



SH 8387-3 EN

Translation of original instructions



Type 3731-3 Electropneumatic Ex d Positioner

Communication: HART®

Edition July 2020



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 8387-3 contains information relevant for the use of the Type 3731-3 Positioner 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 positioner.

- ➔ *Refer to the Mounting and Operating Instructions EB 8387-3 on how to mount the positioner, perform the electric and pneumatic connections as well as start up the positioner.*
 - ➔ *Observe the warnings and safety instructions written in the Mounting and Operating Instructions EB 8387-3.*
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Further documentation

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

Type 3731-3 Positioner

- ▶ T 8387-3: Data sheet
- ▶ EB 8387-3: Mounting and operating instructions
- ▶ KH 8384-3: Configuration manual

EXPERTplus diagnostics (Type 3731-3 Positioner in firmware version 1.50 and higher)

- ▶ T 8389: Data sheet
- ▶ EB 8389: Operating instructions

EXPERT+ diagnostics (Type 3731-3 Positioner up to firmware version 1.49)

- ▶ T 8388: Data sheet
- ▶ EB 8388: Operating instructions

i Note

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

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1 Scope

1.1 General

The Type 3731-3 Electropneumatic Ex d Positioner is a single-acting positioner for mounting on pneumatic rotary and linear actuators with spring-return mechanism. The positioner is used to position control valves.

1.2 Use in safety-instrumented systems

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

Use of the positioner 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 Ex d positioner 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 Type 3731-3 Positioner are suitable for use in safety-instrumented systems.

1.4 Attachment

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

- Direct attachment to SAMSON Type 3277 Linear Actuators
- Attachment to linear actuators according to IEC 60534-6 (NAMUR)
- Attachment to SAMSON Type 3510 Micro-flow Valve
- Attachment to rotary actuators according to VDI/VDE 3845

2 Technical data (excerpt from EB 8387-3)

Type 3731-3 (technical data in test certificates additionally apply to explosion-protected devices)		
Action on fault detection	Type 3731-3xxxxxx000x1x00: emergency shutdown at 0 mA Type 3731-3xxxxxx100x1x00: emergency shutdown at 3.8 mA	
Minimum current	3.6 mA for display · Load impedance $\leq 9 \text{ V}$ corresponding to $450 \text{ } \Omega$ at 20 mA	
Supply	Supply air	Type 3731-321, Type 3731-327: 1.4 to 7 bar (20 to 105 psi), Type 3731-323: 1.4 to 6 bar (20 to 90 psi)
	Air quality acc. to ISO 8573-1 (2004 edition)	Maximum particle size and density: Class 4 · Oil content: Class 3 Moisture and water: Class 3 · Pressure dew point at least 10 K below the lowest ambient temperature to be expected
Signal pressure (output)	0 bar up to the supply pressure Can be limited to 1.4 bar/2.4 bar/3.7 bar ± 0.2 bar by software	
Characteristic		Linear/Equal percentage/Reverse equal percentage Butterfly valve, rotary plug valve or segmented ball valve: Linear/equal percentage User-defined: adjustable over operating software and communication
	Deviation	$\leq 1 \%$
Hysteresis	$\leq 0.3 \%$	
Sensitivity	$\leq 0.1 \%$	
Transit time	Exhaust and supply adjustable separately up to 240 s by software	
Direction of action	Reversible	
Air consumption	Steady state	Independent of supply air approx. $< 110 \text{ l}_n/\text{h}$
Air output capacity	Actuator (supply)	At $\Delta p = 6 \text{ bar}$: $8.5 \text{ m}_n^3/\text{h}$ · At $\Delta p = 1.4 \text{ bar}$: $3.0 \text{ m}_n^3/\text{h} \cdot K_{V_{\max}(20 \text{ } ^\circ\text{C})} = 0.09$
	Actuator (exhaust)	At $\Delta p = 6 \text{ bar}$: $14.0 \text{ m}_n^3/\text{h}$ · At $\Delta p = 1.4 \text{ bar}$: $4.5 \text{ m}_n^3/\text{h} \cdot K_{V_{\max}(20 \text{ } ^\circ\text{C})} = 0.15$
Permissible ambient temperature	-40 to $+80 \text{ } ^\circ\text{C}$, the limits in the test certificate additionally apply.	
Use in safety-instrumented systems (SIL)		Observing the requirements of IEC 61508, the systematic capability of the pilot valve for emergency venting as a component in safety-instrumented systems is given.
		Use 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).
Communication		
Local communication	SAMSON SSP interface and serial interface adapter	
Software requirements (SSP)	TROVIS-VIEW with database module 3731-3	
HART® communication	HART® field communication protocol Impedance in HART® frequency range: Receiving approx. $455 \text{ } \Omega$ · Sending approx. $185 \text{ } \Omega$	

