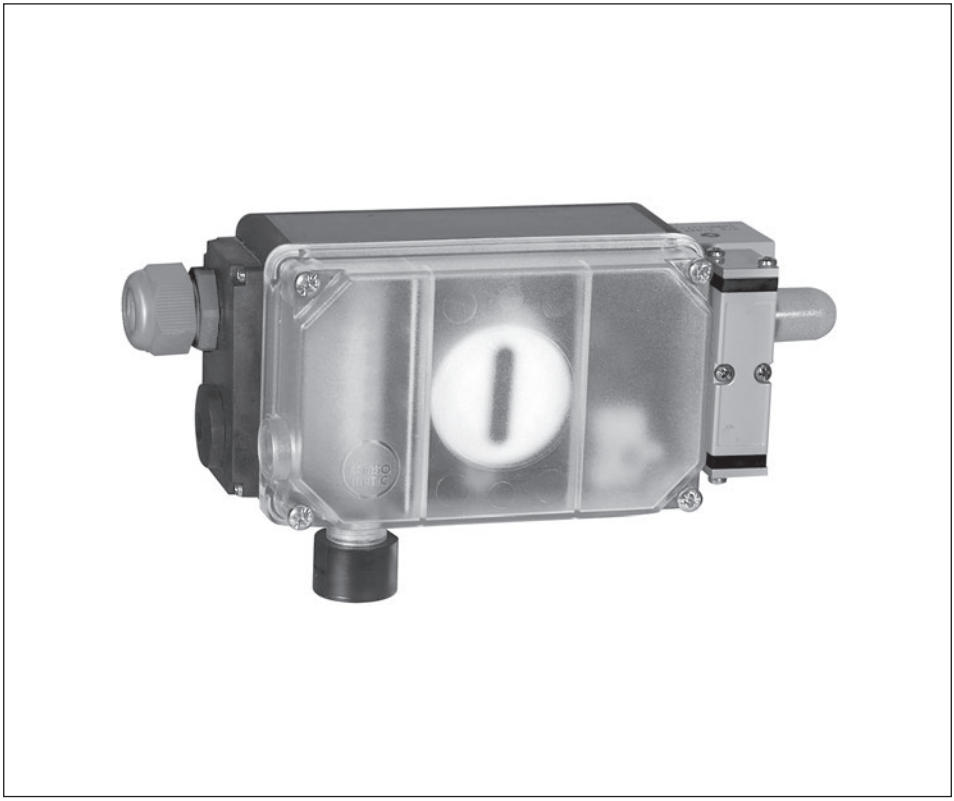
SAFETY MANUAL

SH 3776 EN

Translation of original instructions



Type 3776 Limit Switch

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 3776 contains information relevant for the use of the Type 3776 Limit Switch 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 limit switch.

Refer to the Mounting and Operating Instructions EB 3776 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 3776.*

Further documentation

The documents listed below contain descriptions of the start-up, functioning and operation of the limit switch. You can download these documents from the SAMSON website.

- T 3776: Data Sheet
- EB 3776: Mounting and Operating Instructions

Note

In addition to the limit switch documentation, observe the technical documentation for the pneumatic actuator, control valve and other valve accessories.

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1 Scope

1.1 General

The Type 3776 Limit Switch issues an electric signal when the valve travel exceeds or falls below an adjusted limit. The signal is suitable for switching control signals, issuing visual and audible alarms or for connection to central control or alarm systems. An optional solenoid valve allows the monitored actuator also to be controlled.

1.2 Use in safety-instrumented systems

Observing the requirements of IEC 61508, the systematic capability of the limit switch for safety-related monitoring and the solenoid valve integrated into the limit switch as components in safety-instrumented systems is given.

Use of the booster 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).

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

1.3 Versions and ordering data

Only certain versions of the Type 3776 Limit Switch are suitable for use in safety-instrumented systems.

Only the following inductive limit contacts are suitable for safety-instrumented systems according to SIL:

– SJ3,5-SN sensor
– SC3,5-N0 sensor
– SJ3,5-S1N sensor

Among the integrated solenoid valves, only the solenoid valve with 3-2-way switching function is suitable for use in safety-instrumented systems.

