# Original Instructions
# USi®-safety

Ultrasonic Sensor System USi®-safety


CE

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# Content



Artikelnummer • JJJJ-MM

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# 1. About this manual

This manual is an integral part of the product.

Pepperl+Fuchs will assume no liability and provide no guarantee whatsoever for damages and consequential damages resulting from failure to comply with the manual.

- Read the manual carefully before use.
- Keep the manual for the complete service life of the product.
- Pass the manual on to every subsequent owner or user of the product.
- Add any supplement received from the manufacturer to the manual.

## Validity

This manual is valid only for the product specified on the title page.

## Target Group

The target group of these operating instructions are manufacturers and operators of machines who are familiar with the risk assessment according to ISO 12100 as well as the installation and commissioning of protective devices..

# Danger Symbols and Information

This document contains symbols to identify warning messages and information messages.

## Warning Messages

You always find warning messages whenever hazards could result from your actions. It is essential that you observe these warning messages to ensure your personal safety and to prevent property damage.

Warning messages are shown in descending order according to the risk level, as follows:

**DANGER!**

This symbol warns you of an immediate and present danger.

If you do not observe this warning message there is a risk of personal injury and even death.

## WARNING!

This symbol warns you of a potential fault or hazard.

If you do not observe this warning message, there is a risk of personal injury or severe property damage.

## CAUTION!

This symbol warns you of a potential fault.

Failure to observe this warning message may result in the malfunctioning or complete failure of the product or any systems and plants connected to it.

### Information Messages

## Note

This symbol draws your attention to important information.

# 2. Intended Use

The ultrasonic sensor system USi-safety is designed for industrial use in the medium air. It is comprised of the evaluation unit and up to 2 sensors (ultrasonic transducers). It can be used to achieve the following functions:

- Reflex switch
- Reflex barrier

The integrated output signal switching devices (OSSD) transmit the evaluated safety signals directly to the machine control. There are two additional configurable outputs (OUT) available.

The product complies with ISO 13849-1:2015 Category 3 PL d. So that the safety classification is retained, the downstream control must be of the same or a higher category.

## 2.1. Required Devices for USi-safety

The USi-safety safe ultrasonic sensor system consists at least of one evaluation unit and at least one sensor (ultrasonic transducer). The parameterization software for USi-safety is required for the setup.

The following overview shows all components available for the system and, if applicable, their provision :

- Evaluation unit
- Sensor (ultrasonic transducer).
- Connection cable of the device (V19*)
- Mini USB cable
- Parameterization software for USi-safety
- Original instructions (to download)
- Declaration of conformity (to download)

### Note

Information and software can be downloaded via the Internet from the product page of the product: https://www.pepperl-fuchs.com

## 2.2. Limits

- Objects with a highly sound-absorbing surface such as open-pore foam, corduroy, etc., cannot be reliably detected.
- Objects with an extreme sound-dividing shape such as cone tip, or similar cannot be reliably detected.
- Strong fluctuations in temperature within very short periods of time cannot counter balance the temperature compensation.

These constraints can be reduced with optimised sensor assembly or suitable parameterization though.

## 2.3. Exclusions

- The use of the product in potentially explosive environments (ATEX) is not possible. The product is not authorized for use in these areas.

# 3. Safety Instructions

## CAUTION!

Do not open sensors (ultrasonic transducer)
Never open, manipulate or alter the sensors.

## CAUTION!

Do not squeeze the sensors
Avoid applying increased mechanical loads to the enclosure and the active surface of the sensor (ultrasonic transducer).

## CAUTION!

Check supply voltage
Check supply voltage. It must correspond with the connecting voltage $U_S$ on the type plate.

## CAUTION!

Observe degree of protection
The evaluation unit only has a degree of protection of IP65 with carefully screwed on screw plug and carefully fitted lid.

## CAUTION!

Protect from sunlight
In the case of surface installation, ensure that the evaluation unit is protected from direct sunlight.

## CAUTION!

Do not alter special cable
The special cable on the sensor (ultrasonic transducer) has a fixed length. Never shorten, lengthen or alter the special cable.

## CAUTION!

Observe PIN assignment
Observe the PIN assignment when connecting the supply voltage.

## CAUTION!

Do not overload evaluation unit
Ensure that the specified switching current is not exceeded.

## CAUTION!

Replacing wear parts
Exchange wear parts like O-rings and sensors in time.

## CAUTION!

In the event of a fault, take out of operation
In the event of malfunctions and visible damage, take the control unit out of operation.

.

# 4. Storage

- Store the individual parts in the original packaging in a dry place.
- Observe the storage temperatures given in the technical specifications.

# 5. Product Overview

## 5.1. Sensor (ultrasonic transducer)

The special cable between the sensor (ultrasonic transducer) and the M8 plug has a fixed length of 1.5 m or 3.0 m and may not be lengthened or shortened.

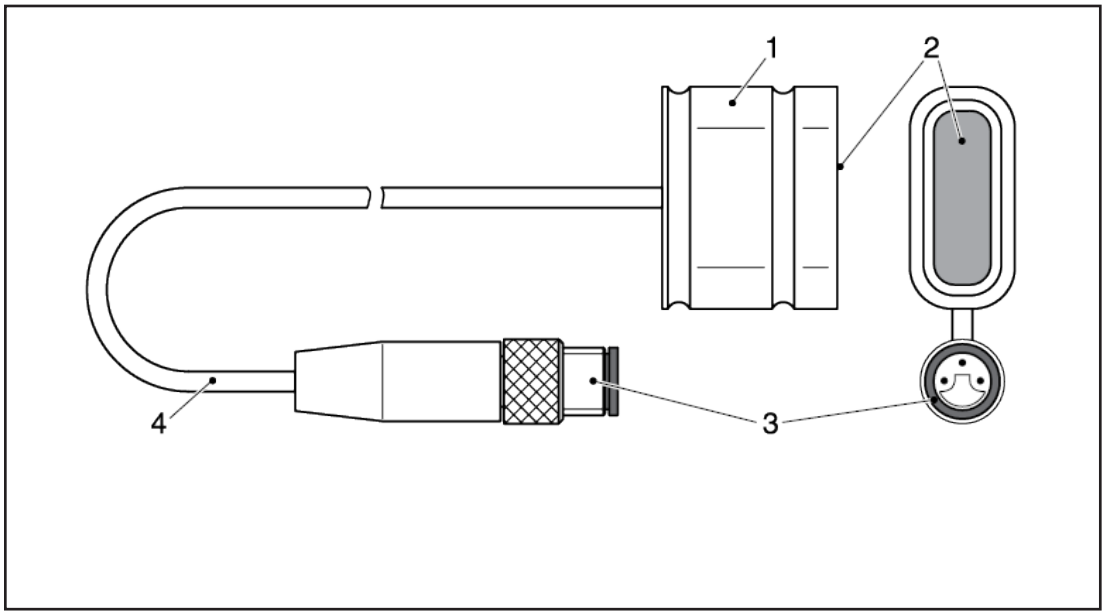



Figure 1

1 Sensor (ultrasonic transducer)

2 Active surface

3 M8 plug

4 Shielded cable

# 5.2. Evaluation Unit

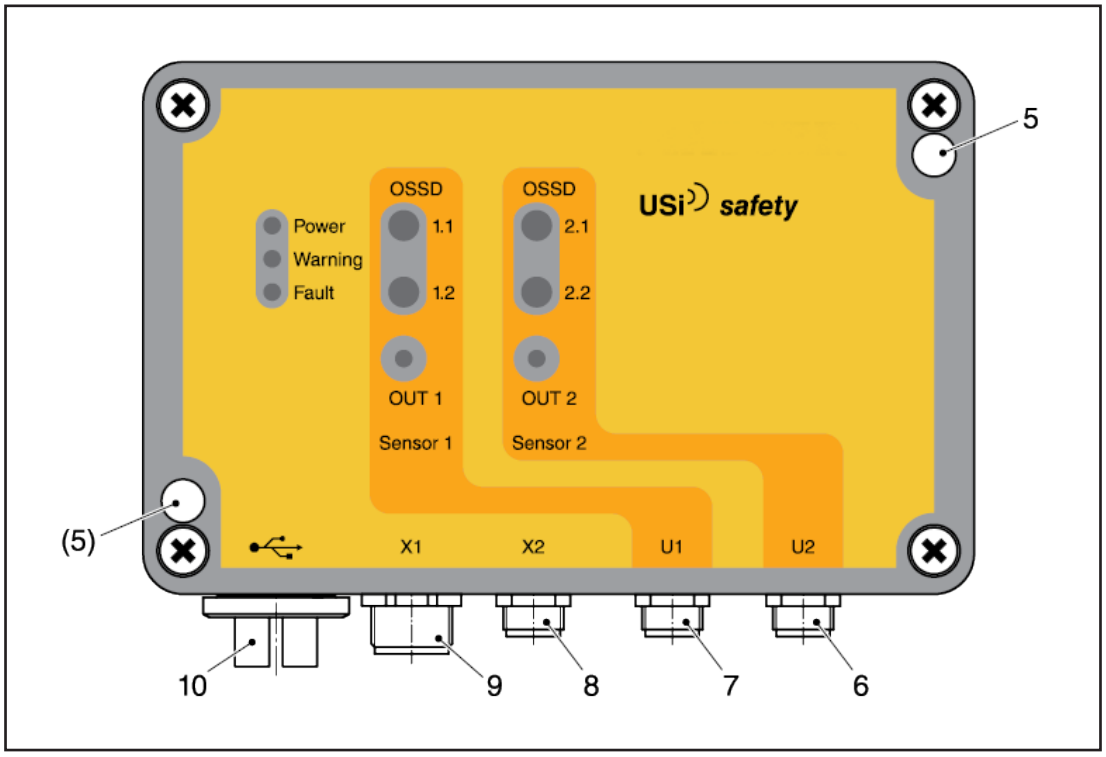



Figure 2

5 Fastening point (M4)

6 M8 socket U2: Sensor 2

7 M8 socket U1: Sensor 1

8 M8 socket X2: RS485, TEMP

9 M12 plug X1: Unit cable

10 Screw plug: Mini USB

# 5.3. LED Indicators

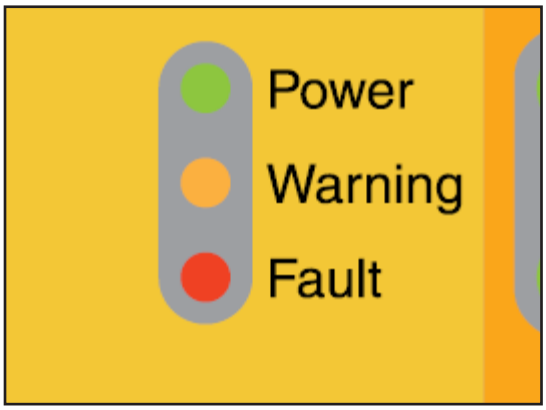



Figure 3

- Green LED „Power“:
  Supply voltage connected
- Yellow LED „Warning“:
  Critical operating state
- Red LED „Fault“:
  Error OSSD are OFF

