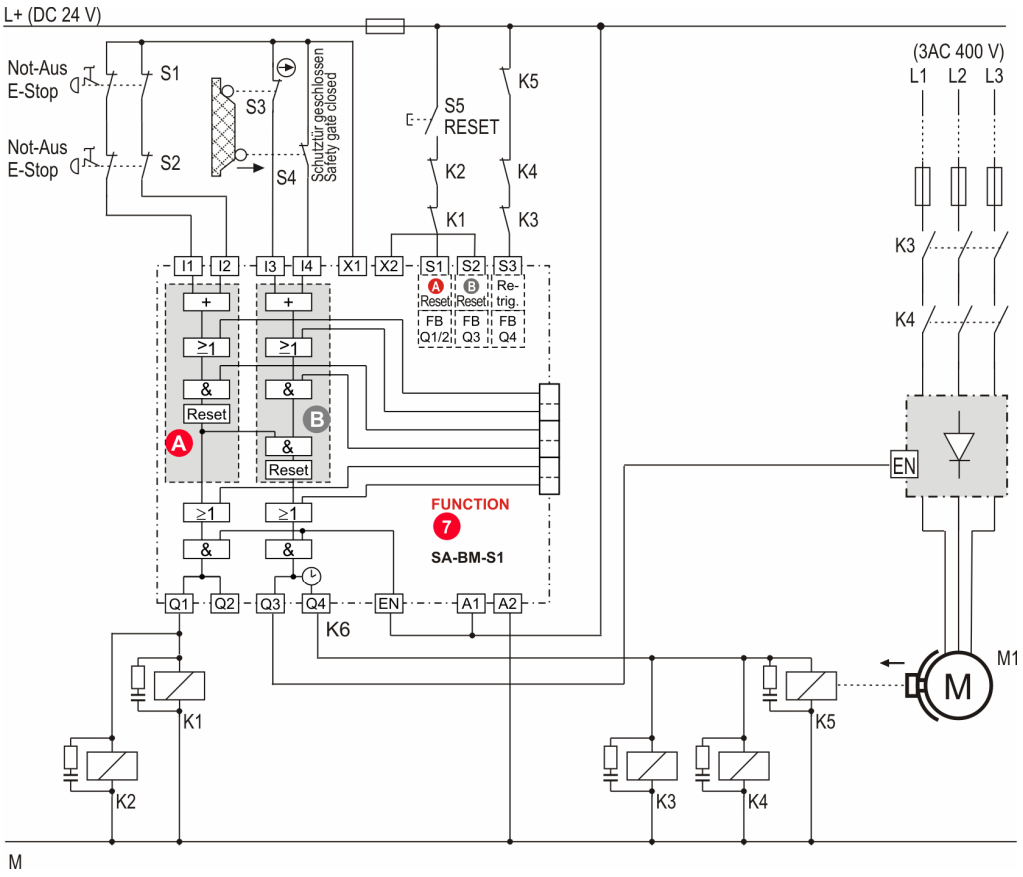
Applications

Application example
A 253_C

Two safety zones
Safety door monitoring with higher-priority emergency stop
Category 3
Stop category 1

Two-channel emergency stop and safety door monitoring. Emergency stop has priority over the safety door function. In case of emergency stop contactors *K1*, *K2* and output *Q3* shut down immediately. The drive shuts down immediately via the enable signal. After the preset time power to the drive is switched off via *K4*, *K5* and a brake applied (safe stopping as per stop category 1).

Reset after emergency stop and after power on is with RESET. When the safety door is opened only the drive is stopped safely. *K1* and *K2* remain switched on. After the safety door has been closed and the feedback circuits checked, the safety device is reset automatically. The machine is ready to switch on.



+ Combination of flipflop + AND operation

samos module	**K-SA1**		
Type	**SA-BM-S1**		
Module revision	≥ B-01		
FUNCTION	7		
Function group	AB	A	B
External circuitry category (EN954-1) up to		3	3
Cross-circuit monitoring		–	–
Synchronous time monitoring			–
Stop category (EN 60204-1)		0	1
OFF delay			Q4 1,5 s
Retriggering ON			–
AUTO-RESET after POWER ON			
MANUAL RESET after POWER ON		X	X
AUTO-RESET			X
MANUAL RESET		X	
Comment	***samos*** modules and contactors in the same enclosure		

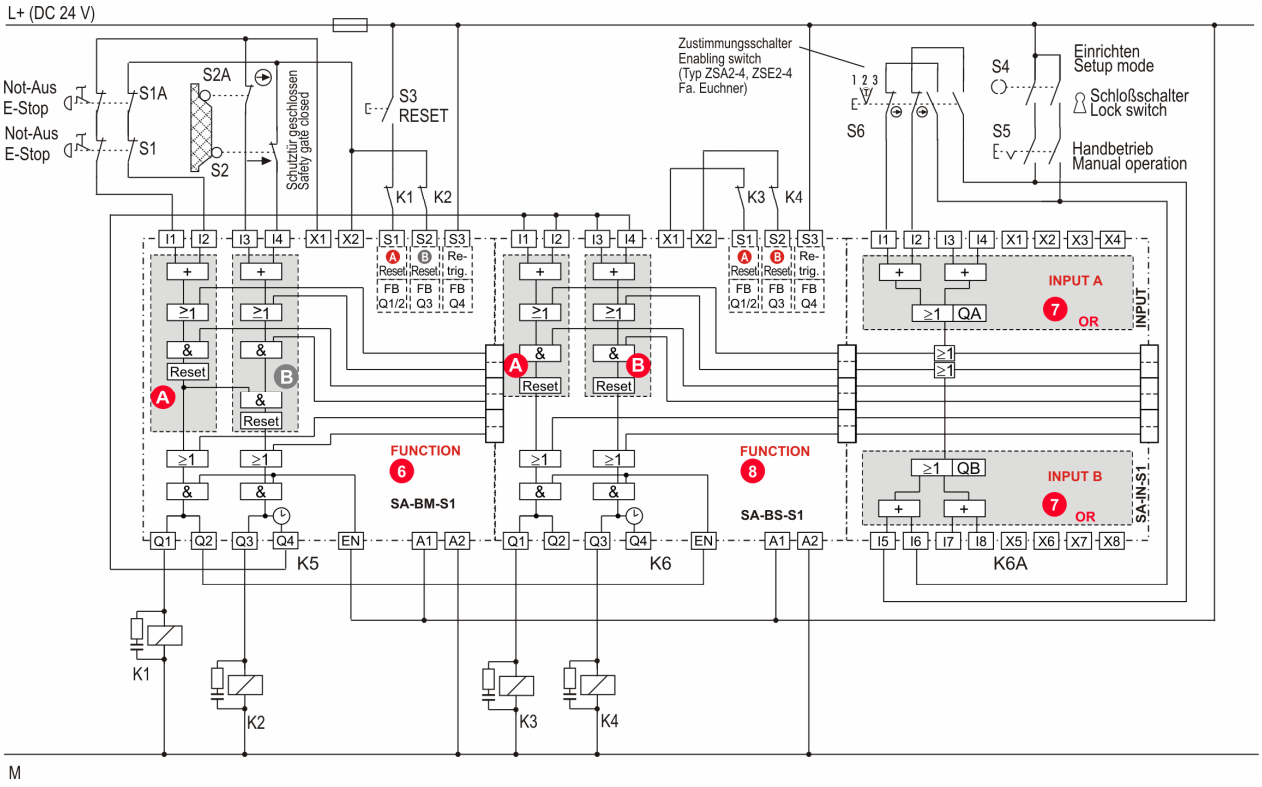
The emergency stop circuit on the machine (*S1* and *S1A*) always shuts down all contactors *K1* to *K4* without delay. The safety door circuit only shuts down contactors *K2* to *K4*. Operate RESET button *S3* to start up. To reset after EMERGENCY STOP you have to press the RESET button. Closing the safety door circuit switches on contactors *K2* to *K4* automatically. The feedback circuits of the contactors are monitored.

