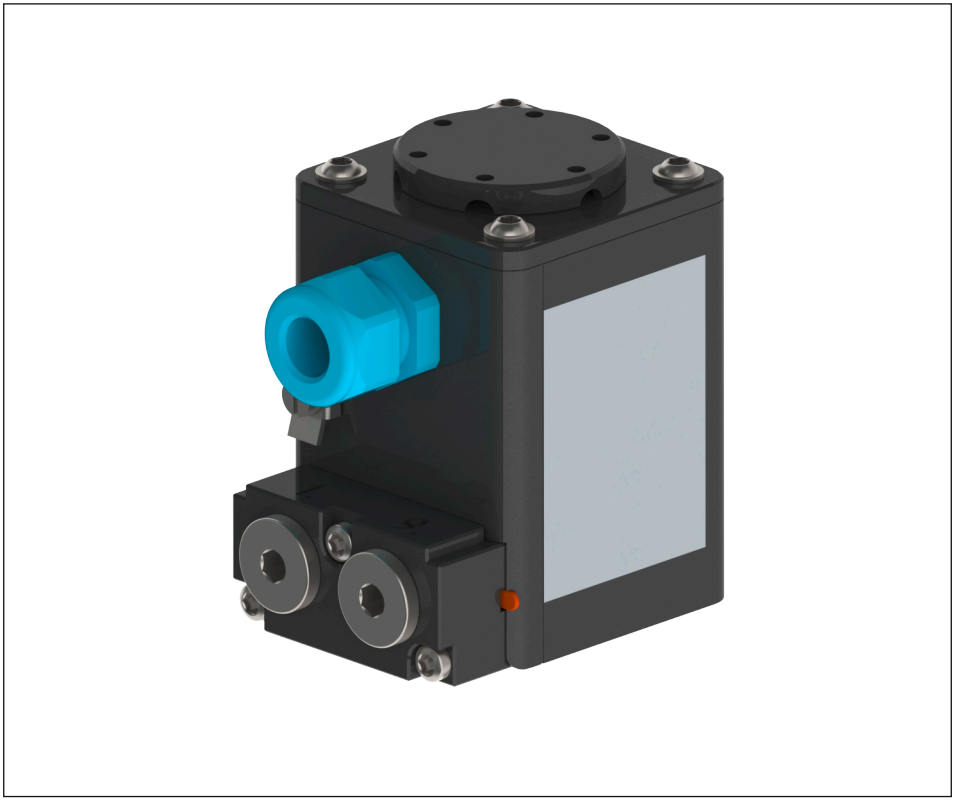
SAFETY MANUAL

SH 3969 EN

Translation of original instructions



Type 3969 Solenoid Valve

Edition June 2024

CE Ex certified

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 3969 contains information relevant for the use of the Type 3969 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 3969 on how to mount the positioner, 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 3969.

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 the SAMSON website. The documents marked with an asterisk (*) are supplied with the solenoid valve either in printed or electronic form.

- T 3969: Data sheet
- EB 3969 *: Mounting and operating instructions

Note

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

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1 Scope

General

The Type 3969 Solenoid Valve converts binary voltage signals into pneumatic control signals. It is used to control pneumatic rotary and linear actuators with spring-return mechanism.

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 individual safety functions of the solenoid valve are to be regarded as Type A elements in accordance with IEC 61508-2.

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i ***Note***

The architecture and the interval between proof tests must be changed accordingly for a higher safety integrity level.

Versions and ordering data

All versions of the solenoid valve marked with the prefix SIL listed in the table on page 6 to 8 are suitable for use in safety-instrumented systems.

Scope

Article code

Solenoid valve Type 3969-	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Type of protection																					
Without explosion protection	**0**	**0**	**0**																		
ATEX II 2G Ex ia IIC T4 Gb	**1**	**1**	**0**																		
Nominal signal																					
14.7 to 24 V DC				**3**																	
Manual override																					
Without					**0**																
Pushbutton underneath the enclosure cover					**1**																
Switching function																					
3/2-way function with spring-return mechanism						**0**	**0**														
Mounting																					
NAMUR interface ¼ according to VDI/VDE 3845 for rotary actuators								**0**													
NAMUR rib according to IEC 60534-6 for linear actuators/threaded connection								**2**													
Direct attachment to mounting block with positioner according to VDI/VDE 3847								**3**													
NAMUR interface ½ according to VDI/VDE 3845 for rotary actuators								**4**													
NAMUR interface ¼ according to VDI/VDE 3845 for rotary actuators with adapter plate for external air connections								**5**													
K_{VS} [1]																					
0.3									**0**												
2.0									**2**												
4.3									**4**												
Material																					
Aluminum										**1**											

[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.

