

Technical Description

Level Detector type LS 300 ... and Measuring Transducer type LS 500 ...

1 Design of the Overfill Protection Device

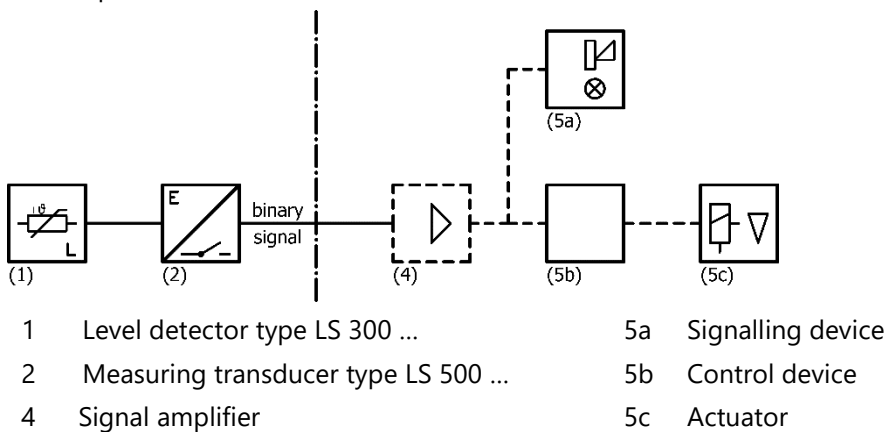
The overfill protection device comprises a level detector (1) and a measuring transducer (2) with binary signal output (relay contact).

The switching signal is supplied to the signalling device (5a) or to the control device (5b) with actuator (5c) either directly or, if necessary, by a signal amplifier (4).

The untested parts of the overfill protection device, such as signalling device (5a), control device (5b), actuator (5c) and signal amplifier (4) must satisfy the requirements of sections 3 and 4 of the German approval guidelines for overfill protection devices.

1.1 Structure of the Overfill Protection Device

Overfill protection device with level limit switch:



1.2 Functional description

Level detector LS 300 ...:

The operating principle of the level detector is based on the difference in thermal conductivity between gases and liquids. A PTC resistor encapsulated in the tip of the level detector is heated in dry condition by the signal current of the measuring transducer until a sudden increase in its electrical resistance occurs. As soon as this tip is immersed in a liquid, the resulting drop in temperature causes a drop-in resistance to the original value. The signal current is limited in such a way that, in this condition (immersed), the resistor cannot be reheated. In a gaseous environment, the PTC resistor takes between 15 seconds and two minutes to heat up, depending on the ambient temperature.

LS 300 ...P...: The test equipment integrated in the level detector must be connected to an external compressed air supply via plug connector or screwing. The gas required for functional testing (e.g. nitrogen) is passed through the test device directly to the PTC resistor sensor. During the blow-on process the PTC resistor is cooled down by the gas flow to the value corresponding to immersion in liquid. This activates the signalling device and the functionality of the overfill protection device is displayed.



Measuring transducer LS 500 ...:

In the measuring transducer, the changes in resistance of the PTC resistor are converted to relay switching signals with binary signal output. The PTC resistor operation is continuously monitored by a scanner integrated in the measuring transducer. The characteristics of the PTC resistor (heating and cooling behaviour) are checked several times each second without effect on the measuring process. This ensures that any PTC resistor that is no longer operationally reliable, e. g. due to external causes (corroded probe sleeve), can be detected instantly and signalled by a response of the overfill protection device's alarm system.

The electrical readiness for operation of the measuring transducer is indicated by a green LED (power). The blue LED (scanner) signals the heating up of the PTC resistor.

A relay deactivation occurs at cooled down level detector tip as well as dysfunction (detection by the scanner), power failure, short circuit and line break in the connection between level detector and measuring transducer. This is indicated by the disappearance of the yellow LED (sensor).

To control the function of the entire overfill protection device the measuring transducer can be fitted with a test button. Whenever this button is pressed, the heat output of the PTC resistor is reduced so much that it cools down (equivalent to a submerged sensor) and the alarm system is triggered.

LS 500 H Duo: This type allows the connection of two level detectors.

LS 500 ... S: For these types, a fault relay and a red LED (error) are available. In case of interruption or short-circuit of the signal line from the level detector to the measuring transducer, the relay energizes and the LED is on.

LS 500 ... Z: For these types, there is a second sensor relay available.

LS 500 H SIL: For this type, there are also a SIL error relay (changeover contact) and two red LEDs (Error and SIL Error) available. In the event of a short circuit or line break, the error LED lights up. If an error is detected by the test electronics, the SIL error relay is activated and the "SIL Error" LED lights up. In addition, the "Error" LED starts blinking.

