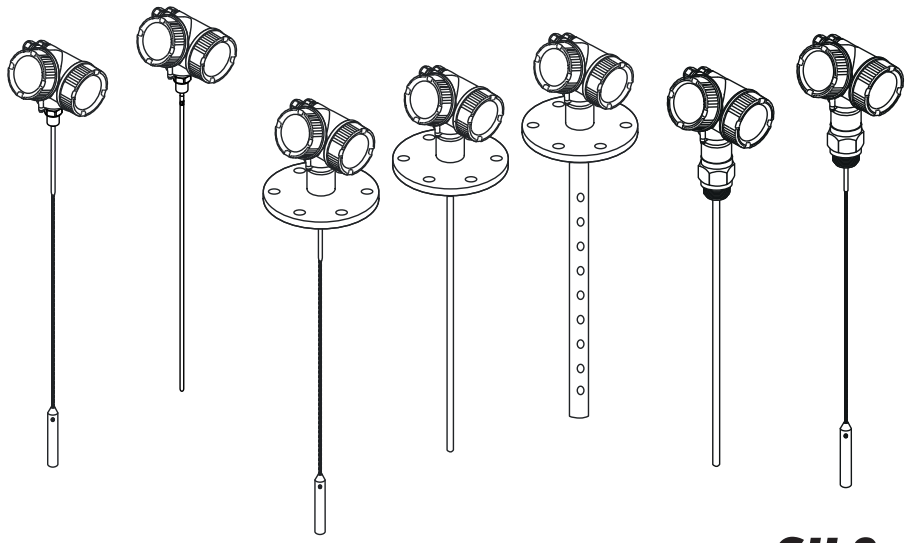
Functional Safety Manual
SD00326O/98/EN/16.14
71260002

Pulscon LTC50, LTC51, LTC57

Guided Level Radar for Liquids and Bulk Solids with 4 to 20 mA Output Signal



SIL3

Application

Operating minimum (e. g. dry run protection), maximum (e. g. overfill protection) and range monitoring of liquids and bulk solids of all types in systems to satisfy particular safety systems requirements as per IEC 61508 Edition 2.0.

The measuring device fulfils the requirements concerning

- Functional safety as per IEC 61508 Edition 2.0
- Explosion protection (depending on the version)
- Electromagnetic compatibility as per EN 61326 and NAMUR recommendation NE 21
- Electrical safety as per IEC/EN 61010-1

Your benefits

- Used for level monitoring (MIN, MAX, range) up to SIL2 (single-channel architecture) or SIL3 (multi-channel architecture, also with homogeneous redundancy)
  - Independently assessed and certified by TÜV North CERT as per IEC 61508 Edition 2.0
- Permanent self-monitoring
- Continuous measurement
- Measurement is virtually independent of product properties
- Measurement is possible even at strongly agitated surfaces and foam
- Easy commissioning
- Proof-test possible without demounting of the device and without variation of the level

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With regard to the supply of products, the current issue of the following document is applicable: The General Terms of Delivery for Products and Services of the Electrical Industry, published by the Central Association of the Electrical Industry (Zentralverband Elektrotechnik und Elektroindustrie (ZVEI) e.V.) in its most recent version as well as the supplementary clause: "Expanded reservation of proprietorship".

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SIL Declaration of Conformity

SIL declaration of conformity / *SIL-Konformitätserklärung* en/de

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No. / *Nr.*: MDEC-1298
Date / *Datum*: 2014-09-19

PEPPERL+FUCHS

SIL Declaration of Conformity / *SIL Konformitätserklärung*

We, Pepperl+Fuchs GmbH declare under our sole responsibility that the products listed below are is suitable for the use in safety-instrumented systems according to IEC 61508 Edition 2.0 / IEC 61511, if the functional safety manual and the safety characteristic values are observed.

Die Pepperl+Fuchs GmbH erklärt hiermit in alleiniger Verantwortung, dass die unten gelisteten Produkte für den Einsatz in Schutzeinrichtungen der IEC 61508 Edition 2.0 / IEC 61511 geeignet ist, wenn das Handbuch zur Funktionalen Sicherheit und die Sicherheitskennwerte beachtet werden.

Products / *Produkte*

Product / *Produkt*	Item number / Teilenummer	Description / *Beschreibung*
LTC50	264917	Guided Microwave / Geführte Mikrowelle (4 – 20 mA)
LTC51	264918	Guided Microwave / Geführte Mikrowelle (4 – 20 mA)
LTC57	264919	Guided Microwave / Geführte Mikrowelle (4 – 20 mA)

Safety Characteristic Values / *Sicherheitskennwerte*

Product / *Produkt*	LTC 50	LTC 51	LTC 57
Functional safety manual / Handbuch zur funktionalen Sicherheit	SD00326O		
Recommended proof test interval / Empfohlenes Intervall für Wiederholungsprüfungen	3 years/Jahre		
SIL	SIL 2 (single-channel architecture 1001), SIL 3 (multi-channel architecture also with homogenous redundancy e.g. 1002 , 2003)		
HFT	0 (SIL 2) / 1 (SIL 3)		
Device Type / Gerätetyp	B		
Safety function / Sicherheitsfunktion	MIN, MAX, Range / Bereich		
MTBF [1)]	57 years / Jahre		
SFF	93 %		

[1)] This value includes functionally relevant failure modes of the electronic components according to Siemens SN 29500. / Dieser Wert berücksichtigt funktionsrelevante Ausfallarten der Elektronikkomponenten nach Siemens SN29500.

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Safety Characteristic Values (cont'd) / *Sicherheitskennwerte (Forts.)*

Product / *Produkt*	LTC 50	LTC 51	LTC 57
PFD $_{avg}$ (1 year / Jahr) [1]	8,91 x 10^{-4}		
PFH	1,99 x 10^{-7} 1/h		
λsd	15 FIT		
λsu	608 FIT		
λdd	2295 FIT		
λdu	199 FIT		
λtot [2]	3117 FIT		
Diagnostic Test Interval / Diagnose-Testintervall [3]	30 min.		
Fault reaction time / Fehlerreaktionszeit	30 s		
System reaction time / Systemreaktionszeit	• In "Increased safety mode": - for "Medium type = Liquid": < 15 s - for "Medium type = Solid": < 90 s • In "Expert mode": freely configurable, shortest response time: 0.8 s In Betriebsart "erhöhte Parametriersicherheit": - bei Einstellung "Medientyp = Flüssigkeit": < 15 s - bei Einstellung "Medientyp = Feststoff": < 90 s • In Betriebsart "Experten-Parametrierung": frei parametrierbar, kleinste Reaktionszeit: 0,8 s		