Solenoid valve Type 3969-	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Pneumatic connection																						
G ¼												**1**										
¼ NPT												**2**										
G ½												**3**										
½ NPT												**4**										
Pilot valve connection																						
Without (ports sealed by two screw plugs)													**0**									
1 (with internal pilot supply)													**1**									
2 (with external pilot supply)													**2**									
Pilot supply																						
Internal pilot supply for actuators for on/off service														**1**								
External pilot supply for actuators for throttling service														**2**								
Electrical connection																						
Without cable gland															**0**	**0**						
Cable gland M20x1.5 made of black polyamide															**0**	**1**						
Cable gland M20x1.5 made of blue polyamide															**1**	**1**						
Cable gland M20x1.5 made of black polyamide (Ex e, CEAG)															**1**	**3**						
Cable gland M20x1.5 made of blue polyamide (Ex e, CEAG)															**1**	**4**						
Cable gland M20x1.5, nickel-plated brass															**1**	**5**						
Cable gland M20x1.5, brass, blue															**1**	**6**						
Cable gland M20x1.5, nickel-plated brass (Ex e, Hummel)															**1**	**7**						
Degree of protection																						
IP 65																	**0**					
Ambient temperature [2]																						
–20 to +80 °C																		**0**				
–45 to +80 °C																		**1**				

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

Solenoid valve	Type 3969-	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Safety function																						
SIL [3]																			**1**			
Restrictor plate																						
Without																				**0**	**0**	**0**
With exhaust air restrictor plate																				**1**	**0**	**0**
With supply air restrictor plate																				**2**	**0**	**0**
With exhaust air and supply air restrictor plates																				**3**	**0**	**0**

[3] SIL according to IEC 61508

Attachment

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
– Direct attachment to mounting block with positioner according to VDI/VDE 3847 (SAMSON Type 3277 Linear Actuator)
– Pipe mounting
– Panel, wall or rail mounting

2 Technical data (excerpt from EB 3969)

General data		
Design		Solenoid with armature and ball/seat valve with return spring
Degree of protection		IP 65 with filter check valve
Compliance		**CE · RoHS**
Materials	Enclosure	Black anodized aluminum (C35)
	Connecting plate	Black anodized aluminum (C35)
	Adapter plate	Aluminum, powder coated, gray beige RAL 1019
	Screws	Stainless steel A4-70
	Springs	Stainless steel 1.4310
	Seals	Silicone rubber
Environmental conditions according to EN 60721-3	Storage	1K6 (relative humidity ≤95 %)
	Transport	2K4
	Operation	4K4 –45 to +80 °C
Ambient temperature [1]		–45 to +80 °C
Mounting position		Any desired position
Resistance to vibration		According to EN 60068-2-27 According to EN 60068-2-47 Recommended continuous duty ≤100 m/s²

Electric data			
Nominal signal		U_N	14.7 V to 24 V DC [2]
Switching point	ON	$U_{80\ °C}$	≥14.7 V
		I	≥ 6.1 mA
		$P_{20\ °C}$	≥71.6 mW
	OFF	I	≤ 0.5 mA
Input impedance		$R_{20\ °C}$	1.87 kΩ
Temperature influence			0.39 %/°C
Connection			Screw terminal, 2-pole, with cable gland M20x1.5

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

[2] The maximum permissible value U_i applies to explosion-protected versions.

Technical data (excerpt from EB 3969)

Explosion protection		
Type of protection [1]		Intrinsic safety II 2G Ex ia IIC T4 Gb
Maximum input voltage [2]	U_i	28 V
Maximum input current [2]	I_i	115 mA
Maximum power input [2]	P_i	1 W
Effective inner capacitance [2]	C_i	Negligibly small
Effective inner inductivity [2]	L_i	Negligibly small
Ambient temperature [3]		–45 to +80 °C (temperature class T4)

