SAFETY MANUAL

SH 3962-4 EN

Translation of original instructions

Type 3962-4 Solenoid Valve

SIL/PL Capability

TÜVRheinland CERTIFIED

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Definition of signal words

⚠ DANGER

Hazardous situations which, if not avoided, will result in death or serious injury

⚠ WARNING

Hazardous situations which, if not avoided, could result in death or serious injury

NOTICE

Property damage message or malfunction

Note

Additional information

Tip

Recommended action

Purpose of this manual

The Safety Manual SH 3962-4 contains information relevant for the use of the Type 3962-4 Solenoid Valve in safety-instrumented systems according to IEC 61508 and IEC 61511. The safety manual is intended for planners, constructors and operators of safety-instrumented systems.

NOTICE

Risk of malfunction due to incorrect mounting, connection or start-up of the device.

➔ *Refer to the Mounting and Operating Instructions EB 3962-4 on how to mount the device, perform the electric and pneumatic connections as well as start up the device.*

➔ *Observe the warnings and safety instructions written in the Mounting and Operating Instructions EB 3962-4.*

Further documentation

The documents listed below contain descriptions of the start-up, functioning and operation of the solenoid valve. You can download these documents from our website.

- T 3962: Data sheet
- EB 3962-4: Mounting and operating instructions

Note

In addition to the solenoid valve documentation, observe the documentation for the pneumatic actuator, valve and other valve accessories.

Contents

1 Scope

1.1 General

The Type 3962-4 Solenoid Valve consists of a pilot valve and a booster valve. It converts voltage signals into pneumatic control signals. It is used to control pneumatic rotary and linear actuators with spring-return mechanism.

1.2 Use in safety-instrumented systems

Observing the requirements of IEC 61508, the systematic capability of the solenoid valve for emergency venting as a component in safety-instrumented systems is given.

Use of the solenoid valve is possible on observing the requirements of IEC 61511 and the required hardware fault tolerance in safety-instrumented systems up to SIL 2 (single device/ HFT = 0) and SIL 3 (redundant configuration/HFT = 1).

The solenoid valve is regarded as a type A device according to IEC 61508-2 in view of its safety functions.

1.3 Versions and ordering data

All versions of the solenoid valve marked with the prefix **SIL** are suitable for use in safety-instrumented systems. The article code written on the nameplate (see table on page 6 to 7) provides details on the optional equipment of the solenoid valve.

Article code

Solenoid valve Type 3962-	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Type of protection																				
Ex em	**SIL**	**4**																		
Nominal signal																				
24 V AC/DC	**SIL**	**2**	**0**																	
230 V AC/DC	**SIL**	**4**	**0**																	
Explosion protection certificate																				
II 2G Ex eb em IIC T4/T5/T6 Gb II 2D Ex tb IIIC T4/T5/T6 (ATEX) [1]	**SIL**	**3**	**1**	**0**																
Manual override																				
Without	**SIL**	**0**																		
Switching function																				
3/2-way function with spring-return mechanism	**SIL**	**0**																		
5/2-way function with spring-return mechanism		**1**																		
5/2-way function with two detent positions		**2**																		
5/3-way function with spring-centered mid-position (ports 2 and 4 closed)		**3**																		
5/3-way function with spring-centered mid-position (ports 2 and 4 supplied with air)		**4**																		
5/3-way function with spring-centered mid-position (ports 2 and 4 vented)		**5**																		
6/2-way function with spring-return mechanism		**6**																		
Attachment																				
NAMUR interface according to VDI/VDE 3845	**SIL**	**0**																		
Threaded connection for wall or pipe mounting	**SIL**	**1**																		
CNOMO interface, 30 mm (pilot valve as spare part)	**SIL**	**2**																		

[1] According to EC type examination certificate BVS 15 ATEX E 029 X.