1.3 Type codes

Level detector LS 300 ...:

Type	Process connection	Sensor tube	Test connection	Overvoltage protection	Temperature range	Option	
LS 300	Level detector					Duo	Dual sensor
						Steck	Plug connection
						Tantal	Sensor made of tantalum
						Trio	Triple sensor
						Normal	-25 °C ... +50 °C (T _a ≤ +80 °C)
						H	High -25 °C ... +80 °C
						HH	Highest -10 °C ... +110 °C
						L	Low -40 °C ... +50 °C (T _a ≤ +80 °C)
							Without overvoltage protection
						U	With (sensor head only in Zone 1 resp. EPL Gb)
							Without
						P	With test connection and without check valve
						PR	With test connection and with check valve
							Standard, e.g. Ø = 10 mm
Bn	n = Ø in mm						
S	"Heavy" version, e.g. Ø = 24 mm						
X	Flexible sensor tube						
	Without (special version)						
E	Screw-in unit						
F	Flange						

Table 1.3a: Type code for level detector LS 300 ...

Measuring transducer LS 500 ...:

Type	Design	Overfill protection	Electrical design	
LS 500	Measuring transducer			One control relay (potential-free changeover contact)
			Duo	Only H: Two sensor circuits
			S	One additional error relay
			Z	Second control relay
			(Mono)	Designation "Mono" only for H and if no additions follow
			SIL	Only mounting rail housing; with SIL 2 certificate; no further additions
				Wall mounting housing
			H	Mounting rail housing with communication via RS-485

Table 1.3b: Type code for Measuring transducer LS 500 ...

1.4 Dimension sheets and technical data

Level detector LS 300 ...:

Dimensions

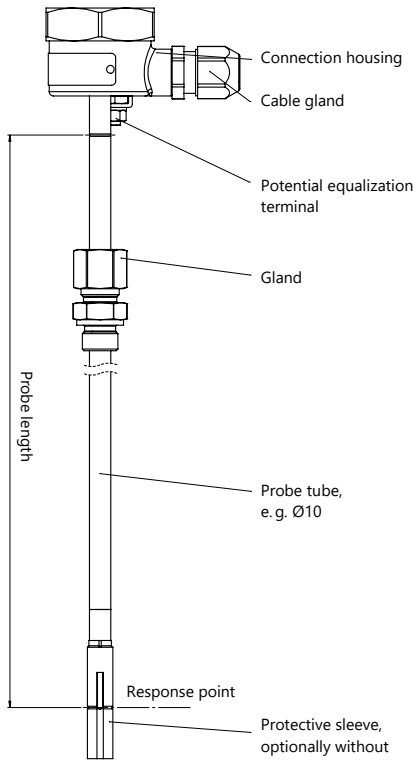


Figure 1.4a: LS 300 E

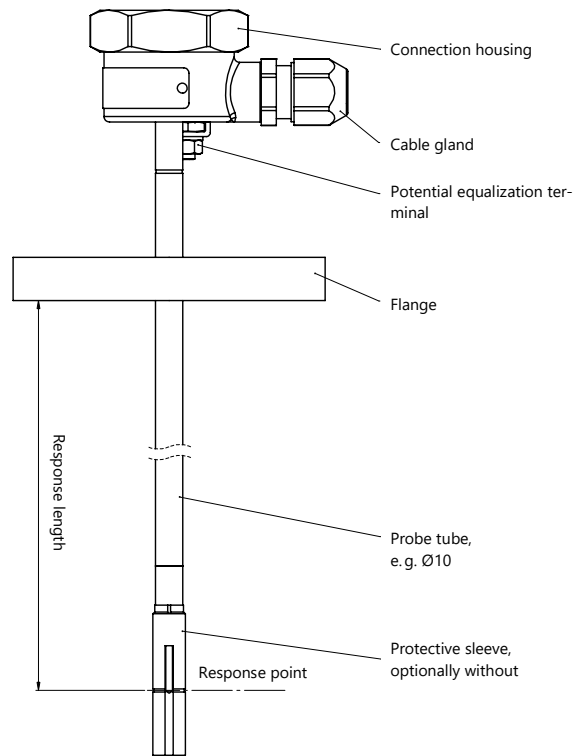


Figure 1.4b: LS 300 F

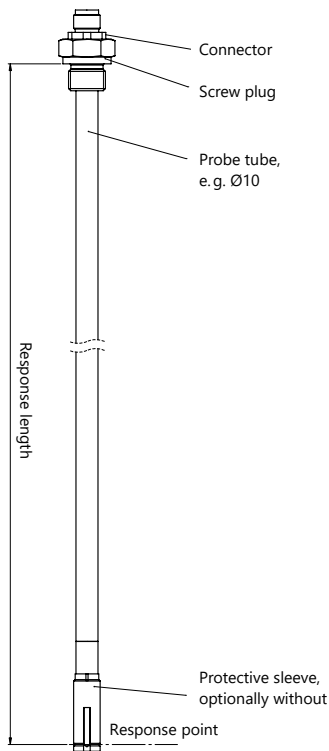


Figure 1.4c: LS 300 E Steck

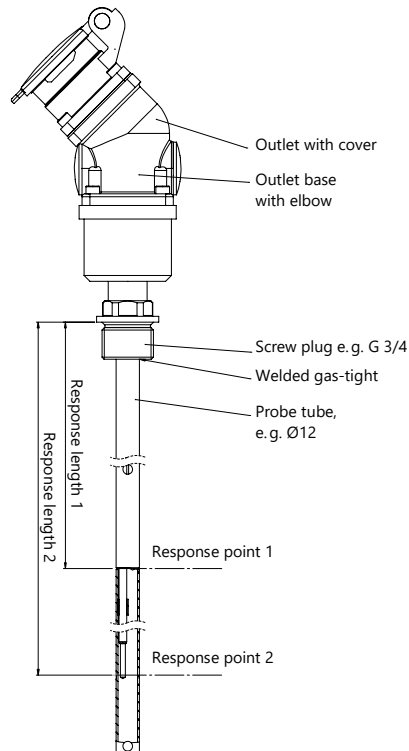


Figure 1.4d: LS 300 E Steck/01

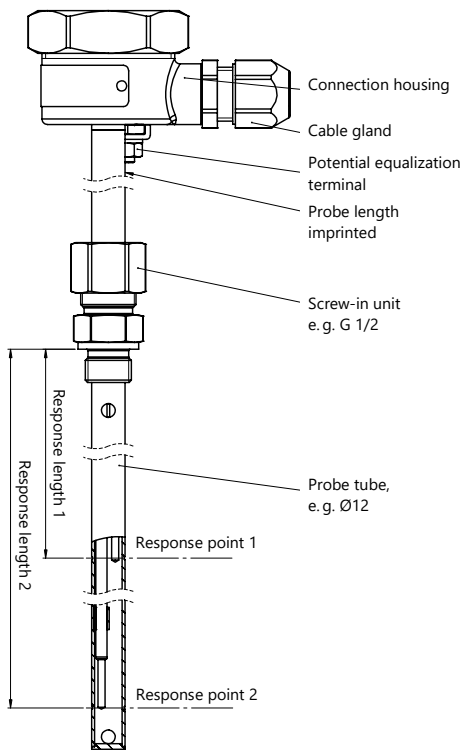


Figure 1.4e: LS 300 E DUO/03

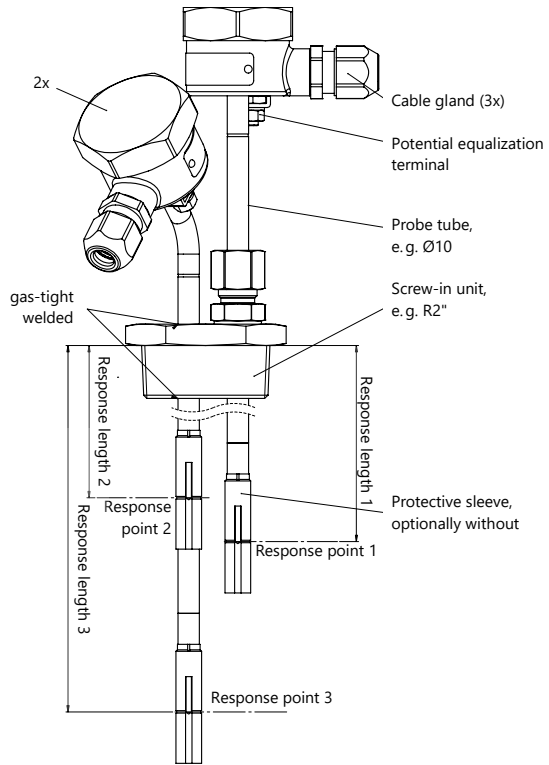


Figure 1.4f: LS 300 E TRIO/02

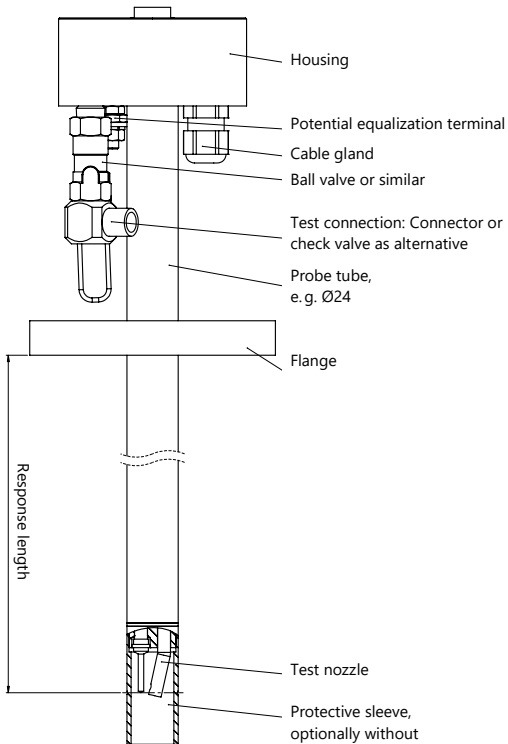


Figure 1.4g: LS 300 FSP

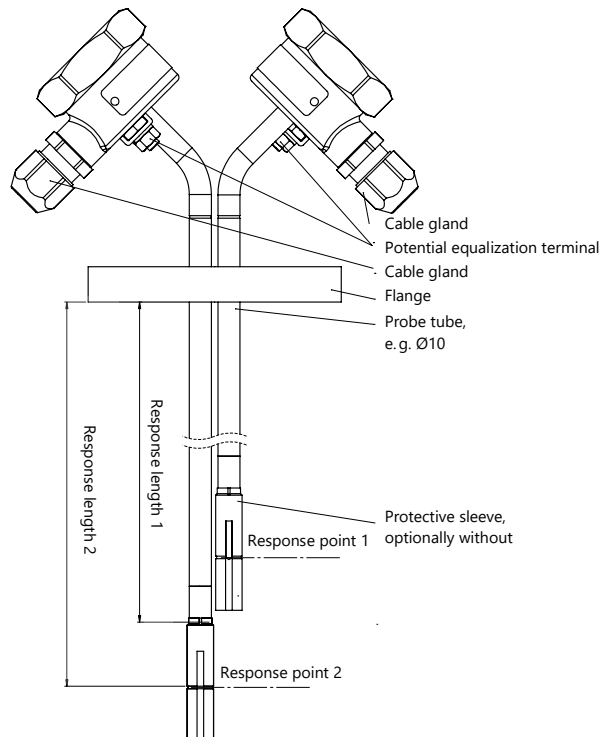


Figure 1.4h: LS 300 F Duo

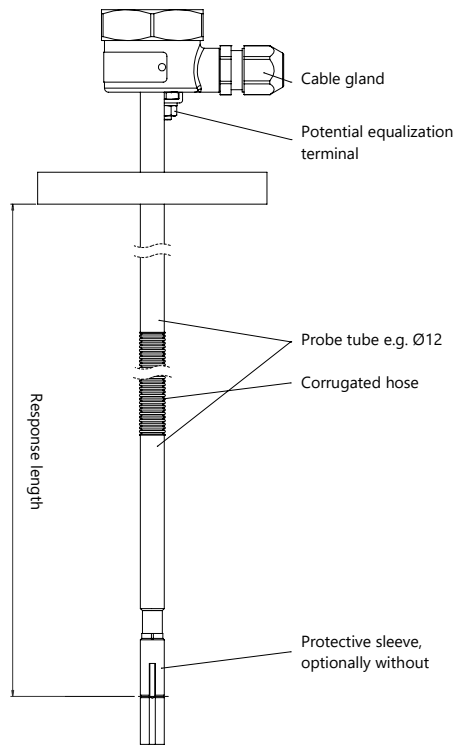


Figure 1.4i: LS 300 FX

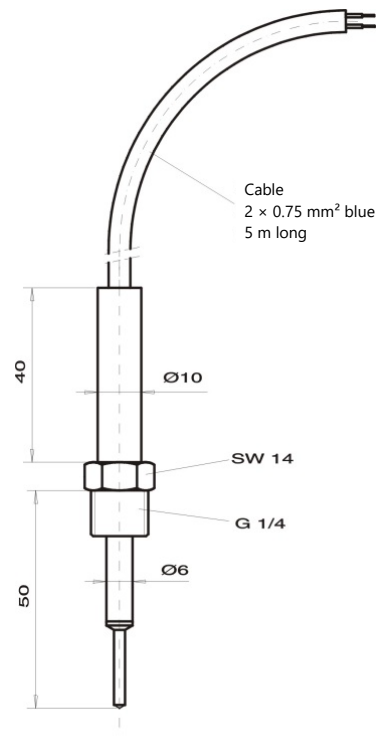


Figure 1.4j: LS 300 EB6

Level detector circuit

Only for connection to the measuring transducer type LS 500 ...

Temperatures

	Media temperature T_F	Ambient temperature T_a
Standard	-25 °C ... +50 °C	-25 °C ... +80 °C
High (H-Type)	-25 °C ... +80 °C	
Highest (HH-Type)	-10 °C ... +110 °C	
Low (L-Type)	-40 °C ... +50 °C	-40 °C ... +80 °C

Pressures

Standard	0 bar ... 3 bar
Special version	0 bar ... 25 bar

Heating times

at $T_a = -20$ °C	< two minutes
at $T_a = +60$ °C	< 15 seconds

Housing protection type (according to EN 60529)

LS 300 ...	≥ IP67
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Measuring transducer LS 500 ...:

Dimensions

There are two different housing designs:

Wall mounting housing

This design has the dimensions (H×W×D) 150 mm × 75 mm × 110 mm.



Figure 1.4k: Measuring transducer LS 500 S in wall mounting housing

Mounting rail housing

This design has the dimensions (H×W×D) 114,5 mm × 22,5 mm × 99 mm.