Pneumatic data for solenoid valve with K_{VS} 0.3, actuated on one side		
Switching function		3/2-way function with exhaust air feedback
K_{VS} [4]		0.3
Safety approval		SIL [5]
Compressed air quality according to ISO 8573-1		Max. 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
Pilot supply	Medium	Instrument air, free from corrosive substances and nitrogen
	Pressure [6]	1.4 to 10 bar
Operating medium		Instrument air, free from corrosive substances and nitrogen
Operating pressure		Max. 10 bar
Air consumption		Without
Switching time		≤ 65 ms
Ambient temperature [3]		–20 to +80 °C –45 to +80 °C
Connection		G ¼, ¼ NPT or NAMUR interface ¼ [7]
Weight		0.7 kg,
		1.05 kg (with adapter plate)

1) According to EU type examination certificate and statement of conformity.
2) Permissible maximum values when connected to a certified intrinsically safe circuit.
3) The maximum permissible ambient temperature depends on the permissible ambient temperature of the components, type of protection and temperature class.
4) 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.
5) SIL according to IEC 61508
6) When using the solenoid valve with an operating pressure from 6 to 10 bar, a minimum pilot supply pressure of 1.9 bar is required.
7) NAMUR interface according to VDI/VDE 3845 and VDI/VDE 3847

Poppet valve with NAMUR interface, K_{VS} 2.0 or 4.3, actuated on one side			
Switching function		3/2-way function	
K_{VS} [1] (direction of flow)		1.1 (4»3) 2.0 (3»5)	1.9 (4»3) 4.3 (3»5)
Safety approval		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)	
	Screws	Stainless steel 1.4571	
	Springs	Stainless steel 1.4310	
Operating medium		Instrument air free from corrosive substances or nitrogen [3] Air containing oil, nitrogen, non-corrosive gases [4]	
Compressed air quality according to ISO 8573-1		Max. 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	
Actuation		With VDI/VDE 3847	
Pilot supply		2.7 to 6 bar [3] 1.4 to 6 bar [4]	
Max. operating pressure		10.0 bar	
Ambient temperature [5]		–20 to +80 °C –45 to +80 °C	
Connection	Supply air	G ¼ or ¼ NPT and NAMUR interface ¼ [6] with G ⅜ or ⅜ NPT	G ½ or ½ NPT and NAMUR interface ½ [6]
	Exhaust air	G ½ or ½ NPT and NAMUR interface ¼ [6] with G ⅜ or ⅜ NPT	G ½ or ½ NPT and NAMUR interface ½ [6]
Approx. weight		1.38 kg	1.5 kg

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} x 36.22 in m³/h.
2) SIL according to IEC 61508
3) With internal pilot supply
4) With external pilot supply
5) The maximum permissible ambient temperature depends on the permissible ambient temperature of the components, type of protection and temperature class.
6) NAMUR interface according to VDI/VDE 3845

