FACTORY AUTOMATION

Instruction Manual

AS-Interface Safety at Work
VAA-2E2A-G2-S/EA2

Version 1.0

PEPPERL+FUCHS

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1 Declaration of conformity

The AS-Interface safety module with 2 safety-related inputs for mechanical switches and 2 non-safety related outputs VAA-2E2A-G2-S/EA2 was developed and manufactured in observance of applicable European standards and regulations.

Note

A corresponding declaration of conformity can be requested from the manufacturer.

The manufacturer of the product, Pepperl+Fuchs GmbH in D-68307 Mannheim, has a certified quality assurance program in accordance with ISO 9001.

CE

ISO**9001**

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2 Symbols used in this document

Warning

This symbol warns of danger.

In the event the warning is ignored, the consequences may range from personal injury to death of persons or from damage to destruction of equipment.

Attention

This symbol warns of a possible fault.

Failure to observe may result in damage to the device or systems and installations connected to it up to and including compete lack of proper functionality.

Note

This symbol brings important information to your attention.

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3 Safety

3.1 Intended Use

The AS-Interface safety module allows the operation of sensor-controlled personal protection equipment up to category 4 in accordance with EN 954-1 or up to SIL 3 in accordance with EN/IEC 61508 - in compliance with intended use and in combination with an appropriately programmed AS-Interface safety monitor. The safety level of the application can either be determined by means of a risk analysis (for example as described by EN 1050) or derived from a C standard.

Warning

Protection of operating personnel and system is not ensured if the module is not used in accordance with its intended use.

3.2 Requirements for Peripheral Devices

3.2.1 Requirements for the Safety Monitor

The module shall only be used as a safety-related slave in an AS-Interface string with an appropriate AS-Interface safety monitor and for its intended purpose. The AS-Interface safety monitor must meet the requirements of the system specification "Specification of a safe AS-Interface transmission" Version 2.01 dated 12.05.2000.

All components must be evaluated for function according to this safety standard for the evaluation of a safety-related function.

The correct execution of the desired safety function also depends on the wiring and programming of the safety monitor. This also applies to the desired safety response after a code malfunction or failure (see also the documentation on the safety monitor). The safety function (including all safety-related sensors) must be tested before it is placed in service the first time. The category or SIL of the safety monitor must at least correspond to the category or SIL required by the application.

3.2.2 Requirements for Wiring

The requirements of EN/IEC 60204-1 (or similar standard) must always be observed. The requirements for external wiring and selection of connected sensors appeal to both the functionality requirement to be met and the required category (EN 954-1/ ISO 13849-1 or EN/IEC 61508).

3.2.3 Switches or Mechanical Contacts

The switches must be forced-opening. Combinations of switches that ensure equal safety (error behaviour analysis) can be used.

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3.3 General Safety Instructions

Warning

Any operation other that what is described in these instructions puts the safety and function of the device and of the connected systems in question.

The module can only be operated by trained specialists in accordance with the available instruction manual.

The connection of the module and maintenance work while the devices are connected to a power source shall only be performed by a trained electrical specialist.

If malfunctions cannot be eliminated, the module must be taken out of operation and protected from being inadvertently put back into operation.

Repairs shall only be performed directly by the manufacturer.

Interferences or changes at the device are not permitted and will render any claim under the warrantee null and void.

When operating the device, care must be taken to ensure that the requirements for installation of a housing in IP20 are also maintained.

Note

The plant management is responsible for keeping local safety regulations.

3.4 Transfer Time of the Safety-Relevant Information

The transfer time depends essentially on the monitor. The corresponding documentation and the switch-off times of the actuators must be observed.

3.5 PFD Calculation

To calculate the PFD (probability of dangerous failure on demand) of a safety-related function, all PFD values of all components used in this function must be taken into consideration. The AS-Interface safety slave does not make any appreciable contribution to the PFD or PFH (probability of dangerous failure per hour) of the overall system.

For the PFD or PFH-values of the other components, especially of the safety monitor, please refer to the relevant documentation.

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4 Principles of Operation of the Module

4.1 Safety-Related Inputs

The module generates a code sequence internally. This code sequence is monitored by a safety monitor (an additional bus station) for the correct sequence.