[1] Valid for ambient temperatures of up to +40°C (104 F). Where the average continuous temperature in use is close to +50°C (122 F), a factor of 1.3 should be taken into account. / Gültig für Umgebungstemperaturen bis zu +40 °C (+104 °F). Bei einer durchschnittlichen Dauereinsatztemperatur nahe +50 °C (+122 °F) sollte ein Faktor von 1,3 berücksichtigt werden.
[2] This value includes functionally relevant failure modes of the electronic components according to Siemens SN 29500. / Dieser Wert berücksichtigt funktionsrelevante Ausfallarten der Elektronikkomponenten nach Siemens SN29500.
[3] During this time all diagnostic functions are executed at least once / In dieser Zeit werden alle Diagnosefunktionen mindestens einmal ausgeführt.
[4] Time between fault detection and fault reaction / Zeit zwischen Fehlererkennung und Fehlerreaktion.
[5] Step response time according to DIN EN 61298-2 / Sprungantwortzeit nach DIN EN 61298-2

This Declaration of Conformity is only valid in connection with the valid datasheet of Pepperl+Fuchs and the Functional Safety Manual.
Diese Konformitätserklärung gilt nur in Zusammenhang mit dem gültigen Pepperl+Fuchs Datenblatt und dem Handbuch zur Funktionalen Sicherheit.

The device including the software and the modification process was independently assessed and certified by TÜV Rheinland as per IEC 61508 Edition 2.0.
Das Gerät einschließlich Software und Änderungsprozess wurde unabhängig auf die Erfüllung der IEC 61508 Edition 2.0 beurteilt und zertifiziert von TÜV Rheinland.

Signatures / *Unterschriften*
Mannheim, 2014-09-19

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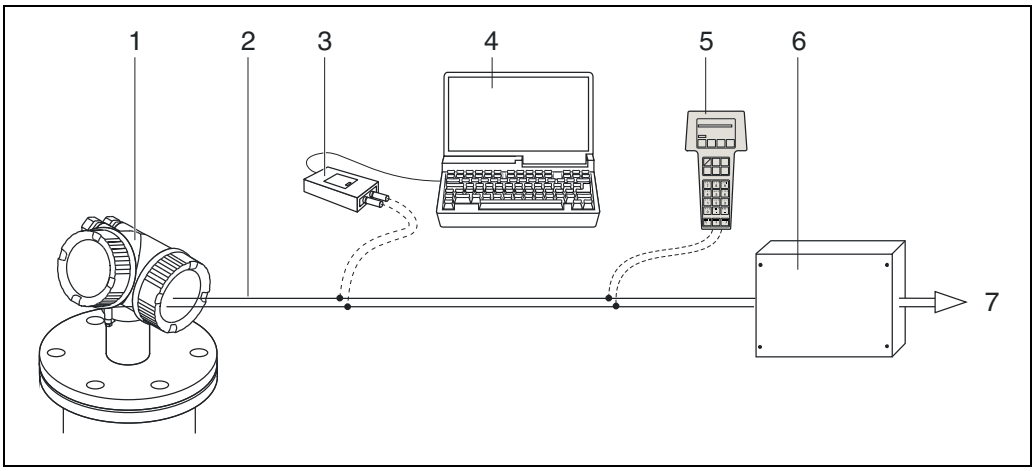
Introduction

NOTICE General information on functional safety (SIL) is available at: SIL manual

Structure of the measuring system

System components

The measuring system's devices are displayed in the following diagram (example).



1

1 Signal converter (optional with display module SD02 or SD03)
2 4 ... 20 mA line
3 Modem (USB)
4 Computer with operating tool, e. g. PACTware
5 Field communicator
6 Logic Unit, e. g. PLC, trip amplifier, ...
7 Actuator

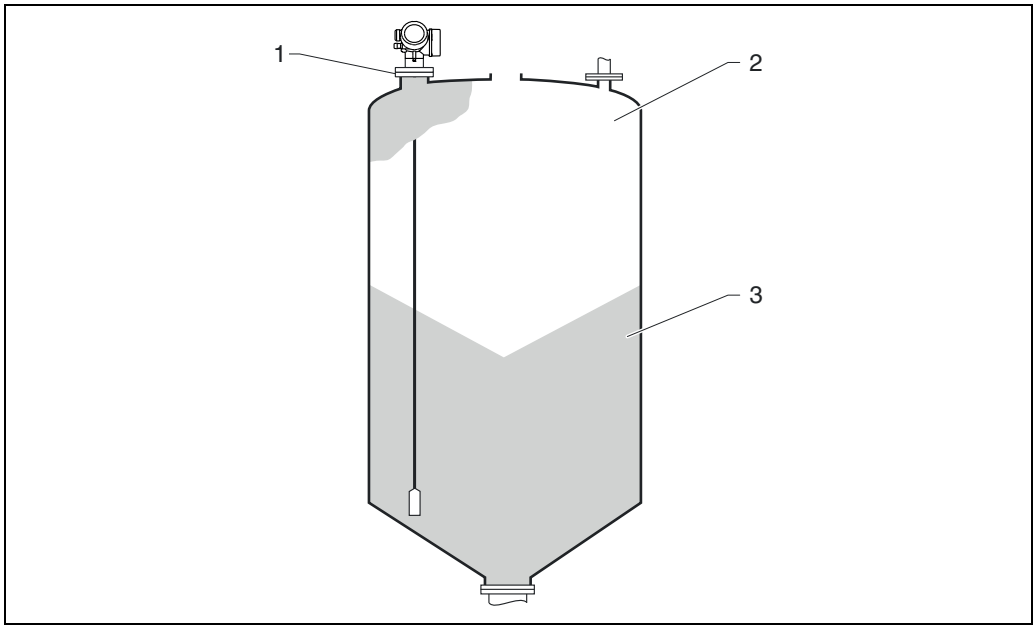
An analog signal (4 to 20 mA) in proportion to the level is generated in the transmitter. This is sent to a downstream logic unit (e. g. PLC, trip amplifier, etc.) where it is monitored to determine whether it is below or above a specified limit value.

For fault monitoring, the logic unit must recognize both HI-alarms (≥ 21.0 mA) and LO-alarms (≤ 3.6 mA).

Description of use as a protective system

The device is a "downward-looking" measuring system that functions according to the ToF method (ToF = Time of Flight). The distance from the reference point to the product surface is measured. High-frequency pulses are injected to a probe and led along the probe. The pulses are reflected by the product surface, received by the electronic evaluation unit and converted into level information. This method is also known as TDR (Time Domain Reflectometry).

Typical measuring arrangement:



2

1 Flange: reference point of measurement
2 20 mA, 100 %
3 4 mA, 0 %

The device can be used in this arrangement in safety instrumented systems for MIN safety, MAX safety and range monitoring.

NOTICE Correct installation is a prerequisite for safe operation of the device.

Permitted device types

The details pertaining to functional safety in this manual relate to the device versions listed below and are valid as of the specified software and hardware version.