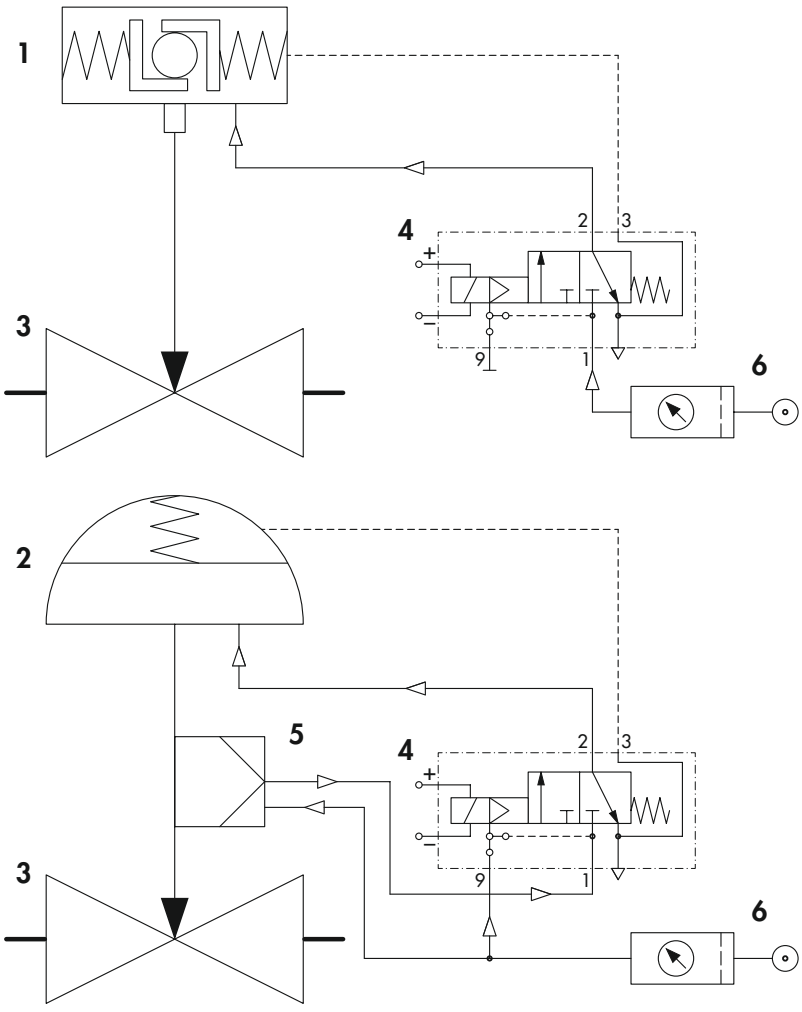
3 Safety-related functions

Emergency venting

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

Safety function

Safety function 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).



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*

4 Mounting, connection and start-up

Refer to Mounting and Operating Instructions ▶ EB 3969 on how to mount, perform the electric and pneumatic connections as well as start up the solenoid valve.

Only use the specified original mounting parts and accessories.

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 after the necessary conditions in the plant have been fulfilled. This also applies to the mounted solenoid valve.

Selection

➔ The required transit times of the control valve are kept.
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
All	–20 to +80 °C
With metal cable gland	–45 to +80 °C
The specifications in the test certificates additionally apply to explosion-protected versions.	

➔ The temperature limits are observed.

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 10 bar.

➔ The pneumatic pilot supply 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 positioner. 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. The internal pilot supply line (1) and output (2) have a minimum inside diameter of 9 mm.
See "Sizing of the connecting line" in the Mounting and Operating Instructions ▶ EB 3969.

➔ Select the cross section and length of the line to ensure that the supply pressure at the device on filling the actuator with air does not fall below the minimum limit of 1.4 (1.9) bar.

➔ The solenoid valve is mounted as prescribed.

➔ The exhaust opening at the solenoid valve remains open when the solenoid valve is installed on site.

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 electrical cables in Ex i circuits comply with the data that planning was based on.

➔ The cable glands and 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

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}).

Useful lifetime

According to IEC 61508-2, section 7.4.9.5, a useful lifetime of eight to twelve years can be assumed. Other values can be used based on the user's previous experience (prior use).

Functional test

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.

! *NOTICE*

Record any faults in the solenoid valve and inform SAMSON of them in writing.

– **Emergency venting through a 0 V signal**

1. Apply supply air within the permissible range (max. 10 bar) to the solenoid valve which allows the control valve to move to the maximum travel/angle of rotation. On using an upstream positioner, adjust it so that the maximum output pressure is available at the positioner output.
2. Supply the solenoid valve with a voltage ≥14.7 V DC.
3. Check whether the control valve moves to its end position on demand.
4. Set the voltage to 0 V DC.
5. Check whether the actuator is fully vented within the demanded time.

Tip

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

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

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 3969. Only use the specified original mounting parts and accessories.

NOTICE

Fail-safe action impaired due to incorrect repair.
Service and repair work must be performed by trained staff only.

8 Safety-related data

The safety-related data are listed in the TÜV Rheinland® shown on the next page.

Certificate

SIL/PL Capability

TÜVRheinland® CERTIFIED

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ID 0600000000

Nr./No.: 968/V 1034.01/24

Prüfgegenstand **Product tested**	Magnetventil Solenoid Valve	**Zertifikats-inhaber** **Certificate holder**	SAMSON AG Weismüllerstr. 3 60314 Frankfurt am Main Germany
Typbezeichnung **Type designation**	3969 (device index 00)		
Prüfgrundlagen **Codes and standards**	IEC 61508 Parts 1-2 and 4-7:2010		
Bestimmungsgemäße Verwendung **Intended application**	Sicherheitsfunktion: Bei Anforderung der Sicherheitsfunktion wird das Magnetventil durch den internen Kraftspeicher (Feder) in die Ausgangsstellung gebracht und entlüftet den angeschlossenen Antrieb. Die Armaturen sind zur Verwendung in einem sicherheitsgerichteten System bis SIL 2 (Low Demand Mode) geeignet. Unter Berücksichtigung der mindestens erforderlichen Hardware-Fehlertoleranz von HFT = 1 für das gesamte finale Element können die Armaturen auch bis SIL 3 eingesetzt werden. Safety function: When the safety function is requested, the solenoid valve is brought into its initial position by the internal force accumulator (spring) and vents the attached actuator. The valves 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 for the complete final element the valves may be used up to SIL 3.		
Besondere Bedingungen **Specific requirements**	Die Hinweise in der zugehörigen Installations- und Betriebsanleitung sowie des Sicherheitshandbuchs sind zu beachten. The instructions of the associated Installation, Operating and Safety Manual shall be considered.		