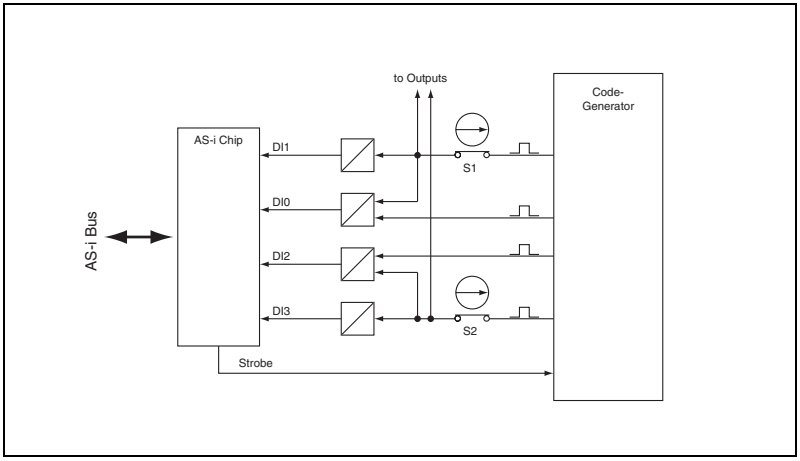

Fig. 4.1: Code generation

The transfer of the code sequence is affected by the status of the externally connected mechanical switch.

Information on the activation of the connected mechanical switches (e.g. for emergency-stop button activated, code transfer interrupted) is transferred as follows:

Activated Input Channel	Code			
	4	3	2	1
1	X	X	0	0
2	0	0	X	X
1 and 2	0	0	0	0
None	X	X	X	X

Code words 0000, XX00 and 00XX cause the safety monitor to bring the system to a secure state (for example with the emergency-stop button) without reporting a malfunction. If a bit of a code word deviates from the nominal code word, the safety monitor switches the system into the secure state and signals a malfunction of the slave.

The two input channels of the safety module are independent of each other. Parameters can be set in the safety monitor for monitoring the synchronicity of the two inputs for two-channel applications. See also Section A.

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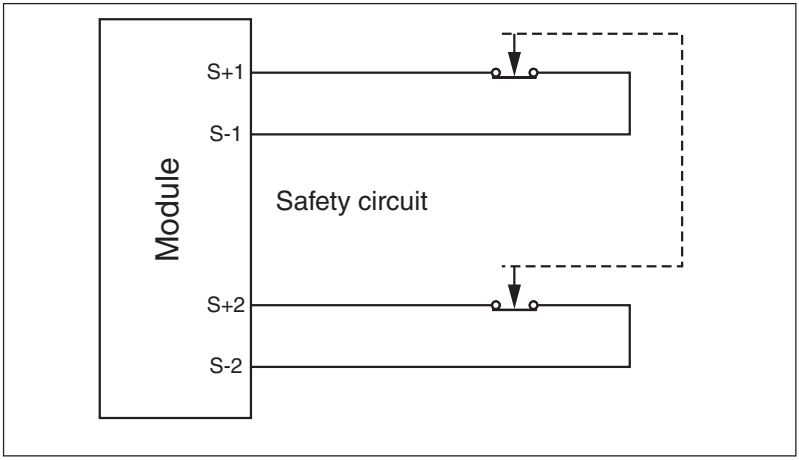

Fig. 4.2: Example: An emergency-stop button with two separate circuits uses both module inputs.

4.2 Non-secure outputs

The outputs are designed according to the AS-Interface standard. These are switched to positive potential (PNP technology).

The state of the outputs is set according to the operating mode, which in turn is adjusted by parameter on the AS-Interface master, either switched by the master or derived from the states of the inputs. For a more detailed description, see Section 6.4.