The configurations suitable for SIL applications can be identified using the article code (see Ordering data).

Scope

Limit Switch	**Type 3776-**	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Type of protection																		
No explosion protection	0																	
II 2G Ex ia IIC T6, ATEX [1] (max. 60/70/80 °C in T6/T5/T4)	1																	
Ex ia FM [2] (max. 60°C in T6/T5)	3																	
II 3G Ex nA II T6, ATEX [3] (max. 60/70/80 °C in T6/T5/T4)	8																	
Limit contact																		
Version																		
Inductive proximity switch SC3,5-N0, two-wire (–40 to +80 °C), **SIL**	1																	
Inductive proximity switch SJ3,5-SN, two-wire (–45 to +80 °C) **SIL**	2																	
Inductive double proximity switch SB3,5 E2, three-wire [3], without explosion protection and AS-i (–20 to +70 °C)	3																	
Electric microswitch, three-wire [3], SPDT with silver contact without AS-i (–40 to +80 °C)	5																	
Electric microswitch, three-wire [3], SPDT with gold contact without AS-i (–40 to +80 °C)	6																	
Quantity [4]																		
1 limit contact			1															
2 limit contacts			2															
3 limit contacts			3															
4 limit contacts			4															
6 limit contacts			6															
Opening angle																		
<100°, adjustable				0														
<180°, adjustable				1														
Special version				9														
Solenoid valve																		
Nominal signal																		
Without solenoid valve, **SIL**					0	0	0	0	0									
6 V DC, **SIL**					1													
12 V DC, **SIL**					2													
24 V DC, **SIL**					3													
230 V AC (without explosion protection), **SIL**					5													
115 V AC (without explosion protection), **SIL**					6													

Limit Switch	**Type 3776-** x x x x x x x x x x x x x x x x x x
Manual override	
Without, **SIL**	0
With pushbutton underneath the enclosure cover, **SIL**	1
Pushbutton/switch underneath the enclosure cover	2
Switching function	
Without switching function (without integrated solenoid valve), **SIL**	0
3/2-way function with spring-return mechanism, K_{VS} 0.2, **SIL**	1
5/2-way function with spring-return mechanism, K_{VS} 0.3	3 0
5/2-way, detent mechanism, K_{VS} 0.3	4
5/3-way, 2 + 4 closed, K_{VS} 0.3	5
5/3-way, 2 + 4 vented, K_{VS} 0.3	6
Connection block with one solenoid pilot valve [5]	8 0
Connection block with two solenoid pilot valves [4] [6]	9 0
Restrictors	
Without, **SIL**	0
2 exhaust air restrictors, K_{VS} 0.01 to 0.18, adjustable (optional with 5/2-way or 5/3-way function)	1
1 supply air/1 exhaust air restrictor, K_{VS} 0.01 to 0.18, adjustable (optional with 3/2-way function)	2
Pneumatic connection	
Without, (without integrated solenoid valve)	0
G ¼	1
¼ NPT	2
Electrical connection	
12-pole terminal block, M20x1.5 threaded connection	
1 black cable gland M20x1.5, polyamide, min. –20 °C	1 0
2 black cable glands M20x1.5, polyamide, min. –20 °C	1 1
1 blue cable gland M20x1.5, polyamide, min. –20 °C	1 2
2 blue cable glands M20x1.5, polyamide, min. –20 °C	1 3
1 adapter M20x1.5 to ½ NPT, aluminum, min. –45 °C	1 4
2 adapters M20x1.5 to ½ NPT, aluminum, min. –45 °C	1 5
1 black CEAG cable gland M20x1.5, polyamide, min. –20 °C	1 6
2 black CEAG cable glands M20x1.5, polyamide, min. –20 °C	1 7
1 cable gland M20x1.5, brass, min. –45 °C	1 8
2 cable glands M20x1.5, brass, min. –45 °C	1 9