(continued from page 6)

Solenoid valve Type 3962-	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
K_{VS} [1]																					
1.4											**3**										
4.3									**SIL**		**4**										
0.05 (pilot valve as spare part)									**SIL**		**5**										
2.9 [1]											**6**										
2.0									**SIL**		**7**										
Material																					
Aluminum										**SIL**	**0**										
Pneumatic connection																					
G ¼											**SIL**	**0**									
¼ NPT											**SIL**	**1**									
G ½											**SIL**	**2**									
½ NPT											**SIL**	**3**									
Without threaded connections (pilot valve as spare part)											**SIL**	**4**									
Pilot supply																					
Internal pilot supply for actuators for on/off service												**SIL**	**0**								
External pilot supply for actuators for throttling service												**SIL**	**1**								
Electrical connection																					
Cable gland M20x1.5, black polyamide												**SIL**		**0**	**1**						
Degree of protection																					
IP 65															**SIL**	**1**					
Ambient temperature [2]																					
–20 to +60 °C																**SIL**	**1**				
Safety approval																					
Without																		**0**			
SIL [3]																	**SIL**	**1**			
Special version																					
Without																		**SIL**	**0**	**0**	**0**

[1] The air flow rate when p_1 = 2.4 bar and p_2 = 1.0 bar is calculated using the following formula: $Q = K_{VS} \times 36.22$ in m³/h.

[2] The maximum permissible ambient temperature of the solenoid valve depends on the permissible ambient temperature of the components, type of protection and temperature class.

[3] SIL according to IEC 61508

1.4 Mounting versions

The solenoid valve is suitable for the following types of attachment in combination with various mounting parts:

– Attachment to rotary actuators with NAMUR interface according to VDI/VDE 3845
– Attachment to linear actuators with NAMUR rib according to IEC 60534-6-1
– Pipe mounting

2 Technical data

General data for pilot valve		
Type		**3962-4**
Design		Solenoid and poppet valve with return spring
Degree of protection		IP 65
Material	Casting compound	Polyurethane
	Enclosure	Polyamide and powder-coated aluminum, gray beige
	Internal parts	Stainless steel and nickel-plated brass
	Screws	Stainless steel
	Seals	Nitrile butadiene rubber
Mounting orientation		Any desired position
Approx. weight		550 g or 650 g

Electrical data for pilot valve with type of protection increased safety and encapsulation Ex em			
Type		**3962-42**	**3962-44**
Nominal signal	U_N	24 V AC/DC (–15 to +10 %), 40 to 65 Hz	230 V AC/DC (–15 to +10 %), 40 to 65 Hz
Power consumption		1.8 W	
Duty cycle		100 %	
Ambient temperature [1] in temperature class	T6	–20 to +50 °C	
	T5	–20 to +60 °C	
Connection		M20x1.5 cable gland	

Pneumatic data for pilot valve		
Type		**3962-4**
Supply	Medium	Instrument air or nitrogen
	Pressure	1.4 to 8 bar
Output signal		Same pressure as pilot supply
Air consumption		No air consumption
K_{VS} [2]		0.05
Switching time		30 ms
Control pressure connection		CNOMO interface

[1] The maximum permissible ambient temperature of the solenoid valve depends on the permissible ambient temperature of the components, type of protection and temperature class.

[2] The air flow rate when p_1 = 2.4 bar and p_2 = 1.0 bar is calculated using the following formula: $Q = K_{VS} \times 36.22$ in m^3/h.

Booster valve, actuated on one side, K_{VS} 4.3, with threaded connections				
Switching function		3/2-way function	5/2-way function	6/2-way function
K_{VS} [1] (direction of flow)		1.9 (4»3), 1.5 (3»4), 4.3 (3»5), 4.7 (5»3)		
Safety function		**SIL** [2]	–	–
Design		Poppet valve with diaphragm actuator, soft seated, with return spring		
Material	Enclosure	Aluminum, powder coated, gray beige RAL 1019 or stainless steel 1.4404		
	Diaphragms	Chloroprene rubber (–20 to +80 °C) or silicone rubber (–45 to +80 °C)		
	Seals	Chloroprene rubber (–20 to +80 °C) or silicone rubber (–45 to +80 °C)		
	Springs	Stainless steel 1.4310		
	Screws	Stainless steel 1.4571		
Actuation		Controlled on one side by a pilot valve		
Operating medium		Instrument air (free from corrosive substances) or nitrogen [3], Instrument air (free from corrosive substances), air containing oil or non-corrosive gases [4]		
Compressed air quality according to ISO 8573-1		Particle size and density: Class 4 · Oil content: Class 3 · Pressure dew point: Class 3 or at least 10 K below the lowest ambient temperature to be expected		
Max. operating pressure [5]		Max. 10.0 bar		
Output signal		Operating pressure		
Pneumatic connection		G ½ or ½ NPT		
Ambient temperature [6]		–20 to +80 °C, –45 to +80 °C		
Approx. weight		585 g	1100 g	

