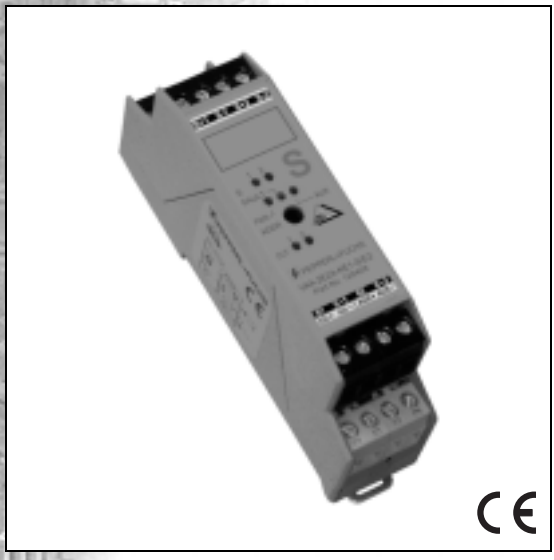
FACTORY AUTOMATION

Instruction Manual

AS-Interface Safety at Work
VAA-2E2A-KE1-S/E2

Version 1.0



PEPPERL+FUCHS

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1 Declaration of conformity

The AS-Interface safety module VAA-2E2A-KE1-S/E2 with 2 safety-related inputs for mechanical switches and 2 non-safety related outputs 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 described here, when used properly in combination with an AS-Interface safety monitor programmed appropriately, allows for operation of sensor-controlled devices for protection of persons up to Category 4 according to EN 954-1 or up to SIL 3 according to EN/IEC 61508.

Warning

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

3.1.1 Non-secure outputs

Warning

The outputs must not be used for safety-related functions.

3.1.2 Requirements for the safety monitor

The module must only be used in a proper manner as a safety-related slave on an AS-Interface line with the corresponding AS-i safety monitor. The AS-Interface safety monitor must meet the requirements of the system specification "Specification of safe AS-Interface transfer" Version 2.01 dated May12, 2000.

All components must be evaluated for functionality 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 malfuntion or failure. See also the documentation for the safety monitor. The safety function (including all safety-related sensors) must be tested before it is placed in service the first time.

3.1.3 Requirements for wiring

The requirements of EN/IEC 60204-1 (or similar standard) must always be observed. The requirements for external wiring and the selection of sensors that are connected are based on both the functionality to be provided as well as the required category (EN 954-1/ISO 13849-1 or EN/IEC 61508). The category can be determined by means of a risk analysis (for example as described by EN1050) or can be derived from a C standard. The category or SIL of the safety monitor must at least correspond to the category or SIL required by the application.

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3.1.4 Switches or mechanical contacts

The switches must either be of the forced-opening variety or must have a defined failure behaviour. Combinations of switches that ensure comparable safety (error behaviour analysis) can be used.

3.2 General safety instructions

Warning

Any type of operation other than what is described in the instructions places the safety and functionality of the module and connected systems in question.

The module can only be operated by trained professionals in accordance with the available instruction manual (see section 8).

Connecting modules and performing maintenance tasks while the devices are connected to a power source must only be performed by trained electrical specialists.

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

Repairs must only be performed directly by the manufacturer.

Making changes to or tampering with the device is not permitted and will render the warranty 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 heeding local safety regulations.

3.3 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.

3.4 PFD-calculation

To calculate the PFD (probability of 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 significant contribution to the PFD or PDH (probability of dangerous failure per hour) of the overall system.

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

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4 Working principles 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.

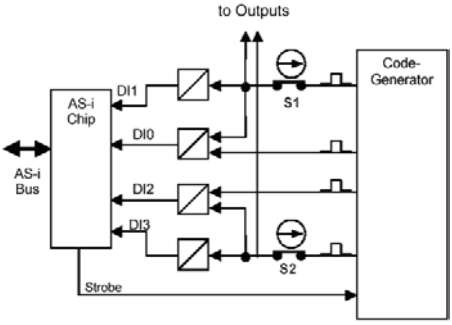

Figure 4.1: Code generation

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			
	DI3	DI2	DI1	DI0
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. For more information, see also the application examples in Appendix A.

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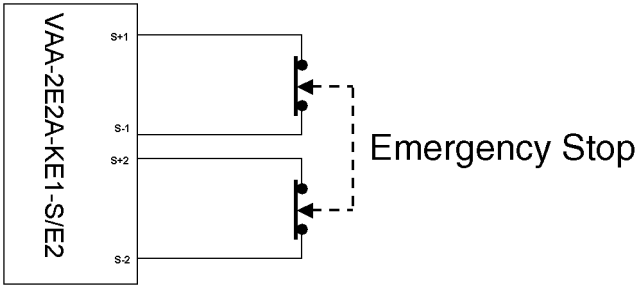

Figure 4.2: Example: An emergency off button with two separate circuits is assigned to both module inputs.