Limit Switch	Type 3776- x x x x x x x x x x x x x x x x x x x
Connector	
1 Harting device connector, 8-pole, max. 50 V AC, made of aluminum, silver gray [7], min –40 °C	2 1
2 Harting device connectors, 7+7-pole, max. 50 V AC, made of aluminum, silver gray [7], min –40 °C	2 2
1 device connector, type A according to DIN EN 175301-803, 4-pole, black polyamide [7], min. –20 °C	2 5
2 device connectors, type A according to DIN EN 175301-803, 4+4-pole, black polyamide [8], min. –20 °C	2 6
1 Binder round connector, 7-pole, black polyamide [7], min. –20 °C	2 7
2 Binder round connectors, 7+6-pole, black polyamide [8], min. –20 °C	2 8
AS-Interface module with bus connection	
Cable adapter for AS-i flat-ribbon cable, two-wire, black polyamide, without explosion protection, –25 to +60 °C	5 2
Round connector M12x1, 4-pole, brass, without explosion protection [7], –25 to +60 °C	5 3
Degree of protection	
IP 54, polyethylene filter (min. –20 °C)	0
IP 65, filter check valve made of polyamide (min. –20 °C)	1
IP 65, filter check valve made of stainless steel 1.4305 (min. –45 °C)	2
Ambient temperature	
The permissible ambient temperature of the limit switch depends on the permissible ambient temperature of the components, type of protection and temperature class.	x
Safety approval	
Without	0
SIL [9]	1
Special version	
Inductive proximity switch SJ3,5-S1N, two-wire, NAMUR NO contact, with explosion protection and SIL capability (–25 to +80 °C), **SIL**	0 0 4
EAC Ex on request	0 1 1
EAC Ex on request	0 1 5
STCC II 2G Ex ia IIC T6	0 1 6
STCC II 3G Ex nA II T6	0 1 7
Further special versions on request	x x x

1) According to EC type examination certificate PTB 98 ATEX 2072
2) According to FM certificate of conformity 3026958
3) According to statement of conformity PTB 02 ATEX 2007 X (II 3G Ex nA II T6)

4) A maximum of two three-wire limit contacts can be used when a solenoid valve is actuated on both sides.
5) For pneumatic actuation on one side of an external 3/2-way or 5/2-way Type 3756 Booster Valve, G ¼/¼ NPT
6) For pneumatic actuation on both sides of an external 5/2-way or 5/3-way Type 3756 Booster Valve, G ¼/¼ NPT
7) The cable socket is not included in the scope of delivery.
8) The cable sockets are included in the scope of delivery.
9) SIL according to IEC 61508 (see section 9)

2 Mounting

The limit switch can be mounted onto linear and rotary actuators. It is suitable for the following types of attachment:

– Direct attachment to SAMSON Type 3277 Linear Actuator
– Attachment to linear actuators according to IEC 60534-6 (NAMUR)
– Attachment to SAMSON Type 3278 Rotary Actuator
– Attachment to rotary actuators according to VDI/VDE 3845

3 Technical data (excerpt)

Table 1: *General data*

Type 3776	
Range of rotation	Adjustable: 0 to 100° or 0 to 180°
Travel range	7.5 to 120 mm when mounted on linear actuators (e.g. SAMSON Type 327X)
Material	
Enclosure	Polyamide PA6-3-T, black
Enclosure cover	Polycarbonate 2807 (transparent)
Follower shaft	Polyoxymethylene
Filter	Filter made of polyethylene, filter check valve made of polyamide or stainless steel 1.4305
Screws	Stainless steel 1.4301
Degree of protection	IP 54 with filter, IP 65 with filter check valve
Mounting orientation	Defined mounting position (▶ EB 3776)

