Correct use

The **C**oded **E**lectronic **S**afety switches series **VAA-...-IEI1...** are operated as slaves on the safety bus *AS-Interface Safety at Work* and are safety devices for monitoring movable safety guards.

They monitor movable safety guards so that

▸ dangerous work on machines can only be carried out if the safety guard is closed.

▸ a stop command is triggered if the guard is opened when the machine is running.

Before safety switches are used, a risk assessment must be performed on the machine in accordance with

▸ EN 954-1, Safety of machinery. Safety related parts of control systems. General principles for design, Annex B

▸ EN ISO 14121, Safety of machinery. Principles for risk assessment

▸ IEC 62061, Safety of machinery - Functional safety of safety-related electrical, electronic and program-mable electronic control systems.

Correct use includes compliance with the relevant requirements for installation and operation, particularly

▸ EN 954-1, Safety of machinery. Safety related parts of control systems. General principles for design

▸ EN 1088, Safety of machinery. Interlocking devices associated with guards. Principles for design and selection

▸ EN 60204-1, Safety of machinery. Electrical equipment of machines. General requirements

▸ EN 60947-5-3 Specification for low-voltage switchgear and controlgear. Control circuit devices and switching elements. Requirements for proximity devices with defined behaviour under fault conditions (PDF).

⚠ Safety precautions ⚠

Safety switches fulfill a personal protection function. Incorrect installation or tampering can lead to severe injuries to personnel.

⚠ Safety switches must **not** be bypassed (bridging of contacts), turned away, removed or otherwise rendered ineffective.

⚠ The switching operation must only be triggered by actuators specifically provided for this purpose which are permanently connected to the safety guard.

⚠ A complete safety-oriented system generally consists of several signaling devices, sensors, evaluation units and concepts for safe shut-down. The manufacturer of a machine or in-stallation is responsible for correct and safe overall function.

⚠ All safety precautions and specifications in the operating instructions for the AS-Interface safety monitor must be observed.

The safety switch VAA-...-IEI1... meets the following safety requirements

- Safety category 4 accordance to EN 954-1:1997

- Proximity device with self-monitoring type PDF-M according to EN 60947-5-3:2000

- Redundant design of the circuit in the evaluation unit with self-monitoring

- As a result the safety system is still effective even if a component fails

- Requirements acc. to SIL 3 as per EN 62061: 2005

- Performance Level „e" acc. to EN ISO 13849-1:2006.

Function

The non-contact safety switch VAA-...-IEI1... consists of three components:

▸ Coded actuator
▸ Read head
▸ Evaluation unit

The evaluation unit is integrated in a housing with a connection to the safety bus AS-Interface *Safety at Work*. It is possible to connect 1 ... 4 read heads to the M12 sockets. Each delivered actuator possesses a unique electronic coding and so is a unique element in the system used. The code in an actuator cannot be reprogrammed.

The read heads are fastened to the fixed part of the safety guard. The actuators attached to the movable part of the safety guard are moved towards the read head by closing the door. When the switch-on distance is reached, power is supplied to the actuator by the inductive read head and data can be transferred.

The bit pattern read is compared with the code saved in the evaluation unit; if the data match, a bit sequence is sent over the AS-Interface bus indicating the safety guard is closed.

Due to the dynamic polling of the actuator and the redundant, diverse design of the safety electronics, the evaluation unit will enter the safe state with every detectable fault.

When the safety guard is opened, the code sequence 0000 is sent over the AS-Interface bus.

The dwell time of an actuator inside and outside the operating distance must be at least 0.5 seconds. The state of the system is monitored internally by two microprocessors. On an internal fault in the evaluation unit, the safety circuit is switched off and the *OUT/ERROR* LED illuminates red. The evaluation unit is reset to the operating state by disconnecting the AS-Interface cable.