Figure 1.4l: Measuring transducer LS 500 H ... in mounting rail housing

Power supply

Type LS 500 ...

$$U = 24 V_{AC} / 115 V_{AC} / 230 V_{AC} \pm 10 \%, 40 \text{ Hz} \dots 60 \text{ Hz}, < 4 \text{ VA}, \text{ or}$$

$$U = 24 V_{DC} \pm 20 \%, < 5 \text{ W}$$

Type LS 500 H ...

$$U = 23 V_{DC} \dots 30 V_{DC}, < 8 \text{ W}$$

Level detector circuit

Only for connection to the level detector type LS 300 ...

Output circuit (potential-free changeover contacts)

LS 500 ... and LS 500 H ... (not SIL) with LS 300 ... not in potentially explosive area

Alternating current AC	$U \leq 250 \text{ V}; I \leq 5 \text{ A}; P \leq 500 \text{ VA}; \cos \varphi \geq 0,7$
Direct current DC	$U \leq 24 \text{ V}/110 \text{ V}/220 \text{ V}; I \leq 5 \text{ A}/300 \text{ mA}/120 \text{ mA}; P \leq 240 \text{ W}/33 \text{ W}/26 \text{ W}$
Minimum switching load	300 mW (5 V / 5 mA)

LS 500 ... and LS 500 H ... (not SIL) with LS 300 ... in potentially explosive area

Alternating current AC	$U \leq 250 \text{ V}; I \leq 5 \text{ A}; P \leq 100 \text{ VA}; \cos \varphi \geq 0,7$
Direct current DC	$U \leq 24 \text{ V}/110 \text{ V}/220 \text{ V}; I \leq 5 \text{ A}/300 \text{ mA}/120 \text{ mA}; P \leq 100 \text{ W}/33 \text{ W}/26 \text{ W}$
Minimum switching load	300 mW (5 V / 5 mA)

LS 500 H SIL* with LS 300 ... not in potentially explosive area

Alternating current AC	$U \leq 250 \text{ V}; I \leq 5 \text{ A}; P \leq 500 \text{ VA}; \cos \varphi \geq 0,7$
Direct current DC	$U \leq 50 \text{ V}/110 \text{ V}/250 \text{ V}; I \leq 5 \text{ A}/1 \text{ A}/400 \text{ mA}; P \leq 400 \text{ W}/110 \text{ W}/100 \text{ W}$
Minimum switching load	5 V / 10 mA

LS 500 H SIL* with LS 300 ... in potentially explosive area

Alternating current AC	$U \leq 42 \text{ V}; I \leq 5 \text{ A}; P \leq 100 \text{ VA}; \cos \varphi \geq 0,7$
Direct current DC	$U \leq 60 \text{ V}; I \leq 5 \text{ A}; P \leq 100 \text{ W}$
Minimum switching load	5 V / 10 mA

Temperatures

Ambient temperature	-25 °C ... +50 °C
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Housing protection (according to EN 60529)

Wall mounting housing	IP40
Mounting rail housing	IP20

2 Material of level detector

All components coming into contact with media are made of stainless steel no. 1.4571 (316Ti), Hastelloy C4 (2.4610), Hastelloy B (2.4617) or Hastelloy C22 (2.4602). Flanges can be made of steel with plated sealing surfaces of stainless steel no. 1.4571 (316Ti), Hastelloy C4 (2.4610), Hastelloy B (2.4617) or Hastelloy C22 (2.4602).

Special materials:

Material	Wetted parts made of
From 1.4301 (304) up to 1.4571 (316Ti) without 1.4305 (303)	Stainless steel
B-2 (2.4617), C-4 (2.4610), or C-22 (2.4602)	Hastelloy
Tantalum (sensor tip) and stainless steel with E-CTFE coating	Tantalum and Halar
Tantalum (sensor tip) and stainless steel	Tantalum and stainless steel
Tantalum	Tantalum

Table 2: Special materials for components of level detector LS 300 ... coming into contact with media

* For the SIL ERROR output, the values for LS 500 ... and LS 500 H ... (not SIL) apply

3 Area of application

The level detector type LS 300 ... and measuring transducer type LS 500 ... as level limit switch of overflow protection device for containers to store water-polluting liquids.

Level detector type LS 300 ... is operated according to the following conditions in containers for storing flammable and non-flammable water-polluting liquids, from which no permanent adhesions are expected.

a) Atmospheric conditions

Temperature:	-20 °C ... +60 °C
Pressure:	800 mbar ... 1,1 bar

b) Different conditions

Liquid temperature

Normal temperature:	-25 °C ... +50 °C
Low temperature "L"	-40° C ... +50° C
High temperature „H“:	-25 °C ... +80 °C
Highest temperature „HH“:	-10 °C ... +110 °C

Pressure

Standard pressure range:	0 bar ... 3 bar
Special version:	0 bar ... 25 bar

Deviations such as 0 °C ... +85 °C are indicated on the type plate.