Application example A 254_C

- **Two safety zones**
- **Safety door monitoring with higher-priority emergency stop**
- **Category 3**
- **Stop category 0**
- **Manual and setup mode**

Manual mode for setup

1. Set lockswitch S4 to setup mode and operate switch S5 “manual mode” (safety door closed). The door can be opened. Only contactors *K2* and *K3* shut down.
2. Set lockswitch *S4* to setup mode, operate switch *S5* “manual mode” and also operate enabling switch *S6* (safety door closed). The door can be opened. Only contactor *K2* shuts down.



samos module	K5			K6			K6A		
Type	SA-BM-S1			SA-BS-S1			SA-IN-S1		
Module revision	≥ B-01			≥ B-01			≥ B-01		
FUNCTION	6			8			7	7	
Function group	AB	A	B	AB	A	B		A	B
External circuitry category (EN954-1) up to		3	3		3	3		3	3
Cross-circuit monitoring		X	X		–	–		–	–
Synchronous time monitoring		–	–		–	–		–	–
Stop category (EN 60204-1)		0	0		0	0			
OFF delay			Q4 0 s			Q4 0 s			
Retriggering ON			–			–			
AUTO-RESET after POWER ON					X	X			
MANUAL RESET after POWER ON		X	X						
AUTO-RESET			X		X	X			
MANUAL RESET		X							
Comment	***samos*** modules and contactors in the same enclosure								

+ Combination of flipflop + AND operation

Applications

Application example A267

- **Machine zone protection with light grille**
- **Muting function**
- **Categorie 4**
- **Stop category 0**

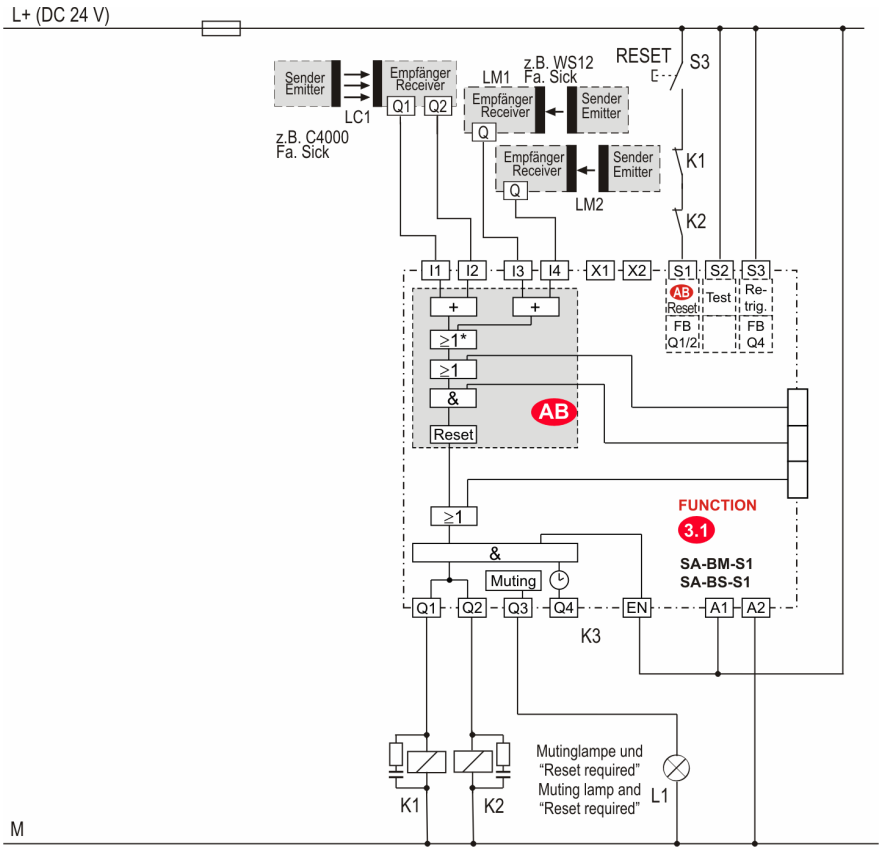
The safety light grille LC1 monitors the access to the machine zone. The optical muting sensors LM1 and LM2 are OR-linked with light grille LC1 (muting function).

Both muting sensors are pulse controlled and must be active to carry out the muting function (light grille bypass).

The muting function requires that outputs Q1, Q2, Q4 have previously been switched on. This means that the vision of LC1 has to be uninterrupted for power on.

Lamp L1 indicates the active muting state (static on). The expected Reset signal at S1 is indicated by blinking of L1. L1 control complies with EN 60496-1.

Restart is possible after exiting the danger zone and pushing Reset button S3.



+ Combination of flipflop + AND operation

≥1 MUTING the conditional OR-combination is valid only if the result of the Reset function before was =1 (see pages 48/49).*