Safety-related functions

Software requirements (HART®)	For handheld communicator	Device description for Type 3731-3
	For computer	DTM file certified according to specification 1.2, suitable for integrating the device into frame applications that support the use of FDT/DTM (e.g. PACTware); Integration into AMS™ Suite available

3 Safety-related functions

Emergency venting over the i/p converter (Fig. 1 path ———)

In automatic mode, the PD controller (3) compares the valve position to the DC control signal from 4 to 20 mA issued by the microcontroller. In case of a system deviation, the activation of the i/p converter is changed so that the actuator (1) is either vented or supplied with air. Fail-safe action is triggered and the actuator is vented when no signal (0 mA) is applied to terminals for 4 to 20 mA, HART® and, as a result, to the i/p converter.

3.1 Fail-safe action

Fail-safe action is triggered by the i/p converter upon supply air failure. The positioner 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). When the air supply fails, all positioner functions, except for open/closed-loop control, remain active (including diagnostics and communication).

i Note

The pneumatic output of the positioner can also be vented to the atmosphere over the software, e.g. by entering a suitable set point. This procedure is not a safety-instrumented function.

3.2 Protection against unauthorized changes to the configuration

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

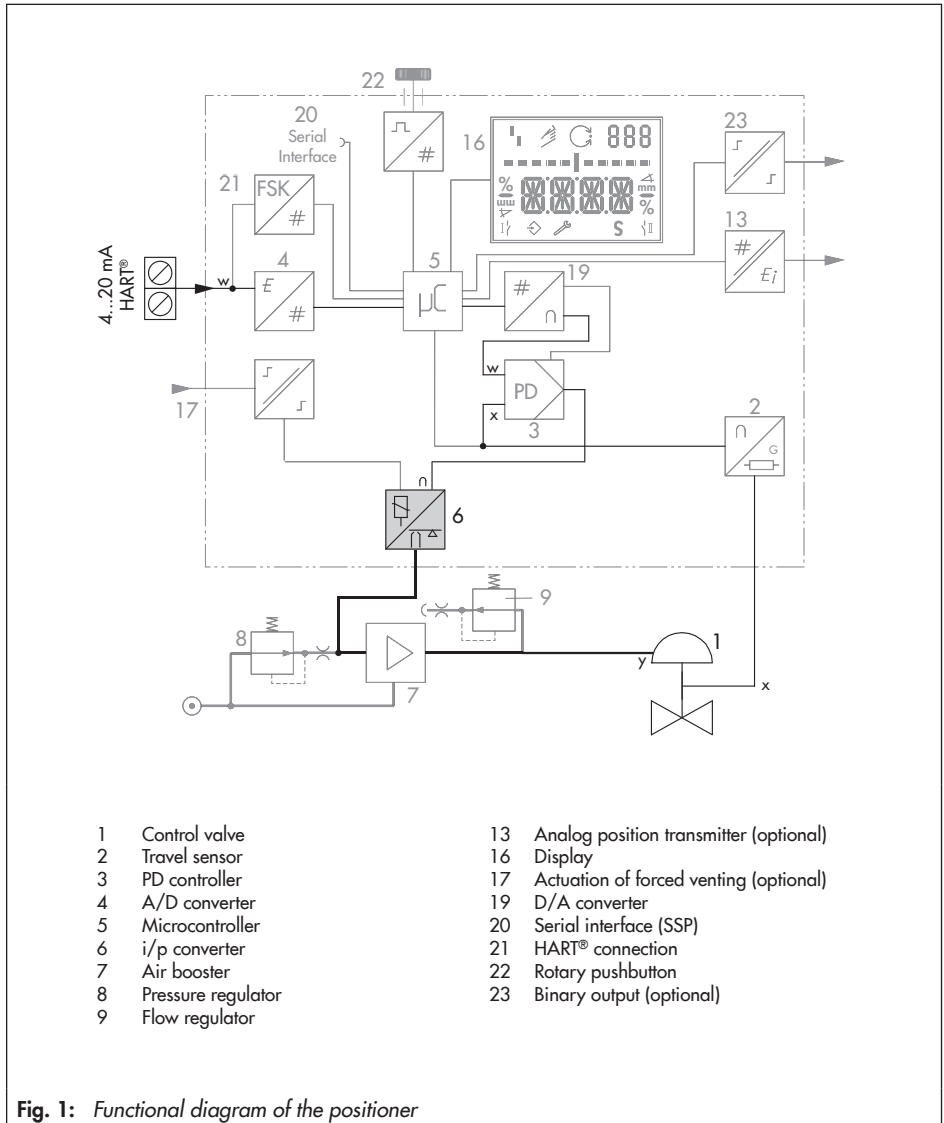
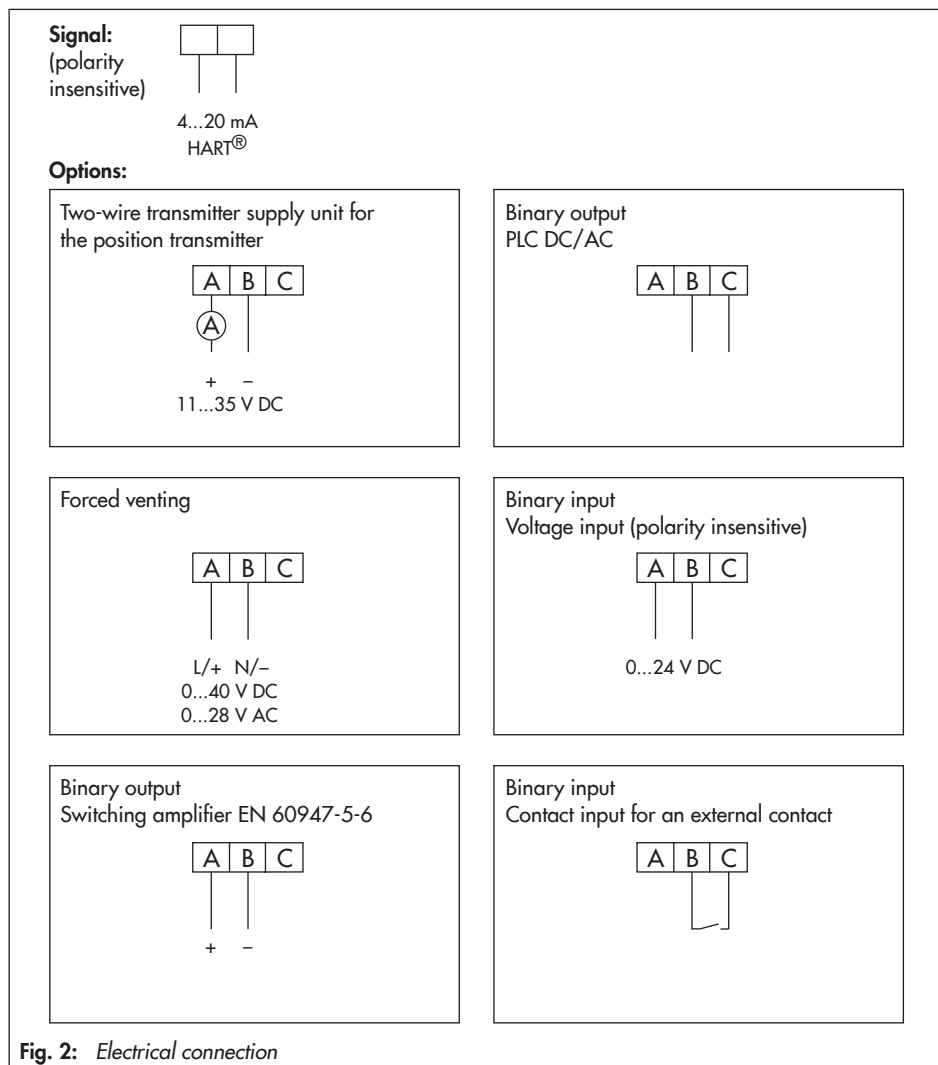


Fig. 1: Functional diagram of the positioner

4 Mounting, connection and start-up

Refer to Mounting and Operating Instructions ► EB 8387-3 on how to mount, perform the electric and pneumatic connections as well as start up the positioner.