1) The air flow rate when p_1 = 2.4 bar and p_2 = 1.0 bar is calculated using the following formula: $Q = K_{VS} \times 36.22$ in m^3/h.
2) SIL according to IEC 61508
3) With internal pilot supply
4) With external pilot supply
5) To control the booster valve in the reversed direction of flow (3»4), the supply pressure must be higher than the operating pressure.
6) The maximum permissible ambient temperature of the solenoid valve depends on the permissible ambient temperature of the components, type of protection and temperature class.

Booster valve, actuated on one side, K_{VS} 2.0 or 4.3, with NAMUR interface			
Switching function		3/2-way function with exhaust air feedback	
K_{VS} [1] (direction of flow)		1.1 (4»3) 2.0 (3»5)	1.9 (4»3) 4.3 (3»5)
Safety function		**SIL** [2]	
Design		Poppet valve with diaphragm actuator, soft seated, with return spring	
Material	Enclosure	Aluminum, powder coated, gray beige RAL 1019 or stainless steel 1.4404	
	Diaphragms	Chloroprene rubber (–20 to +80 °C) or silicone rubber (–45 to +80 °C)	
	Seals	Chloroprene rubber (–20 to +80 °C) or silicone rubber (–45 to +80 °C)	
	Springs	Stainless steel 1.4310	
	Screws	1.4571	
Actuation		Controlled on one side by a pilot valve	
Operating medium		Instrument air (free from corrosive substances) or nitrogen [3], Instrument air (free from corrosive substances), air containing oil or non-corrosive gases [4]	
Compressed air quality according to ISO 8573-1		Particle size and density: Class 4 · Oil content: Class 3 · Pressure dew point: Class 3 or at least 10 K below the lowest ambient temperature to be expected	
Max. operating pressure		Max. 10.0 bar	
Output signal		Operating pressure	
Pneumatic connection	Supply	G ¼ or ¼ NPT and NAMUR interface ¼" [5] with G ⅜ / ⅜ NPT	G ½ or ½ NPT and NAMUR interface ½" [5]
	Exhaust	G ½ or ½ NPT and NAMUR interface ¼" [5] with G ⅜ / ⅜ NPT	G ½ or ½ NPT and NAMUR interface ½" [5]
Ambient temperature [6]		–20 to +80 °C, –45 to +80 °C	
Approx. weight		1380 g	1500 g

1) The air flow rate when p_1 = 2.4 bar and p_2 = 1.0 bar is calculated using the following formula: $Q = K_{VS} \times 36.22$ in m³/h.
2) SIL according to IEC 61508
3) With internal pilot supply
4) With external pilot supply
5) NAMUR interface according to VDI/VDE 3845
6) The maximum permissible ambient temperature of the solenoid valve depends on the permissible ambient temperature of the components, type of protection and temperature class.