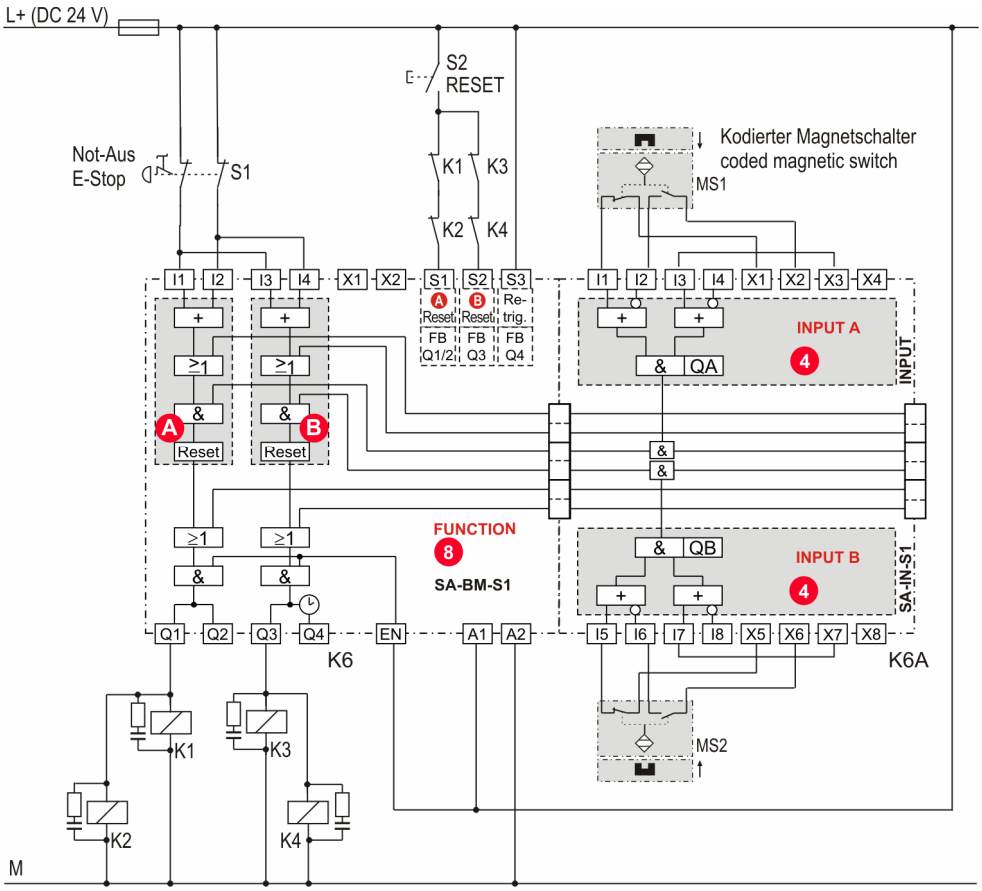
samos module	**K3**
Type	**SA-BM-S1**
Module revision	≥ C-01
FUNCTION	3.1
Function group	AB
External circuitry category (EN954-1) up to	4
Cross-circuit monitoring	X
Synchronous time monitoring	--
Stop category (EN 60204-1)	0
OFF delay	Q4 0 s
Retriggering ON	--
AUTO-RESET after POWER ON	
MANUAL RESET after POWER ON	X
AUTO-RESET	
MANUAL RESET	X
Comment	Crossmonitoring by safety sensors

When the safety door monitored with *MS1* is opened *K1* and *K2* shut down. When the safety door monitored with *MS2* is opened *K3* and *K4* shut down.

In case of emergency stop via *S1*, all contactors *K1* to *K2* shut down. With button *S2* you can reset the safety system while the safety devices are closed. Reset button *S2* is monitored for errors.

Application example A 258_B

- **Two independent safety zones**
- **Monitoring with coded electromagnetic switches**
- **Higher-order emergency stop**
- **Category 3/4**
- **Stop category 0**



samos module	K6			K6A		
Type	SA-BM-S1			SA-IN-S1		
Module revision	≥ B-01			≥ B-01		
FUNCTION	8			4	4	
Function group	AB	A	B	A	B	
External circuitry category (EN954-1) up to		3	3	4	4	
Cross-circuit monitoring		–	–	X	X	
Synchronous time monitoring		–	–	–	–	
Stop category (EN 60204-1)		0	0			
OFF delay			Q4 0 s			
Retriggering ON			–			
AUTO-RESET after POWER ON						
MANUAL RESET after POWER ON		X	X			
AUTO-RESET						
MANUAL RESET		X	X			
Comment	***samos*** modules and contactors in the same enclosure					

+ Combination of flipflop + AND operation

Applications

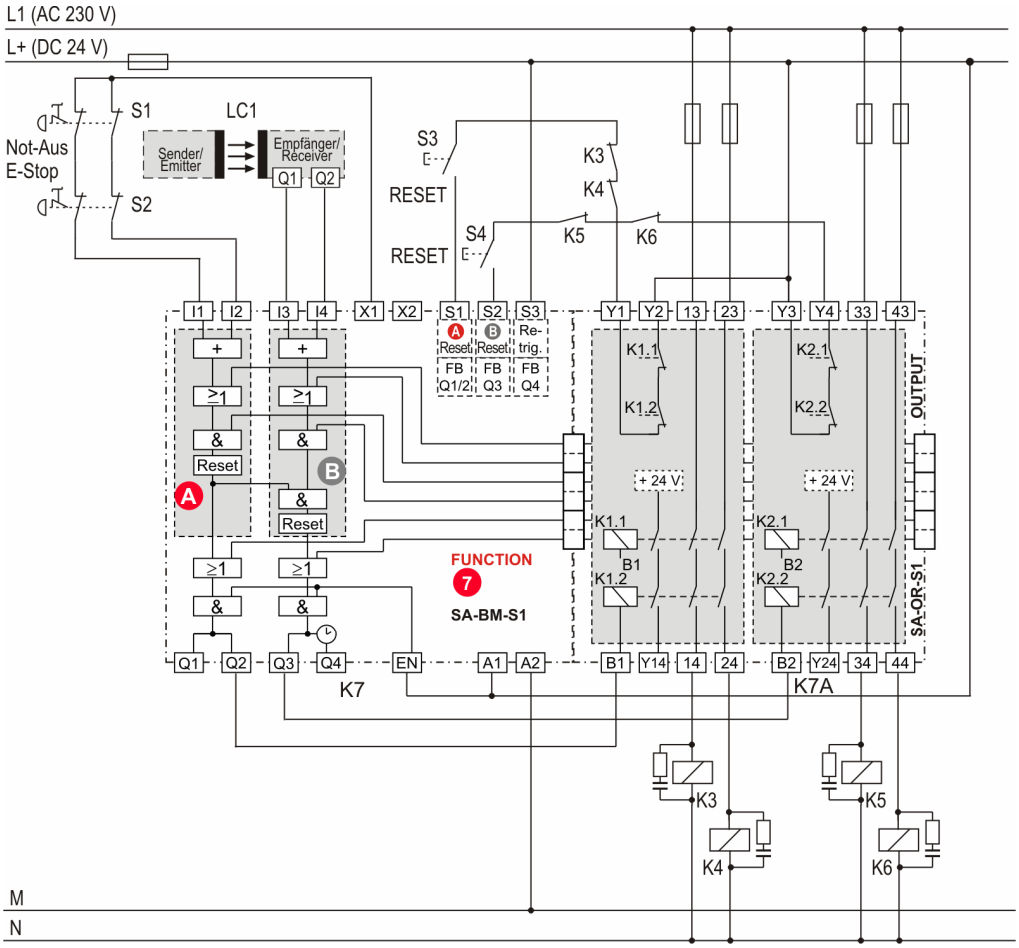
Application example A 259_C

- **Two safety zones**
- **Emergency stop and zone monitoring with light grille**
- **Output expansion with SA-OR-S1**
- **Category 3**
- **Stop category 0**

Two-channel emergency stop and zone monitoring with light grille. Emergency stop has priority over the light grille function.

In case of emergency stop relays *K1*, *K2* on the relay output expansion SA-OR-S1 shut down immediately. Reset after emergency stop and after power on is with RESET.

If light grille *LC1* is interrupted (e.g. C4000, M4000, 30-FGS from Sick) only *K2* is switched off. After the light grille has been enabled and the feedback circuits checked, the safety device is reset automatically.