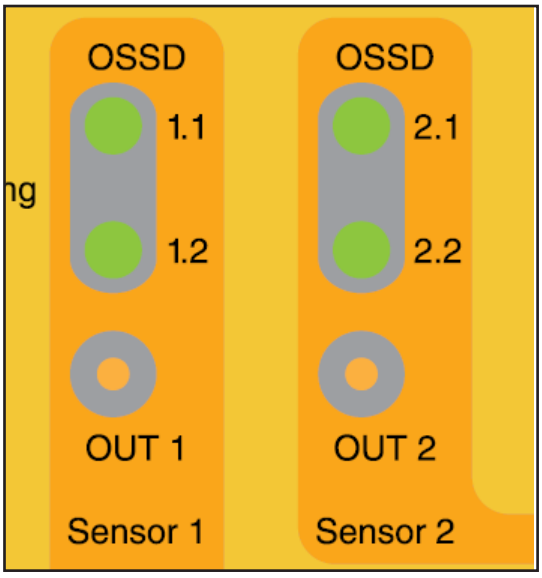



Figure 4

- Green LED „OSSD“:
  Safe output is ON
- Red LED „OSSD“:
  Safe output is OFF
- Yellow LED „OUT“:
  Signal output is activated

# 5.4. Connections

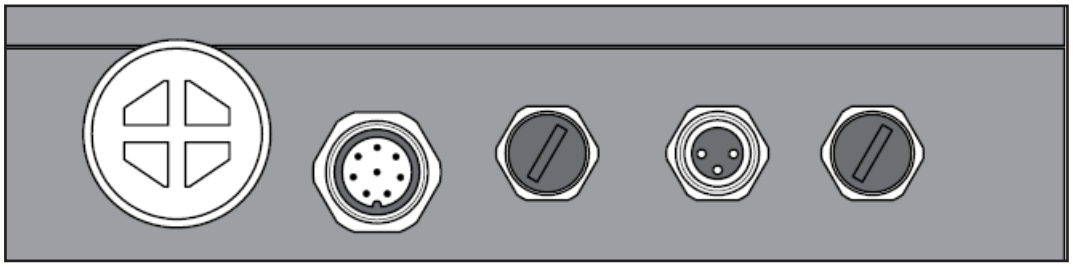


Figure 5 View with covers

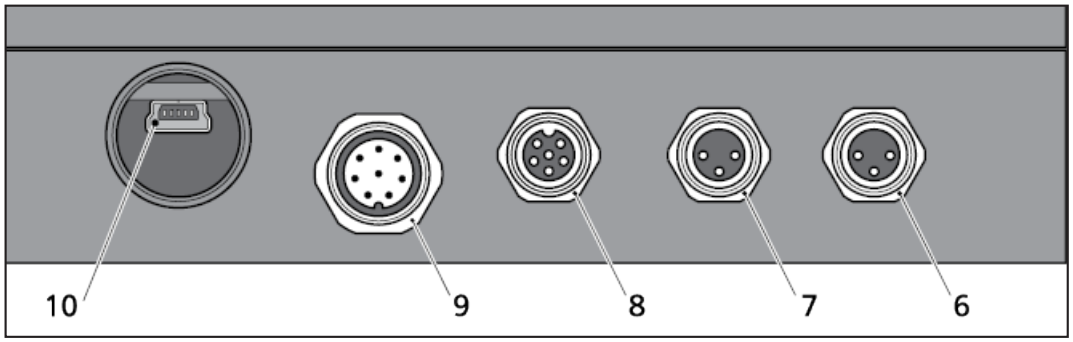



Figure 6 View without covers

| | | | |
|---|---|---|---|
| 6 | M8 socket U2: Sensor 2 | 8 | M8 socket X2: RS485, TEMP |
| 7 | M8 socket U1: Sensor 1 | 9 | M12 plug X1: Unit cable |
| | | 10 | USB socket: Mini-B |

| Connection | Type | Explanation |
|---|---|---|
|  | Mini-USB 2.0 | For parameterization via software |
| X1 | M12, 8-pin | For unit cable |
| X2 | M8, 6-pin | RS485 interface, temperature sensor |
| U1 | M8, 3-pin | Sensor 1 (ultrasonic transducer 1) |
| U2 | M8, 3-pin | Sensor 2 (ultrasonic transducer 2) |

Table 1

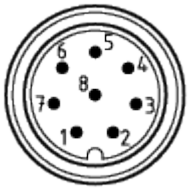
| Connector X1 | Signal | Pin | Circular Connector |
|---|---|---|---|
| Supply voltage | $+U_S$,$-U_S$ | 2, 7 |  M12 |
| Safe output 1.1 | OSSD 1.1 | 1 | |
| Safe output 1.2 | OSSD 1.2 | 3 | |
| Safe output 2.1 | OSSD 2.1 | 4 | |
| Safe output 2.2 | OSSD 2.2 | 5 | |
| Signal output 1 | OUT 1 | 6 | |
| Signal output 2 | OUT 2 | 8 | |

Table 2

# 5.5. Unit Cable with M12 Socket

Cable for connection with downstream control.

The LifYCY type device cable must be 8-pole (at least 0.25 mm² per core), shielded and equipped with a M12 socket.

Maximum device cable length: 30 m.

A device cable with different cable lenghts is available as an accessory.

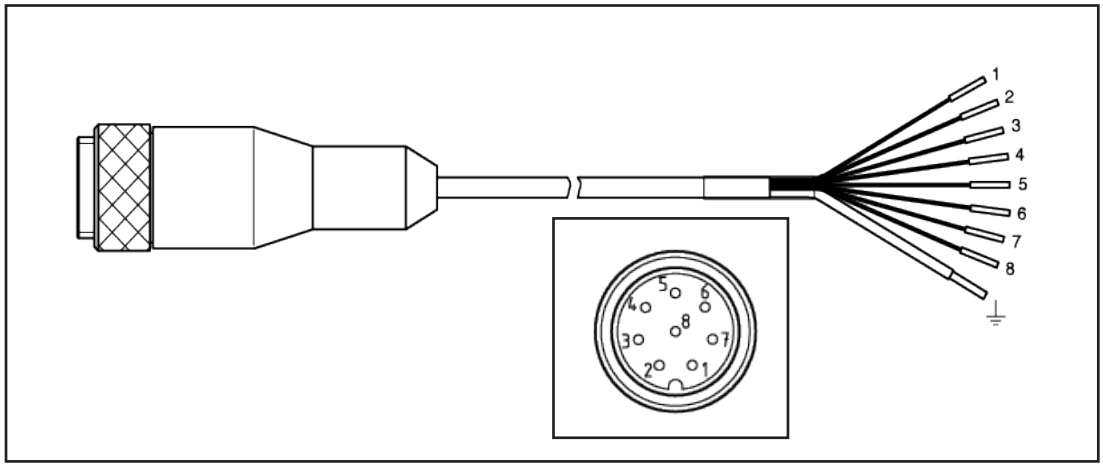



Figure 7

| Description | Signal | PIN | Core Color | |
|---|---|---|---|---|
| Supply Voltage | + $U_S$ | 2 | BN | Brown |
| | - $U_S$ | 7 | BU | Blue |
| Safe output 1.1 | OSSD 1.1 | 1 | WH | White |
| Safe output 1.2 | OSSD 1.2 | 3 | GN | Green |
| Safe output 2.1 | OSSD 2.1 | 4 | YW | Yellow |
| Safe output 2.2 | OSSD 2.2 | 5 | GY | Grey |
| Signal output 1 | OUT 1 | 6 | PK | Pink |
| Signal output 2 | OUT 2 | 8 | RD | Red |

Table 3

# 5.6. Temperature Sensor

The temperature sensor (optional; see accessories) is equipped with a M8 plug and a cable with a length of 1.5 m.