If the sensor tip is cooled down due to strong sprays or strong gas flow, a premature shutdown occurs. One remedy against strong gas flow is to retrofit a protective probe sleeve.

4 Fault and error messages

Level detector LS 300 ...:

Corrosion monitoring is not required since the level detector is constantly being tested and monitored by the measuring transducer. The integrated scanner in the measuring transducer checks the PTC resistor in the level detector several times during a second, at the start and during the entire filling period. This process is indicated on the measuring transducer by blinking of the blue LED. Queried is the typical characteristic of the PTC resistor during heating up and cooling down. A dysfunction of the PTC resistor due to corrosion of the probe sleeve is detected and signalled as an alarm signal of the overflow protection device. Faults such as short circuit and cable breakage due to corrosion are immediately detected and signalled.

Measuring transducer LS 500 ...:

During power failure, failure of the device fuse, non-functioning sensor elements, interruption or short circuit of the signal line from the level detector to the measuring transducer, the sensor relay in the measuring transducer releases and switches the sequential circuit (opening relay is the same as: "Response level" of overflow protection device has been reached).

LS 500 ... S: In addition to the relay control described, the error relay activates during an interruption or short circuit of the signal line from the level detector to the measuring transducer. At the same time the red "Error" LED lights up. In case of a short circuit additionally the blue "Scanner" LED lights up.

LS 500 H SIL: In addition to the previously described relay control, the "Error" LED lights up during an interruption or short circuit of the signal line from the level detector to the measuring transducer. If an error is detected by the test electronics (SIL fault), the SIL error relay is activated, the "SIL Error" LED lights up and the "Error" LED starts to flash. The measuring transducer can be reset from the "SIL error" state to normal operation by touching the test button for 10 seconds. The user is informed when the device starts up by the green power LED briefly going out.



5 Installation notes

Level detector LS 300 ...:

The level detector must be installed in the container in a position where no liquid splashes or strong vapour flows would cause the overflow protection device to respond prematurely or cause faults. The level detectors should be installed as vertically as possible so that residual liquid can drip easily from the probe.

During all work on the container, the relevant safety and accident prevention regulations of the employers' liability insurance associations, as well as the rules and regulations of the Professional Associations for engineering and electrical technology, must be observed.

Level detectors LS 300 ...U... resp. overvoltage protection:

For use in potentially explosive atmospheres, where a part of an intrinsically safe electric circuit in Zone 0 is installed in such a way that there is a risk of dangerous or damaging differences in potential within Zone 0, an overvoltage protection device must be installed. The overvoltage protection is required between every conductor of the cable, including the shield and the system, unless this conductor is already connected to the system. The overvoltage protection device must be installed outside, but as close to the border of Zone 0 as technically possible, preferably at up to 1 m.

The level detector LS 300 ...U... is fitted with internal overvoltage protection. The sensor head must therefore be set up outside Zone 0. External overvoltage protection, e.g. BA 350-..., must be set up outside Zone 0. For the electrical connection (wire cross-section 4 mm²) from the housing to the container, an external potential equalization terminal is provided.

Measuring transducer LS 500 ...:

If measuring transducer LS 500 ... is mounted outdoors, the housing protection class must be at least IP54.

The wiring must be carried out only with the power disconnected. Special local rules and regulations of relevant Professional Associations and Authorities must be observed (e.g. VDE in Germany). The maximum admissible cable length is 250 m for 0.5 mm², 500 m for 1 mm² and 750 m for 1.5 mm². Other cross-sections result in other maximum cable lengths. When using the overflow protection device in potentially explosive areas, the wiring from the level detector to the measuring transducer must be marked as intrinsically safe cable. For colour marking, a blue cable or blue marked cable is to be used. The measuring transducer must be installed outside the potentially explosive atmospheres/areas.

Measuring transducer type LS 500 ... in wall mounting housing

The measuring transducer is suitable for wall mounting.

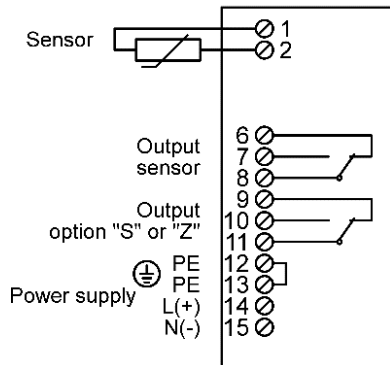


Figure 5a: Measuring transducer LS 500 ... in wall mounting housing

Measuring transducer type LS 500 H ... in mounting rail housing

The measuring transducer is intended for installation on a mounting rail.