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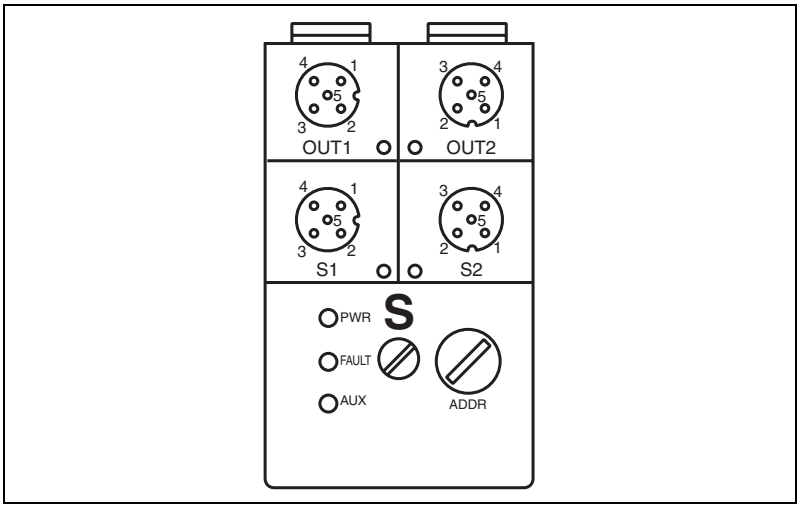
5 Connections, Displays and Operating Components

5.1 Connection Layout



5.1.1 Safety-related Inputs

Socket	Pin	Description	Designation
S1	1	Mechanical switch 1+	S1+
	2	Mechanical switch 1-	S1-
	3	Mechanical switch 2+	S2+
	4	Mechanical switch 2-	S2-
	5	Reserved	
S2	1	Mechanical switch 2+	S2+
	2	Mechanical switch 2-	S2-
	3	not assigned	
	4	not assigned	
	5	Reserved	

Note

Pins 5 are reserved and must not be assigned.

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5.1.2 Non-secure outputs

Socket	Pin	Description	Designation
OUT1	1	not assigned	
	2	Output 2 +	OUT2
	3	Output -	AUX-
	4	Output 1 +	OUT1
	5	Functional ground	FG
OUT2	1	not assigned	
	2	not assigned	
	3	Output -	AUX-
	4	Output 2 +	OUT2
	5	Functional Ground	FG
		Auxiliary power +	AUX+
		Auxiliary power -	AUX-
		AS-Interface +	
		AS-Interface -	

5.2 Displays

Designation	Description
FAULT	Error display; LED red red: Communication error
PWR	AS-Interface voltage; LED green
AUX	Auxiliary power U_{AUX}; LED green
S1	Switch status of input channel 1; LED yellow
S2	Switch status of input channel 2; LED yellow
OUT1	Switch status of output channel 1; LED yellow (AUX+ switched through with active LED)
OUT2	Switch status of output channel 2; LED yellow (AUX+ switched through with active LED)

5.3 Accessory

5.3.1 Short-circuit jumper

To fit the device with only one mechanical switch (for example emergency stop category 2), a short-circuit jumper must be mounted on the free socket of the emergency stop connection. To protect these short circuit jumpers from dirt or from falling out, a blind plug is included with delivery. It can be screwed onto the open plug socket.

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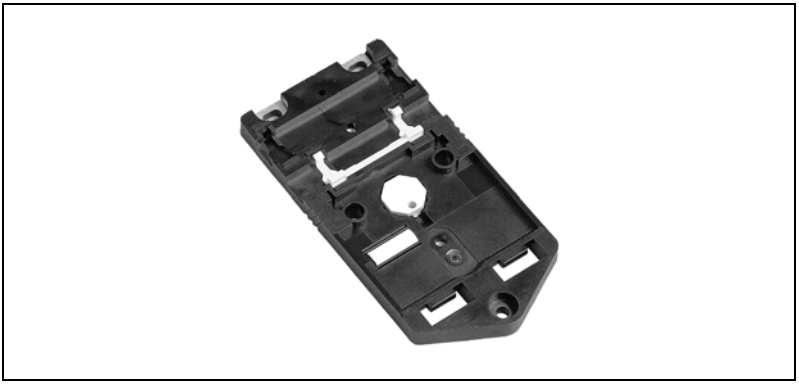
6 Interface Properties

6.1 AS-Interface

The G2 series module is connected to the AS-Interface with the U-G3FF electromechanical interface. A yellow AS-Interface flat band cable is used for the connection, for example VAZ-FK-S-YE.



6.2 Auxiliary power

The auxiliary power AUX is also connected to the AS-Interface by the U-G3FF electromechanical interface. The black flat band cable is used for the connection, for example VAZ-FK-S-BK.

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6.3 Inputs

6.3.1 General

Switches are connected to M12 sockets. One or more mechanical switches, switched in series, may be connected per channel.