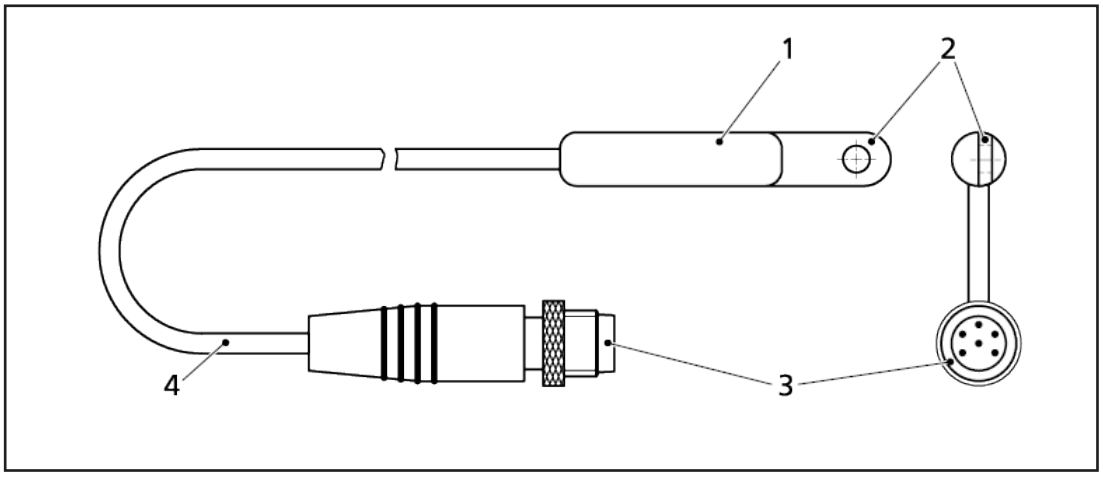



Figure 8

| | | | |
|---|---|---|---|
| 1 | Temperature sensor | 3 | M8 socket |
| 2 | Mounting tab | 4 | Cable |

# 5.7. Sonic Lobe

The following representations refer to the product in delivery condition. Measurement object: steel rod with Ø 10 mm. If parameters have been changed or if a different measurement object is used, the representations will change accordingly.

**Sonic lobe from the narrow side and the broad side**

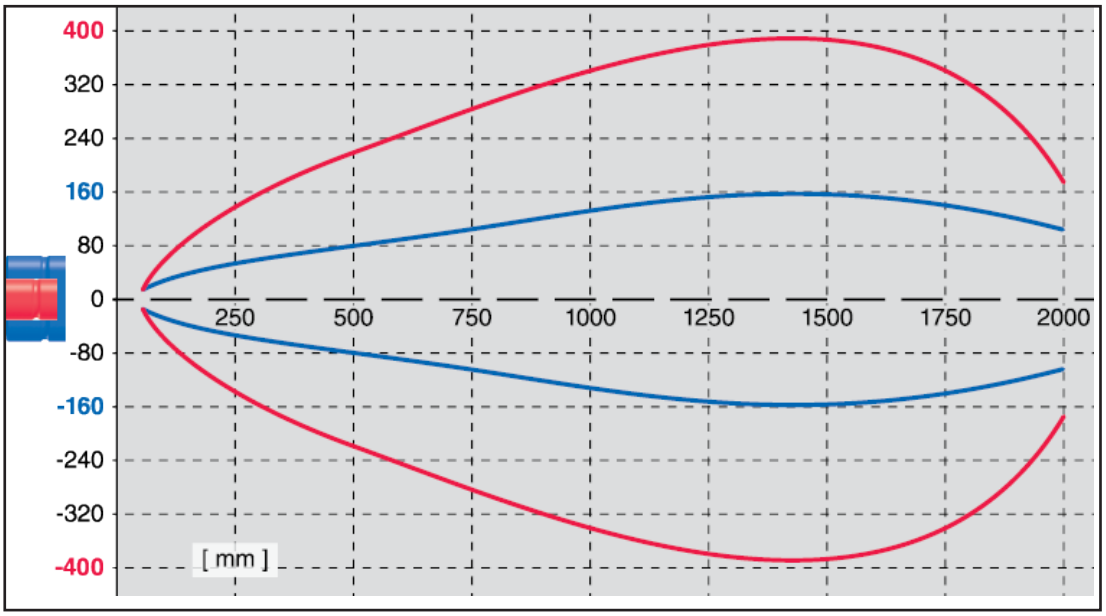



Figure 9

**Opening angle (-6 dB) narrow side**

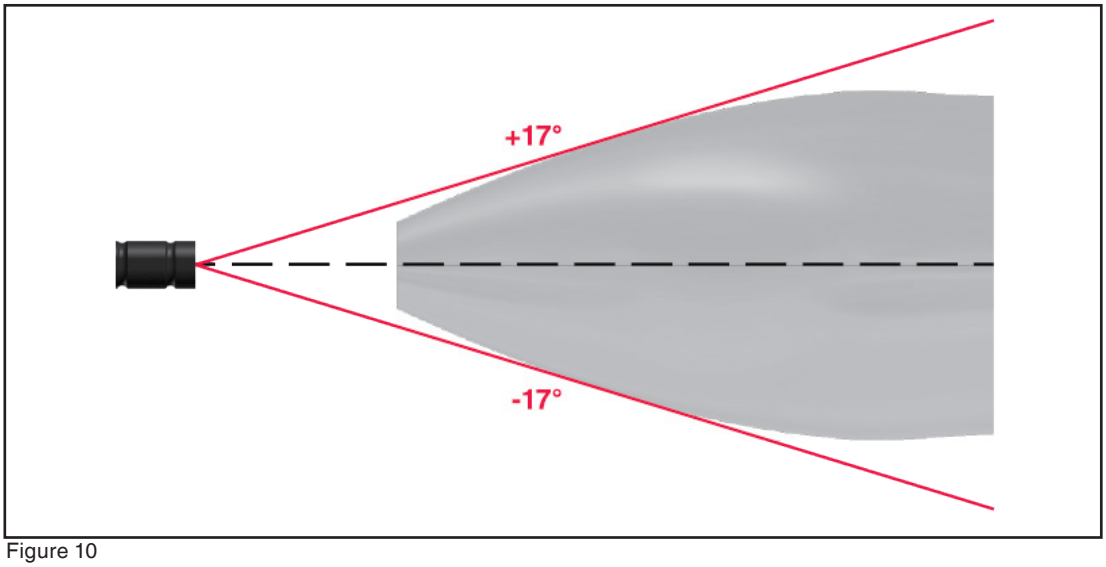



Figure 10

**Opening angle (-6 dB) broad side**

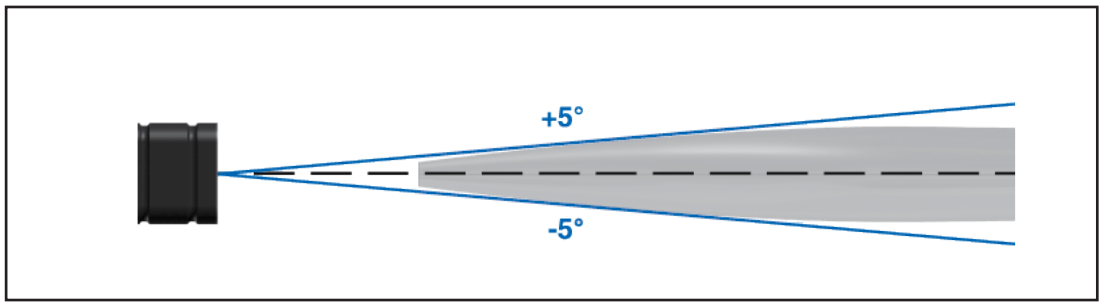



Figure 11

**Sonic lobe spatially**

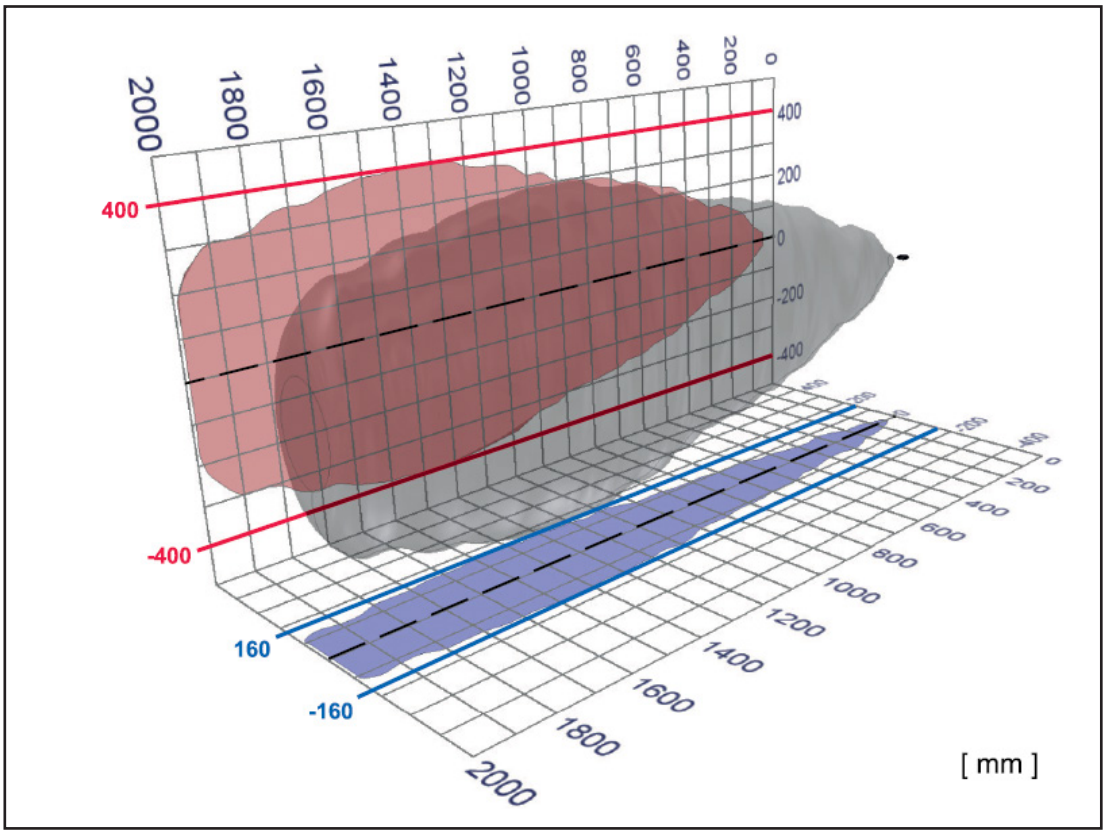



Figure 12

# 6. Function

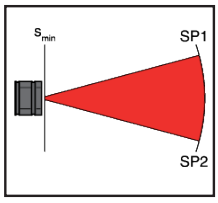
The USi-safety is a contactless protective device (CPD) and complies with ISO 13849-1:2015 category 3 PL d.