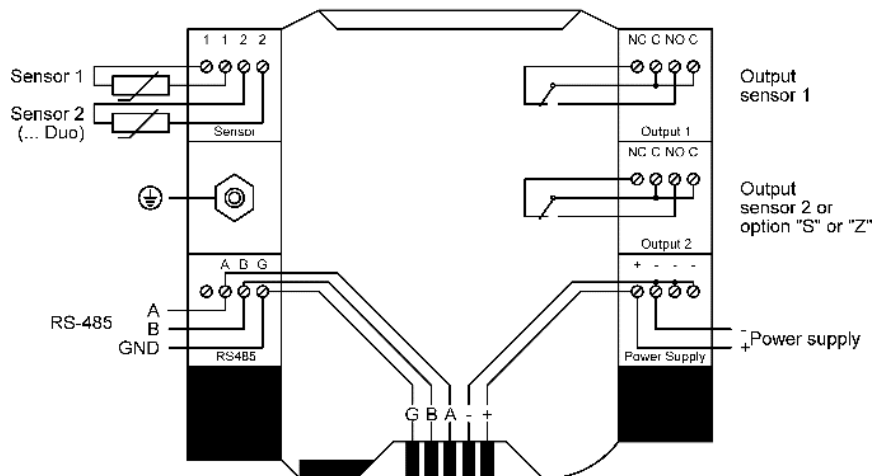


Figure 5b: Measuring transducer LS 500 H ... in mounting rail housing (without SIL)

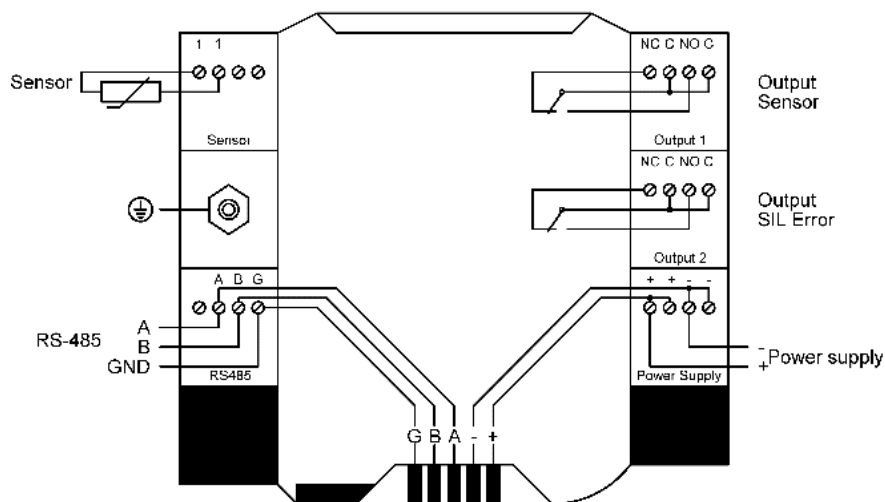


Figure 5c: Measuring transducer LS 500 H SIL in mounting rail housing (with SIL)

6 Setting instructions

Based on the permissible filling ratio in the container, the response level (A) of the overflow protection device must be determined in accordance with Appendix 1 of the approval guidelines for overflow protection devices. The switch delay time of ≤ 2 s must be taken into consideration here.

The level detectors type LS 300 E... comprise a sensor tube with screw-in unit which projects height adjustable into the storage container. The respective sensor length is permanently impressed above the groove marking at the upper end of the sensor. The sensor length is a measure of the distance between the groove marking and the response point of the level detector. The response length (L) is calculated from the container dimensions and the response level and is set on the level detector as distance between the hexagon nut seat of the screw-in unit and the groove marking on the protective sleeve of the probe at the bottom end of the level detector. When installed, the correct adjustment of the response level can be checked with the control dimension (Y). Y is the distance between the groove marking on the upper end of the sensor tube and the hexagon nut seat of the screw-in unit. After subtracting the control dimension from the imprinted sensor length you get the result of the response length.