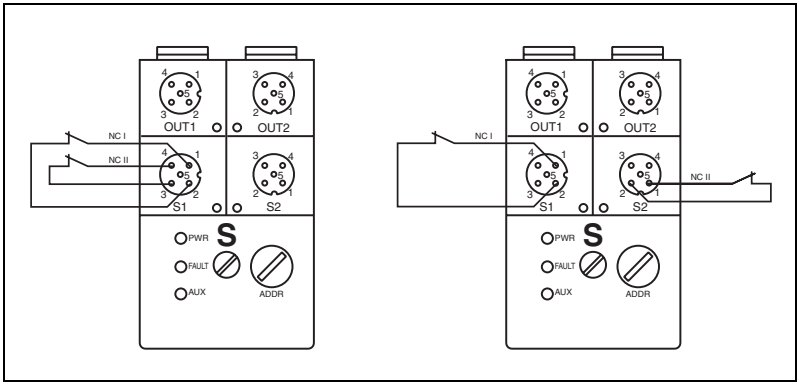

Fig. 6.1: 2 mechanical switches (or a two-channel switch)

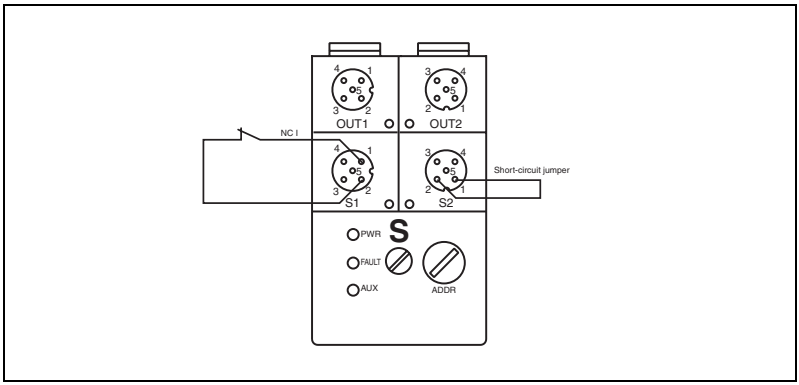

Fig. 6.2: 1 mechanical switch

If only one single-channel switch is to be used, input 1 must be used for this purpose. If input 2 is to remain unswitched, it must be jumpered. This can be done with the short-circuit jumper included with deliver that bridges connections S2+ to S2-. The short-circuit bridge must be fastened with a blind plug VAZ-V1-B.

6.3.2 Safety Category

The module contains two input channels independent of each other and redundantly structured that individually meet the requirements of category 4 according to EN 954-1.

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6.3.3 Cross Fault Monitoring

The inputs are monitored for cross fault with each other. The cross fault monitoring is capable of detecting low-resistance cross faults between the two inputs caused by a metallic connection.

6.4 Outputs

The outputs are designed according to the AS-Interface standard. These are switched to positive potential (PNP technology).

The outputs can be operated in two modes:

1. The outputs are controlled directly by the corresponding data bits of the AS-Interface master.
2. The output signals of the AS-Interface master are linked with the secure inputs. The outputs are turned on if the master turns them on or if the inputs are in a secure state.
   This operating mode is used to control signal lights that must display the state of the inputs without the master being involved.

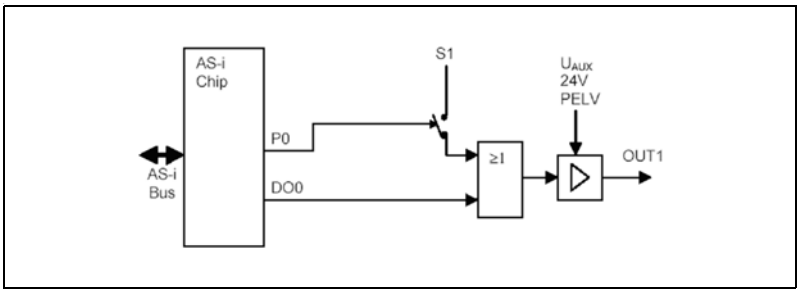

Bild 6.3: Output modes

Modes and logic table of the outputs

The modes are selected by the Master with parameter bit P0:

P0	S1 / S2 [1]	DO0 / DO1 [2]	OUT1 / OUT2	Mode
1	X / X	0 / 0	0 / 0	Outputs independent of inputs
	X / X	1 / 1	1 / 1	
0	0 / 0	X / X	1 / 1	Open switches on the inputs set the inputs
	1 / 1	0 / 0	0 / 0	When the switches are closed on the inputs, the master controls the outputs
	1 / 1	1 / 1	1 / 1	

[1] 0 corresponds to an open switch (secure state). 1 means closed switch.
X means any state that has no effect on the outputs.