The safe ultrasonic industrial sensor USi safety uses the connected sensors (ultrasonic transducers) to both transmit and receive sound in the medium air. With a complex measurement method, objects as well as persons and parts of persons are reliably detected.

If the switching points SP1 and SP2 are defined and the protection field test was successful, then USi safety starts detecting in the predefined operating mode. The two possible operating modes are:

- Operating mode 1 range
- Operating mode 2 ranges

## 6.1. Operating Mode 1 Range

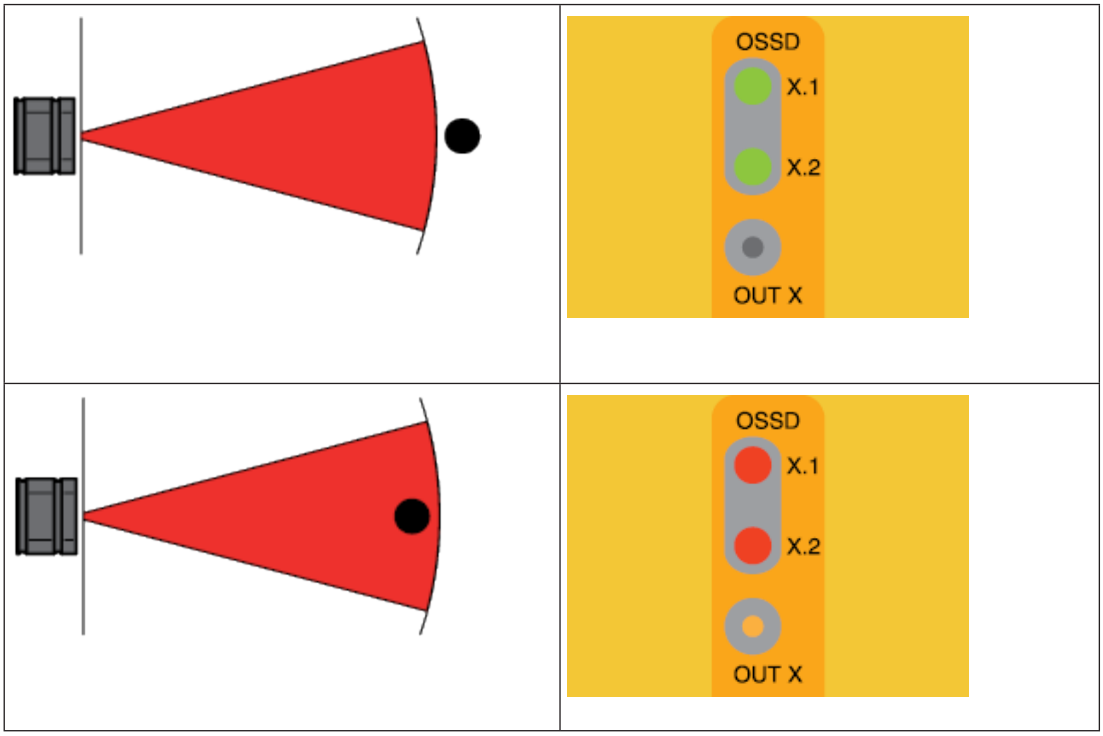



Operating mode 1 range is the preset standard operating mode.

SP1: 200 cm SP2: 200 cm

If SP1 = SP2, then there is no upstream warning field. From the minimum switching distance to switching point SP2 only one range extends as a detection field: the protection field.

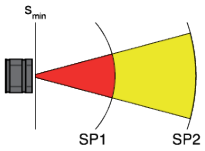
If an object enters the detection field, the safe outputs OSSD go into the OFF state (red LEDs are lit), the signal output OUT is activated (yellow LED is lit).



# 6.2. Operating Mode 2 Ranges

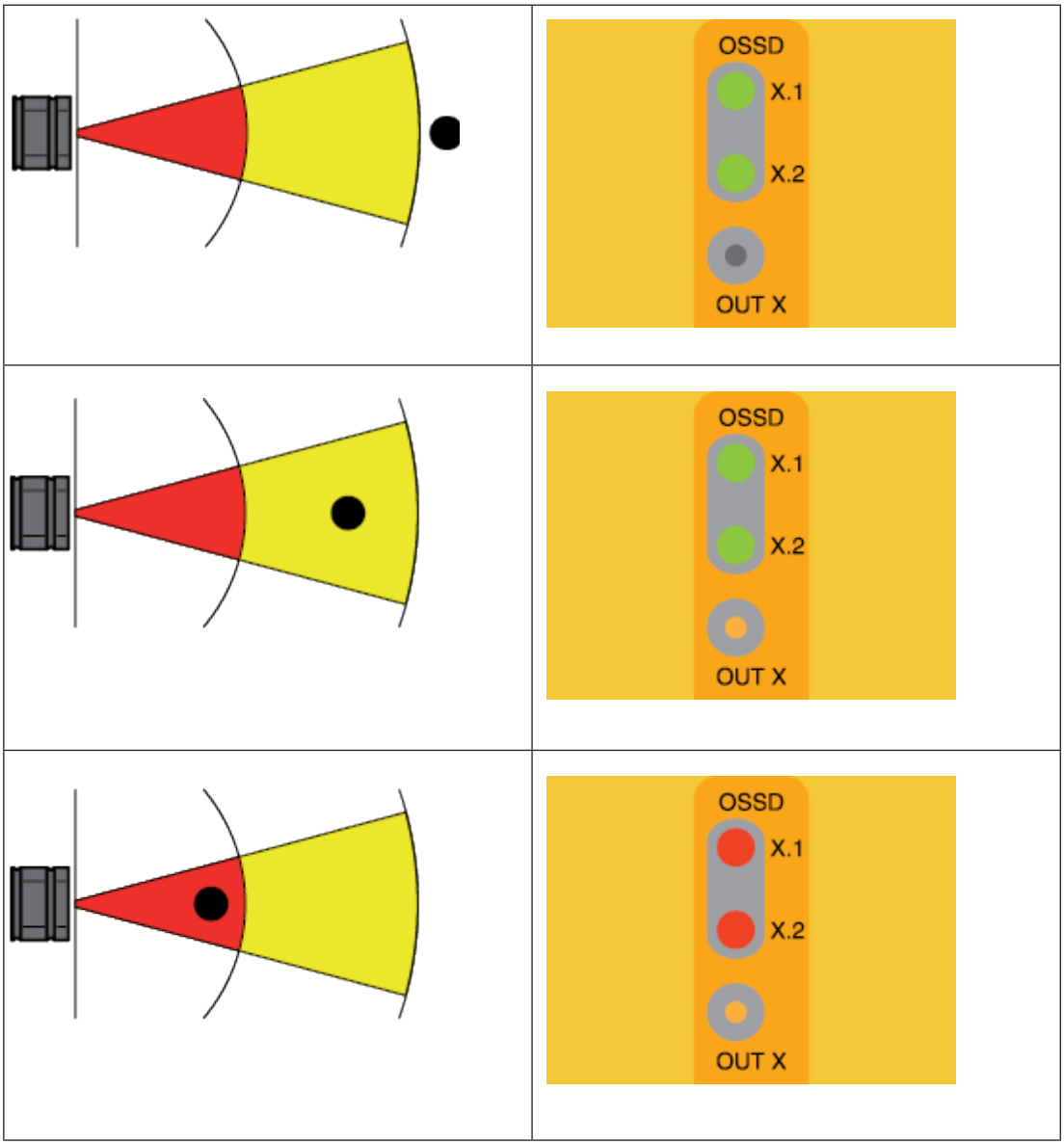
If switch point SP2 selection is larger than switch point SP1, the USi safety automatically changes to operating mode 2 ranges.

SP1: > 15 cm  SP2: > (SP1 + 1 cm)




If SP1 < SP2, then the detection field is divided into 2 ranges: protection field and warning field. The detection field (red) close to the sensor extends from the minimum switching distance to switching point SP1 and defines the protection field. The detection field (yellow) far from the sensor extends from the minimum switching distance to switching point SP2 and defines the warning field. The safe outputs OSSD are assigned to the protection field, the signal output OUT to the warning field.

If an object enters the warning field (yellow), the signal output OUT is activated (yellow LED OUT lights up). If an object enters the protection field (red), the safe outputs OSSD go into the OFF state (red LEDs are lit), the signal output stays activated (yellow LED is lit).



## 6.3. Expansion „Reference Axis only“

In both operating modes, expanding the protection field range is possible by selecting the option “expanded (reference axis only)”. The protection field can now be parameterised to a width of 2.5 m. Prerequisite: The anticipated objects always enter the detection field in the immediate vicinity of the reference axis (see Chapter Specifying protection field range).