+ Combination of flipflop + AND operation

samos module	K-SA1			K-SA2					
Type	SA-BM-S1			SA-OR-S1					
Module revision	≥ C-01			≥ A-02					
FUNCTION	7								
Function group	AB	A	B						
External circuitry category (EN954-1) up to		3	3						
Cross-circuit monitoring		–	–						
Synchronous time monitoring			–						
Stop category (EN 60204-1)		0	0						
OFF delay			Q4 0 s						
Retriggering ON			–						
AUTO-RESET after POWER ON									
MANUAL RESET after POWER ON		X	X						
AUTO-RESET			X						
MANUAL RESET		X							
Comment	***samos*** modules and contactors in the same enclosure								

Robot zone access is monitored by light grille LC1. The machine zone is further protected by a safety door and an emergency stop circuit.

Sensor S3 is OR-linked with LC1 and detects the safe position of the robot.

This enables e.g. equipping through an opening in the processing area without switching off the robot power supply. If the robot is not in the safe position when the light grille is interrupted, the entire machine and the robot are switched off.

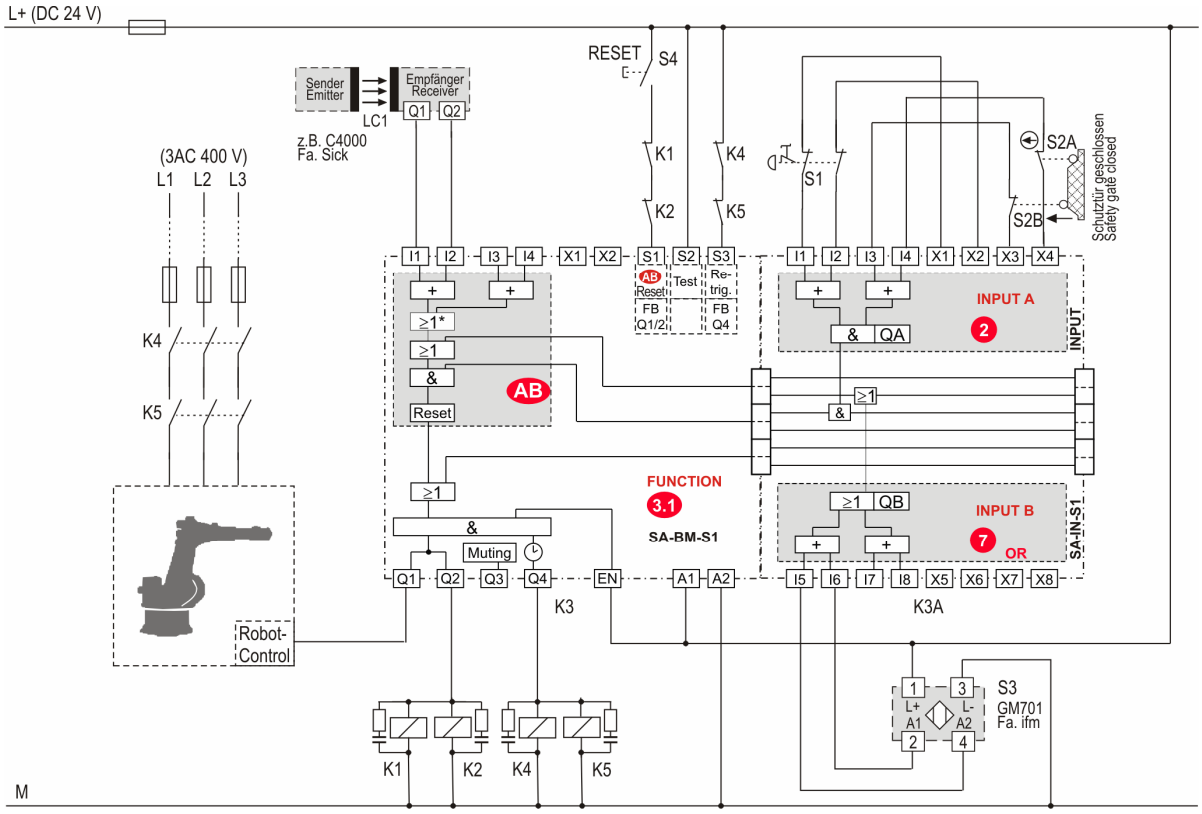
Opening the safety door or actuating the emergency stop button also result in a safe switch off. The robot control receives the command to switch off (returning to the safe position) from Q1.

K1 and K2 immediately interrupt the power supply to other consumers. The power supply of the robot is switched off safely via K4 and K5 after 1 s.

Restart is possible after exiting the danger zone and pushing Reset button S4.

Application example A268

- **Robot zone monitoring with light grille**
- **Emergency stop**
- **Safety door monitoring**
- **Category 4**
- **Stopp category 1**



samos module	K3			K3A					
Type	SA-BM-S1			SA-BS-S1					
Module revision	≥ B-01			≥ B-01					
FUNCTION	3.1			3.2					
Function group	AB	A	B	AB	A	B			
External circuitry category (EN954-1) up to	4			4					
Cross-circuit monitoring	X			X					
Synchronous time monitoring	–			–					
Stop category (EN 60204-1)	0			0					
OFF delay	Q4 0 s			Q4 0 s					
Retriggering ON	–			–					
AUTO-RESET after POWER ON									
MANUAL RESET after POWER ON	X			X					
AUTO-RESET									
MANUAL RESET	X			X					
Comment	Crossmonitoring by safety sensors								

+ Combination of flipflop + AND operation

≥1 MUTING the conditional OR-combination is valid only if the result of the Reset function before was =1 (see pages 48/49).*

Anti-Manipulation Measures

Manipulation	**... during operation (power not switched off)**	**... with power off**	
	System response	System response when power connected	Action required
Rotary switch moved	• All outputs shut down immediately • System goes into "System error" condition • Red *FLT* LED on affected module flashes • Green *PWR* LED flashes • All other *FLT* LEDs continuous red • Message via field bus coupler module	• System outputs cannot be switched on • Red *FLT* LED on master module flashes • All other *FLT* LEDs continuous red	• Return switch to original position (setting aid if power remains on: flashing *PWR* LED switches to continuous green) • Restart system by switching power off and on again
Change to control circuit configuration (inputs settings on *S1*, *S2*, *S3*)	• Outputs of system/ subsystem shut down at next cycle • Red *FLT* LED on affected module flashes • Message via field bus coupler module	• System/subsystem outputs cannot be switched on • Red *FLT* LED on master module flashes • All other *FLT* LEDs continuous red	• Restore old configurations on *S1*, *S2*, *S3*. • Restart system by switching power off and on again
Deliberate acceptance of an incorrect configuration	• The configurations are saved internally in non-volatile form and can be read out by the manufacturer if required		• User reads out last (correct) configuration CRC via bus coupler module • Cyclical visual check of configuration