[2] 1 means outputs are turned on, 0 means outputs are voltage-free.

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7 Commissioning

7.1 Requirements for Configuration of the Safety Monitor

Organisational measures necessary for the configuration of the safety monitor, are given in the safety monitor documentation.

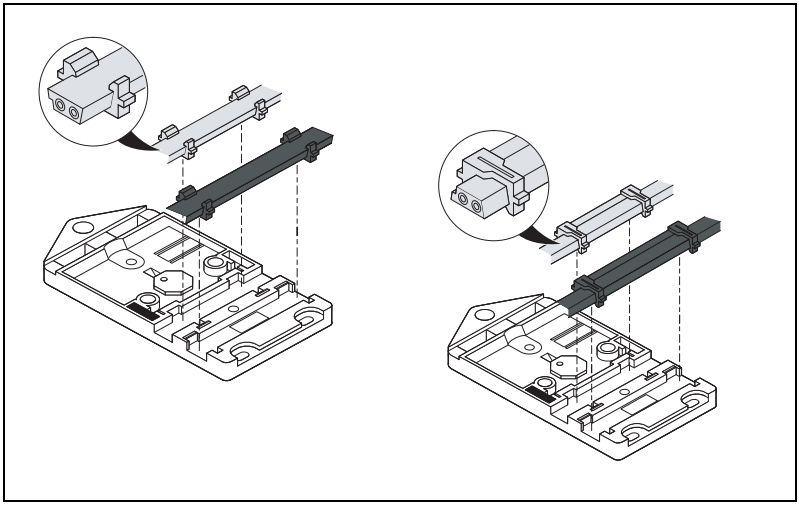
7.2 Installation

To achieve protection class IP67, care must be taken to ensure the line pass-throughs are sealed.
Protective caps (VAZ-V1-B) must be used for connections that are not in use and rubber seals (for example VAZ-FKED-G2) for line ends.

The mounting plate U-G3FF (not included in the delivery package) must be screwed together tightly on a flat mounting surface.

To ensure the cable is in the right place in the pass-through, the saddle brackets must be removed.

The cables must be inserted into the cages outside the module and the cages must then be inserted into the mounting plate according to the position of the cable groove. 2 directions are possible for this.



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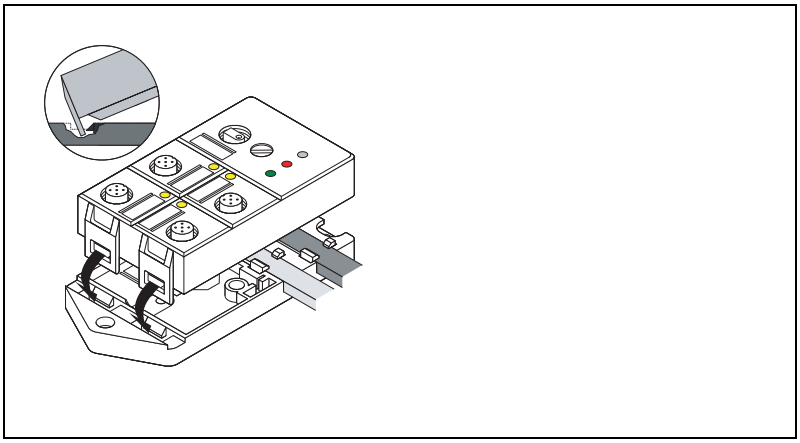
The fastening straps of the module must be locked into the support hooks of the mounting plate and the module must then be pressed onto the mounting plate. The central fastening screw must be tightened.



Ground the module with the lower fastening screws using the FE connection.

7.3 Addressing of the Modules

The addressing of the module is performed by means of a manual addressing device or an AS-Interface master. If the manual addressing device is used, it should be connected and addressed to the addressing socket of the module (identified with ADDR) using the addressing cable enclosed with delivery. Addresses from 1 to 31 can be assigned. The state as supplied is address 0.