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 if the necessary conditions in the plant are fulfilled. The same applies to the mounted positioner.

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.

Tip

The minimum OPEN and CLOSE transit times can be read in Codes 40 and 41 after the positioner has been initialized.

→ The positioner is suitable for the prevailing ambient temperature.


Versions	Temperature range
All	-40 to +80 °C
The temperature limits for the explosion-protected devices may be further restricted by the limits specified in the test certificates.	

→ The temperature limits are observed.

5.2 Mechanical and pneumatic installation

→ The positioner is mounted properly as described in the mounting and operating instructions and connected to the air supply.

Tip

Error codes 50 to 58 indicate incorrect attachment. For safety-instrumented systems, we recommend assigning the 'Maintenance alarm' status to these errors to quickly recognize them when they occur (indicated by  on the display).

Required conditions

→ The supply pressure does not exceed the maximum limit specified below.

- Type 3731-321 and Type 3731-327: 7 bar
- Type 3731-323: 6 bar

→ The pneumatic air supply meets the instrument air specifications.

Particle size and quantity	Oil content	Moisture and water
Class 4	Class 3	Class 3
$\leq 5 \mu\text{m}$ and $1000/\text{m}^3$	$\leq 1 \text{ mg}/\text{m}^3$	Pressure dew point: 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, the SAMSON Type 4708 Supply Pressure Regulator with $5 \mu\text{m}$ filter cartridge can be used.

→ The supply air line has a minimum inside diameter of 4 mm.

Select the cross section and length of the line to ensure that the supply pressure at the positioner on supplying air to the actuator does not fall below the minimum limit.

→ The positioner is mounted as prescribed.

→ The vent opening at the back of the positioner remains open when the positioner is installed on site.

5.3 Electrical installation

→ The positioner is connected to the electric power supply properly as described in the mounting and operating instructions.

→ Only cables whose outside diameters are suitable for the cable glands are used.

→ When the positioner is connected according to the type of protection Ex d, cable entries or conduit systems are used that comply with EN 60079-1 Explosive Atmospheres – Part 1: Equipment Protection by Flameproof Enclosures "d", Clauses 13.1 and 13.2 and for which a separate test certificate is available.

→ When the positioner is connected according to the type of protection Ex e, cable entries and blanking plugs are used, which are certified according to type of protection Ex e (ATEX) and have a separate test certificate.

→ 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 (periodic)

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 Visual inspection to avoid systematic failure

To avoid systematic failure, inspect the positioner 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.

6.2 Function testing

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

Note

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

Type 3731-3xxxxxx000x1x000: emergency venting by applying a 0 mA signal to the terminals for 4 to 20 mA, HART®

1. Supply the positioner with air within the permissible supply pressure range (max. 7 bar for Type 3731-321 and Type 3731-327 or 6 bar for Type 3731-323) which allows the valve to move to the maximum travel/angle of rotation.
 2. Connect an electric input signal >3.6 mA to the positioner (terminals for 4 to 20 mA, HART®).
 3. Switch the positioner to automatic mode (if it has not already been done).
 4. Set the input signal (terminals for 4 to 20 mA signal, HART®) over a local current source or over the control system in such a way that the valve moves to the approx. 50 % of its travel/angle of rotation. Check whether the valve moved to this position.
-

Tip

The travel/angle of rotation in automatic mode can be read at the positioner in Code 0.