3 Safety-related functions

Emergency venting

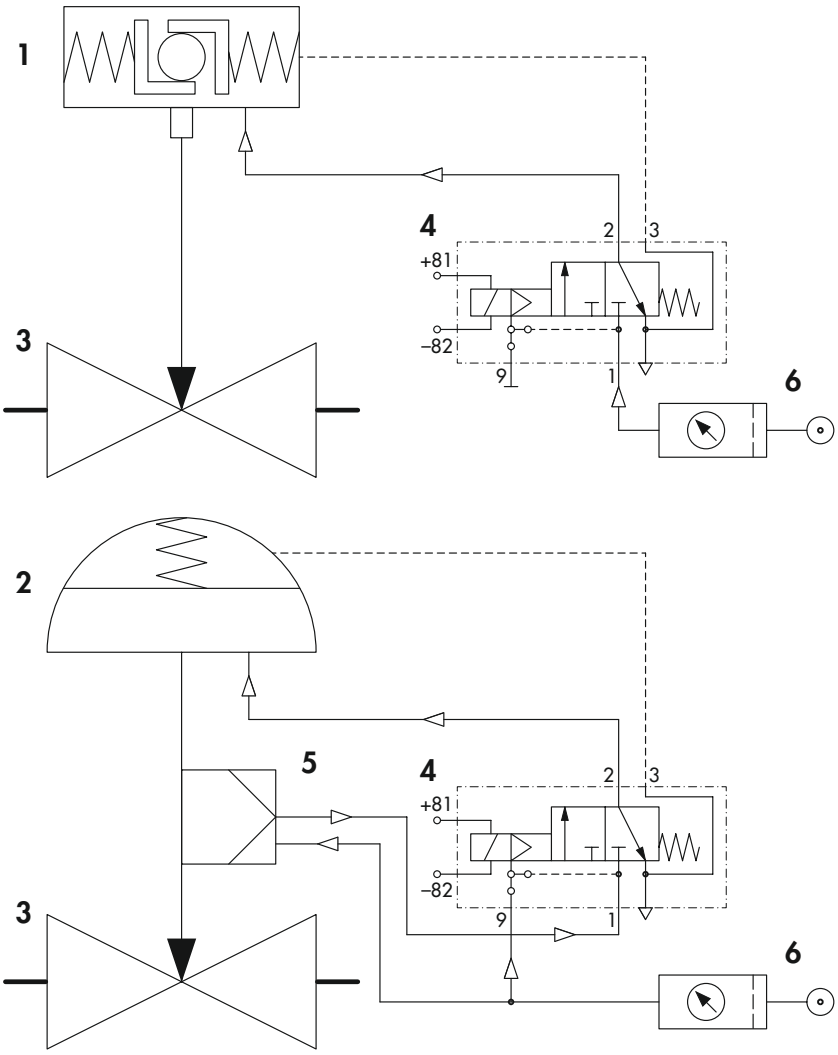
The solenoid valve is energized by a binary voltage signal. Fail-safe action is triggered when no voltage signal (0 V AC/DC) is applied to terminals + and –. The solenoid valve vents to the atmosphere and the actuator is vented as well (see Fig. 1, page 13).

3.1 Fail-safe action

Fail-safe action is triggered by the solenoid valve and upon supply air failure.
The solenoid valve fully discharges its pneumatic output to the atmosphere, causing the mounted actuator to be vented. As a result, the valve moves to the fail-safe position. The fail-safe position depends on how the springs are arranged in the pneumatic actuator (air-to-close or air-to-open).

4 Mounting, connection and start-up

Refer to Mounting and Operating Instructions ▶ EB 3962-4 on how to mount the solenoid valve, perform the electric and pneumatic connections as well as start up the solenoid valve. Only use original mounting parts and accessories.



1 Rotary actuator
2 Linear actuator
3 Valve
4 Solenoid valve
5 Pneumatic positioner
6 Compressed air supply

Fig. 1: *Functional diagram showing emergency venting in actuators for on/off and throttling service*

5 Required conditions

⚠ WARNING

Risk of malfunction due to incorrect selection or wrong installation and operating conditions.

➔ *Only use control valves in safety-instrumented systems if the necessary conditions in the plant are fulfilled. This also applies to the mounted solenoid valve.*

5.1 Selection

➔ The required transit times of the control valve are observed.
The transit times to be implemented are determined by the process engineering requirements.

➔ The solenoid valve is suitable for the prevailing ambient temperature.

Versions	Temperature range
With diaphragm and seals made of chloroprene rubber	–20 to +60 °C
With diaphragm and seals made of silicone rubber	–20 to +60 °C
With plastic cable gland	–20 to +60 °C
With metal cable gland	–20 to +60 °C
The specifications in the test certificates additionally apply to explosion-protected versions.	

➔ The temperature limits are observed.

5.2 Mechanical and pneumatic installation

➔ The solenoid valve is mounted properly as described in the mounting and operating instructions and connected to the air supply.

➔ The maximum supply pressure does not exceed 8.0 (10.0) bar.

➔ The supply air meets the instrument air specifications.

Particle size and quantity	Oil content	Pressure dew point
Class 4	Class 3	Class 3
≤5 µm and 1000/m³	≤1 mg/m³	–20 °C or at least 10 K below the lowest ambient temperature to be expected

Tip

We recommend installing a supply pressure regulator/filter upstream of the device. For example, Type 3999-009x Service Unit or Type 3999-0096 Filter Regulator can be used.

