

SIL Instructions

Safety-related parameters

Safety Integrity Level		SIL2		
Operating Modes		Low and continuous demand mode		
Architecture		1oo1		
Device Type		B		
Hardware Fault Tolerance	HFT	0		
		Basic module	HART-module	switching module
Safe Failure Fraction	SFF	92,85 %	95,62 %	91,70 %
Failure rate for safe detected failures	λ_{SD}	$4,04 \times 10^{-8}$ 1/h	$4,11 \times 10^{-7}$ 1/h	$2,61 \times 10^{-7}$ 1/h
Failure rate for safe undetected failures	λ_{SU}	$8,97 \times 10^{-7}$ 1/h	$9,10 \times 10^{-8}$ 1/h	$1,66 \times 10^{-7}$ 1/h
Failure rate for dangerous detected failures	λ_{DD}	$6,53 \times 10^{-8}$ 1/h	$4,23 \times 10^{-7}$ 1/h	$1,96 \times 10^{-7}$ 1/h
Failure rate for dangerous undetected failures	λ_{DU}	$7,73 \times 10^{-8}$ 1/h	$4,24 \times 10^{-8}$ 1/h	$5,63 \times 10^{-8}$ 1/h
Probability of a dangerous undetected failure per hour	PFH	$7,73 \times 10^{-8}$ 1/h	$4,24 \times 10^{-8}$ 1/h	$5,63 \times 10^{-8}$ 1/h
Mean time between failures = Mean time to failure	MTBF = MTTF	106 a	118 a	168 a
Mean time to dangerous failure	MTTF _d	1477 a	2692 a	2028 a

Test interval for Basic module	T ₁	1 year	2 years	3 years	5 years
Probability of a dangerous failure in the event of a request	PFD	3,38x10 ⁻⁴	6,78x10 ⁻⁴	1,02x10 ⁻³	1,69x10 ⁻³
Test interval for HART module	T ₁	1 year	2 years	3 years	5 years
Probability of a dangerous failure in the event of a request	PFD	1,86x10 ⁻⁴	3,75x10 ⁻⁴	5,61x10 ⁻⁴	9,32x10 ⁻⁴
Test interval for switching module	T ₁	1 year	2 years	3 years	5 years
Probability of a dangerous failure in the event of a request	PFD	2,47x10 ⁻⁴	4,95x10 ⁻⁴	7,42x10 ⁻⁴	1,23x10 ⁻³

for MTTR = MRT = 8 h

1 General Information

These SIL Instructions contain information and instructions for using the device as part of a protection system according to IEC/EN 61508. In addition to these instructions, please take all relevant legal requirements, applicable standards as well as the additional technical specifications on the accompanying data sheet into account (see www.labom.com).

1.1 Safety Function

The safety function of the device according to IEC/EN 61508 is:

- the 4..20 mA current signal for the basic module,
- the measured values and parameters transmitted by HART signal for the HART module,
- actuation of the switching contacts for the switching module.

The display module, which can optionally also be used, does not have an impact on the safety function of the pressure transmitter.

1.2 Validity

The safety function can only be guaranteed if the option "Functional safety according to IEC/EN 61508" has been chosen for the device. These devices are marked as shown on the right.

SIL2

SIL marking on the unit.

2 Technical Data

The following technical data applies to the safety function of the device.

2.1 Accuracy

Assured accuracy in safe mode: 1% Nominal range

The value for the assured accuracy is only valid if a test according to section 3.3 is carried out at least every 5 years.

For a turndown from 5:1 to 10:1, the guaranteed accuracy in safe mode is 2%.

For devices with diaphragm seal take the error of the diaphragm seal into account as well.

2.2 Reaction Times

The reaction times indicate how long the device may need to reach a safe state (correct measured value or alarm current) in the worst possible case.

- In the event of a request: 1750 ms
- In the event of fault detection: 500 ms

Note that any set damping value can extend the reaction time in the event of a request.

Additional elements in the process connection, such as capillaries, can extend the reaction time in the event of sudden pressure changes in the process.

2.3 Start-up Behaviour

Following completion of initialisation, after about 15 seconds, the current output jumps to a current proportional to the applied pressure or approaches the correct current according to the set damping value.

2.4 Fault Detection

In the event of a critical device malfunction, an alarm current of $< 3.6 \text{ mA}$ or $> 21 \text{ mA}$ is permanently issued at the output.

The alarm current can be deactivated by a manual restart only.

3 Requirements for the Operator

The operator has to consider the following requirements to ensure that the safety function is not jeopardised.

3.1 Unsafe Operating Conditions

Avoid the following functions while the device is operating as part of a safety device:

- HART multi-drop operation
- Current simulation
- Adjustment of the current output
- Pressure adjustment
- Plugging modules

Communicating with the device via HART or the display module does not affect the safety function, providing no parameters are changed that affect the current signal.

The value at the current output is no longer proportional to the pressure when using the table function, for example, to map the tank shape when measuring the level. A fault in the support points of the table leads to a faulty signal current. There is a linear interpolation of the measurement between these support points. This reduces the accuracy between the support points.

When using the table function in SIL application, the operator should therefore take appropriate measures to ensure the correctness and sufficient accuracy of the table.

3.2 Requirements for Safety Function

Avoid unsafe operating conditions (see 3.1).

Ensure compatibility of wetted materials with process media and cleaning agents.

Avoid environmental conditions that exceed the data sheet limits.

Avoid a pressure load that exceeds the permissible pressure limits as per the data sheet.

Monitor both alarm states (< 3.6 mA or > 21 mA) regardless of the alarm function setting.

Avoid an excessive supply voltage above 30 V.

Note that “Normally closed” or “Normally open” can be set as the switching function. The contact is always open in a de-energised status.

Only replace/extend the module when the supply voltage is switched off.

Pay attention to the specified polarity (+ and -) when connecting circuits to the switching contacts.

3.3 Regular Inspections

Hazardous undetected faults during operation can be detected with a high level of certainty during regular inspections. The operator can define the inspection interval depending on the PFD value required.

Not only the device but the complete measuring chain should be tested during inspection. It is the responsibility of the plant operator to determine an adequate test of the safety function.

The following inspection procedure is recommended for the device to achieve a high fault detection.

- Set the current simulation to a value of ≤ 3.6 mA and check whether the current output reaches this value
- Set the current simulation to a value of > 21 mA and check whether the current output reaches this value
- Apply one or more pressure values - depending on the safety-related pressure range - and check whether the current output corresponds to the applied pressure
- Visual monitoring of damage

Switching module:

- Apply the relevant pressure level of the switching point and check whether the device switches correctly