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 6.3.

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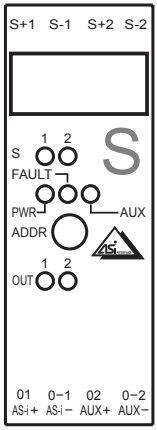
5 Connections and displays



5.1 Connections

Safety related inputs	
Designation	Description
S1+	Mechanical switch 1+
S1+-	Mechanical switch 1-
S2+	Mechanical switch 2+
S2-	Mechanical switch 2-

Outputs and others	
Designation	Description
O1	Output 1+
O-1	Output 1-
O2	Output 2+
O-2	Output 2-
ASi+	AS-Interface +
ASi-	AS-Interface -
AUX+	Auxiliary power U_{AUX} +
AUX-	Auxiliary power U_{AUX} -

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5.2 Displays

Designation	Description
S1	Yellow LED, switching state of input circuit 1
S2	Yellow LED, switching state of input circuit 2

Designation	Description
PWR	Green LED, AS-Interface power
FAULT	Red LED, AS-Interface communication error
AUX	Green LED, auxiliary power
OUT1	Yellow LED, switching state of output 1, U_{AUX} + switched through with active LED
OUT2	Yellow LED, switching state of output 2, U_{AUX} + switched through with active LED

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6 Interface properties

6.1 AS-Interface, auxiliary energy

In case of the KE1-series all interfaces are connected via removable terminals. Thus also AS-Interface and auxiliary energy. The cable has to meet the minimum requirements for AS-Interface (e.g. AS-Interface flat band cable, VAZ-FK-S-YE for AS-Interface and VAZ-FK-S-BK for auxiliary energy).

6.2 Inputs

6.2.1 General

In this case the switches are also connected to removable terminals. One or more mechanical switches, switched in series, can be connected per channel.

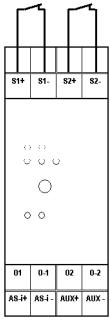

Figure 6.1: 2 mechanical switches (or one two-channel switch)

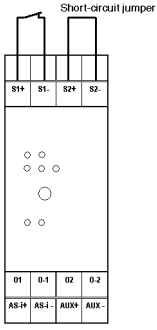

Figure 6.2: 1 mechanical switch

If only one single-channel switch is used, input 1 must be used for this purpose. If input 2 is to remain unswitched, it must be jumpered.

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6.2.2 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.

6.2.3 Cross fault monitoring

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

6.3 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.

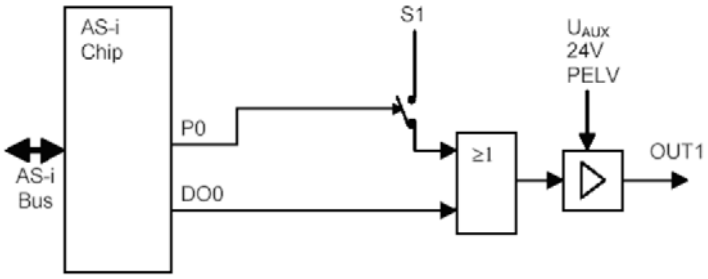

Figure 6.3: Output modes

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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 switch at the input sets the corresponding output
	1 / 1	0 / 0	0 / 0	When the switches are closed on the input, the master controls the output
	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 configuring the safety monitor

On measures related to the safety monitor that are required for organisation, please refer to the safety monitor documentation.

7.2 Installation

For installation of the module a suitable top hat DIN rail in accordance with DIN 50022 is recommended.

7.3 Addressing modules

Addressing of the module is performed by means of a manual addressing device or with an AS-Interface master. If a 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 included with delivery. Addresses from 1 to 31 can be assigned. The state as supplied is address 0.

7.4 Function test

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 AS-Interface can affect the behaviour of the outputs. For a more detailed description of connecting peripheral devices, consult section 5.

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8 Operation of 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 not be required.

9 Certificates

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

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A Application examples

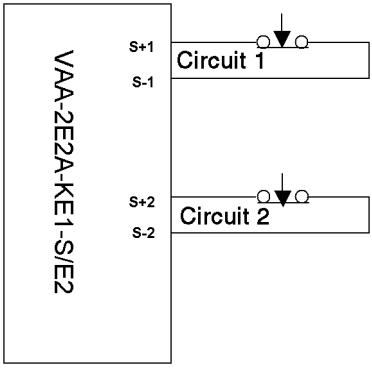
Note

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 the machine control system. Loss of the safety function will be detected by the test. The test intervals must be adjusted to match the application.