5. Set the electric input signal to 0 mA or disconnect it. This must cause the valve to move to its fail-safe position.
 6. Check whether the actuator is fully vented within the demanded time.
-

Tip

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

Type 3731-3xxxxxx100x1x000: emergency venting by applying a <3.8 mA signal to the terminals for 4 to 20 mA, HART®

1. Supply the positioner with air within the permissible supply pressure range (max. 7 bar for Type 3731-321 and Type 3731-327 or 6 bar for Type 3731-323) which allows the valve to move to the maximum travel/angle of rotation.
2. Connect an electric input signal >3.8 mA to the positioner (terminals for 4 to 20 mA, HART®).
3. Switch the positioner to automatic mode (if it has not already been done).
4. Set the input signal (terminals for 4 to 20 mA signal, HART®) over a local current source or over the control system in such a way that the valve moves to the approx. 50 % of its travel/angle of rotation. Check whether the valve moved to this position.



Tip

The travel/angle of rotation in automatic mode can be read at the positioner in Code 0.

5. Set the electric input signal to <3.8 mA. This must cause the valve to move to its fail-safe position.
6. Check whether the actuator is fully vented within the demanded time.



Tip

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

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} :

$$PTC \text{ (Proof Test Coverage)} = 92 \% \text{ for a proof test}$$

7 Maintenance and repair

Only perform the work on the positioner described in ► EB 8387-3.

! 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 %

8 Safety-related data and certificates

PSTC (Partial Stroke Test Coverage)	68 %
PTC (Proof Test Coverage)	92 %
MTC (Maintenance Coverage)	>99 %

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

Certificate



SIL/PL
Capability

www.tuv.com
ID 060000000

No.: 968/V 1161.00/20

Product tested Electro pneumatic positioners **Certificate holder** SAMSON AG
Weismüllerstr. 3
60314 Frankfurt / Main
Germany

Type designation 3730-0, 3730-1, 3730-2, 3730-3, 3730-4, 3730-5,
3730-6, TROVIS SAFE 3730-6
3731-3, TROVIS SAFE 3731-3, 3731-5

Codes and standards IEC 61508 Parts 1-2 and 4-7:2010

Intended application Safety Function: Safe venting (and safe indication of the end positions)

The positioners 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 positioners may be used in a redundant architecture up to SIL 3 according to IEC 61508 and IEC 61511:2016 + 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 1161.00/20 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®
Precisely Right.

Holder: **SAMSON AG**
Weilmüllerstraße 3
60314 Frankfurt am Main
Germany

Product tested: **Electropneumatic positioners**
3730-0, 3730-1, 3730-2, 3730-3, 3730-4, 3730-5,
3730-6³, TROVIS SAFE 3730-6²

3731-3⁴, TROVIS SAFE 3731-3⁴, 3731-5

Results of Assessment

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

Safe venting via I/p-converter- all above mentioned types with or without

Lambda Dangerous Undetected ¹	λ_{DU}	9.58 E-08 / h	96 FIT
Average Probability of Failure on Demand ²	$PFD_{avg}(T_1)$	4.19 E-04	

Safe venting via forced venting (3730-6, TROVIS SAFE 3730-6)

Lambda Dangerous Undetected ¹	λ_{DU}	9.58 E-08 / h	96 FIT
Average Probability of Failure on Demand ²	$PFD_{avg}(T_1)$	4.19 E-04	

Safe venting solenoid valve (3730-2, 3730-3, 3730-4, 3730-5, 3730-6, TROVIS SAFE 3730-6)

Lambda Dangerous Undetected ¹	λ_{DU}	8.83 E-08 / h	89 FIT
Average Probability of Failure on Demand ²	$PFD_{avg}(T_1)$	3.87 E-04	

Safe Indication of the end positions (3730-1, 3730-2, 3730-3, 3730-4, 3730-5, 3730-6, TROVIS SAFE 3730-6)

Lambda Dangerous Undetected ¹	λ_{DU}	7.43 E-08 / h	74 FIT
Average Probability of Failure on Demand ²	$PFD_{avg}(T_1)$	3.26 E-04	

¹ assumed Diagnostic Coverage DC = 0 %

² assumed Proof Test Interval T_1 = 1 year

³ The types 3730-6 and TROVIS SAFE 3730-6 optionally have switch-off thresholds of < 3.8 mA or < 4.4 mA

⁴ The types 3731-3 and TROVIS SAFE 3731-3 optionally have switch-off thresholds of < 3.8 mA

Origin of values

The stated failure rates are the result of an FMEA 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 (SIL 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.

SH 8387-3 EN



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