Unless otherwise specified, all subsequent versions can also be used for safety instrumented systems.

A modification process according to IEC 61508 is applied for device changes.

Valid device versions for safety-related use:

Designation	Version
Approval	all
Electrical output	IH, ID [1], IE [2], AH
Display. operation	all
Housing	all
Electrical connection	all
Probe	all
Seal	all
Process connection	all
Additional operation language	all
Application package	all
Calibration	all
Service	all
Test, Certificate	all
Additional approval	A An additional selection of any further versions is possible.
Probe design	all
Accessory mounted	all
Accessory enclosed	all
Firmware version	If no version is selected here, the latest SIL-enabled SW is supplied. Alternatively, the following SW version may be selected: • 01.01.zz, HART, DevRev02 • 01.02.zz, HART, DevRev03

[1] For this version with one current output and one switching output, only the current output (terminals 1 and 2) is suitable for safety functions. The switching output can, if necessary, be wired for non-safety-oriented purposes.

[2] For this version with 2 current outputs, only the first output (terminals 1 and 2) is suitable for safety functions. The second output can, if necessary, be wired for non-safety-oriented purposes.

Valid firmware version: as of 01.01.zz (→ nameplate of the device)

Valid hardware version (electronics): as of date of production 28.01.2011 (→ nameplate of the device)

NOTICE SIL certified devices are marked with the following symbol on the nameplate: (SIL)

Supplementary device documentation

Documentation	Contents	Comment
Technical Information: • TI01000O/98 (LTC50) • TI01001O/98 (LTC51) • TI01004O/98 (LTC57)	• Technical data • Instructions on accessories	The documentation is available on the Internet. → www.pepperl-fuchs.com
Operating Instructions (HART): • BA01000O/98 (LTC50) • BA01001O/98 (LTC51) • BA01001O/98 (LTC57)	• Basic safety instructions • Product description • Incoming acceptance and product identification • Storage, Transport • Mounting • Electrical connection • Operating options • Device integration via the HART protocol • Commissioning • Trouble shooting • Repairs • Maintenance • Accessories • Return • Disposal • Overview of the operating menu • Description of device parameters	The documentation is available on the Internet. → www.pepperl-fuchs.com
Brief Operating Instructions: • KA01053O/98 (LTC50) • KA01077O/98 (LTC51) • KA01061O/98 (LTC57)	• Basic safety instructions • Product description • Incoming acceptance and product identification • Storage, Transport • Mounting • Electrical connection • Commissioning	• The documentation is supplied with the device. • The documentation is available on the Internet. → www.pepperl-fuchs.com
Description of Device Parameters: GP01000O/98	• Operating options • Overview of the operating menu • The "Expert" menu	The documentation is available on the Internet. → www.pepperl-fuchs.com
Safety instructions depending on the selected version "Approval"	Safety, installation and operating instructions for devices, which are suitable for use in potentially explosive atmospheres or as overfill protection (WHG, German Water Resources Act).	• Additional safety instructions (SI, ZE) are supplied with certified device versions. • Please refer to the nameplate for the relevant safety instructions.

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Description of the safety requirements and restrictions

Safety function

The measuring system's safety functions are:

- Maximum level limit monitoring (overfill protection)
- Minimum level limit monitoring (dry run protection)
- Level range monitoring

The safety functions include level measurement of a liquid or bulk solid.

Safety-related signal:

The device's safety-related signal is the 4 to 20 mA analog output signal. All safety measures refer to this signal exclusively.

For devices with one current output and one switching output (feature "Electrical output", option ID "2-wire, 4 to 20 mA HART, switch output"), only the current output (terminals 1 and 2) is suitable for safety functions. The switching output can, if necessary, be wired for non-safety-oriented purposes.

For devices with two current outputs (feature "Electrical output", option IE "2-wire, 4 to 20 mA HART, 4 to 20 mA"), only the first current output (terminals 1 and 2) is suitable for safety functions. The second output (terminals 3 and 4) can, if necessary, be wired for non-safety-oriented purposes.

The device additionally communicates for information only via HART and contains all HART features with additional device information.

The safety-related output signal is fed to a downstream logic unit, e. g. a programmable logic controller or a limit signal transmitter where it is monitored for the following:

- Exceeding and/or deceeding a specified level limit.
- The occurrence of a fault, e. g. error current (≤ 3.6 mA, ≥ 21.0 mA, interruption or short-circuit of the signal line).

NOTICE In case of fault it must be ensured that the equipment under control achieves or maintains a safe state.

Restrictions for use in safety-related applications

- The measuring system must be used correctly for the specific application, taking into account the medium properties and ambient conditions. Carefully follow instructions pertaining to critical process situations and installation conditions from the Operating Instructions.
- The application-specific limits must be observed.
- Information on the safety-related signal (→ 11, "Safety function").
- The specifications from the Operating Instructions must not be exceeded (→ 10, "Supplementary device documentation").
- The following restriction also applies to safety-related use: The accuracy of the 4 mA to 20 mA safety-related output signal is ±2 %.

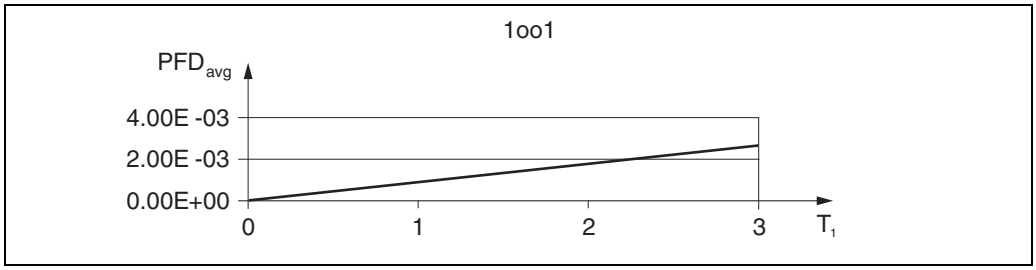
Functional safety parameters

The table shows the specific functional safety parameters:

Characteristic as per IEC 61508	Value
Safety function	MIN, MAX, range
SIL	• SIL2 (single-channel architecture 1oo1) • SIL3 (multi-channel architecture, also with homogeneous • redundancy, e. g. 1oo2, 2oo3)
HFT	0
Device type	B
Mode of operation	Low Demand Mode, High Demand Mode
SFF	93 %
MTTR	8 h
Recommended time interval for proof-testing T_1	3 years
λ_{sd}	15 FIT
λ_{su}	608 FIT
λ_{dd}	2295 FIT
λ_{du}	199 FIT
λ_{tot} [1]	3117 FIT
PFD_{avg} for T_1 = 1 year [2]	8.91×10^{-4}
PFD_{avg} for T_1 = 3 years [2]	2.64×10^{-3}
PFH	1.99×10^{-7} 1/h
MTBF [1]	57 years
Diagnostic test interval [3]	30 min
Fault reaction time [4]	30 s
System reaction time [5]	• In "Increased safety mode": - for "Medium type = Liquid": < 15 s - for "Medium type = Solid": < 90 s • In "Expert mode": freely configurable, shortest response time: 0.8 s

1 This value takes into account failure types relevant to the function. Failure rates of the electronic components as per Siemens SN29500.
2 Valid for ambient temperatures up to +40 °C (+104 °F). Where the average temperature when in continuous use is in the region of +50 °C (+122 °F), a factor of 1.3 should be taken into account.
3 During this time, all diagnostic functions are executed at least once.
4 Time between fault detection and fault reaction.
5 Step response time as per DIN EN 61298-2.