7.4 Function Tests

Function tests must be performed as part of the installation. Because of the cross fault monitoring of the secure inputs, there is no need for a test for short circuits in the wiring. The function test covers all faults present at the time of installation.

7.5 Operating Modes

No operating modes can be switched for the inputs. The parameters in the ASInterface can affect the behaviour of the outputs. For a more detailed description of connecting peripheral devices, consult Section 5.

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8 Operating AS-Interface Safety Modules

The safety function of the module is determined by how the monitor is programmed. Please observe the corresponding documentation. Depending on the safety category, regular function tests may be required.

9 Certificates

Approvals according to EN 954-1/ISO 13849-1 and EN/IEC 61508.

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A Application examples

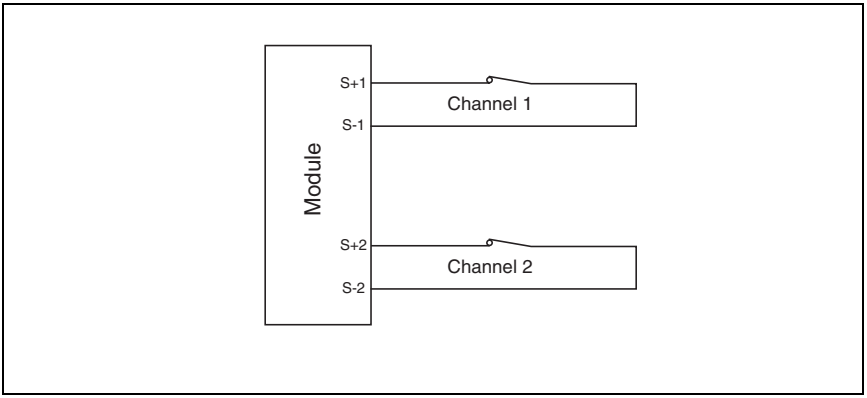
Note

The examples listed here correspond to our understanding of the categories according to EN 954-1 and should not be seen as binding.

A.1 Category 2

The safety function(s) must be tested at appropriate intervals of time by operating the mechanical switches. The correct reaction of the safety monitor must be controlled. The test intervals must be adjusted to match the application.

Connecting two independent mechanical position switches of Category 2:



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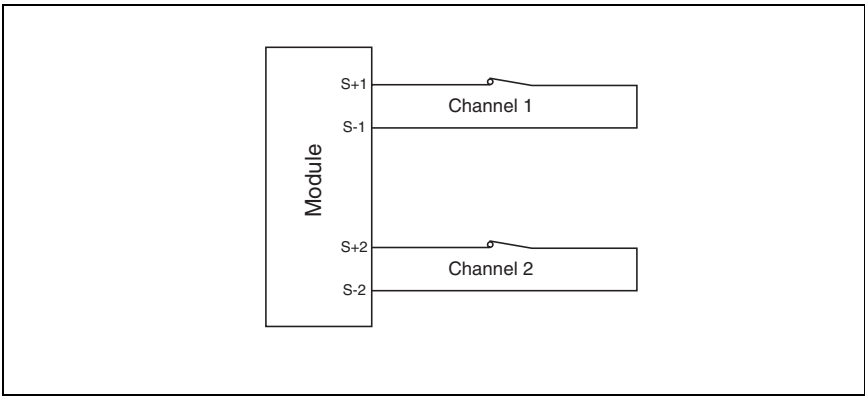
A.2 Category 3

Occurrence of a fault must not result in a loss of the safety function.