Ambient temperature depending on the components and type of protection	**No explosion protection**	**Permissible components**
	–20 to +80 °C	All components, inductive proximity switch SB3,5-E2 (max. 70 °C)
	–40 to +80 °C	Inductive proximity switch SC3,5-N0, electric microswitch, pilot valve AC/DC, adapter ½ NPT made of aluminum, brass cable gland, device connector (Harting) made of aluminum, filter check valve made of stainless steel 1.4305
	–45 to +80 °C	Inductive proximity switch SJ3,5-SN, pilot valve AC/DC, adapter ½ NPT made of aluminum, brass cable gland, device connector (Harting) made of aluminum, filter check valve made of stainless steel 1.4305
	Type of protection Ex ia IIC [1]	**Permissible components**
	–20 to +60 °C (T6) –20 to +70 °C (T5) –20 to +80 °C (T4)	Inductive proximity switch SC3,5-N0, inductive proximity switch SJ3,5-SN, inductive double proximity switch NCN3-F24R-N4, electric microswitch, pilot valve DC, all electric connection options, all filter options
	–45 to +60 °C (T6) –45 to +70 °C (T5) –45 to +80 °C (T4)	Inductive proximity switch SC3,5-N0, inductive proximity switch SJ3,5-SN, pilot valve DC, adapter ½ NPT made of aluminum, brass cable gland, device connector (Harting) made of aluminum, filter check valve made of stainless steel 1.4305
	Type of protection Ex nA II [2]	**Permissible components**
	–45 to +60 °C (T6) –45 to +70 °C (T5) –45 to +80 °C (T4)	Inductive proximity switch SC3,5-N0, inductive proximity switch SJ3,5-SN, electric microswitch, pilot valve DC, adapter ½ NPT made of aluminum, brass cable gland, device connector (Harting) made of aluminum, filter check valve made of stainless steel 1.4305
Electrical connection	Terminal connection, connector or integrated AS-Interface module with bus connection	
Weight	Approx. 450 g (without connection block/booster valve)	

[1] II 2G Ex ia IIC T6 according to EC type examination certificate PTB 98 ATEX 2072
[2] II 3G Ex nA II T6 according to statement of conformity PTB 02 ATEX 2007 X

Table 2: *Limit contact with safety function (SIL)*

Type 3776	**-x1**	**-x2**	**-xxxxxxxxxxxxx004**
Version	Inductive proximity switch		
	SC3,5-N0, with yellow LED	SJ3,5-SN	SJ3,5-S1N
Switching function	NAMUR NC contact	NAMUR NC contact	NAMUR NO contact
Service life of the integrated solenoid valve	>2,000,000 switching cycles [5]		
Perm. ambient temperature	–40 to +80 °C	–45 to +80 °C	–25 to +80 °C
Safety approval [4]	SIL capability	SIL capability	SIL capability

Limit contact in type of protection Ex ia IIC [1] for use in hazardous areas (Zone 1)							
Type 3776		**-11**		**-12**		**-1xxxxxxxxxxxx004**	
Maximum values when connected to a certified intrinsically safe circuit							
Input voltage	U_i	16 V		16 V		16 V	
Input current	I_i	25 mA	52 mA	25 mA	52 mA	25 mA	52 mA
Power input	P_i	64 mW	169 mW	64 mW	169 mW	64 mW	169 mW
Inner capacitance	C_i	150 nF		30 nF		30 nF	
Inner inductance	L_i	150 µH		100 µH		100 µH	
Ambient temperature in temperature class							
I_i = 52 mA [3] P_i = 169 mW [3]	T6	–45 to +45 °C		–45 to +45 °C		–45 to +45 °C	
	T5	–45 to +60 °C		–45 to +60 °C		–45 to +60 °C	
	T4	–45 to +80 °C		–45 to +80 °C		–45 to +80 °C	
I_i = 25 mA [3] P_i = 64 mW [3]	T6	–45 to +65 °C		–45 to +65 °C		–45 to +65 °C	
	T5	–45 to +80 °C		–45 to +80 °C		–45 to +80 °C	
	T4	–45 to +100 °C		–45 to +100 °C		–45 to +100 °C	
Limit contact in type of protection Ex nA II [2] for use in hazardous areas (Zone 2)							
Type 3776		**-81**		**-82**		**-8xxxxxxxxxxxx004**	
Ambient temperature in temperature class							
	T6	–45 to +60 °C		–45 to +60 °C		–45 to +60 °C	
	T5	–45 to +70 °C		–45 to +70 °C		–45 to +70 °C	
	T4	–45 to +80 °C		–45 to +80 °C		–45 to +80 °C	

1) II 2G Ex ia IIC T6 according to EC type examination certificate PTB 98 ATEX 2072
2) II 3G Ex nA II T6 according to statement of conformity PTB 02 ATEX 2007 X
3) Permissible maximum values of an upstream isolating switch amplifier
4) The permissible ambient temperature depends on the permissible ambient temperature of the components, type of protection and temperature class.
   A restricted temperature range may arise for SIL applications.
5) The number of actually achievable switching cycles depends on the prevailing operating conditions.