PFD_{avg} as a function of the proof-testing interval, in the case that the proof-test detects all dangerous undetected failures:



3 Proof-test interval

Dangerous undetected failures in this scenario:

An incorrect output signal that deviates from the real value by more than 2 %, but is still in the range of 4 to 20 mA, is considered a dangerous, undetected failure.

Useful lifetime of electrical components:

The established failure rates of electrical components apply within the useful lifetime as per IEC 61508-2, section 7.4.9.5 note 3.

NOTICE In accordance with DIN EN 61508-2:2011, note NA4, appropriate measures taken by the manufacturer and operator can extend the useful lifetime.

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Behavior of device during operation and in case of error

Device behavior when switched on

When switched on, the device runs through a diagnostic phase lasting approx. 15 seconds. During this time, the current output is at error current. For 5 seconds during the diagnostic phase, this current is ≤ 3.6 mA.

After that, depending on the setting of the "Start-up mode" parameter, the current is:

- at the MIN value: ≤ 3.6 mA
- at the MAX value: ≥ 21 mA.

During the diagnostic phase, no communication is possible via the service interface (CDI) or via HART.

Behavior of device on demand

The device outputs a current value corresponding to the limit value to be monitored. This value must be monitored and processed further in an attached logic unit.

Device response in the event of alarms or warnings

Fault current

In the event of an alarm, the output current is set to the configured value of ≤ 3.6 mA or ≥ 21 mA.

In some cases (e. g. failure of power supply, a cable open circuit and faults in the current output itself, where the error current ≥ 21 mA cannot be set), output currents ≤ 3.6 mA irrespective of the configured fault current can occur.

In some other cases (e. g. short circuit of cabling), output currents ≥ 21 mA can occur irrespective of the configured fault current.

For alarm monitoring, the logic unit must therefore be able to recognize both HI-alarms (≥ 21 mA) and LO-alarms (≤ 3.6 mA).

Alarm and warning messages

Additional information is provided by the alarm and warning messages in the form of error codes and associated clear text messages.

The following table shows the correlation between the error code and the current output.

Error code [1]	Current output (message type)	Note
Fxxx	≥ 21.0 mA or ≤ 3.6 mA	xxx = three-digit number
Mxxx	corresponding to measuring mode	xxx = three-digit number
Cxxx	corresponding to measuring mode	xxx = three-digit number
Sxxx	corresponding to measuring mode	xxx = three-digit number

Exceptions:

Error code [1]	Current output (message type)	Note
M272	≥ 21.0 mA or ≤ 3.6 mA	Main electronic failure
C484	≥ 21.0 mA or ≤ 3.6 mA	Simulation failure mode
S942	≥ 21.0 mA or ≤ 3.6 mA	In safety distance

[1] The error codes are listed in the Operating Instructions.

NOTICE

When SIL locking is active on the device, additional diagnostics are activated (e. g. a comparison between the readback-current with the nominal value). If one of these diagnostics results in an error message (e. g. F803 loop current) and the SIL locking is then deactivated, the error message remains while the error persists, even if the diagnostics is no longer active in the unlocked state.

In this case, the device must be disconnected briefly from the power supply (e. g. by unplugging the terminals). When the device is then restarted, a self-check is carried out, and the error message is reset where applicable.

Installation

Mounting and wiring

The mounting and wiring of the device is described in the accompanying Operating Instructions (→ 10, "Supplementary device documentation").

Mounting orientation

The permitted mounting orientations of the device are described in the Operating Instructions.

Commissioning

Commissioning of the device is described in the accompanying Operating Instructions (→ 10, "Supplementary device documentation").

Operation

Calibration of the measuring point

Calibration of the measuring point is described in the Operating Instructions.

Check the initial factory setting of the E (zero point) and F (range) parameters in accordance with the desired measuring range and correct if necessary.

Methods of device configuration

When using the devices in process control safety systems, the device configuration must comply with two requirements:

1. Confirmation concept:
   Proven, independent testing of safety-related parameters entered.
2. Locking concept:
   Locking of the device once configuration is complete (as required by IEC 61511-1 §11.6.4 and NE 79 §3).

To activate SIL mode, the device must run through an operating sequence, during which the device can be operated by means of the device display or any Asset Management Tool (PACTware, field communicator, …), for which integration is available.

Two methods of configuring the device are provided, which differ mainly with regard to the confirmation concept:

1. "Increased safety mode"
   While running through the commissioning sequence here, critical parameters which control functions in the safety path are either set automatically by the device to safe values or transferred to the display/operating tool via an alternative data format, to enable checking of the setting.
   This mode can be used for standard applications.
   As there are only a few safety-related parameters which can be freely configured, the risk of operating errors is greatly reduced, and the level in the tank does not need to be changed during commissioning in order to check the settings.
2. "Expert mode"
   A larger number of safety-related parameters can be freely configured here. This means that the device difficult applications can be adapted to. However, the settings must be checked by directly approaching the level in the tank.

A detailed description of both modes is provided in the following sections.

NOTICE It is only in the case of SIL devices (feature "Additional Approval", option A "SIL") that the SIL commissioning sequence is visible on the display and in external operating tools. For this reason, SIL locking can only be activated on these devices.

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Locking in increased safety mode

To commission the device, carry out and document the following steps in the order shown (template → 26).

1. Reset device. To do this, select...
   - With Firmware-Version 01.01.zz
     "Diagnostics > Device reset > To factory defaults" or
     "Diagnostics > Device reset > To delivery settings".
   - With Firmware-Version 01.02.zz
     "Setup > Advanced setup > Administration > Device reset > To factory defaults" or
     "Setup > Advanced setup > Administration > Device reset > To delivery settings".