## 6.4. Examples of Use

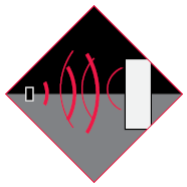
| | | |
|---|---|---|
| Object Detection | | |
|  | 1. Simplest function: Is an object located in the free detection field?<br>2. Presence / absence monitoring: Does the taught-in environment change? | 1. Operating mode 1 range.<br>2. Operating mode 1 range. |
| Distance detection | | |
|  | 3. Distance check: When is a defined distance not reached?<br>4. Two-zone observation: Did an object enter the warning field?<br>With further approach: Did an object enter the protection field? | 3. Operating mode 1 range and specification of the switch point SP1 = SP2.<br>4. Operating mode 2 ranges and specification of the switch points SP1 and SP2. |
| Obstacle Detection | | |
|  | 5. Path check: Is the path taken unobstructed?<br>6. Distance check: When is a defined distance to the obstacle fallen so far short (SP1) that action must be taken? | 5. Operating mode 1 range.<br>6. Operating mode 2 ranges and specification of the switch points SP1 and SP2. |

Table 4

## 6.5. Protection Field Design

Whether it is object detection, distance detection or obstacle detection, you do not reach the highest performance with random adjustment of various parameters of the USi safety. More expedient is a systematic approach that starts with meaningful protection field design, uses strategy for parameter alignment and ends with the determination of how the protection function is to be validated.

This chapter illustrates the most important factors that are necessary for an effective protection field design.

## Consider the Temperature

The USi safety is designed exclusively for the medium air. The ultrasound technology used already indicates that sound is used for measurements. The measurement methods thus has one constant: the speed of sound.

The **speed of sound** – along with the medium – also depends on frequency and temperature. In air, a non-dispersive medium, frequency is immaterial, temperature (ϑ) however does matter.

Applicable with sufficient accuracy:

$c_{S(\vartheta)} = 331\ m/s + (\vartheta \times 0{,}6)\ m/s$

e. g.:

$\vartheta = +50\ °C$ $\quad c_{S(+50)} = 331 + 30 = 361\ m/s$

$\vartheta = +18\ °C$ $\quad c_{S(+18)} = 331 + 11 = 342\ m/s$

$\vartheta = -10\ °C$ $\quad c_{S(-10)} = 331 - 6 = 325\ m/s$

As an **echo** recognition unit, the USi safety requires twice the sound path:

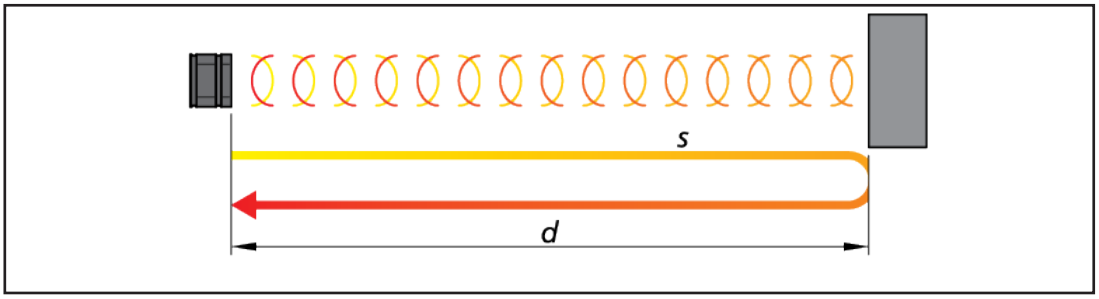



Figure 13

If an object is detected at the distance d = 2 m, then the sound moves the distance s = 2× d = 4 m until it is received again and evaluated by USi safety. The time required for this is:

$t_{(\vartheta)} = s / c_{S(\vartheta)}$

e. g.

$\vartheta = +50\ °C$ $\quad t_{(+50)} = 4\ m / 361\ m/s = 0{,}01108\ s = 11{,}08\ ms$

$\vartheta = +18\ °C$ $\quad t_{(+18)} = 4\ m / 342\ m/s = 0{,}01169\ s = 11{,}69\ ms$

$\vartheta = -10\ °C$ $\quad t_{(-10)} = 4\ m / 325\ m/s = 0{,}01231\ s = 12{,}31\ ms$

The time difference depending on the temperature (ϑ) seems to be marginal but it is not. However: A time difference of Δt = 0,6 ms corresponds to a path difference of Δs = 20 cm or a distance difference of Δd = 10 cm. From a safety-related view, this is a substantial difference. Large temperature differences should therefore be avoided or compensated by means of automatic temperature compensation.

**Conclusion:** In order to be able to guarantee a reliable protective device on the

basis of ultrasound, **considering** the prevalent t**emperature** is indispensable.

The USi safety takes this insight into account: the system-related temperature drift of 0.17 %/K must be considered via the temperature compensation parameter (see chapter Setting temperature compensation).

## Calculating the Protection Field

Next to the approach speed, the response times of the entire control chain as well as additional safety constants for the protection field design are of importance. The basis for the observation of the minimum distance ( = minimum length of the protection field) is ISO 13855 „Safety of machinery; Positioning of safeguards with respect to the approach speeds of parts of the human body“.

The minimum distance S describes the distance to the danger zone at which the protective device must react at the latest. If USi safety is installed directly at the danger zone and aligned so that sound can spread parallel to the reference level (floor), then minimum distance S and switching point SP1 are identical.

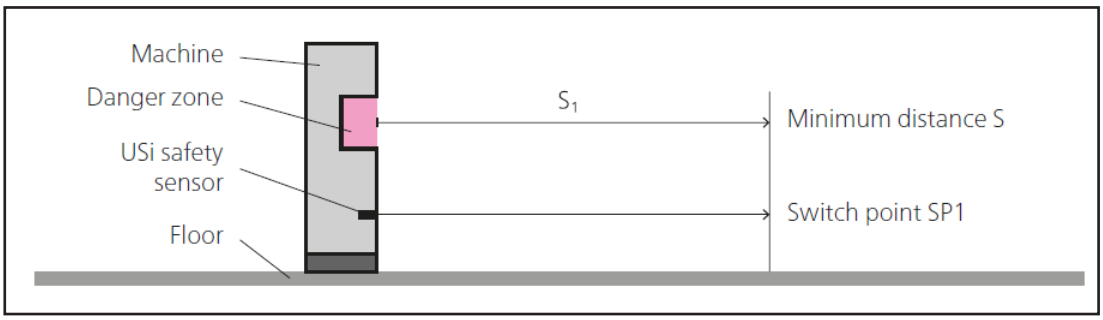



Figure 14

The general calculation formula for the minimum distance S is:

$$S = (K \times T) + C$$

**S = minimum distance to the danger zone [mm]**
**K = approach speed [mm/s]**
**T = stopping time of the entire system [s]**
**C = additional safety constant [mm]**

For the **approach speed K**, the highest anticipated speed that results from the movement of an approaching person and the individual movement of USi safety (e.g. to AGV) must be used.

The **stopping time T** describes the follow-up time of the entire system. This includes all times: the response time of the protective device, the response time of the subsequent control and the stopping time of the dangerous movement.

The **safety constant C** defines an additional path as safety buffer and depends on the definite application case.
If the protection field is installed parallel to the floor, the height of the protection field above the reference level (floor) plays the decisive role for the safety constant C.
With an orthogonal set-up (e.g. sound curtain), the detection capacity of the protective device for the safety constant C is decisive.
Determined by the system, additional factors can also enter into the safety constant, such as e.g. worst-case considerations on temperature differences.

It is generally sufficient to assume two cases – stationary hazard protection (e.g. machine) and mobile hazard protection (e.g. AGV).

## Minimum Distance with Stationary Hazard Protection

**$t_1$ = response time of the protecting device**
**$t_2$ = stopping time of the machine**

The stationary case is generally a machine with a man-machine interface in whose area a dangerous movement takes place.
For stationary hazard protection, the minimum distance is S:

$S = (K \times T) + C$ where: $K = 1600$ mm/s , $T = t_1 + t_2$, $C = c_1 + c_2$

**$c_1$ = coefficient for the configuration**
**$c_2$ = coefficient for highest temperature difference**

Consequent:

$S = (K \times (t_1 + t_2)) + (c_1 + c_2)$

The approach speed K is assumed to be 1600 mm/s. That is equivalent to the step speed according to ISO 13855.

The response time $t_1$ of the protective device results with USi safety from the measuring frequency (30 Hz) and the multiplier multiple scan. The standard setting for multiple scan (MS) is 3. That means that USi safety must register the same change in three consecutive measurement cycles before it puts the OSSD in the OFF state.

That results in:

$t_1 = MS \times (1/30\ Hz) = (MS/30)$ s

e.g.

MS = 3 $t_1 = (3/30)$ s = 0,1 s = 100 ms

MS = 10 $t_1 = (10/30)$ s = 0,333 s = 333 ms

The stopping time $t_2$ comprises the time between the receipt of the OFF signal in the subsequent safety-related control system and the actual stoppage of the dangerous movement.

The safety increase $c_1$ results from the configuration of the hazardous situation: Height hazard, height protective device, layout protective device, sensor detection capacity as well as reference objects.

**Tip:** The method for the selection and configuration of protective devices is described in ISO 13855 in Chapter 4.

The safety increase $c_2$ is a system-caused increase. Since sound spreads with different speeds at different temperatures (see Chapter Taking temperature into consideration), this phenomenon must be considered if a consistent temperature cannot be assumed. The starting position is the temperature stored in the parameter temperature compensation.

If additional **higher temperatures** are anticipated, the minimum distance is quasi extended. From a safety-related point of view, a fail-safe situation. In this case $c_2$ = 0.

If additional **lower temperatures** are anticipated, the minimum distance is quasi reduced. From a safety-related point of view, this is critical. To stay on the safe side, the maximum temperature difference Δϑ must be determined and the matching safety increase c2 must be selected.