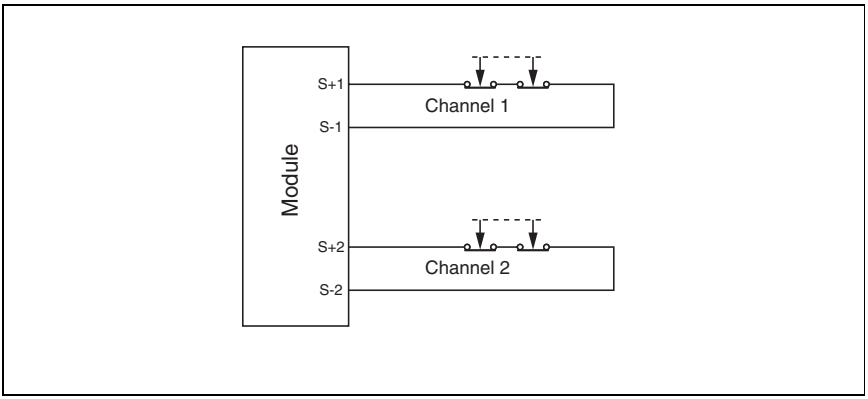
Connecting two dependent mechanical position switches per channel (2 safety functions)

Example 1



Example 2

If the possibility of a dangerous failure (short circuit) of the switch cannot be excluded, these switches must be doubled and switched in series.



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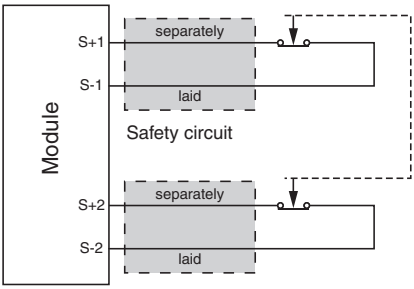
Example 3

If the possibility of a short circuit in the wiring cannot be excluded with the switches, both channels are required to achieve a Category 3 safety function.



Parameters can be set for the following function modules to achieve safety category 3 in this application while the AS-Interface safety module is in operation on a safety monitor (for example VAS-1A-K12 or VAS-2A-K12):

Example 1 and 2:


Dual channel independent

Example 3:


Dual channel dependent


Dual channel force-guided

Warning

The function module  *'two-channel independent' must* ***not*** *be used in example 3.*

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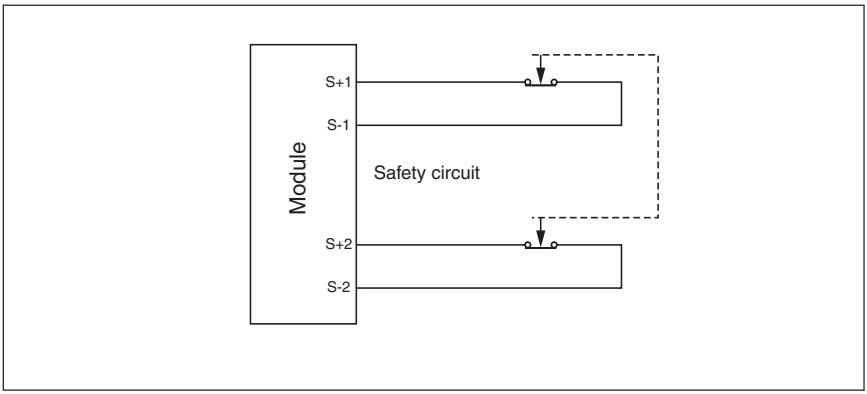
A.3 Category 4

Occurrence of a fault and an accumulation of faults must result in a loss of the safety function.

Example 1

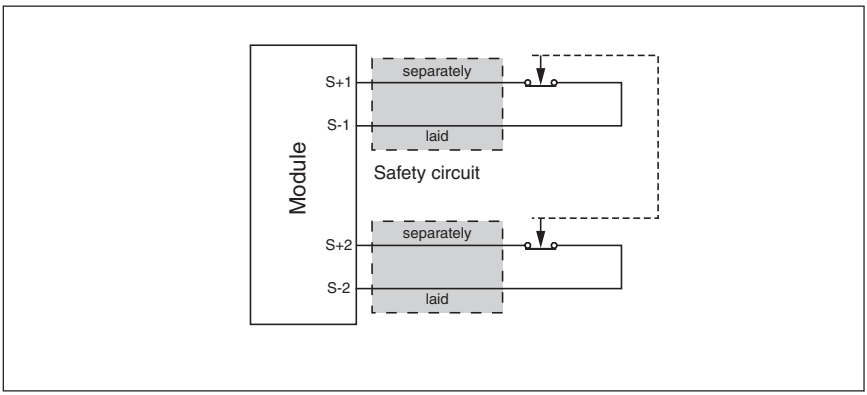
Connecting a dual-channel mechanical position switch.

The safety function must be tested to detect a dangerous accumulation of faults. The test intervals must be adjusted to match the application.