Zusammenfassung der Testergebnisse siehe Rückseite des Zertifikates.
Summary of test results see back side of this certificate.

Der Ausstellung dieses Zertifikates liegt eine Evaluierung entsprechend dem Zertifizierungsprogramm CERT FSP1 V3.0:2020 in der aktuellen Version zugrunde, deren Ergebnisse im Bericht Nr. 968/V 1034.01/24 vom 14.05.2024 dokumentiert sind. Dieses Zertifikat ist nur gültig für Erzeugnisse, die mit dem Prüfgegenstand übereinstimmen. Ausgestellt von der durch die DAkkS nach DIN EN ISO/IEC 17065 akkreditierte Zertifizierungsstelle. Die Akkreditierung gilt nur für den in der Urkundenanlage D-ZE-11052-02-00 aufgeführten Akkreditierungsumfang.
The issue of this certificate is based upon an evaluation in accordance with the Certification Program CERT FSP1 V3.0:2020 in its actual version, whose results are documented in Report No. 968/V 1034.01/24 dated 2024-05-14. This certificate is valid only for products, which are identical with the product tested. Issued by the certification body accredited by DAkkS according to DIN EN ISO/IEC 17065. The accreditation is only valid for the scope listed in the annex to the accreditation certificate D-ZE-11052-02-00.

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

Köln, 2024-06-12

Certification Body Safety & Security for Automation & Grid

Dipl.-Ing. (FH) Wolf Rückwart

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TÜVRheinland®
Precisely Right.

TÜV Rheinland Industrie Service GmbH, Am Grauen Stein, 51105 Köln / Germany
Tel.: +49 221 806-1790, Fax: +49 221 806-1539, E-Mail: industrie-service@de.tuv.com

Hersteller / Holder: **Samson AG**
Weismüllerstraße 3
60314 Frankfurt am Main
Deutschland

Prüfgegenstand / Product tested: **Pneumatic Solenoid Valve Type 3969**

Results of Assessment

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

Closing on Demand

Dangerous Failure Rate	λ_D	1,14 E-07 / h	**114 FIT**
Average Probability of Failure on Demand 1oo1	$PFD_{avg}(T_1)$	5,08 E-04	
Average Probability of Failure on Demand 1oo2	$PFD_{avg}(T_1)$	5,10 E-05	

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

Ursprung der Werte / *Origin of values*
Die angegebenen Werte sind das Ergebnis umfangreicher Qualifikationstests zur Zuverlässigkeit der Sicherheitsfunktion unter kritischen Bedingungen.Zufällige und systematische Ausfälle wurden untersucht, diese liegen in der Verantwortung des Herstellers.

The stated values are the results of extensive qualification tests on the reliability of the safety function under critical conditions. Random and systematic failures which are the responsibility of the manufacturer were examined.

Systematische Tauglichkeit / *Systematic Capability*
Der Entwicklungs- und Herstellungsprozess sowie das vom Hersteller in den relevanten Lebenszyklusphasen des Produkts angewandte Management der funktionalen Sicherheit wurden auditiert und als geeignet für die Herstellung von Produkten für den Einsatz in Anwendungen mit einem maximalen Sicherheitsintegritätslevel von 3 (SC 3) bewertet.

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).

Wiederkeherende Prüfungen und Wartung / *Periodic Tests and Maintenance*
Die angegebenen Werte erfordern periodische Prüfungen und Wartungen, wie sie im Sicherheitshandbuch beschrieben sind. Der Betreiber ist verantwortlich für die Berücksichtigung spezifischer äußerer Bedingungen (z.B. Sicherstellung der geforderten Medienqualität, max. Temperatur) und adäquater Prüfzyklen.

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), and adequate test cycles.

SH 3969 EN

SAMSON AKTIENGESELLSCHAFT
Weismüllerstraße 3 · 60314 Frankfurt am Main, Germany
Phone: +49 69 4009-0 · Fax: +49 69 4009-1507
samson@samson.de · www.samson.de

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