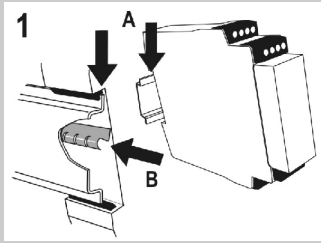
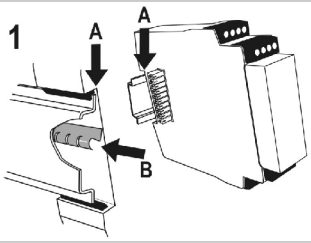
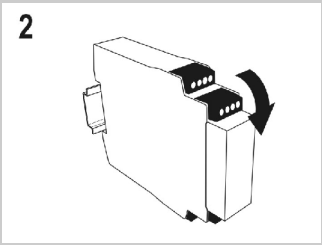
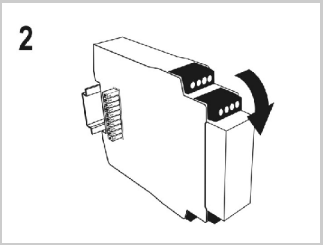
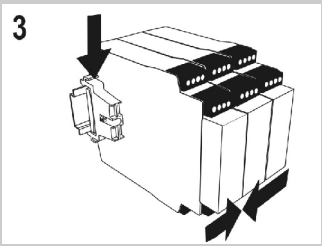
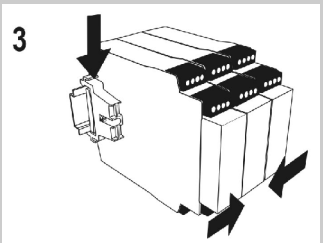
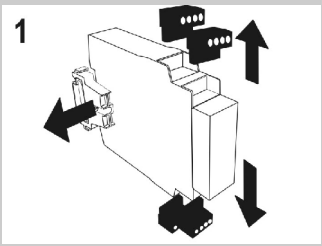
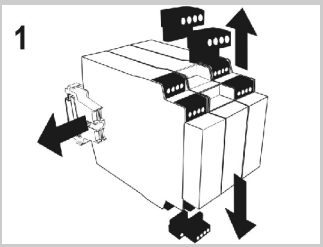
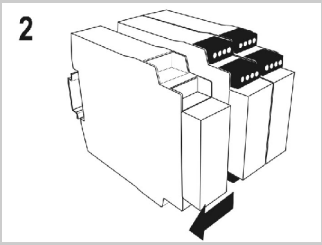
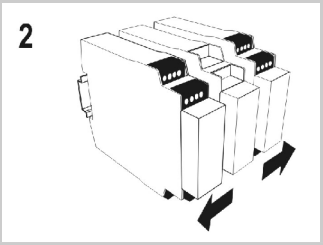
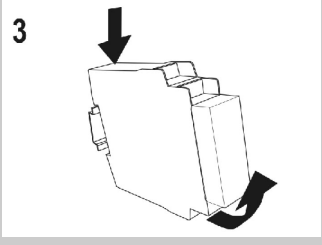
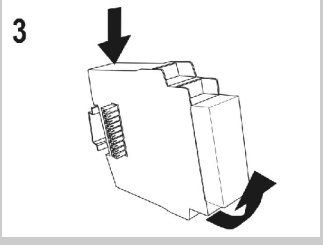
The leadable cover **SA-COVER** is available as an accessory for the safe ***samos*** modules. It prevents the rotary switches from changing their setting after system start-up.

Error Codes of *FLT* Error LED

Error codes FLT

Blink code	**Cause of error**
• Static	Secondary error on modules that have not discovered the error themselves
• 2x	Error in module configurations on *S1*, *S2*, *S3*, other module configuration
• 3x	Rotary switch altered during operation
• 4x	Module location list comparison when power switched on has detected a difference (including alteration of rotary switch position before or during power off)
• 5x	Voltage supply internal and external
• 6x	Self-monitoring, internal error, etc. (e.g. enter button pressed longer than 5 s)

Installing / Removing

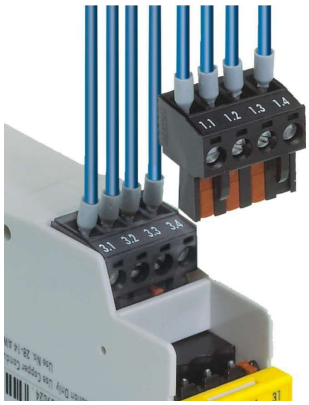
Master module		Slave modules
	Installing	
1 	Place device on DIN rail *A*. Ensure that earth spring *B* is in the correct position. The earth spring on the module must make a secure and electrically conductive connection with the DIN rail.	1 
2 	Snap the module onto the DIN rail by pressing gently in the direction of the arrow.	2 
3 	If there are several modules, push them together one at a time in the direction of the arrow until the connectors at the sides engage and then install the end clamps at the left and right ends.	3 
	Removing	
1 	Remove the plug-in terminals, wiring and end clamps.	1 
2 	If there are several modules, push them apart one at a time in the direction of the arrow until the connectors at the sides disengage.	2 
3 	Push down at the back. While pressing down, remove the module from the DIN rail in the direction of the arrow.	3 

Connection of Modules

Screw terminals

For technial data of the terminal see general technical data.

Marking -A

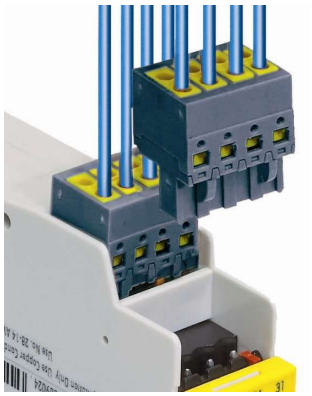


The modules are equipped with coded pluggable terminal blocks with 4 screw terminals each.
To avoid mix-ups, all module blocks are coded differently. Individual modules are not coded differently. Up to 2 stranded wires can be contacted per terminal.

Spring force terminals

For technial data of the terminal see general technical data.

Marking -C

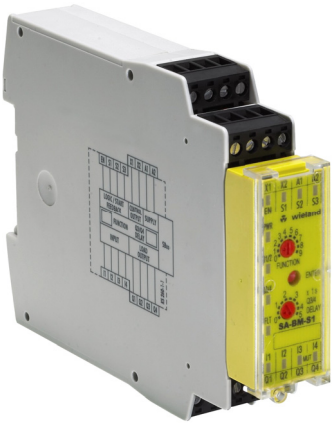


The modules are equipped with coded pluggable terminal blocks with 4 spring force terminals each.
To avoid mix-ups, all module blocks are coded differently. Individual modules are not coded differently.
Up to 2 stranded wires can be contacted per terminal.
The spring force terminals are provided with push-in technology. This means that no tools are required for installation.
Stranded wires are removed with a screwdriver by pushing the terminal from the front of the module (vertically to the inserted stranded wires). The voltage check can also be carried out vertically to the stranded wires through the inspection holes provided.

Switch Cover

SA-COVER

The optional switch cover **SA-COVER** can be snapped onto the front of the safe module to prevent the switch setting from changing after start-up. The cover is leadable and can only be removed with a tool (screwdriver) after the lead has been removed.