Coefficient $c_2$ as a function of temperature difference and measuring distance:

| Δϑ | 5° | 10° | 15° | 20° | 25° | 30° | 35° | 40° | 45° | 50° | 55° | 60° | 65° | 70° | 75° | 80° |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Measuring distance d = 500 mm [0,85 mm/K] | | | | | | | | | | | | | | | | |
| $c_2$ | 5 | 9 | 13 | 17 | 22 | 26 | 30 | 34 | 39 | 43 | 47 | 51 | 56 | 60 | 64 | 68 |
| Measuring distance d = 1000 mm [1,70 mm/K] | | | | | | | | | | | | | | | | |
| $c_2$ | 9 | 17 | 26 | 34 | 43 | 51 | 60 | 68 | 77 | 85 | 94 | 102 | 111 | 119 | 128 | 136 |
| Measuring distance d = 1500 mm [2,55 mm/K] | | | | | | | | | | | | | | | | |
| $c_2$ | 13 | 26 | 39 | 51 | 64 | 77 | 90 | 102 | 115 | 128 | 141 | 153 | 166 | 179 | 192 | 204 |
| Measuring distance d = 2000 mm [3,40 mm/K] | | | | | | | | | | | | | | | | |
| $c_2$ | 17 | 34 | 51 | 68 | 85 | 102 | 119 | 136 | 153 | 170 | 187 | 204 | 221 | 238 | 255 | 272 |

Table 5

The values were determined with the following formula:

$c_2 = \Delta\vartheta \times 0{,}0017 \times d\ [\ mm\ ]$

The result is rounded up to the next integer.

## Note

When you enter the lowest anticipated temperature for the temperature compensation, USi safety will always work in the safe range but the minimum distance can still be extended by up to 272 mm.

## Temperature Sensor and Factor $c_2$

The factor $c_2$ must always be taken into account. Also in case a temperature sensor (optional) is connected. The sensor improves the performance substantially, but the factor $c_2$ still applies to the full extent.

If access to the danger zone is hampered by steps, the minimum distance S is reduced: 40 % of the **step height H** will be deducted.

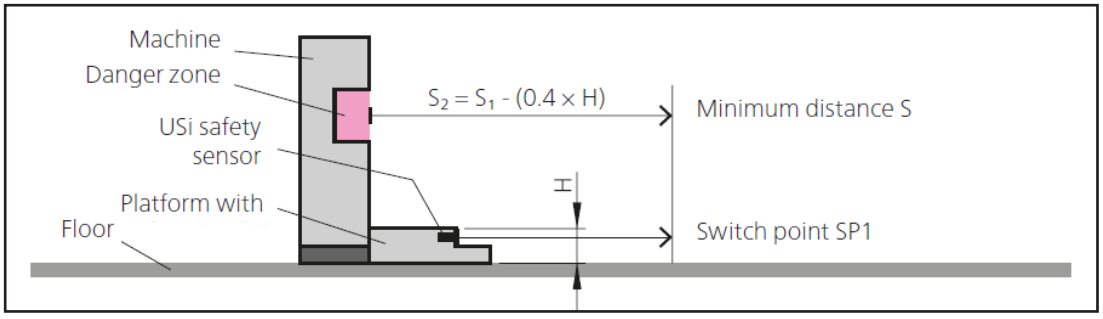



Figure 15

If the USi safety sensor is not installed on the same level as the front edge of the danger zone in such a case, the switching point SP1 will be reduced appropriately.

## Minimum Distance with Mobile Hazard Protection

With mobile hazard protection, a single parameter is added – the travel speed $k_2$ of the mobile object.

**$k_1$ = approach speed**
**$k_2$ = travel speed**
**$t_1$ = response time of the protecting device**
**$t_2$ = stopping time of the mobile object**
**$c_1$ = coefficient for the configuration**
**$c_2$ = coefficient for highest temperature difference**

$S = (K \times T) + C$ where:

$K = k_2 - k_1$, $T = t_1 + t_2$, $C = c_1 + c_2$

Consequent

$S = ((k_2 - k_1) \times (t_1 + t_2)) + (c_1 + c_2)$ $\quad k_1 = 1600$ mm/s

The approach speed $k_1$ is the walking speed of the person approaching parallel to the reference axis.

If the person moves in another direction, only the vector that runs parallel to the reference axis will be taken into consideration. This can be negative (person moving towards USi safety) as well as positive (person by tendency moving away from USi safety).

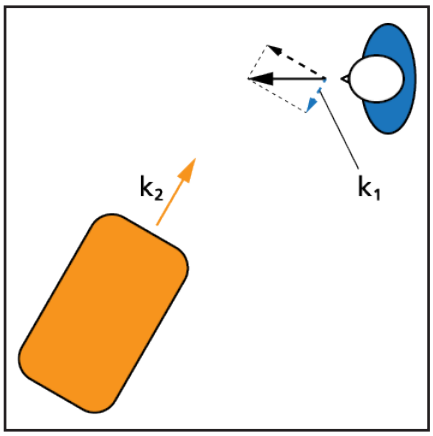


Figure 16

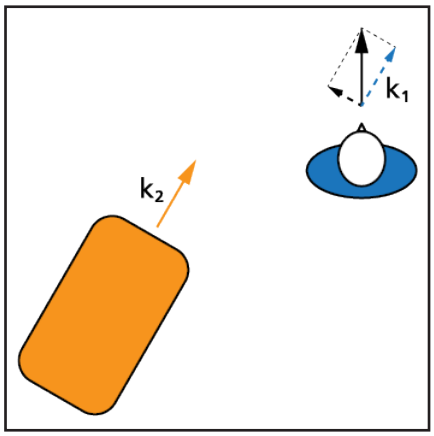


Figure 17

$K = k_2 - (-k_1)$

$K = k_2 - k_1$

The travel speed $k_2$ of the USi safety results from the travel speed of the mobile object plus the angular anticipated speed with cornering if the USi safety is installed outside the centre of the object.

All other parameters are considered as with stationary hazard protection.

## Determining the Validation

The temperature is taken into consideration, the protection field is designed optimally and USi safety is parameterised appropriately – only the validation must still be determined.

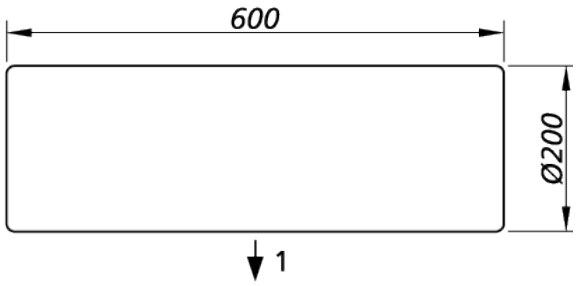
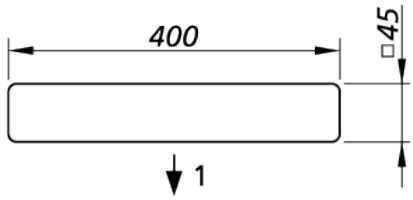
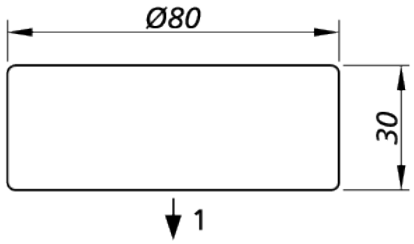
The validation is intended to confirm the correct design of the protection field by testing the protection field with all essential **test specimens**, with all anticipated **speeds** and with all anticipated **temperatures**.

The USi safety supports you in that with the protection field release including a protocol which records the user, the installation situation, the test specimen, the time as well as the most important parameters..

## Determining the Test Specimens

Whether a leg, body, head, arm, hand or even finger is to be detected, there is a matching test specimen for every case. If several test specimens are possible, the selection can possibly be reduced to the smallest test specimens:

If the test is positive with a small test specimen, a positive rest result can generally also be expected with a larger test specimen.

| Simulated Body Part | Test Specimen |
|---|---|
| Whole body |  |
| Arm, leg or<br>shoulder |  |
| Head or hand |  |

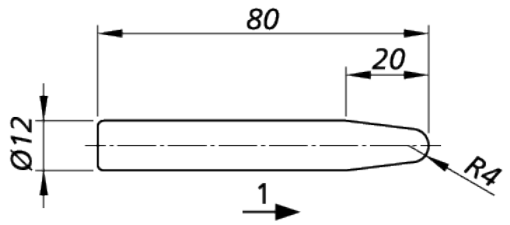
| Simulated Body Part | Test Specimen |
|---|---|
| Finger (fingertip) |  |

Table 6

Tip: Table 2 in ISO 13856-3 lists suitable test specimens.

Sound-soft test specimens are preferable to sound-hard test specimens.

## Test speed and test direction

The highest anticipated approach speed should be selected for the test speed. That is the same speed that was used for the calculation of the protection field length. Lower speeds are co-validated with the high test speed.

The test directions are oriented to the anticipated approach directions.

## Test Temperature

The test temperature should be the average anticipated temperature. That is the same temperature that was entered for temperature compensation with the parameterization of the USi safety.

The same test should additionally be performed with the lowest anticipated temperature. The most important question hereby: Is the defined minimum distance adhered to?

With the highest anticipated temperature, USi safety is – from a safety-related point of view – on the safe side. Spot tests are recommendable. The question here: Is the expanded minimum distance still tolerable?

## Aids for Validation

An **illustration of the protection field** on the floor or on the wall can be a big help: e.g. drawn with chalk or an appropriately cut film. Depending on the alignment of the sensor, either the wide (±17°) or the narrow (±5°) sound beam is used as a basis, limited by the parameterised protection field length (= minimum distance).

The **standard test routine** in Chapter Function check can serve for a rough orientation.

Another source for validation ideas can be I**SO 13855** „Safety of machinery; Positioning of safeguards with respect to the approach speeds of parts of the human body“.

