

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
Safe failure fraction	SFF	94.69 %
Failure rate for safe detected failures	λ_{SD}	$1.78 \cdot 10^{-7}$ 1/h
Failure rate for safe undetected failures	λ_{SU}	$2.96 \cdot 10^{-7}$ 1/h
Failure rate for dangerous detected failures	λ_{DD}	$4.92 \cdot 10^{-7}$ 1/h
Failure rate for dangerous undetected failures	λ_{DU}	$5.42 \cdot 10^{-8}$ 1/h
Probability of a dangerous undetected failure per hour	PFH	$5.42 \cdot 10^{-8}$ 1/h
Mean time between failures = Mean time to failure	MTBF = MTTF	112 a
Mean time to dangerous failure	MTTF _d	2,106 a

Inspection interval	T ₁	1 year	2 years	3 years	5 years
Probability of a dangerous undetected failure on demand	PFD	$2.42 \cdot 10^{-4}$	$4.79 \cdot 10^{-4}$	$7.17 \cdot 10^{-4}$	$1.19 \cdot 10^{-3}$

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.

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.

The logo consists of the text "SIL2" in a blue, sans-serif font. The "2" is slightly larger and positioned to the right of the "IL".

SIL marking on the unit.

2 Technical data

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

2.1 Accuracy

Inspection interval [years]	SIL-accuracy [% of nominal range]
1	1
2	1.1
3	1.4
5	1.9

The value for the assured accuracy is only valid if a test according to chapter 3.3 is carried out after the specified inspection interval.

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

Please note that in hydrogen applications in combination with products with pressure transmission fluid, premature undetected failure (incorrect measured values) is possible due to permeation effects of hydrogen into the pressure transmission fluid. The time until this effect can occur depends on the process conditions. Make sure that the service life determined by our consulting team is not exceeded.

For devices with ATC-option the accuracy for devices without ATC-option applies only.

Please observe that for devices with operating software for level applications inaccurate level parameters directly affect the accuracy of the level calculation. E. g. the less accurate the density is set, the more the calculated level deviates from the actual level.

2.2 Reaction times

- In the event of a request: 220 ms
- In the event of fault detection: 100 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 or flame arresters, can extend the reaction time in the event of sudden pressure changes in the process.

2.3 Start-up behaviour

A safe state is also guaranteed during initialisation or a phase of low voltage. After connecting the supply voltage, a current of < 3.6 mA (alarm current) is issued at the current output. Following completion of initialisation, after about 5 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 mA or > 21 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 in fixed current mode
- Pressure or current simulation
- Adjustment of the current output

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.

3.1.1 Ci4 LEVEL

For devices with operating software for level applications please pay attention to the following points:

Set the height offset first and then scale the current output (parameters „value for 4 mA“ and „value for 20 mA“). This is because the scaling of the current output is based on the height offset.

Ensure that the hydrostatic pressure of a completely filled tank does not exceed the nominal range of the device.

Ensure that the value for 4 mA does not represent a level that lies below the process connection of the device.

3.2 Requirements for safety function

Avoid unsafe operating conditions (chapter 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.

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 several pressure values and check whether the current output corresponds to the applied pressure. At least the zero point and span as well as a safety-relevant pressure reading must be checked. For more information on the calibration of Labom measuring devices, see HE_107.

- Visual inspection for damage and dirt. The entire device must be checked. In particular
 - the plug or cable gland must be checked for moisture, dirt or corrosion.
 - the front cover and the cover to the electrical connection compartment must be unscrewed and the interior and the covers checked for moisture and dirt. Also check the seals.
 - check the two ventilation elements for dirt and moisture. The two ventilation elements of the Ci4 are located
 - radially on the housing on the side of the electrical connection
 - on the underside of the unit (only for relative pressure units up to 40 bar and in protection class IP65/67).
 - the process connection must be checked for contamination.
 - the diaphragm, if present, must be checked for contamination and damage.

When evaluating the test, use the accuracy values from the data sheet or the order documents.

When performing the recommended tests, a PTC (Proof Test Coverage) value of 95 % can be assumed following Namur NA106, Section D3.