Connecting two independent mechanical position switches of Category 2:



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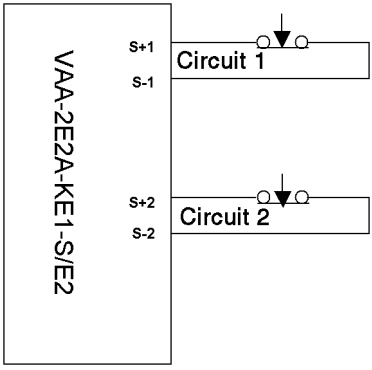
A.2 Category 3

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

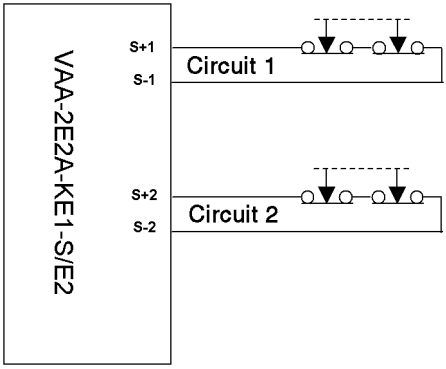
Connecting two dependent mechanical position switches per channel (2 safety functions)

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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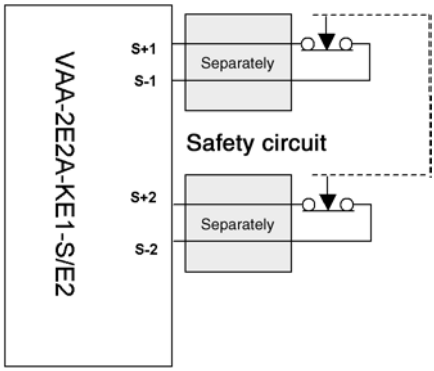
Example 3

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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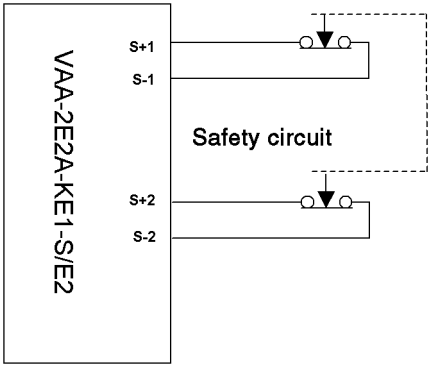
A.3 Category 4

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

Example 1

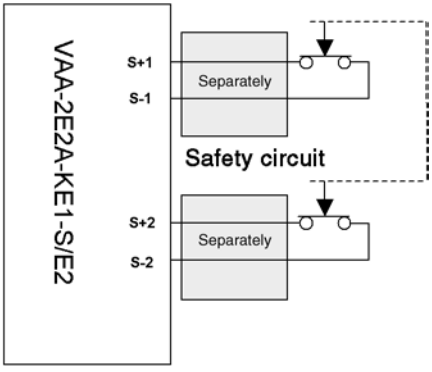
Connecting a dual-channel mechanical position switch.

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 VAA-2E2A-KE1-S/E2 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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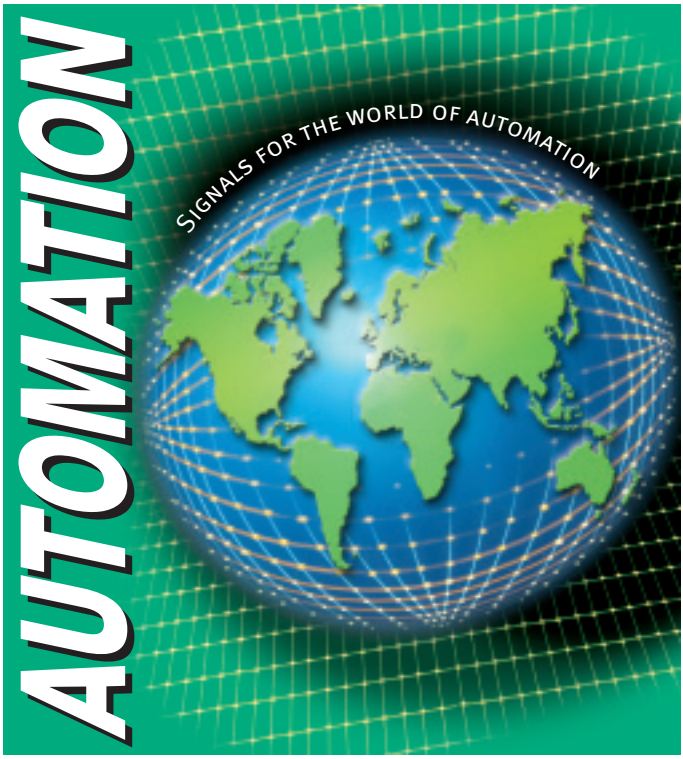

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