   This resets all parameters to defined values.
2. Carry out configuration.
   The configuration procedure and the meaning of the individual parameters are described in the Operating Instructions. Further parameter settings, → 17.
3. Carry out "Device check"
   Activate the "Diagnostics > Device check > Start device check" parameter (more information available in the Operating Instructions (→ 10, "Supplementary device documentation")). The signal quality is tested and possible installation errors are detected.
4. Start SIL/WHG confirmation sequence.
   To do so, enter the appropriate locking code in the "Setup > Advanced setup > SIL/WHG confirmation > Set write prot." parameter:
   - WHG: 7450
   - SIL: 7452
   - SIL and WHG: 7454

NOTICE In this way, forbidden parameter changes (e. g. via external operating tools if the confirmation sequence is performed at the device display) are prevented already during the SIL/WHG confirmation sequence.

5. For "Commissioning" select the "Increased safety mode" entry from the list.
   The device checks the parameter settings in accordance with the table (→ 17) and carries out a forced switching of parameters if necessary. Once testing is complete, "SIL/WHG preparation: Finished" is displayed, and the commissioning sequence can continue.

NOTICE If configuration was not performed in accordance with the specifications in point 2, only "Expert mode" can be selected at this point.

6. Simulate distance values via the "Value sim. dist." parameter, and verify that the response of the current output is correct. For MIN monitoring and MAX monitoring, in each case simulate a distance directly above and below the switch point. For range monitoring, 5 distance values should be simulated which cover the entire measuring range.

⚠ CAUTION During distance simulation, the loop current does not correspond to the measured value. It must be ensured that there is no risk of danger arising from this.

7. Confirm that the distance simulation is correct. To do so, select the "Yes" value for the "Sim. correct" parameter.
8. Compare the character string which is now output ("0123456789+-,.") with the reference string printed here, and confirm if the output is correct.
9. The parameters previously configured and which require confirmation are transferred via an independent data format to the display/operating tool.
   Check the parameters one after the other and confirm if correct.
10. Enter locking code again under "Set write prot.":
    - WHG: 7450
    - SIL: 7452
    - SIL and WHG: 7454

    The "End of sequence" message indicates that the device was successfully locked.
11. Optional, hardware locking may also be activated (via the DIP switch marked "WP" on main electronics).

Locking in expert mode

To commission the device, carry out and document the following steps in the order shown (template → 26).

1. Reset device. To do this, select...
   – With Firmware-Version 01.01.zz
   "Diagnostics > Device reset > To factory defaults" or
   "Diagnostics > Device reset > To delivery settings".
   – With Firmware-Version 01.02.zz
   "Setup > Advanced setup > Administration > Device reset > To factory defaults" or
   "Setup > Advanced setup > Administration > Device reset > To delivery settings".

   This resets all parameters to defined values.
2. Carry out configuration.
   The configuration procedure and the meaning of the individual parameters are described in the Operating Instructions. Further parameter settings, → 17.
3. Carry out "Device check".
   Activate the "Diagnostics > Device check > Start device check" parameter (more information available in the Operating Instructions (→ 10, "Supplementary device documentation")). The signal quality is tested here and possible installation errors are detected.
4. Start SIL/WHG confirmation sequence.
   To do so, enter the appropriate locking code in the "Setup > Advanced setup > SIL/WHG confirmation > Set write prot." parameter:
   – WHG: 7450
   – SIL: 7452
   – SIL and WHG: 7454
5. For "Commissioning" select the "Expert mode" entry from the list.
   The device checks the parameter settings in accordance with the table (→ 17) and forces the switching of parameters if necessary. Once testing is complete, "SIL/WHG preparation: Finished" is displayed, and the commissioning sequence can continue.
6. Carry out function test.
   For MIN monitoring and MAX monitoring, in each case approach a level directly above and below the switch point. For range monitoring, 5 distance values should be approached which cover the entire measuring range.
7. Confirm that the function test has been successful. To do so, select the "Yes" entry for "Conf. funct. test".
8. Enter locking code again under "Set write prot.":
   – WHG: 7450
   – SIL: 7452
   – SIL and WHG: 7454

   The "End of sequence" message indicates that the device was successfully locked.
9. Optional, hardware locking may also be activated (via the dip switch marked "WP" on main electronics).

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Further parameter settings

Description	Parameter displayed		
These parameters affect the safety function. However, they may be freely configured in accordance with the application. In increased safety mode, it is necessary to confirm the configured values during the remainder of the commissioning process. Confirmation is not required in expert mode. Recommendation: Note configured values!	Setup	> Tank type [3, 4]	
		> Bin type [3, 5]	
		> Empty calibration	
		> Full calibration	
		> Advanced setup	> Level
			> Medium type [2]
			> Process property. [3]
			> Advanced process conditions. [3]
			> Probe length corr.
			> Present length [1]
			> Current output 1
			> Assign current

Description	Parameter displayed		
These parameters affect the safety function and are not freely configurable in increased safety mode. Instead, they are automatically set by the device at the start of the SIL/WHG confirmation to the safety-oriented values mentioned. If these parameters are to be set to other values, expert mode must be selected.	Display/ Operation	> Backlight = Deactivate	
	Setup	> Advanced setup	> Level
			> Process property = Standard
			> Level correction = 0
			> Linearization
			> Linearization type = None
			> Current output 1
			> Current span ≠ Fixed current
			> Damping = 0 s
	Expert	> Sensor	> Level
			> Distance offset = 0 mm
			> L max. drain. speed = 0
			> L max. filling speed = 0
			> I max. draining speed = 0
			> I max. filling speed = 0
			> Level limit mode = Off
			> Output mode = Level
			> Sensor diagnostics
			> Broken probe detection = On
			> Safety settings
			> Delay time echo lost = 1 s (firmware 01.01.10 and 01.01.16) 3 s (as of firmware 01.01.18)
		> Output	> Envelope curve
			> Add. meas. range = 0
			> Add. env. points = 0
		> Communication	> Current output 1
			> Turn down = Off
			> Measuring mode = Standard
			> HART address = 0 [2]
			> Configuration
			> HART address = 0 [3]

Description	Parameter displayed			
These parameters affect the safety function and are automatically set by the device when configuring higher-ranking parameters (known as application parameters). This indirect setting is permitted in increased safety mode. However, it is not permitted to change the parameters directly. If these parameters were changed directly, only expert mode is available for selection in the SIL/WHG confirmation.	Setup	> Dist. up.connect [3]		
		> Advanced setup	> Level	> Medium type [3]
				> Blocking distance [3]
	Expert	> Sensor	> Distance	> Dead time
				> Integration time
				> Max. integration time
				> Delta integ.time
				> BD evaluat. mode
			> Gas phase comp.	> GPC mode [3]
			> Sensor diag.	> BP reflect fact. [3]
			> Safety settings	> Jump del. echol.
				> Draining speed
				> Filling speed.
			> Mapping	> Map gap to LN [3]
			> Envelope curve	> Env. stat. down
				> Env. stat. up
			> First echo fact.	> First echo mode
				> First echo fact.
			> EOP evaluation	> EOP level eval. [3]
				> EOP search mode
				> EOP evaluation
				> EOP range up.area
				> Refl.fact.near
				> Attenuat. const.
				> Refl. fact. far
			> Echo tracking	> Evaluation mode
				> Wind.size track.
				> Max track count
			> Interface	> Empty capacity