Table 3: *Solenoid pilot valve*

Electric data						
Type 3776		**-XXXX1**	**-XXXX2**	**-XXXX3**	**-0XXX6**	**-0XXX5**
Nominal signal	U_N	6 V DC Max. 27 V [1]	12 V DC Max. 25 V [1]	24 V DC Max. 32 V [1]	115 V AC Max. 130 V [1]	230 V AC Max. 255 V [1]
	f_N	–	–	–	48 to 62 Hz	
Switching point	$U_{+80\ °C}$	≥4.8 V	≥9.6 V	≥18 V	82 to 130 V	183 to 255 V
ON	$I_{+20\ °C}$	≥1.41 mA	≥1.52 mA	≥1.57 mA	≥2.2 mA	≥2.6 mA
	$P_{+20\ °C}$	≥5.47 mW	≥13.05 mW	≥26.71 mW	≥0.17 VA	≥0.46 VA
OFF	$U_{-25\ °C}$	≤1.0 V	≤2.4 V	≤4.7 V	≤18 V	≤36 V

Impedance	$R_{+20\ °C}$	2.6 kΩ	5.5 kΩ	10.7 kΩ	Approx. 40 kΩ	Approx. 80 kΩ
Effect of temperature		0.4 %/°C	0.2 %/°C	0.1 %/°C	0.05 %/°C	0.03 %/°C
Ambient temperature		−45 to +80 °C · The restrictions listed in Table 1 apply.				
K_{VS} [5]		0.01				
Supply	Medium	Instrument air, free from corrosive substances				
	Pressure	2.2 to 6.0 bar				
Output signal		1.5 to 2.5 bar				
Air consumption	ON	≤10 l/h with 1.4 bar supply				
	OFF	≤60 l/h with 1.4 bar supply				
Switching time		≤50 ms				
Effect of temperature		0.4 %/°C				

Table 4: *Booster valve with safety function SIL* [2]

Type 3776	**-XXXXXX10**	**-XXXXXX12**
Switching function	3/2-way function	
	With spring-return mechanism	With spring-return mechanism
K_{VS} [1]	0.20	–
With restrictors	–	0.01 to 0.18
Design	Poppet valve, soft seated	
Material		
Enclosure	GD AlSi 12, powder coated, gray beige RAL 1019	
Seals	Silicone rubber	
Filter	Polyethylene	
Screws	Stainless steel 1.4571	
Actuation [3]	One side	
Operating medium	Instrument air free from corrosive substances or nitrogen	
Operating pressure	2.2 to 6.0 bar	
Ambient temperature	−45 to +80 °C · The restrictions listed in Table 1 apply.	
Port	G ¼ · ¼ NPT	
Approx. weight	175 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 (see section 9)
3) Actuation with one or two solenoid pilot valves

Table 5: *Connection block with safety function SIL* [2]

Type 3776	**-XXXXXX80**
Version	Single [1]
K_{VS} [3]	0.01
Material	
Enclosure	GD AlSi 12, powder coated, gray beige RAL 1019
Seals	Perbunan
Screws	Stainless steel 1.4571
Ambient temperature	−45 to +80 °C · The restrictions listed in Table 1 apply.
Port	G ¼ · ¼ NPT
Approx. weight	150 g

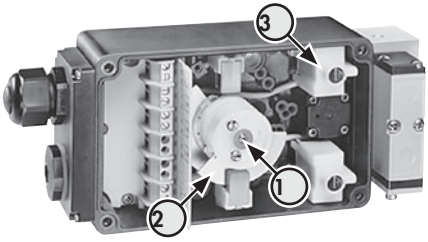
1) For pneumatic actuation on one side of an external 3/2-way or 5/2-way Type 3756 Booster Valve, G ¼/¼ NPT
2) SIL according to IEC 61508 (see section 9)
3) The air flow rate when p_1 = 2.4 bar and p_2 = 1.0 bar is calculated using the following formula:
$Q = K_{VS} \times 36.22$ in m^3/h.