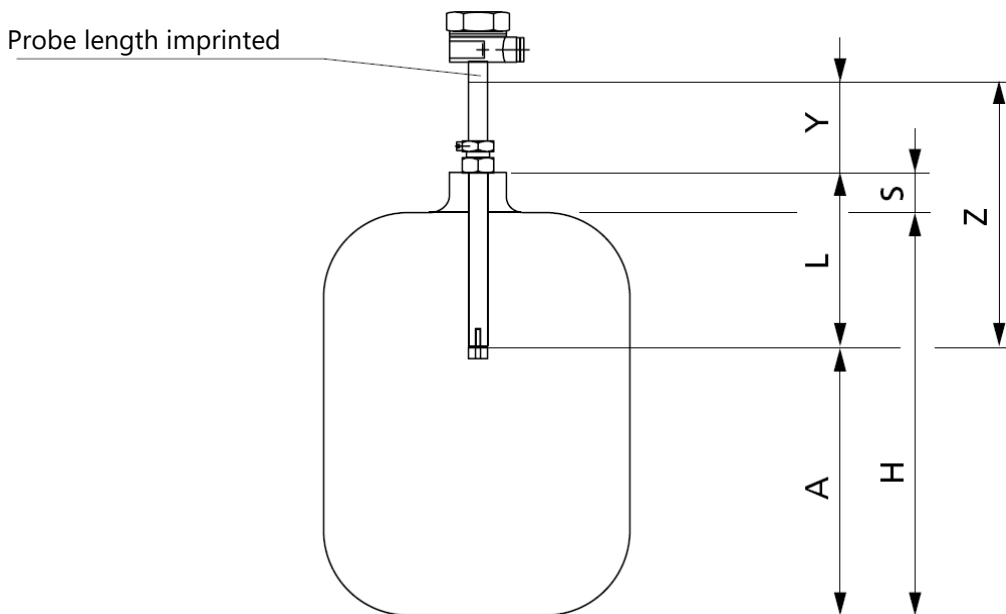


Figure 6: Setting instructions

A =	Response level	S =	Spigot or muff height
L =	Response length	Y =	Control dimension
H =	Container height	Z =	Sensor length

The response length (L) is calculated with

$$L = (H - A) + S$$

For a check, the response length (L) can be calculated without removing the level detector

$$L = Z - Y$$

To fix the sensor tube, it is necessary to tighten the upper gland screw and the locking screw of the screw-in unit. The screw-in thread must then be provided with a suitable resistant sealing material and screwed into the existing tank coupling.

Since the response length (L) of level detectors type LS 300 F... with flange is not variable (sensor tube welded with flange), this dimension must be determined precisely from the container dimensions prior to ordering and be specified. The response length is permanently impressed in the flange of the level detector.

7 Instructions

The level limit switch is generally maintenance-free when operated as intended.

Before commissioning, all system parts of the overflow protection device must be checked for correct connection and function. The electrical supply, as well as downstream devices, must be checked.

The general instructions for the devices being used must be observed.

8 Recurring inspections

The functionality of the overflow protection device must be tested at reasonable intervals, but at least once a year. The operator shall be responsible for the type and frequency of inspection within the specified period.

The test must be conducted in such a way that proof is obtained of correct operation of the overflow protection device with all components interacting. This condition can be satisfied by allowing the liquid to reach the response level during a filling process. If filling to the response level is not practicable, the level detector should be caused to respond through simulation of the fill level or physical measuring effect by suitable means. If the functionality of the level detector / measuring transducer is demonstrable by other means (exclusion of function-impairing faults), the test can also be carried out by simulating the corresponding output signal.

Function test for level detectors without test connection:

- a) Remove the level detector and immerse it in the stored liquid.
Shortly after the immersion (≤ 2 s) the relay in the measuring transducer must de-energize and thereby activate the signalling device.
- b) By filling the container up to response level A.
The filling process must be very closely monitored! The overflow protection and the downstream signalling devices must respond.

The test to determine whether the alarm system of the overflow protection device works in accordance with the closed-circuit principle or whether the monitoring of the sensor element functions, can be performed as follows:

- a) Interrupt the auxiliary power supply of the measuring transducer.
The green LED of the measuring transducer must turn off and the downstream signalling devices must respond.
- b) Interrupt or short-circuit the signal line between the level detector and measuring transducer.
The level limit switch and the downstream signalling devices must respond.

Function test for level detectors with test connection type LS 300 ...P...:

To enable the test of level detectors type LS 300 ...P..., an external compressed gas system must be connected to the test connection integrated in the level detector. This is carried out via a plug connector or screwed connection (version with check valve LS 300 ...PR...). As additional protection to the container there is a ball valve on the test connection of the level detector behind the coupling or the check valve. The ball valve must be opened for the test process.

The gas is fed to the PTC resistor via the test connection. This cools the PTC resistor down to the value which corresponds to the immersion in liquid.

The functionality of the overflow prevention device is displayed by the activated signalling device.



Function test for measuring transducers with test button:

To control the function of the entire overflow protection device the measuring transducer can be fitted with a test button "Test". Whenever this button is pressed, the heat output of the PTC resistor is reduced so much that it cools down (equivalent of a submerged sensor) and the alarm system is triggered. The alarm must occur no more than two seconds after the button has been pressed (keep the button pressed). After releasing the test button the PTC resistor is heated up and after the heating-up time (> 5 s) the overflow protection device is back again in alarm state. If no alarm is triggered after the test button has been pressed or immediately after its release, the overflow protection device must be checked immediately.

The selected test method and the result must be documented.

Level detector with measuring transducer LS 500 H SIL:

In the version of the level limit switch with measuring transducer LS 500 H SIL the function-impairing faults are excluded by a permanent self-monitoring function. For this reason, the recurring inspection is not required.

By pressing the test button "Test" for less than two seconds, the downstream signalling devices can be tested. If the test button is pressed for longer than five seconds, a "SIL Error" is triggered and the downstream fault message devices can be checked. The measuring transducer can be reset from the "SIL error" state to normal operation by touching the test button for 10 seconds. The user is informed when the device starts up by the green power LED briefly going out.