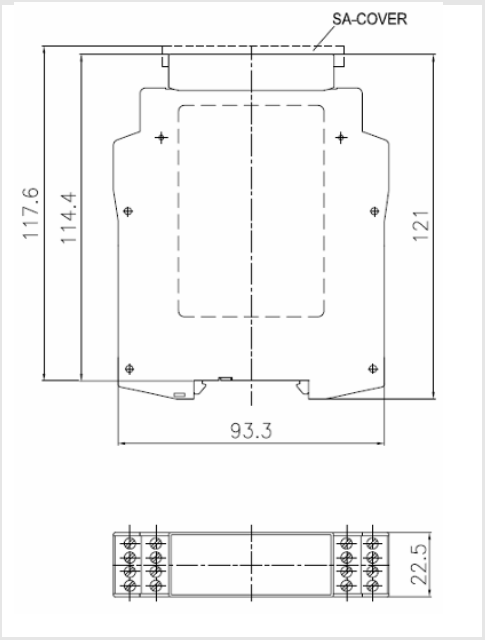
The screwdriver is inserted at the lower edge vertically to the cover and releases the cover from its locked position using an upward lever movement.

The **SA-COVER** accessory can be used with safe modules as of revision C-01.

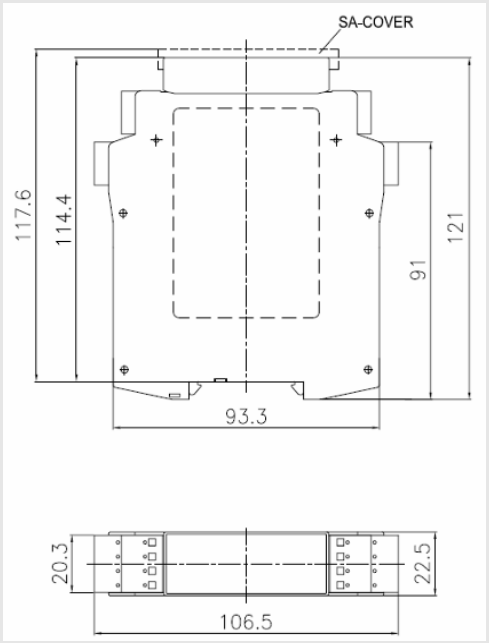
Dimensions

Master base module

SA-BM



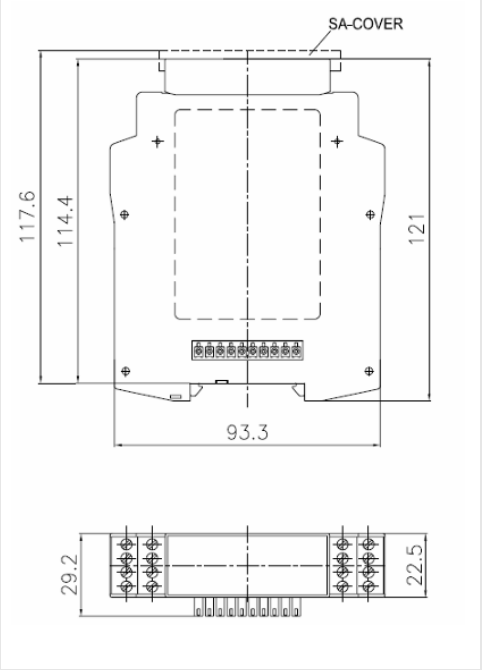
Screw terminals pluggable
Marking -A



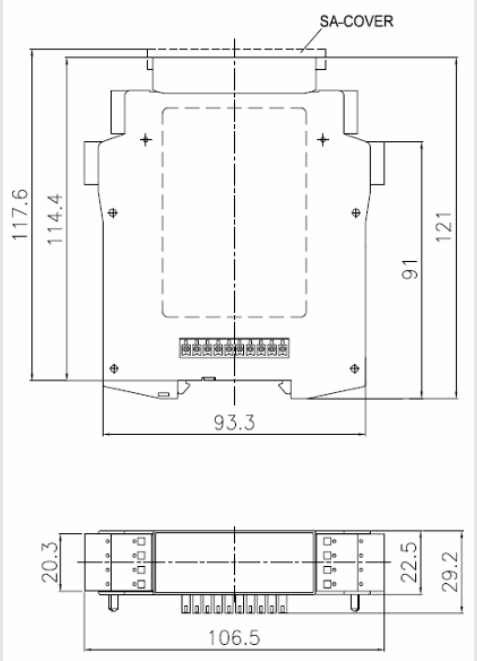
Spring force terminals pluggable
Marking -C

Slave base module, Input module, Output module

SA-BS
SA-IN, SA-OR



Screw terminals pluggable
Marking -A



Spring force terminals pluggable
Marking -C

General Technical Data

Unless otherwise stated, the general technical data applies to all base, expansion and bus coupler modules.

Climatic conditions

Ambient operating temperature T_B	–25 to +55 °C
Storage temperature	–25 to +70 °C
Relative humidity	10 to 95%, no condensation
Climatic conditions (EN 61131-2)	
Air pressure in operation	860 to 1060 hPa

Mechanical strength

Sinusoidal vibration (EN 60068-2-6)	
Frequency range	5 to 150 Hz
Amplitude	3.5 mm (5 to < 9 Hz)
Acceleration	1 g (9 to 150 Hz)
Number of cycles	10 per axis (on 3 axes)
Broad-band random vibration (EN 60068-2-64)	
Frequency range	5 to 500 Hz
Acceleration	4.9 g
Semi-sinusoidal shock (EN 60068-2-27)	
Acceleration / Duration	15 g / 11 ms

Electrical safety

Protect. type housing / terminals (EN 60529)	IP 40 / IP 20
Finger-proof	to DIN EN 50274
Clearance/creepage (EN 61131 -2)	
Overvoltage category	III
Contamination level	2 inside, 3 outside
Test voltage	
DC 24 V	350 V~
AC 300 V	2000 V~

Electromagnetic compatibility

Burst	EN 61000-4-4
Supply	2 kV
I/O	1 kV
Functional earth (shield)	1 kV
Surge	EN 61000-4-5, diff. mode / com. mode
Supply	1.0 kV / 2.0 kV
I/O	1.0 kV / 2.0 kV
Functional earth (shield)	– / 1.0 kV
Communication (field bus)	– / 1.0 kV
High-frequency electromagnetic fields acc. to EN 61000-4-3	10 V/m
Conducted induced disturbances acc. to EN 61000-4-6	10 V
Electrostatic discharge acc. to EN 61000-4-2	± 4 kV (contact discharge) ± 8 kV (air discharge)
Interference emissions acc. to DIN EN 55011:2003 class A	40 dB (V/m) (20 - 230 MHz) 47 dB (V/m) (230 -1000 MHz)

System safety (not for bus coupling modules)

Safety integrity level	SIL 3 (IEC/EN 61508)

The system must be switched off and restarted at least once a year and the safety functions must be tested!