➔ Full technical data including the data of the limit contacts and solenoid pilot valve
▶ EB 3776

4 Safety-related functions

Safety-related end position monitoring

The limit switch with inductive proximity switches has a maximum of six adjustable metal tags (2) on the shaft (1).



1 Shaft
2 Metal tag
3 Inductive proximity switch

– Versions with SC3,5-N0 or SJ3,5-SN limit contact (NC contact)

  When the tag is inside the magnetic field of the proximity switch (3), the proximity switch is attenuated and the output has a high impedance (switching function “Contact open”). This state corresponds to the fail-safe action. When the tag (2) leaves the magnetic field, the proximity switch (3) is unattenuated and the output has a low impedance (switching function "Contact closed").

– Versions with SJ3,5-S1N limit contact (NO contact)
  When the tag is inside the magnetic field of the proximity switch (3), the proximity switch is attenuated and the output has a high impedance (switching function “Contact closed”). This state corresponds to the fail-safe action. When the tag (2) leaves the magnetic field, the proximity switch (3) is unattenuated and the output has a low impedance (switching function "Contact open").

Emergency venting

The solenoid valve integrated into the limit switch is actuated by a binary voltage signal. Fail-safe action is triggered when no voltage signal (0 V AC/DC) is applied to terminals +81 and –82 or no supply air is supplied. The solenoid valve vents to the atmosphere and the actuator is vented as well.

4.1 Fail-safe action

Safety-related end position monitoring

Fail-safe action is triggered by the adjustable metal tags of the inductive proximity switch. When the control valve reaches the switching position, the metal tag is located in the magnetic field of the proximity switch and the limit switch issues a limit signal.

Emergency venting

Fail-safe action is triggered by the integrated solenoid valve and upon supply air failure. The integrated solenoid valve fully discharges its pneumatic output to the atmosphere, causing the pneumatic 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).

4.2 Protection against unauthorized changes to the configuration

A change to the configuration cannot affect the safety function nor cause it to be deactivated.

5 Mounting, connection and start-up

Refer to Mounting and Operating Instructions ▶ EB 3776 for details on how to mount, perform the electric and pneumatic connections as well as start up the limit switch.
Only use the specified original mounting parts and accessories.

6 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. The same applies to the mounted limit switch.*

6.1 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 limit switch is suitable for the prevailing ambient temperature.
Permissible ambient temperature of Type 3776: –45 to +80 °C
The restrictions listed in Table 1 and Table 2 apply.

➔ The temperature limits are observed.

6.2 Mechanical and pneumatic installation

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

➔ The maximum supply pressure does not exceed 6 bar.

➔ The pneumatic air 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 device. For example, Type 3999-009x Service Unit or Type 3999-0096 Filter Regulator can be used.

➔ The minimum cross section of the supply air line is observed.
Pipe (outside diameter x wall thickness): 6×1 mm
Hose (inside diameter × wall thickness): 4×1 mm
The specifications apply to a connecting line shorter than 2 m. Use a larger nominal size for lines longer than 2 m.

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 2.2 bar.

➔ The prescribed mounting position of the limit switch is observed.

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

➔ 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.

7 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}).

7.1 Visual inspection to avoid systematic failure

To avoid systematic failure, inspect the limit switch 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.*

7.2 Function testing

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

Note

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

Safety-related end position monitoring

➔ Apply the nominal voltage U_0 specified in Table 3 to the limit contact.

➔ Test switching point of the limit contacts.

➔ De-energize the solenoid pilot valve and perform a visual check. The valve must be in the fail-safe position.

➔ Check the switching state of the limit switch. The tag of the limit contact must be outside the magnetic field. The LED of limit switches with SC3,5-N0 proximity switch must be switched off.

➔ Apply the nominal voltage U_N specified in Table 3 to the solenoid pilot valve and move the valve in the other end position opposite to the fail-safe position.

➔ Check the switching state of the limit switch. The tag of the limit contact must be outside the magnetic field. The LED of limit switches with SC3,5-N0 proximity switch must be switched off.

Emergency venting

➔ Connect the air supply at the G ¼ (¼ NPT) tapped holes on the connection block or booster valve.

➔ When an upstream positioner is used, adjust it in such a way that the maximum output pressure is available at the positioner output.