### Is the Safeguard appropriate?

The PL required for the hazard must be decided by the integrator. This is followed by the choice of safeguard. Finally, the integrator needs to check whether the category and PL of the safeguard chosen are appropriate.

### Allowance for Inherent Limits

In addition to the safety technology analysis, the inherent limits of ultrasonic proximity switches must be considered:

- Environmental conditions, (frost, swirling leaves, etc.)
- Shape of the sonic lobe (asymmetrical funnel)
- Reaction time (influence of diverse parameters)
- Temperature compensation (highly fluctuating temperatures)

## 6.6. Installation Situation of the Sensors

The installation situation of the sensors ( ultrasonic transducer) has a significant influence on the performance of the protective device. The three typical installation situations are:

- flush installation,
- installation with funnel,
- installation with reference object and

combinations thereof.

### Flush Installation

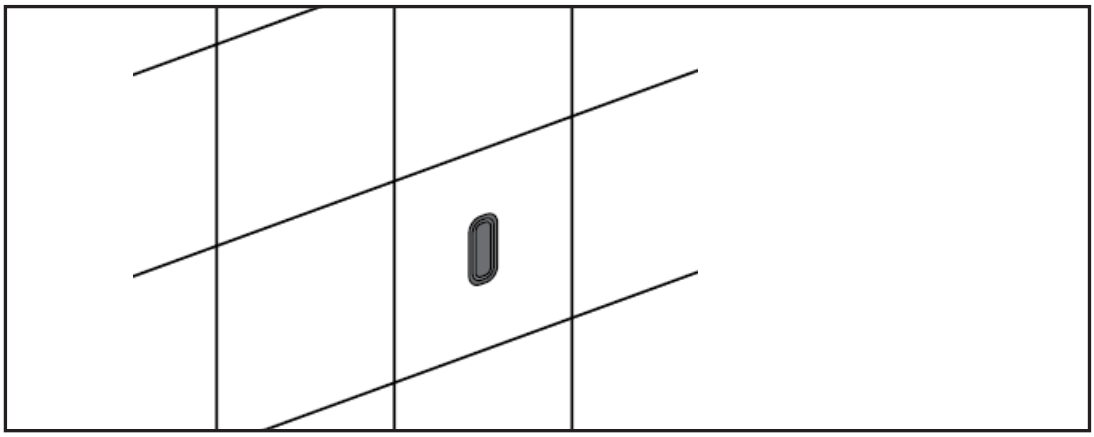


Figure 18

Inconspicuousness is the main characteristic of flush installation. This makes it the installation situation of first choice if design issues have priority.

Also to be rated positive is the hidden mounting that effectively prevents manipulation. Solely the accidental manipulation through suspended films, cloths or the like directly in front of the sensor (blind zone) is critical. “Open” integration naturally provides acoustic noise sources from any direction the chance to influence the sensor.

## Installation with Funnel

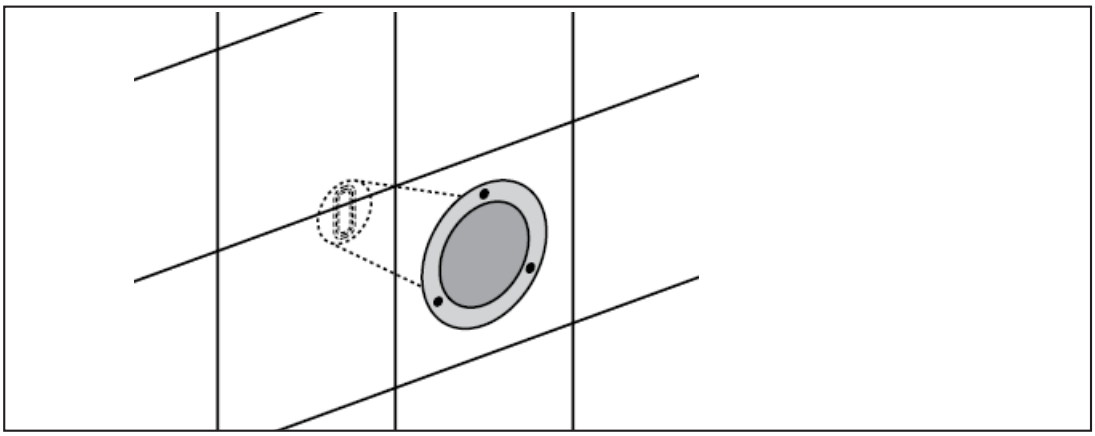


Figure 19

Installation with or in a funnel convinces with high insensitivity to acoustic noise sources that are at an obtuse angle to the sensor. However, acoustic noise sources at a sharp angle can – caused by the reinforcing funnel effect – have an even higher influence. With a funnel, the sensor quasi no longer has a blind zone: Suspended films and the like are kept at a distance by the funnel. This makes such objects detectable outside the blind zone and by USi safety. However, a funnel permits the placement of a cotton ball directly in the blind zone. This manipulation cannot be detected.

## Installation with reference object

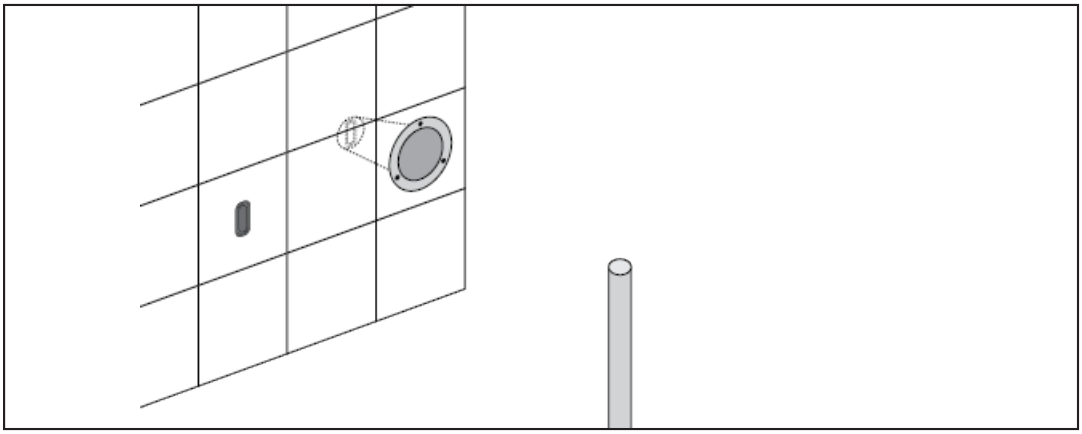


Figure 20

Installation with reference object means that a suitable reference object is integrated in the detection field of the sensor which is always positioned in the same place and with the same alignment. During the release test, this object is detected as “set” and subsequently treated as a basic prerequisite. If the reference object is no longer detected at its taught position – regardless of whether removed, only slightly displaced or through manipulation (e.g. cotton ball in the funnel) – it triggers the fail-safe mode. A random number of reference objects can be integrated.

Each additional reference object increases manipulation safety, but at the same time, performance drops because of possible false activations due to “wandering reference objects”. The “wandering” can be caused by great temperature drifts but also by ageing of the sensor.

Suitable reference objects are those reflecting at least an 80 % echo and thus clearly surpassing the internal threshold value.

This installation situation disregards whether the sensor is installed flush or with funnel. This is rather an additional option to the two preceding installation situations.

## Advantages and Disadvantages

| Flush Installation | Installation with Funnel | Installation with Reference Object |
|---|---|---|
| + design integration<br>+ for stationary and mobile application | + not sensitive to acoustic noise sources at obtuse angles<br>+ detect suspended films<br>+ for stationary and mobile application | + tamper-resistant<br>+ ideal with stationary application |
| tamper-resistant for the most part | the better, the longer the funnel and the smaller the diameter | requires a suitable object |
| - sensitive to acoustic noise sources<br>- suspended films and the like are not detected in the blind zone | - sensitive to acoustic noise sources at sharp angles<br>- additional length<br>- simple manipulation with cotton balls | - sensitive to acoustic noise sources<br>- false activations through temperature drift<br>- false activations through ageing |

Table 7

## Installation Position of the Temperature Sensor

The temperature sensor (optional) can be installed in any position. Pepperl+Fuchs recommends positioning the temperature sensor near the sensor (ultrasonic transducer).

Temperature compensation by means of the temperature sensor is always applied to both evaluations, to sensor 1 and sensor 2. A substantial difference in temperature between the operating ranges of sensor 1 and sensor 2 necessitates two separate evaluation units.

# 7. Installation

The design of the protection field comes before the assembly (see Chapter Designing the protection field). This sometimes determines at which position, which height and in which direction a sensor is to be attached.

The installation includes four individual installation steps:

1. Mounting the sensor (ultrasonic transducer)

2. Mounting the temperature sensor (optional)

3. Mounting the evaluation unit

4. Wiring the unit cable

## 7.1. Mounting the Sensor (Ultrasonic Transducer)

The sensors can be mounted in any position.

If the sensors are supposed to be mounted in quiet workplaces or in areas where there are hearing-sensitive animals, the interfering sonification must be considered. Ultrasound is not audible for human beings. The “hard” transmission burst, however, is perceived as a clearly audible crackle. At a measurement frequency of 30 Hz, 30 crackles per second are audible. This can be stressful when continuous. Here, it is recommended to not align the sensor directly to the ears, but at an angle of at least 20°. The same applies for indirect sonification reflected from hard reflectors like e.g. walls.

As an alternative, parameterization software can be used to reduce transmission intensity – however, to the detriment of the detection capacity.

### Key for Safe Function

There are some points that, if appropriately taken into consideration, form the best basis for safe sensor function.