Description	Parameter displayed			
These parameters affect the safety function and cannot be freely configured neither in increased safety mode nor in expert mode. Instead they are automatically set at the start of the SIL/WHG confirmation to the safety-oriented values mentioned.	Setup	> Advanced setup	> Safety settings	> Output echo lost = Alarm
	Diagnostics	> Simulation	> Assign measurement variable = Off	
			> Value current output 1 = Off	
			> Simulation device alarm = Off	
			> Simulation Diagnostics = 65533	
	Expert	> Sensor	> Distance	> Hysteresis = 0 mm
		> Output	> Current output 1	> Trim = Off
		> Diagnostics	> Simulation	> Simulation distance = Off

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Description	Parameter displayed			
These parameters affect the safety function. If the settings differ from the as-delivered state of the device, only expert mode is available for selection in the SIL/WHG confirmation.	Setup	> Advanced setup	> Probe settings	> Probe grounded [3]
			> Current output 1	> Assign current [2]
	Expert	> Sensor	> Sensor properties	> Sensor type
				> Microfactor
				> Ideal sig. near
				> Ideal sig.atten.
				> Ideal signal far
				> Ant. zero dist.
				> Cable zero dist.
				> Electr.zero dist
				> Fine zero dist.
				> F zdist.win.left
				> F zdist.win.right
				> Thres. f. z-dist
				> Fine z-dist.corr
				> Inactive length
			> Sensor diagnostics	> O. Blkd. Sondb. erk. [3]
				> LBD broken probe
				> HF cable failure
			> Safety settings	> Echo l.win.right
				> Echo l.win.left
			> Echo threshold	> Threshold near
				> Threshold far
				> Thres.atten.cons
				> Weight area
				> Refl.fact.weight [3]
			> Mapping	> Map gap to LN [2]
			> First echo fact.	> Fix factor EWC
			> Echo adjust. fine	> Fine adjust.mode [3]
				> Merge echo dist. [3]
				> Merg.echo window [3]
				> Merging ratio. [3]
				> Parab fit window
			> EOP evaluation	> EOP level eval. [2]
			> Echo tracking	> Lower level area [3]
		> Communication	> HART output	> Assign PV [2]

Description	Parameter displayed			
These parameters affect the safety function. If the settings differ from the permitted values mentioned, the SIL/WHG confirmation is canceled automatically, and the device cannot be locked neither in increased safety mode nor in expert mode.	Setup	> Advanced setup	> Current output 1	> Assign curr. [3]
				> Failure mode = MIN or MAX
	Expert	> Output	> Current output 1	> Start-up mode ≠ Customized
		> Communication	> Output	> Assign PV [3]

1 After the probe has been shortened, if possible use the function for automatically redetermining the probe length ("Setup > Advanced setup > Probe length corr." sequence).
If the probe length is not determined automatically, but is entered manually in the device, only expert mode is possible.
2 Firmware 01.01.10, 01.01.16 and 01.01.18.
3 From Firmware 01.02.00
4 Only for liquids.
5 Only for bulk solids.

Those parameters which are not mentioned do not affect the safety function and can be configured to any meaningful values. The visibility of the parameters mentioned in the operating menu depends in part on the user role, the SW options ordered and on the configuration of other parameters.

NOTICE If gas phase compensation is activated ("GPC mode" parameter set to "On" or "Const. GPC factor"), this results in a differing specification for accuracy, → Operating Instructions.
Coaxial probes with gas phase compensation are precalibrated ex works and may be commissioned either in increased safety mode or in expert mode.
When using a rod probe with gas phase compensation, expert mode must be selected, and the correct setting of the "Reference distance" parameter must be verified during commissioning.

NOTICE In SIL mode, the device must not be operated in HART multidrop mode, as otherwise the current output will have a fixed value. For this reason, only the setting "Expert > Communication > HART address = 0" is permitted in SIL mode and in the combined SIL/WHG mode when in increased safety mode. In pure WHG mode, HART multidrop is permitted in expert mode as long as the HART signal is evaluated in an external switching unit (e. g. Tank Side Monitor NRF590) which complies with the approval principles as per WHG.

Unlocking a SIL device

When SIL locking is active on a device, the device is protected against unauthorized operation by means of a locking code and, as an additional option, by means of a hardware write protection switch. The device must be unlocked in order to change the configuration for proof-tests as per test sequence B (→ 23) or test sequence C (→ 24), as well as to reset self-holding diagnostic messages.

CAUTION Unlocking the device deactivates diagnostic functions, and the device may not be able to carry out its safety function when unlocked. Therefore, independent measures must be taken to ensure that there is no risk of danger while the device is unlocked.

To unlock, proceed as follows:

1. Check the position of the hardware write protection switch (dip switch marked "WP" on main electronics), and set this switch to "Off".
2. Select the "Setup > Advanced setup > Deactivate SIL/WHG" sequence, and enter the appropriate unlocking code for the "Res. write prot." parameter:
   - WHG: 7450
   - SIL: 7452
   - SIL and WHG: 7454

   The "End of sequence" message indicates that the device was successfully unlocked.

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Maintenance

Please refer to the relevant Operating Instructions (→ 10, "Supplementary device documentation") for instructions on maintenance and recalibration.

Alternative monitoring measures must be taken to ensure process safety during configuration, proof-testing and maintenance work on the device.

Proof-test

Proof-test

Check the operativeness and safety of safety functions at appropriate intervals! The operator must determine the time intervals.

You can refer to the diagram "Proof-test interval", → 12, for this purpose.

NOTICE

In a single-channel architecture, the PFD_{avg} value to be used depends on the diagnostic rate of coverage for the proof-test (PTC = Proof Test Coverage) and the intended lifetime (LT = Lifetime), as specified in the following formula:

$$PFD_{avg} = 1/2 \times PTC \times \lambda_{du} \times T_1 + \lambda_{dd} \times MTTR + 1/2 \times (1 - PTC) \times \lambda_{du} \times LT$$

For the proof-tests described as follows, the respective proof test coverages are specified, which may be used for calculation.

Proof-testing of the device can be performed as follows:

- Approaching the level in the original tank (→ Test sequence A).
- Removing of the device and immersing in a medium with comparable properties (→ Test sequence B).
- Device self-test and level simulation (→ Test sequence C). No change of level in the tank is necessary for this sequence.

You must also check that all cover seals and cable entries are sealing correctly.

CAUTION

During the proof-test, alternative monitoring measures must be taken to ensure process safety.