Approvals

SIL 3 (EN 61508) and category 4 (EN 954-1) (not for bus coupling modules)
TÜV
cULus

Mechanical and installation		
Housing material		Polycarbonate
Housing type		Enclosure installation
Color	Bus coupler modules	light gray / light gray
	Other modules	yellow / light gray
Terminals		
Number of terminals		16 (base modules, I/O modules) 4 (bus coupler modules)
Plug-in terminals with screws		
Conductor sizes		
– single-core / finely stranded		1x 0.2 to 2.5 mm² / 2x 0.2 to 0.75 mm²
– finely stranded with wire-end ferrules		1 x 0.25 to 2.5 mm² / 2 x 0.25 to 0.5 mm²
Stripping length		max. 8 mm
Max. tightening torque		0.5 to 0.6 Nm
For UL and CSA applications		
– Conductor sizes		AWG 24-12 (use only Cu conductors)
– Max. tightening torque		5.25 lbs-in
Plug-in spring force terminals		
Conductor sizes		
– single-core / finely stranded		2x 0.2 to 1.5 mm²
– with wire-end ferrules		2x 0.25 to 1.5 mm² (AWG 24-16)
Stripping length		max. 8 mm
SBus connector		
Poles		10
Number:	Master base module	1 female (right), coded
	Slave base module, I/O modules	1 female (right), 1 male (left), coded
	Bus coupler modules	1 male (left)
Rail		DIN rail EN 50022-35

Module connections	
Max. number of parallel-connected module inputs I_n or S_n that can be controlled from one module output X_n or Q_n	8

Overview of Devices and Order Numbers

Type	Distinguishing function	Plug-in terminals	Order number
Base modules			
SA-BM-S1-4EKL-A	Master module, off delay 0-5 s	Screws	R1.180.0010.0
SA-BM-S1-4EKL-A	Master module, off delay 0-50 s	Screws	R1.180.0020.0
SA-BM-S1-4EKL-A	Master module, off delay 0-5 min	Screws	R1.180.0030.0
SA-BS-S1-4EKL-A	Slave module, off delay 0-5 s	Screws	R1.180.0040.0
SA-BS-S1-4EKL-A	Slave module, off delay 0-50 s	Screws	R1.180.0050.0
SA-BS-S1-4EKL-A	Slave module, off delay 0-5 min	Screws	R1.180.0060.0
SA-BM-S1-4EKL-C	Master module, off delay 0-5 s	Spring force	R1.180.0360.0
SA-BM-S1-4EKL-C	Master module, off delay 0-50 s	Spring force	R1.180.0370.0
SA-BM-S1-4EKL-C	Master module, off delay 0-5 min	Spring force	R1.180.0380.0
SA-BS-S1-4EKL-C	Slave module, off delay 0-5 s	Spring force	R1.180.0390.0
SA-BS-S1-4EKL-C	Slave module, off delay 0-50 s	Spring force	R1.180.0400.0
SA-BS-S1-4EKL-C	Slave module, off delay 0-5 min	Spring force	R1.180.0410.0
Input module			
SA-IN-S1-K-A	2 x 4 inputs, 2 x 10 input functions, cod. 1	Screws	R1.180.0070.0
SA-IN-S1-K-C	2 x 4 inputs, 2 x 10 input functions, cod. 1	Spring force	R1.180.0420.0
SA-IN-S2-K-A	2 x 4 inputs, 2 x 10 input functions, cod. 2	Screws	R1.180.0790.0
SA-IN-S2-K-C	2 x 4 inputs, 2 x 10 input functions, cod. 2	Spring force	R1.180.0840.0
SA-IN-S3-K-A	2 x 4 inputs, 2 x 10 input functions, cod. 3	Screws	R1.180.0800.0
SA-IN-S3-K-C	2 x 4 inputs, 2 x 10 input functions, cod. 3	Spring force	R1.180.0850.0
SA-IN-S4-K-A	2 x 4 inputs, 2 x 10 input functions, cod. 4	Screws	R1.180.0810.0
SA-IN-S4-K-C	2 x 4 inputs, 2 x 10 input functions, cod. 4	Spring force	R1.180.0860.0
SA-IN-S5-K-A	2 x 4 inputs, 2 x 10 input functions, cod. 5	Screws	R1.180.0820.0
SA-IN-S5-K-C	2 x 4 inputs, 2 x 10 input functions, cod. 5	Spring force	R1.180.0870.0
SA-IN-S6-K-A	2 x 4 inputs, 2 x 10 input functions, cod. 6	Screws	R1.180.0830.0
SA-IN-S6-K-C	2 x 4 inputs, 2 x 10 input functions, cod. 6	Spring force	R1.180.0880.0
Relay output modules			
SA-OR-S1-4RK-A	2 x 2 relay outputs	Screws	R1.180.0080.0
SA-OR-S2-2RK-A	1 x 2 relay outputs	Screws	R1.180.0320.0
SA-OR-S1-4RK-C	2 x 2 relay outputs	Spring force	R1.180.0430.0
SA-OR-S2-2RK-C	1 x 2 relay outputs	Spring force	R1.180.0440.0
Bus coupler modules			
SA-PROFIBUS-DP-A	Profibus-DP field bus	Screws	R1.180.0090.0
SA-CANopen-A	CANopen field bus	Screws	R1.180.0100.0
SA-DeviceNet-A	DeviceNet field bus	Screws	R1.180.0350.0
SA-PROFIBUS-DP-C	Profibus-DP field bus	Spring force	R1.180.0450.0
SA-CANopen-C	CANopen field bus	Spring force	R1.180.0460.0
SA-DeviceNet-C	DeviceNet field bus	Spring force	R1.180.0470.0
Gateways			
SA-PROFIBUS-DP-A	Profibus-DP field bus	Screws	R1.180.0090.0
SA-CANopen-A	CANopen field bus	Screws	R1.180.0100.0
SA-DeviceNet-A	DeviceNet field bus	Screws	R1.180.0350.0
SA-PROFIBUS-DP-C	Profibus-DP field bus	Spring force	R1.180.0450.0
SA-CANopen-C	CANopen field bus	Spring force	R1.180.0460.0
SA-DeviceNet-C	DeviceNet field bus	Spring force	R1.180.0470.0
SA-EN-MOD-A	Modbus/TCP	Screws	R1.180.0750.0
SA-EN-IP-A	EtherNet/IP	Screws	R1.180.0770.0
Accessories			
SA-COVER	Cover for samos modules, leadable,PU 10 p.		R9.211.0430.0

Print media

SA-MANUAL-D BA000255	***samos*** manual, German		R1.180.0280.0
SA-MANUAL-GB BA000256	***samos*** manual, English		R1.180.0290.0
SA-MANUAL-BUS-D BA000268	***samos*** bus coupler manual, German		R1.180.0330.0
SA-MANUAL-BUS-GB BA000269	***samos*** bus coupler manual, English		R1.180.0340.0
samos-DISC	***samos****-Disc* *Design tool for combination of base module – input module function*		0056.5