Polling the door position using parameter bits

The status of each activated input can be polled with the aid of the parameter bits P0 ... P3. If the actuator is in the read head's operating distance (door closed), the related parameter bit is set to HIGH. The following allocation applies: P0=IN1, P1=IN2 etc. At www.pepperl-fuchs.de you can download an example program that describes the parameter polling by the master.

Mounting and electrical connection

⚠ Mounting and electrical connection must be performed only by authorized personnel.

To ensure the degree of protection IP67 is achieved, a ribbon cable must be placed in both cable entries.

Unused inputs must be sealed using the sealing cap provided.

For use and operation as per the requirements of ᶜ⒰ᴸᵘˢ, an isolating transformer or a power supply with secondary overcurrent protection (3 A) must be used.

▸ Mount bottom of housing with four M4 screws

▸ Place yellow AS-Interface ribbon cable correctly aligned (pay attention to profile) in yellow cable entry

▸ Engage fastening straps on the top of the housing in the corresponding mounting hooks on the bottom of the housing and press onto the base plate

▸ Tighten fastening screw

▸ Connect the VAZ read heads to the read head inputs *IN* (M12 socket 5-pin) (see Figure 1)

The screen on the read head's connection cable must be connected to pin 3 *SH* on the read head input *IN* (M12 socket 5-pin).

Read head input *IN*
1 ▸ Not used
2 ▸ Data line
3 ▸ SH (screen)
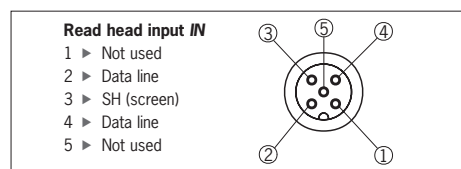4 ▸ Data line
5 ▸ Not used

Figure 1: Socket assignment (view of connection side)

Setup/teach-in function for new actuator

⚠ Setup must be performed only by authorized personnel.

The actuator must be allocated to the evaluation unit using a teach-in function before the system forms a functional unit. During a teach-in operation, the code sequence 0000 is sent over the AS-Interface bus, i.e. the system is in the safe state.

During setup, the parameters are set in the evaluation unit by the user using a teach-in operation (number of connected read heads, assignment of the actuators to the read heads). During this process the read heads are activated.

These configuration parameters are saved in the non-volatile memory in the evaluation unit.

To trigger a teach-in operation, the user must perform the following actions in the stipulated order:

① Prepare for teach-in operation

▸ Isolate device from the AS-Interface bus

▸ Unscrew right blanking cover (DIP switch for the teach-in mode) and set DIP switch 1 to ON. The device is then switched to the teach-in mode.

② Unscrew left blanking cover and set required configuration on the DIP switches for the read head activation (see following table)

Switch	OFF	ON
1	No read head on IN1	Read head on IN1
2	No read head on IN2	Read head on IN2
3	No read head on IN3	Read head on IN3
4	No read head on IN4	Read head on IN4

③ Close all doors to be monitored (the actuators must be in the operating distance of the related read head)

④ Start teach-in operation

▸ Connect device to the AS-Interface bus

▸ Wait for self-test (STATE LED flashes for approx. 10 seconds at 15 Hz)

▸ Teach-in operation starts (STATE LED flashes at approx. 1 Hz)

▸ Wait for acknowledgement of the teach-in operation (STATE LED goes out after approx. 10 seconds)

⑤ End teach-in operation

▸ Isolate device from the AS-Interface bus for at least 10 seconds

▸ Set DIP switch for the teach-in mode back to OFF and re-fit blanking cover. The device is then switched back to normal operation.

▸ Connect device to the AS-Interface bus

▸ Wait for self-test (STATE LED flashes for approx. 10 seconds at 15 Hz)

Addressing

The device address can be set using either the AS-Interface safety bus or using the addressing socket on the device.

Configuration in the AS-Interface safety monitor (refer to the operating instructions for the AS-Interface safety monitor)

The safety switch is configured in the AS-Interface safety monitor with the AS-Interface address set as follows, for example:

▸ dual-channel dependent

▸ with start-up test

▸ synchronization time = 0.5 seconds

In this operating mode, the safety guard must be opened each time prior to restarting in order to perform the start-up test.