Process for proof-testing

Test sequence A

Preparation

1. Connect suitable measuring device (recommended accuracy better ±0.1 mA) to the current output.
2. Determine the safety setting (level limit or range monitoring).

Procedure for level limit monitoring

1. Approach a level directly below (MAX monitoring) or directly above (MIN monitoring) the level limit to be monitored.
2. Read the output current, record it and assess for accuracy.
3. Approach a level directly above (MAX monitoring) or directly below (MIN monitoring) the level limit to be monitored.
4. Read the output current, record it and assess for accuracy.
5. The test is deemed successful if the current in step 2 does not result in activation of the safety function but the current in step 4 does.

Procedure for range monitoring

1. Approach five levels within the range to be monitored.
2. Read the output current at each level value, record it and assess for accuracy.
3. The test is deemed successful if the current values in step 2 are within the required level of accuracy.

NOTICE

The proof-test is deemed to have failed if the expected current value deviates for a specific level by > ±2 %. For troubleshooting, → Operating Instructions (→ 10, "Supplementary device documentation"). 98 % of dangerous, undetected failures are detected using this test (Proof test coverage, PTC = 0.98).

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Test sequence B

Preparation

1. Prepare a test tank with test medium (dielectric constant comparable to that of the medium to be measured).
   For installation instructions, → Operating Instructions (→ 10, "Supplementary device documentation").
2. Deactivate SIL mode. To do so, enter the appropriate unlocking code in the "Setup > Advanced setup > Deactivate SIL/WHG" operating menu:
   – WHG: 7450
   – SIL: 7452
   – SIL and WHG: 7454
3. Remove the device and mount it in the test tank.
4. Connect suitable measuring device (recommended accuracy better than ±0.1 mA) to the current output.
5. Perform interference echo mapping if the shape and size of the test tank is different.
6. Determine the safety setting (level limit or range monitoring).

Procedure for level limit monitoring

→ Test sequence A

Procedure for range monitoring

→ Test sequence A

NOTICE The proof-test is deemed to have failed if the expected current value deviates for a specific level by > ±2 %. For troubleshooting, → Operating Instructions (→ 10, "Supplementary device documentation"). 98 % of dangerous, undetected failures are detected using this test (Proof test coverage, PTC = 0.98).

CAUTION After re-installation in the original tank, SIL mode must be reactivated, → 14. If an interference echo mapping was performed in the test tank, it is necessary following installation in the original tank to carry out another interference echo mapping that is valid for that tank.

Test sequence C

Preparation

1. Deactivate SIL mode. To do so, enter the appropriate unlocking code in the "Setup > Advanced setup > Deactivate SIL/WHG" operating menu:
   – WHG: 7450
   – SIL: 7452
   – SIL and WHG: 7454
2. Connect suitable measuring device (recommended accuracy better than ±0.1 mA) to the current output.
3. Determine the safety setting (level limit or range monitoring).

Procedure for level limit monitoring

1. Perform device self-check. To do so, select the value "Yes" in the menu [1] in the "Expert > Sensor > Sensor diag. > Start self check" list. After performing the test, read the result in the "Expert > Sensor > Sensor diag. > Result self check" parameter.
   This part of the test has been passed only when "OK" is displayed here.
2. Simulate a level directly below (MAX monitoring) or directly above (MIN monitoring) the level limit to be monitored. To do so, select the value "Level" in the operating menu in the "Diagnostics > Simulation > Assign measurement var." list. Alternatively, in the case of interface measurement, select the values "Interface" or "Upper interface thickness" if applicable, and enter the value in the "Diagnostics > Simulation > Value proc. var." parameter.
3. Read the output current, record it and assess for accuracy.
4. Simulate a level directly above (MAX monitoring) or directly below (MIN monitoring) the level limit to be monitored.
5. Read the output current, record it and assess for accuracy.
6. The test is deemed successful if the current in step 2 does not result in the activation of the safety function but the current in step 4 does.

Procedure for range monitoring

1. Perform device self-check. To do so, select the value "Yes" in the menu [1] in the "Expert > Sensor > Sensor diag. > Start self check" list. After performing the test, read the result in the "Expert > Sensor > Sensor diag. > Result self check" parameter.
   This part of the test has been passed only when "OK" is displayed here.
2. Simulate five levels within the range to be monitored. Procedure → Limit value monitoring, point 2.
3. Read the output current at each level value, record it and assess for accuracy.
4. The test is deemed successful if the current values in step 2 are within the required level of accuracy.

NOTICE The proof-test is deemed to have failed if the expected current value deviates for a specific level by > ±2 %. For troubleshooting, → Operating Instructions (→ 10, "Supplementary device documentation"). 93 % of dangerous, undetected failures are detected using this test (Proof test coverage, PTC = 0.93). A number of sensor (probe) faults are not detected.

NOTICE If one of the test criteria from the test sequences described above is not fulfilled, the device may no longer be used as part of a safety instrumented system. The purpose of proof-testing is to detect random device failures (λ_{du}). The impact of systematic faults on the safety function is not covered by this test and must be assessed separately. Systematic faults can be caused, for example, by process material properties, operating conditions, build-up or corrosion.

CAUTION After the test sequence has been passed, the SIL mode must be activated again, → 14.

[1] When selecting the "Expert" menu group, a prompt for the access code appears on the display. If an access code was defined under "Setup > Advanced setup > Def. access code", this must be entered here. If no access code was defined, the prompt can be acknowledged by pressing the "E" key.

Repairs

Repairs

NOTICE Repair means a one-to-one replacement of components.

Repairs on the devices must always be carried out by Pepperl+Fuchs. Safety functions cannot be guaranteed if repairs are carried out by anybody else.

Exceptions:

Qualified personnel may replace the following components on the condition that original spare parts are used and the relevant Installation Instructions are observed:

Component	Device	Checking the device after repair
Probe with process connection	LTC5X	Proof check; test sequence A or B
Probe without process connection	LTC57	• With change of the probe length: – Unlock the device – Recalibrate the probe length – Check the measurement at an arbitrary level – Lock the device • Without change of the probe length: – Check the probe length, e. g. using a measuring tape – Visual inspection to check whether all parts are present and properly mounted – After remounting: Check the measurement at an arbitrary level
Weights of rope probes	LTC5X	Visual inspection to check whether all parts are present and properly mounted.
Nord-lock washers and lock nuts for probe mounting	LTC51, LTC57	Visual inspection to check whether all parts are present and properly mounted.
Seal kits for probes	LTC50, LTC51	• Visual inspection to check whether all parts are present and properly mounted. • After remounting: Check the measurement at an arbitrary level.
Display	LTC5X	Visual inspection to check whether all parts are present and properly mounted.
Main electronics	LTC5X	• Unlock the device • Navigate to: Menu "Setup" > "Mapping" > "Confirm distance". Compare the displayed distance to the actual value in order to start the recording of a map, if required. • Lock the device.
I/O modules	LTC5X	Proof check (test sequence C is sufficient as it detects all critical errors which may result from repair).
Terminals for I/O modules	LTC5X	• Visual inspection to check whether all parts are present and properly mounted. • After remounting: Check the measurement at an arbitrary level.
Housing covers	LTC5X	Visual inspection to check whether all parts are present and properly mounted.
Seal kits for housing covers	LTC5X	Visual inspection to check whether all parts are present and properly mounted.
Housing filters (vent plugs)	LTC5X	Visual inspection to check whether all parts are present and properly mounted.
Safety clamps, housing	LTC5X	Visual inspection to check whether all parts are present and properly mounted.