Example 2

If it is not possible to exclude a dangerous failure (short circuit) for the switches, two dependent mechanical switches must be used for each channel. The safety function must be tested to detect a dangerous accumulation of faults. The test intervals must be adjusted to match the application.



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Parameters can be set for the following function modules to achieve safety category 4 in this application while the AS-Interface safety module is in operation on a safety monitor (for example VAS-1A-K12 or VAS-2A-K12):


Dual channel force-guided


Dual channel dependent


Warning

The function module  *'two-channel independent' must* ***not*** *be used.*


Attention

The cable length between the module and the sensor is limited to 30 m.

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B Summery of the requirements for categories to EN 954-1/ISO 13849-1

Category	Summary of requirements	System behaviour [1)]	Important principle for achieving safety
B	The safety-related parts of the machine control system and/or their components must be designed, constructed, selected, put together and combined to meet the requirements of the corresponding standards in such a manner as to be able to withstand anticipated effects.	If a fault occurs, it may result in a loss of the safety function.	By selection of components
1	The requirements of B must be met. Use of components and principles with proven safety-related effectiveness	As described for Category B, but with higher safety-related reliability of the safety function	
2	The requirements of B and the use of components and principles with proven safety-related effectiveness must be satisfied.The safety function(s) must be tested at appropriate intervals of time by the machine control system. **NOTE:** What is suitable depends on the application and the type of machine.	• The occurrence of a fault may result in a loss of the safety function between testing intervals. • Loss of the safety function will be detected by the test.	By the structure
3	The requirements of B and the use of components and principles with proven safety-related effectiveness must be satisfied. The control systems must be designed in such a manner that: • an individual fault in the control system does not result in a loss of the safety function and • the individual fault is detected whenever it is practical to do so in a reasonable manner.	• If the individual fault occurs, the safety function still remains intact. • Some but not all faults are detected. • An accumulation of unknown faults may result in a loss of the safety function.	
4	The requirements of B and the use of components and principles with proven safety-related effectiveness must be satisfied. The control systems must be designed in such a manner that: • an individual fault in the control system does not result in a loss of the safety function and • the individual fault is detected during or before the next requirement for the safety function. If this is not possible, then it must not be possible for an accumulation of faults to result in loss of the safety function.	If errors occur, the safety function still remains intact. The fault is detected with sufficient time to prevent a loss of the safety function.	

[1)] The risk evaluation indicates whether the complete or partial loss of safety function(s) resulting from the occurrence of faults is acceptable.

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Summery of the requirements for categories

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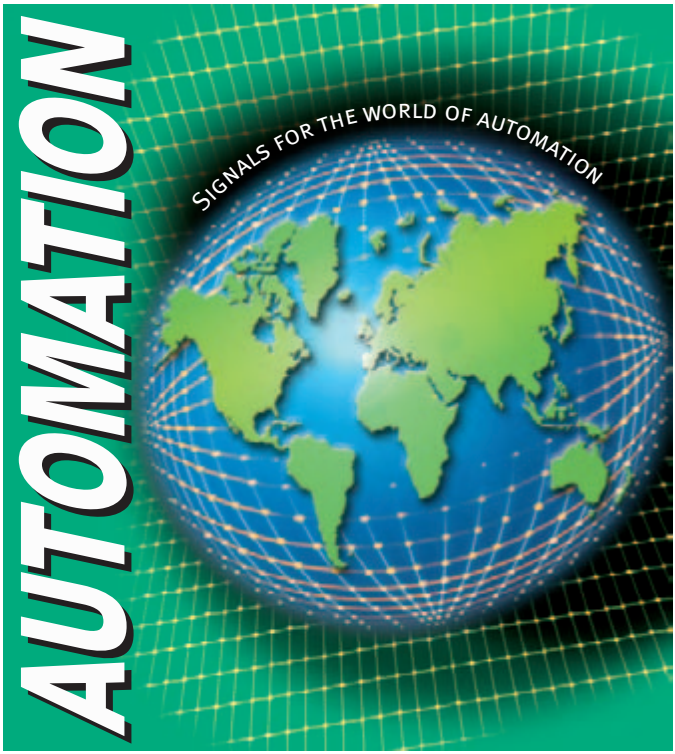

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