

Rotating Paddle Switch

SITRANS LPS200

Functional Safety Manual • 05/2016



SITRANS

SIEMENS

Table of contents

1. SCOPE.....	2
1.1. DEVICE IDENTIFICATION	2
1.2. APPLICABLE DOCUMENTS	3
1.3. RESTRICTIONS.....	3
2. DEVICE DESCRIPTION	3
2.1. APPLICATION RANGE	3
2.2. OPERATING CONDITIONS	3
2.3. SAFETY FUNCTION	3
2.3.1. <i>Safe state</i>	4
2.3.2. <i>Failure modes</i>	4
2.4. SAFETY-RELATED CHARACTERISTIC DATA	4
3. INSTALLATION NOTES.....	5
3.1. ELECTRICAL CONNECTION	5
3.2. SETTINGS.....	5
3.2.1. <i>Configuration</i>	5
3.2.2. <i>Delay</i>	5
3.3. FUNCTION TEST	5
4. APPLICATION NOTES.....	6
4.1. BEHAVIOR IN CASE OF FAILURE	6
4.2. FAULT REACTION TIME.....	6
4.3. PERIODIC FUNCTIONAL TESTING	6

1. Scope

The Safety manual at hand refers to devices SITRANS LPS200 with the special requirements for safety technique in accordance with IEC 61508-2:2010 (option C20 "Functional safety SIL 2").

1.1. Device identification

The identification of a device is done by its nameplate. On the nameplate a device name (SITRANS LPS200) is noted. For detailed identification the fields *Modelcode* and *Options* are relevant. All devices with the option "Functional safety SIL 2" are marked with "C20" at the field *Options* of the nameplate.

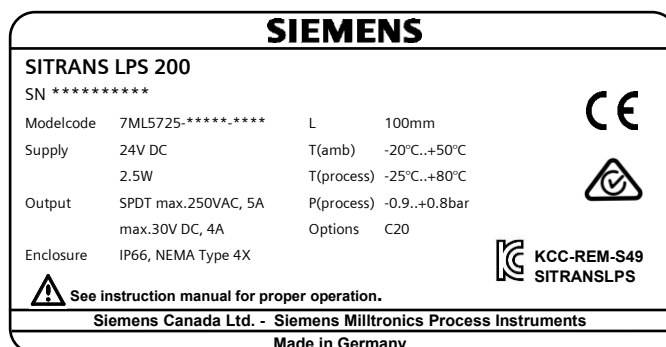


Figure: exemplary nameplate for device identification

1.2. Applicable documents

The following documents have to be considered additional to this Safety manual:

- SITRANS LPS200 Operating Instructions
- SIL-Declaration of Conformity
- FMEDA report
- If necessary Ex-documentations

1.3. Restrictions

The Safety manual is only valid for devices listed in the *SIL-Declaration of Conformity*. Modifications to devices are only allowed to the manufacturer under compliance of the safety life cycle.

2. Device description

2.1. Application range

The device is designed to implement a safety function in a safety-related system.

The device can be used for overall safety functions in low demand mode as well as for overall safety functions in high demand mode / continuous mode.

2.2. Operating conditions

At transport, storage, installation, operation and maintenance of the device the requirements according *SITRANS LPS200 Operating Instructions* have to be obtained.

Additional to operating conditions the EMC-limits for general industrial applications according EN 61326-3-1 (Electrical equipment for measurement, control and laboratory use - EMC requirements – Part 3-1: Immunity requirements for safety-related systems and for equipment intended to perform safety-related functions (functional safety) - General industrial applications) must not be exceeded.

2.3. Safety function

The safety function of the device is the detection of a limit level of bulk material in containers. Thereby the device can be configured as full detector (overfilling protection) or empty detector (running dry protection).

The output of the safety function depends on the configuration of the device as full detector or empty detector:

- **Full detector:**
detection of a filling level exceeding a defined limit value (covered rotating paddle)
- **Empty detector:**
detection of a filling level below a defined limit value (uncovered rotating paddle)

2.3.1. Safe state

The safe state is given, when the signal output presents an open electric circuit. Under normal conditions this depends on the state of the rotating paddle:

	Safe state (open circuit at signal output)	Unsafe state (closed circuit at signal output)
Full detector	covered rotating paddle	uncovered rotating paddle
Empty detector	uncovered rotating paddle	covered rotating paddle

In case of failure the device is designed to switch permanent to safe state.