AS-Interface status messages

The ASI PWR (green) and FAULT (red) LED indicators indicate the status messages on the AS-Interface bus. The following table provides assistance with troubleshooting.

LED state		Explanation
ASI PWR Green	FAULT Red	
on	off	Normal operation
on	on	No data exchange between master and slave Cause: - Master in the STOP mode - Slave not in LPS - Slave with incorrect IO/ID - Reset active on the slave
flashing	on	No data exchange between master and slave Cause: Slave address =0
flashing	flashing	Device fault in the slave. Contact P+F.
on	flashing	

Function test

▸ Close the safety guard.

Start the machine.

Machine **must** stop immediately when the safety guard is opened!

▸ Switch off the machine.

Open the safety guard.

The machine must **not** start when the safety guard is open!

Service and inspection

No servicing is required on the battery-less actuator, but **regular inspection** of the following is necessary to ensure trouble-free long-term operation:

▸ Secure fastening of the actuator and the read head (use of safety screws included)

▸ Sealing of the plug connector on the evaluation unit

▸ Loose cable connections on the evaluation unit

▸ Switch-off distance check

▸ A function test should be performed at least once a year.

Shorter intervals may be necessary depending on the specific application.

Exclusion of liability under the following circumstances

▸ if the unit is not used for its intended purpose

▸ non-compliance with safety regulations

▸ mounting and electrical connection not performed by authorized personnel

▸ non-implementation of functional checks

▸ if modifications are made.

| Bit sequence on AS-Interface bus	LED STATE (green)	LED OUT/ERROR (yellow)	LED OUT/ERROR (red)	State
Normal operation				
safe code sequence	on	on	off	All monitored doors are closed
0000	on	off	off	All monitored doors are not closed
0000	off	off	on	Device-internal component failure or excessively high external interference (EMC) or actuator in the operating distance for less than 0.5 s
0000	flashing 15 Hz	off	off	Self-test after connecting to the AS-Interface bus Duration approx. 10 s
Initial setup				
0000	flashing 4 Hz continuously	off	off	Initial setup, ready for teach-in operation
0000	flashing 1 Hz	off	off	Teach-in operation
0000	off	off	off	Teach-in operation complete, switch off device for setup
Operating fault				
0000	continuous flashing 3 times	off	on	Configuration fault: Teach-in operation must be performed again. Possible causes: - State change during the teach-in operation - None of the DIP switches in ON position - DIP switch setting and connected configuration did not match during teach-in operation - DIP switch setting has been changed without teach-in operation - DIP switch for the teach-in mode changed with power supply switched on

Table 1: System states
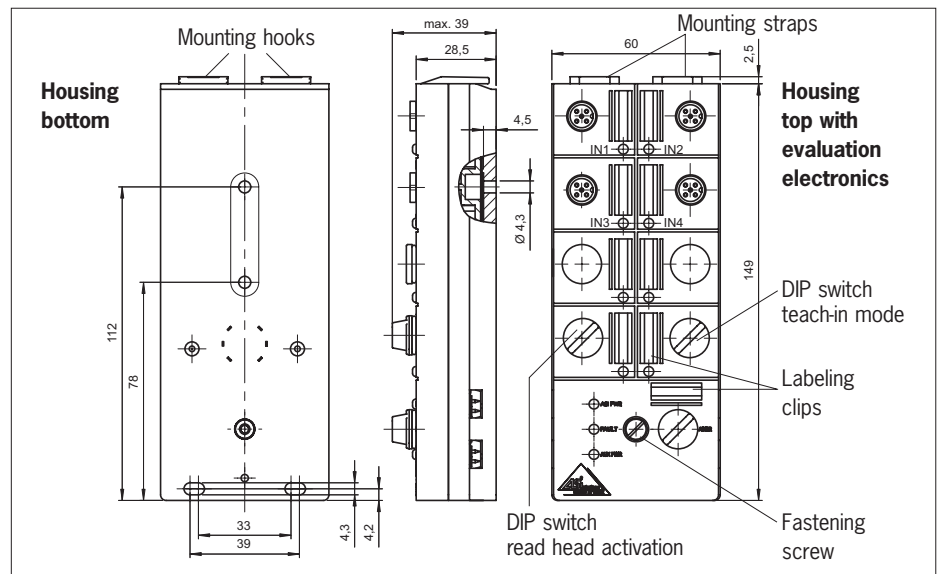
Figure 2: Dimension drawing VAA-4E-IEI... CONTROL-...)