- ➔ The external pilot supply line (9) has a minimum inside diameter of 4 mm and the internal pilot supply line (4) has a minimum inside diameter of 9 mm.
  See "Sizing of the connecting line" in the mounting and operating instructions ▶ EB 3962-4.
- ➔ Select the cross section and length of the line to ensure that the supply pressure at the device on supplying air does not fall below the minimum limit of 1.4 bar.
- ➔ The solenoid valve is mounted as prescribed.
- ➔ The exhaust opening on the solenoid valve remains open when the solenoid valve is installed on site.

5.3 Electrical installation

- ➔ The solenoid valve is mounted properly as described in the mounting and operating instructions and connected to the electric power supply.
- ➔ Only cables whose outside diameters are suitable for the cable glands are used.
- ➔ The cable glands and enclosure cover screws are fastened tightly to ensure that the degree of protection is met.
- ➔ The installation requirements for the applicable explosion protection measures are observed.
- ➔ The special conditions specified in the explosion protection certificates are observed.

6 Proof testing (periodic testing)

The proof test interval and the extent of testing lie within the operator's responsibility. The operator must draw up a test plan, in which the proof tests and the interval between them are specified. We recommend summarizing the requirements of the proof test in a checklist.

⚠ WARNING

Risk of dangerous failure due to malfunction in the event of emergency (actuator is not vented or the valve does not move to the fail-safe position).

➔ *Only use devices in safety-instrumented systems that have passed the proof test according to the test plan drawn up by the operator.*

Regularly check the safety-instrumented function of the entire SIS loop. The test intervals are determined, for example on calculating each single SIS loop in a plant (PFD_{avg}).

6.1 Function testing

Regularly check the safety function according to the test plan drawn up by the operator.

Refer to the SIL proof test when large deviations occur or any other irregularities. The necessary documentation for this is provided by SAMSON.

The SIL proof test can be performed by SAMSON on request.

i *Note*

Record any device faults and e-mail (aftersalesservice@samsongroup.com) them to SAMSON.

➔ In case of internal pilot supply, air with the permissible operating pressure from 1.4 to 8.0 bar is applied to port 4.
In case of external pilot supply, air with the maximum operating pressure of 8.0 (10.0) bar or the maximum available operating pressure must be applied to port 9. On using an upstream positioner, adjust it so that the maximum output pressure is available at the positioner output.

➔ Apply the nominal voltage U_N specified on the nameplate to the solenoid valve.

➔ Check whether the valve moves to its end position on demand.

➔ De-energize the solenoid valve.

Check whether the actuator is fully vented within the demanded time (fail-safe position).

Tip

Connect a pressure gauge to check that the actuator has completely vented.

➔ Record the valve transit time and compare it to the time the valve took at start-up and during proof tests.

6.2 Visual inspection to avoid systematic failure

To avoid systematic failure, inspect the solenoid valve regularly. The frequency and the scope of the inspection lie within the operator's responsibility. Take application-specific influences into account, such as:

– Dirt blocking the pneumatic connections
– Corrosion (destruction primarily of metals due to chemical and physical processes)
– Material fatigue
– Aging (damage caused to organic materials, e.g. plastics or elastomers, by exposure to light and heat)
– Chemical attack (organic materials, e.g. plastics or elastomer, which swell, leach out or decompose due to exposure to chemicals)

NOTICE

Risk of malfunction due to the use of unauthorized parts.

➔ *Only use original parts to replace worn parts.*

7 Repairs

Only perform the work on the solenoid valve described in ▶ EB 3962-4.

Only use the specified original mounting parts.

8 Safety-related data and certificates

The Type 3962-4 Solenoid Valves consist of a FESTO pilot valve VOFC-LT-M32C and a SAMSON Type 3756 Booster Valve. The versions with ¼ NAMUR interface (K_{VS} 2.0) and with ½ NAMUR interface (K_{VS} 4.3) as well as with ½ threaded connection for pipe mounting are suitable for use in safety-instrumented systems according to IEC 61508. The devices have an HFT of 0 and can be used up to SIL 2 (single device, HFT = 0) and SIL 3 (redundant configuration, HFT = 1) according to IEC 61511.

Verification must be performed taking into account the following certificates issued by TÜV Rheinland®.