The replaced components must be sent to Pepperl+Fuchs for the purpose of fault analysis, if the device has been operated in protective equipment. Once the components have been replaced, observe column "Checking the device after repair" of table!

In the event of failure of a SIL-labeled Pepperl+Fuchs device, which has been operated in a protection function, the "Declaration of Contamination and Cleaning" with the corresponding note "Used as SIL device in protection system" must be enclosed when the defective device is returned.

Please refer to the Section "Return" in the Operating Instructions (→ 10, "Supplementary device documentation").

Appendix

Notes on the redundant use of multiple sensors

This section provides additional information regarding the use of homogeneously redundant sensors e. g. 1oo2 or 2oo3 architectures.

The common cause factors ß and $ß_D$ indicated in the table below are minimum values for the device. These must be used when designing the sensor subsystem.

Minimum value ß with homogeneous redundant use	2 %
Minimum value $ß_D$ with homogeneous redundant use	1 %

The device meets the requirements for SIL 3 in homogeneously redundant applications.

The following must be taken into account during installation:

- Install rod and rope probes in separate reference vessels (bypasses, stilling wells), to prevent them from interfering with each other. When installing in the same tanks, the sensor axes must be a minimum distance of 100 mm (3.94 in) apart. Coaxial probes may be installed at any distance.
- Application limits of measuring systems in contact with the process must be observed! In particular, in the case of highly viscous, build-up forming or crystallizing media.

The following must be taken into account in proof-testing:

- If an error is detected in one of the redundantly operated devices, the other devices must be checked to see if there is the same error.

Commissioning or proof test protocol

For firmware version: 01.01.zz

System-specific data		
Company		
Measuring point/TAG no.		
System/plant		
Device type/order code		
Serial number of device		
Name		
Date		
Access code (if individual to each device)		
Locking code used	WHG:	7450
	SIL:	7452
	SIL and WHG:	7454
Signature		
Device-specific commissioning (only in "Increased safety mode")		
Empty calibration		
Full calibration		
Blocking distance		
Operating mode		
Assign current (interface measurement)		
Medium type		
Present length		
Medium property (level measurement)		
	Set point	Actual point
Proof-test protocol		
Test step		
1. Current value 1		
2. Current value 2		
3. Current value 3 (if necessary)		
4. Current value 4 (if necessary)		
5. Current value 5 (if necessary)		

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For firmware version: 01.02.zz

System-specific data		
Company		
Measuring point / TAG no.		
System / Plant		
Device type / Order code		
Serial number of device		
Name		
Date		
Access code (if individual to each device)		
Locking code used	WHG: ..... 7450 SIL: ..... 7452 SIL and WHG: 7454	
Signature		
Device-specific commissioning (only in "Increased safety mode")		
Empty calibration		
Full calibration		
Operating mode (interface measurement)		
Assign curr. (interface measurement)		
Tank type (liquids)		
Bin type (bulk solids)		
Process property		
Adv. conditions		
Present length		
Tube diameter (interface measurement)		
Medium property (level measurement)		
	Set point	Actual point
Proof-test protocol		
Test step		
1. Current value 1		
2. Current value 2		
3. Current value 3 (if necessary)		
4. Current value 4 (if necessary)		
5. Current value 5 (if necessary)		

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Certificate

Nr./No.: 968/FSP 1034.00/14

Prüfgegenstand **Product tested**	Sichere Überwachung eines Füllstandes sowie sichere Trennschichterkennung Safe detection of a level as well as safe detection of an interface level	**Zertifikats-inhaber** **Certificate holder**	Pepperl+Fuchs GmbH Lilienthalstraße 200 68307 Mannheim Germany
Typbezeichnung **Type designation**	Pulscon, Typ LTC50, Pulscon, Typ LTC51, Pulscon, Typ LTC57		
Prüfgrundlagen **Codes and standards**	IEC 61508 Parts 1-7:2010 IEC 61511-1:2003 + Corr. 1:2004	IEC 61010-1:2010 IEC 61326-3-2:2008	
Bestimmungsgemäße Verwendung **Intended application**	Die Geräte erfüllen die Anforderungen der Prüfgrundlagen (Hardware Sicherheitsintegrität SIL 2 nach IEC 61508 und systematische Eignung SIL 3 nach IEC 61508) und können in Anwendungen bis SIL 2 (HFT=0) bzw. SIL 3 (HFT=1) nach IEC 61508 für die Sicherheitsfunktionen MIN, MAX oder Bereichsüberwachung eingesetzt werden. The devices comply with the requirements of the relevant standards (Hardware safety integrity SIL 2 acc. to IEC 61508 and systematic capability SIL 3 acc. to IEC 61508) and can be used in applications up to SIL 2 (HFT=0) resp. SIL 3 (HFT=1) acc. to IEC 61508 for the safety functions MIN, MAX or monitoring of a range.		
Besondere Bedingungen **Specific requirements**	Die Hinweise in der zugehörigen Betriebsanleitung und dem Sicherheitshandbuch sind zu beachten. The instructions of the associated Operating Manual and Safety Manual shall be considered.		

Gültig bis / Valid until 2016-01-26

Der Ausstellung dieses Zertifikates liegt eine Prüfung zugrunde, deren Ergebnisse im Bericht-Nr. 968/FSP 1034.00/14 vom 08.09.2014 dokumentiert sind.
Dieses Zertifikat ist nur gültig für Erzeugnisse, die mit dem Prüfgegenstand übereinstimmen. Es wird ungültig bei jeglicher Änderung der Prüfgrundlagen für den angegebenen Verwendungszweck.
The issue of this certificate is based upon an examination, whose results are documented in report-no.: 968/FSP 1034.00/14 dated 2014-09-08.
This certificate is valid only for products which are identical with the product tested. It becomes invalid at any change of the codes and standards forming the basis of testing for the intended application.

TÜV Rheinland Industrie Service GmbH
Bereich Automation
Funktionale Sicherheit
Am Grauen Stein, 51105 Köln

Köln, 2014-09-08 — Certification Body for FS-Products — Dipl.-Ing. Heinz Gall

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