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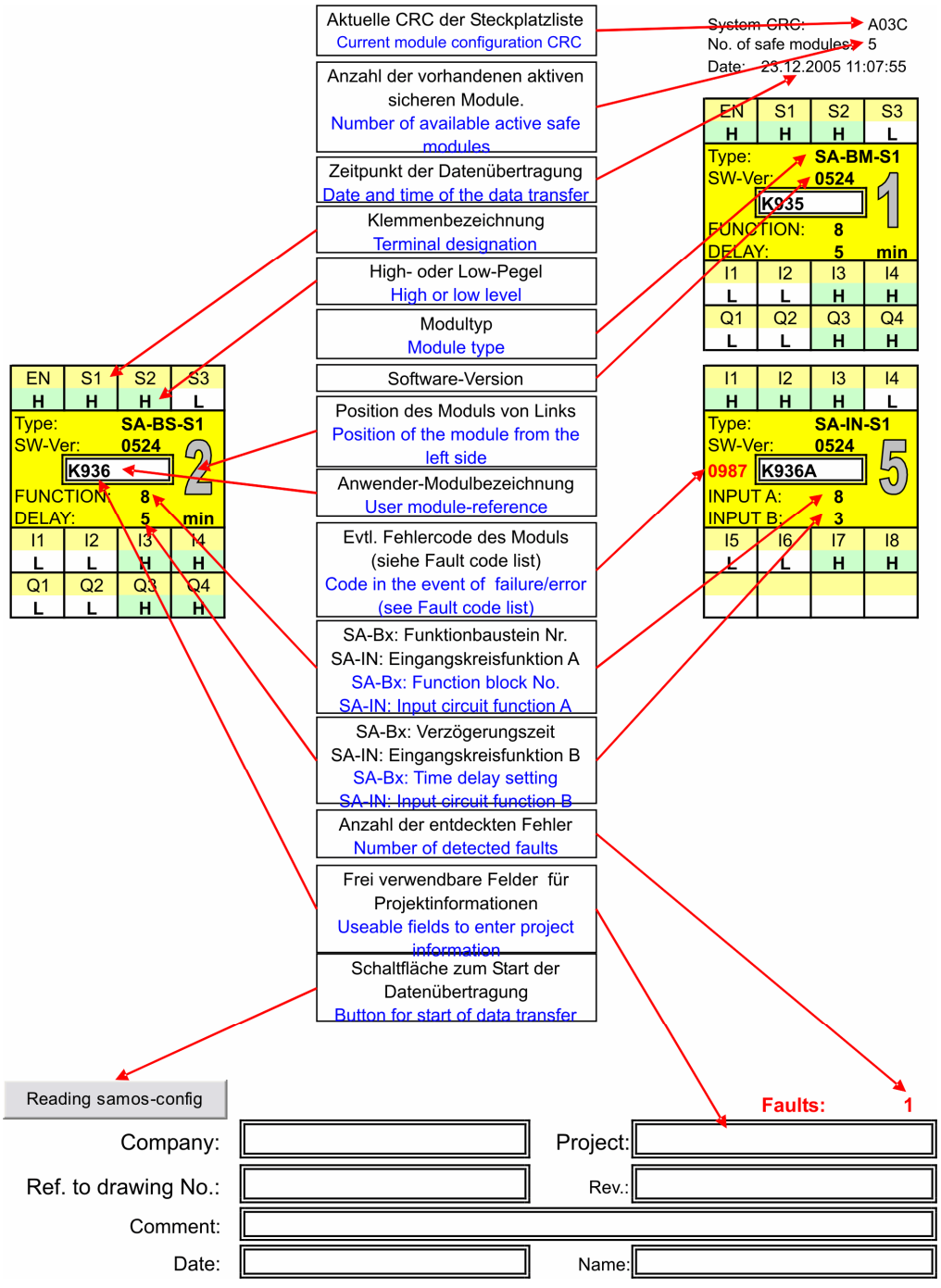
samos Configuration List

This is a blank ***samos*** configuration list (module location list) for copying. We recommend keeping a record of the configuration with the documentation or in a clearly visible place in the enclosure.

The configuration list is also available online ("samosConfigListSetup") at **www.wieland-electric.com → Info Service → Download Center**. If you use the online version with a ***samos*** SA-PROFIBUS-DP bus coupler module and a BW1131 master simulator (Bihl und Wiedemann) you will be able to load the module location list.

Notes on the *samos* configuration list



samos-Konfigurationsliste

Release 2.0

wieland

D

Diese Übersicht zeigt die Anzahl, Reihenfolge und Konfiguration der aktiven sicheren samos-Module eines Systems in einem bestimmten, vom Anwender gewählten Zustand der Maschine. Sie dient der Dokumentationsergänzung einer Anlage/Maschine.
Die dargestellten Informationen sind vom Anwender mit dem tatsächlichen Zustand des samos-Systems zu vergleichen! Für die Richtigkeit und Vollständigkeit der Daten übernimmt die Firma Wieland keine Haftung!
Ausgangsmodule Relais SA-OR sind nicht dargestellt.

GB

This overview shows the number, the order, and the configuration of the active samos modules of a system designed and constructed by the user's selected structure of the machine. This overview can be used to supplement the documentation for the machine configuration.
The indicated information must be compared with the actual conditions of the samos system! Company Wieland does not take responsibility for the correctness and completion of the dates!
Output modules relays SA-OR are not shown in this overview.

System-CRC:
No. of active modules:
Date:

Left side module

Type: SW-Ver: 1	Type: SW-Ver: 2	Type: SW-Ver: 3	Type: SW-Ver: 4
Type: SW-Ver: 5	Type: SW-Ver: 6	Type: SW-Ver: 7	Type: SW-Ver: 8
Type: SW-Ver: 9	Type: SW-Ver: 10	Type: SW-Ver: 11	Type: SW-Ver: 12
Type: SW-Ver: 13			

max. module number

Faults:

Company: Project:

Ref. to drawing No.: Rev.:

Date: Name:

Comment:

Sign:

wieland

Electrical
Connections

Headquarters:
Wieland Electric GmbH
Brennerstraße 10 – 14
D-96052 Bamberg

Sales and Marketing Center:
Wieland Electric GmbH
Benzstraße 9
D-96052 Bamberg

Phone +49 (951) 9324-0
Fax +49 (9 51) 9324-198
www.wieland-electric.com
info@wieland-electric.com

Safety Hotline:
+49 (951) 9324-999

Product Range

AT Wieland

Components and system components for the control cabinet

- DIN rail terminal blocks
  - with screw connection
  - with spring clamp connection
  - with IDC connection
- Safety
  - Safety relays
  - Modular safety systems
- Fieldbus components
- Interface
  - Power supplies
  - Overvoltage protection
  - Measuring and monitoring relays
  - Time and switching relays
  - Coupling relays/solid state relays
  - Analog modules
  - Passive interfaces

Components and system components for field applications

- Remote automation
  - Remote power distribution
  - Remote fieldbus interface
- Industrial multipole connectors
  - Modular multipole connectors
  - High-density multipole connectors
  - High-current multipole connectors
  - Multipole connectors for hazardous areas
  - Bushings for control cabinets
  - D-Sub connectors
- Round connectors

Empty housings and appliance connectors/terminal strips

AT Schleicher

PLC systems and CNC based control systems

- Operator panels
- Application engineering & system solutions
- Customized products

BIT Wieland

Building installation systems

- Mains connectors IP20/IP65...IP68
- Bus connectors
- Combined connectors
- Low-voltage connectors
- Flexible flat cable systems
- Distribution systems
- Switching devices for EIB/KNX, LON, Ethernet, radio control
- DIN rail terminal blocks for electrical installations
- Overvoltage protection

PCB connectors Wieland

PC board connectors

- PC board connectors
  - with screw connection
  - with spring clamp connection
  - with TOP connection