Certificate

SIL/PL Capability

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ID 0000000000

No.: 968/V 1160.00/20

Product tested	Electromagnetic control, solenoid, booster valves and electrical position feedback	**Certificate holder**	SAMSON AG Weismüllerstr. 3 60314 Frankfurt / Main Germany
Type designation	3963, 3967, 3964, 3756, 3701, 3968, 3776 (with option solenoid valve as well as safe indication of end positions)		
Codes and standards	IEC 61508 Parts 1-2 and 4-7:2010		
Intended application	Safety Function: Safe venting (and safe indication of end positions) The test items are suitable for use in a safety instrumented system up to SIL 2 (low demand mode). Under consideration of the minimum required hardware fault tolerance HFT = 1 the valves may be used in a redundant architecture up to SIL 3 according to IEC 61508 and IEC 61511-1:2016 + AMD1:2017.		
Specific requirements	The instructions of the associated Installation, Operating and Safety Manual shall be considered.		

Summary of test results see back side of this certificate.

Valid until 2025-05-04

The issue of this certificate is based upon an examination, whose results are documented in Report No. 968/V 1160.00/20 dated 2020-05-04.
This certificate is valid only for products which are identical with the product tested.

TÜV Rheinland Industrie Service GmbH
Bereich Automation
Funktionale Sicherheit
Am Grauen Stein, 51105 Köln

Köln, 2020-05-04

Certification Body Safety & Security for Automation & Grid

Dipl.-Ing. Gebhard Bouwer

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TÜVRheinland®
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Holder: SAMSON AG
Weismüllerstraße 3
60314 Frankfurt am Main
Germany

Product tested: Electromagnetic control, solenoid and booster valves of the types
3963, 3967, 3964, 3756, 3701, 3968 [4],
3776 (with option "solenoid valve" as well as "safe indication of end positions")

Results of Assessment

Route of Assessment		2_H / 1_S
Type of Sub-system		Type A
Mode of Operation		Low Demand Mode

Safe venting - Type 3701, 3963, 3967, 3776 (with option solenoid valve)

Hardware Fault Tolerance	HFT	0	
Lambda Dangerous Undetected [1]	λ_{DU}	8.02 E-08 / h	80 FIT
Average Probability of Failure on Demand [2]	**$PFD_{avg}(T_1)$**	**3.51 E-04**	

Safe indication of end positions - Type 3776 (only with inductive proximity switches)

Hardware Fault Tolerance	HFT	0	
Lambda Dangerous Undetected [1]	λ_{DU}	7.35 E-08 / h	74 FIT
Average Probability of Failure on Demand [2]	**$PFD_{avg}(T_1)$**	**3.22 E-04**	

Safe venting - Type 3756

Hardware Fault Tolerance	HFT	0 (1 as variant, see report)	
Lambda Dangerous Undetected [1]	λ_{DU}	8.38 E-08 / h	84 FIT
Average Probability of Failure on Demand [2]	**$PFD_{avg}(T_1)$**	**3.67 E-04**	
Average Probability of Failure on Demand 1oo2 [3]	**$PFD_{avg}(T_1)$**	**3.69 E-05**	

Safe venting - Type 3964 pilot valve

Hardware Fault Tolerance	HFT	0	
Lambda Dangerous Undetected [1]	λ_{DU}	5.12 E-09 / h	5 FIT
Average Probability of Failure on Demand [2]	**$PFD_{avg}(T_1)$**	**2.24 E-05**	

[1] assumed Diagnostic Coverage DC = 0 %

[2] assumed Proof Test Interval T_1 = 1 year

[3] assumed Proof Test Interval T_1 = 1 year and β_{1oo2} = 10 %

[4] The solenoid valve manifold of type 3968 is a combination of the control valves 3756 and the pilot valves 3964. The failure rates must be determined for each individual applicationfrom the given characteristic values of the single components.

Origin of values

The stated failure rates are the result of an FMEDA with tailored failure rates for the design and manufacturing process.
Furthermore the results have been verified by qualification tests and field-feedback data of the last 5 years.
Failure rates include failures that occur at a random point in time and are due to degradation mechanisms such as ageing.
The stated failure rates do not release the end-user from collecting and evaluating application-specific reliability data.