Technical data

Parameters	Value		
Housing material	Plastic		
Degree of protection according to IEC/EN 60529:2000	IP67		
Category according to EN 954-1:1997	4		
Classification according to EN 60947-5-3:2000	PDF-M		
Ambient temperature	0 ... +50 °C		
Weight	Approx. 0.4 kg		
AS-Interface data acc. to AS-Interface specification 3.0	EA code: 0 ID code: B		
Operating voltage AS-Interface	DC 22.5 ...31.6 V		
Total current consumption max.	130 mA		
Valid AS-Interface addresses	1 - 31		
AS-Interface inputs	Acc. to AS-Interface Safety at Work		
Activated read head inputs for VAA-4E-IEI1-CONTROL-J-S *IN1 - IN4* (4 M12 sockets, 5-pin)	AS-Interface bit P0 - P3 D0		
Times			
Dwell time min.	0.5 s		
Time-delay from state change [1]			
- 4 activated actuators	450 ms		
- 3 activated actuators	370 ms		
- 2 activated actuators	290 ms		
- 1 activated actuator	210 ms		
Difference time (for the two dependent AS-Interface inputs)	400 ms (with 4 monitored read heads)		
Ready delay	12 s		
Distances [2]	**min.**	**typ.**	**max.**
Safe switch-off distance S_{ar}	-	-	32 mm
Cable length l = 0 ... 25 m			
Switch-on distance S_{a0}	10 mm	15 mm	-
Switching hysteresis	0.5 mm	2 mm	-
Cable length l ≥ 25 ... 50 m			
Switch-on distance S_{a0}	8 mm	12 mm	-
Switching hysteresis	0.4 mm	1.6 mm	-

1) Corresponds to the risk time according to EN 60947-5-3. This is the maximum switch-off delay for the safety outputs following removal of the actuator. In case of EMC interference in excess of the requirements in accordance with EN 60947-5-3, the switch-off delay can increase to max. 750 ms. After a brief actuation < 0.8 s, the switch-on delay can increase to max. 3 s if this is followed immediately by further actuation.

2) With evaluation unit VAA-4E-IEI1-CONTROL-J-S in conjunction with read head VAZ-IEI1-READER1-S-V3 and actuator VAZ-IEI1-TAG1-S on surface mounting of the read head and the actuator. If installed flush, the switching distance changes as a function of the installation depth and the safety guard material.

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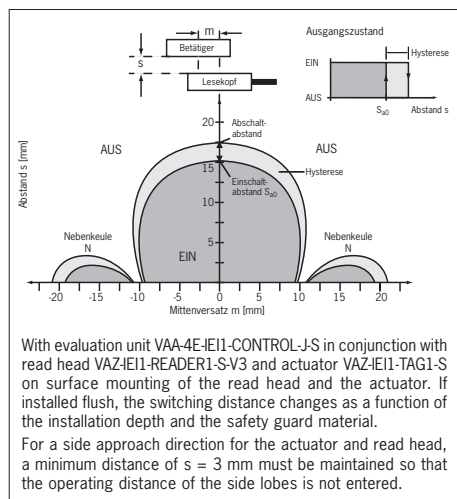For a side approach direction for the actuator and read head, a minimum distance of s = 3 mm must be maintained so that the operating distance of the side lobes is not entered.

Fig. 3: Typical operating distance