➔ Apply the nominal voltage U_N specified in Table 3 to the solenoid pilot valve.

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

➔ De-energize the solenoid pilot 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.

Proof test

A full stroke test must be performed as the proof test. The following value can be used for Proof Test Coverage to calculate PFD_{avg}:

PTC (Proof Test Coverage) = 95 % for a proof test

8 Maintenance and repair

Only perform the work on the limit switch described in ▶ EB 3776.

NOTICE

Safety function impaired due to incorrect repair.

➔ *Only allow trained staff to perform service and repair work.*

For devices operated in the low demand mode, a useful lifetime of 11 years (plus 1.5 years storage time) is confirmed by TÜV Rheinland® from the date of manufacture while taking into account the specific conditions of use specified in the Safety Manual and the Mounting and Operating Instructions.

The results of the proof test must be assessed and the maintenance scheduled based on it. In particular, after changes (e.g. signs of aging in elastomers, changed switching times or leakage etc.), it is essential that the manufacturer performs maintenance or repair work on the device.

MTC (Maintenance Coverage) > 99 %

9 Safety-related data and certificates

The safety-related data are listed in the following certificate.

Certificate

No.: 968/V 1160.02/21

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.

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 1160.02/21 dated 2021-09-08. This certificate is valid only for products, which are identical with the product tested.

TÜV Rheinland Industrie Service GmbH
Bereich Automation
Funktionale Sicherheit
Certification Body Safety & Security for Automation & Grid

Köln, 2021-09-13

Dipl.-Ing. (FH) Wolf Rückwart

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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

Revision List
referred to on Certificate No.: 968/V 1160.02/21
Certified Product: Electromagnetic control, solenoid, booster valves and electrical position feedback

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Safety related modules / components

Type Designation	Description	Report–No.:	Certification Status
3963	Solenoid valve	968/V 1160.00/20	*Valid*
3967	Solenoid valve	968/V 1160.00/20	*Valid*
3964	Solenoid valve	968/V 1160.00/20	*Valid*
3756	Solenoid valve	968/V 1160.00/20	*Valid*
3701	Solenoid valve	968/V 1160.00/20	*Valid*
3968	Solenoid valve	968/V 1160.00/20	*Valid*
3776	Limit switch (with option solenoid valve as well as safe indication of end positions)	968/V 1160.00/20	*Valid*

SAMSON AG
Weismüllerstraße 3
60314 Frankfurt am Main

TÜV Rheinland Industrie Service GmbH
Automation - Functional Safety (A-FS)
Am Grauen Stein
51105 Köln / Germany

Revision List
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Certified Product: Electromagnetic control, solenoid, booster valves and electrical position feedback

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Manufacturing locations

Type Designation	Description	Report–No.:	Certification Status
SAMSON AG	Weismüllerstraße 3 60314 Frankfurt am Main	968/V 1160.00/20	*Valid*
SAMSON REGULATION S.A.S.	1 rue Jean Corona 69120 Vaulx-en-Velin France	968/V 1160.02/21	*Valid*

Safety Manual

Document No.	Description	Report–No.:	Certification Status
SH_3963.pdf	Safety manual for type 3963	968/V 1160.00/20	*Valid*
SH_3967.pdf	Safety manual for type 3967	968/V 1160.00/20	*Valid*
SH_3701.pdf	Safety manual for type 3701	968/V 1160.00/20	*Valid*
e3756sde.pdf	Safety manual for type 3756	968/V 1160.00/20	*Valid*
e3964sde.pdf	Safety manual for type 3964	968/V 1160.00/20	*Valid*
e3776sde.pdf	Safety manual for type 3776	968/V 1160.00/20	*Valid*
e3968sde.pdf	Safety manual for type 3968	968/V 1160.00/20	*Valid*

The content of this Revision List has been agreed between Manufacturer and Certification Body.

Revision List
referred to on Certificate No.: 968/V 1160.02/21

Certified Product: Electromagnetic control, solenoid, booster valves and electrical position feedback

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Revision:

Date	Rev.	Description / Changes	Author
2021-09-08	1.0	Initial creation, based on Report-No.: 968/V 1160.02/21	JCz/A-FS

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