Systematic Capability

The development and manufacturing process and the functional safety management applied by the manufacturer in the relevant lifecycle phases of the product have been audited and assessed as suitable for the manufacturing of products for use in applications with a maximum Safety Integrity Level of 3 (SC 3).

Periodic Tests and Maintenance

The given values require periodic tests and maintenance as described in the Safety Manual.
The operator is responsible for the consideration of specific external conditions (e.g. ensuring of required quality of media, max. temperature, time of impact), and adequate test cycles.

TÜV Rheinland Industrie Service GmbH, Am Grauen Stein, 51105 Köln / Germany

Certificate

No.: 968/V 1251.00/21

Product tested	3/2-way solenoid valve, normally closed	**Certificate holder**	Festo SE & Co. KG Ruiter Straße 82 73734 Esslingen Germany
Type designation	VOFC-LT-M32C-..., in combination with solenoid of type VACC-S13-... VOFD-L50T-M32-...F10, in combination with solenoid of type VACC-S18-...		
Codes and standards	EN 61508 Parts 1-2 and 4-7:2010		
Intended application	Safety Function: Taking the safe position by de-energize the solenoid (Safe venting of output / input port 2, if power supply is cut off.) The valves are suitable for use in a safety instrumented system up to SIL 2 (low and high demand mode). Under consideration of the minimum required hardware fault tolerance HFT = 1 for the complete final element, the valves may be used up to SIL 3.		
Specific requirements	The instructions of the associated Installation, Operating and Safety Manual shall be considered.		

Summary of test results see back side of this certificate.

Valid until 2027-01-04

The issue of this certificate is based upon an evaluation in accordance with the Certification Program CERT FSP1 V1.0:2017 in its actual version, whose results are documented in Report No. 968/V 1251.00/21 dated 2021-12-07. This certificate is valid only for products, which are identical with the product tested.

TÜV Rheinland Industrie Service GmbH
Bereich Automation
Funktionale Sicherheit

Köln, 2022-01-04 — Certification Body Safety & Security for Automation & Grid — Dipl.-Ing. (FH) Wolf Rückwart

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Holder: Festo SE & Co. KG
Ruiter Str. 82
73734 Esslingen
Germany

Product tested: **3/2-way Solenoid Valves (NC)**
- VOFC-LT-M32C-... in combination with solenoids of type VACC-S13-...
- VOFD-L50T-M32-...F10 in combination with solenoids of type VACC-S18-...

Results of Assessment

Route of Assessment		2_H / 1_S
Type of Sub-system		Type A
Mode of Operation		Low Demand Mode/High Demand Mode
Hardware Fault Tolerance	HFT	0
Systematic Capability		SC 3

Safety Function: Taking the safe position by de-energize the solenoid

Low Demand Mode

Dangerous Failure Rate	λ_D	1.18 E-07 / h	118 FIT
Average Probability of Failure on Demand 1oo1	$PFD_{avg}(T_1)$	5.25 E-04	
Average Probability of Failure on Demand 1oo2	$PFD_{avg}(T_1)$	5.28 E-05	

Assumptions for the calculations above: DC = 0 %, T_1 = 1 year, MRT = 72 h, β_{1oo2} = 10 %

High Demand Mode

Nominal Lifetime	B_{10d}	1,478,101
Average Frequency of a Dangerous Failure per Hour	PFH	6.8 E-08 / h

Origin of failure rates

The stated failure rates for low demand mode are the result of an FMEDA with tailored failure rates for the design and manufacturing process. The failure rates for high demand are the result of endurance tests. The results have been verified by qualification tests and field-feedback data.
Failure rates include failures that occur at a random point in time and are due to degradation mechanisms such as ageing. The stated failure rates do not release the end-user from collecting and evaluating application-specific reliability data.

Systematic Capability

The development and manufacturing process and the functional safety management applied by the manufacturer in the relevant lifecycle phases of the product have been audited and assessed as suitable for the manufacturing of products for use in applications with a maximum Safety Integrity Level of 3 (SC 3).

Periodic Tests and Maintenance

The given values require periodic tests and maintenance as described in the Safety Manual.
The operator is responsible for the consideration of specific external conditions (e.g. ensuring of required quality of media, max. temperature, time of impact), and adequate test cycles.
If the periodic tests are performed as prescribed the useful lifetime can be up to 14 years according to the current state of knowledge.

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