2.3.2. Failure modes

Aging of components can lead to random hardware defects of the device. This can result in a failure of the device. In the following table the possible failures are listed:

Failure modes	Signal output	Correct level indication
Safe, detected failure	open	yes
Safe, undetected failure	open	yes
Unsafe, detected failure	open	no
Unsafe, undetected failure	closed	no

2.4. Safety-related characteristic data

Assumptions for determining safety-related characteristic data:

- Failure rates according to SN 29500
- Single channel architecture (1001D)
- Mean time to repair (MTTR) = 24h

SIL:	2
HFT:	0
Type:	B
MTBF:	81 years
Fault reaction time:	<120s (see section 4.2)

	Full detector	Empty detector
λ_{SD}	0 FIT	323 FIT
λ_{SU}	268 FIT	269 FIT
λ_{DD}	519 FIT	196 FIT
λ_{DU}	72 FIT	71 FIT
SFF	91.6%	91.8%
PFH	$0.0717 \times 10^{-6}/h$	$0.0706 \times 10^{-6}/h$
PFD_{avg} depending on time interval for periodic function test	1 year	3.2×10^{-4}
	2 years	6.3×10^{-4}
	5 years	1.6×10^{-3}
	10 years	3.2×10^{-3}

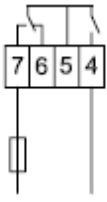
3. Installation notes

3.1. Electrical connection

→ see *SITRANS LPS200 Operating Instructions*

The instructions for electrical connection mentioned in the Technical information / Instruction manual have to be obtained.

The signal output of the safety function has to be connected like in connection example "maximum safety" (see *SITRANS LPS200 Operating Instructions*).

Terminal block pair for the signal output of the safety function	4-7
Schematic signal output	
Additional terminal blocks <u>not</u> to be used for safety function	5, 6, 8, 9, 10

NOTE: The signal output of the safety function (terminal block pair 4-7) is realized internally by a series connection of two redundant switching relays (terminal block pairs 4-5 and 5-7).

WARNING: The additional terminal blocks (5, 6, 8, 9, 10) are not part of the devices safety function. They can be used according to the instruction manual. The safety-related characteristic data are **not** valid for the additional terminal blocks.

3.2. Settings

3.2.1. Configuration

→ see *SITRANS LPS200 Operating Instructions*

WARNING: When configured wrong, the safety function cannot be assured. A missing of the jumper FSH/FSL is diagnosed and turns the device into safe state.

3.2.2. Delay

→ see *SITRANS LPS200 Operating Instructions*

WARNING: For the safety function the maximum delay times have to be considered.

3.3. Function test

To avoid systematic failures during installing as well as for periodic functional testing a function test has to be carried out. While the function test is performed, the overall safety function has to be ensured otherwise than by the device.

Procedure of function test:

- **Checking of the device configuration:**
 - Does the configuration (FSH/FSL) correspond to the overall safety function of the device?

- **Checking of the mechanics:**
 - Does the rotating paddle turn when uncovered?
 - Does the rotation speed of the rotating paddle correspond to the devices specification?
 - Does the switching lug tense when changing from uncovered to covered rotating paddle?
- **Checking of the signal output:**
 - Does the signal output in uncovered state correspond to the device configuration (FSH/FSL)?
 - Does the signal output in covered state correspond to the device configuration (FSH/FSL)?
 - Does the delay at the signal output (uncovered to covered rotating paddle / covered to uncovered rotating paddle) correspond the requirement of the overall safety function?

NOTES: The covered / uncovered state has to be induced by ramping-up the bulk material to the respective limit level or by a suitable simulation of this.
The checking of the signal output is done based on a continuity test at terminal block pair 4-5 as well as at terminal block pair 5-7 and has to be identical for both at terminal block pairs.

WARNING: In case of failed function test, the overall safety function has to be ensured otherwise than by the device until replacing.

4. Application notes

4.1. Behavior in case of failure

In case of failure the device turns to safe state.

Furthermore the failure is signaled by light up of the red LED.

Is the failure diagnosed, the safe state is hold even if the diagnosed failure disappears. To reset the failure the supply voltage has to be turned off.

4.2. Fault reaction time

The maximum fault reaction time from appearance until switching to the safe state for failures able to diagnose is 120s.

The fault reaction time is independent from the configured delay of the signal output in normal condition (see *SITRANS LPS200 Operating Instructions*).

4.3. Periodic functional testing

When the device is used to realize a overall safety function in low demand mode, a periodic function test has to be performed. The procedure of the periodic function test is a described in section 3.3.

The maximum time interval for the periodic function test has to be calculated depending on the tolerable failure probability for the device and its PFD_{avg} – value (see section 2.4) according to IEC 61511.

For more information

www.siemens.com/level

www.siemens.com/weighing

Siemens Canada Limited
1954 Technology Drive
P.O. Box 4225
Peterborough, ON
Canada K9J 7B1

sc300623

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