When you observe the following points during sensor assembly, safe function is nearly guaranteed:

- First check the attachment site: At what position, in which alignment, at which height can the protective device be installed optimally and tamper-resistant?
- Avoid pressure on the sensor.
  Pressure may be exerted only on the O-rings, not on the sensor housing itself.
- Install the sensor so that the active surface is preferably flush with the front edge of the danger zone.
- Avoid EMC noise sources in the immediate vicinity of the sensors and their cables.

- Avoid strong acoustic noise sources in the immediate vicinity of the sensors or at sharp angles to the active surfaces.
- Avoid strong temperature fluctuations.
- Prevent accidental manipulation.
  E.g. with safety screws, with the integration of sensors so that no films or the like can be thrown over, with reference objects in the detection field and other solutions.

1. Mount the lower section of the housing at the intended position. Use the M5 screws that are included.

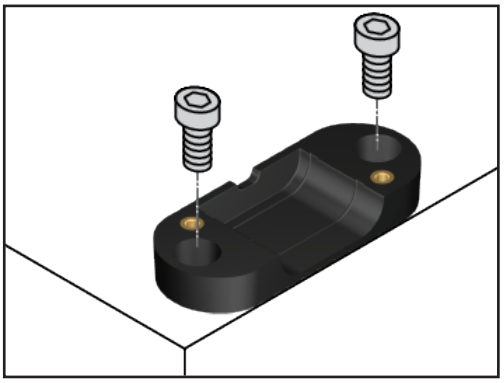


Figure 21

2. Ensure that O-rings are present both sensor grooves.

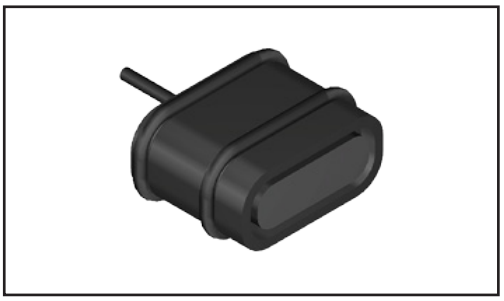


Figure 22

3. Position the sensor in the lower section of the housing so that the O-rings are in the grooves and the cable lies loosely in the cable bushing.
4. Carefully set the upper section of the housing in place.

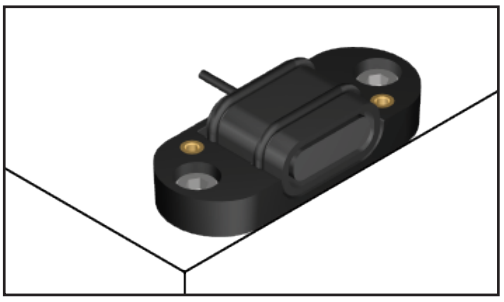


Figure 23

5. When the upper section of the housing is level and the cable is loose in the cable bushing, bolt the upper section to the lower section with the M3 screws included.

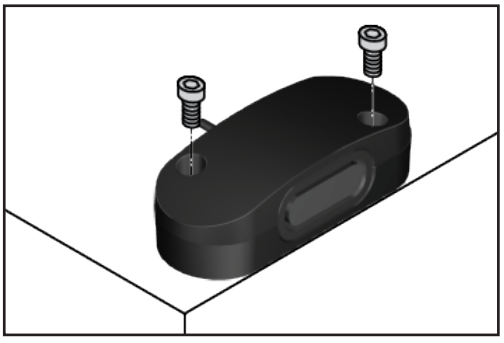


Figure 24

6. Route the sensor cables with no tension and at a sufficient distance to sources of electromagnetic interference, such as DC motors.

## CAUTION!

**Functional impairment through EMC noise sources**

Electromagnetic noise sources in the immediate vicinity of the sensors and their cables can cause malfunctioning.

- Position the sensors with sufficient distance to the noise sources.
- Install the cables with sufficient distance to the noise sources.

## Alternative: Use your Own Mounts

Instead of the housing sets from Pepperl+Fuchs you can also use your own mounts. They can be simple (standard mounting fixture) or integrated (optimised mounting fixture). In both cases, certain dimensions must be allowed for. Use only O-rings from Pepperl+Fuchs for fastening the sensor in the mount. The primary function of the O-rings is to provide acoustic decoupling.

**Sensor: Dimensions**

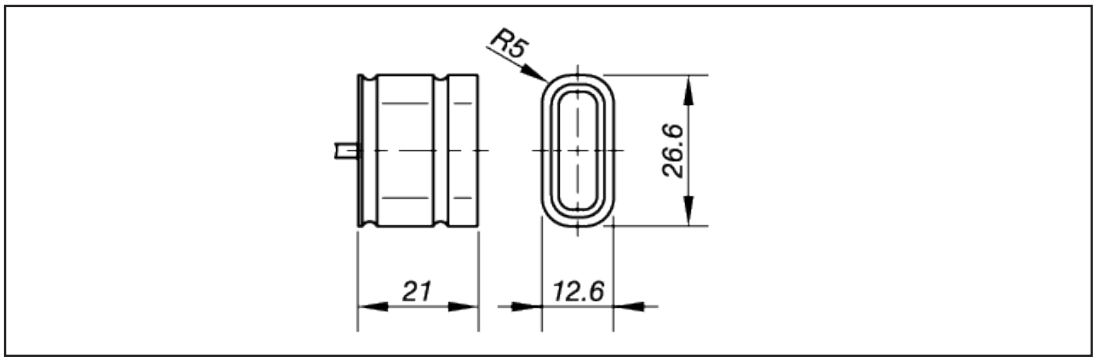



Figure 25

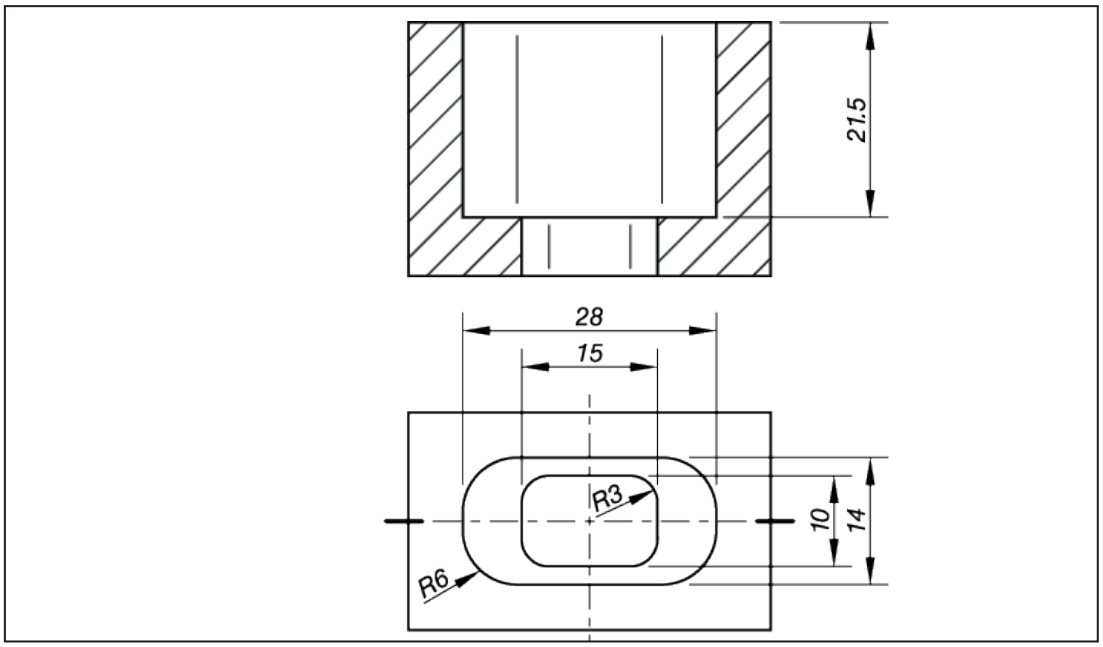



Figure 26

Tolerances: ISO 2768-1 m, with O-rings 17,5 × 2,0 mm

1. Ensure that an O-ring is mounted in each of the two sensor grove N1 and N2. This is the delivery status of the sensor.

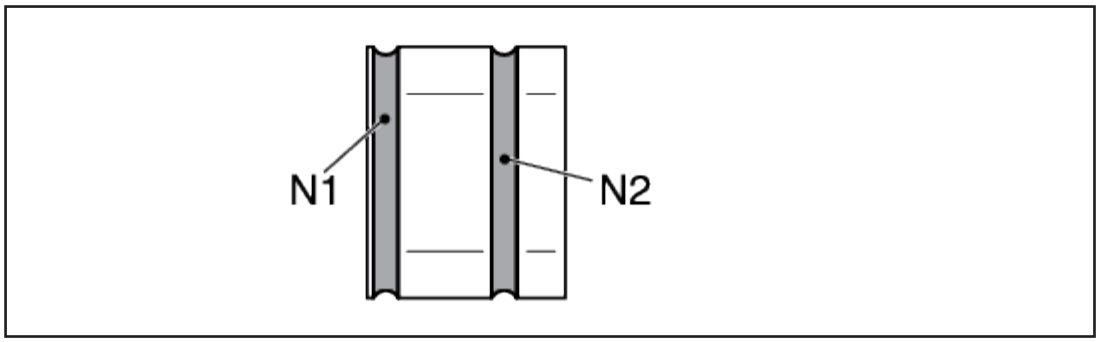



Figure 27

2. Attach the sensors (ultrasonic transducer) in a random position in tamper-proof (e.g. with safety screws) holders.

## WARNING!

**Failure of the protective function through manipulation**

Freely accessible standard screws are not manipulation-proof. Releasing the screws and twisting the sensor can completely cancel the protective function.

- Preferably attach the sensor with safety screws.
- Hide the standard screws under a lockable cover.

## CAUTION!

**Functional impairment due to incorrect mounting**

Squeezing the sensor – particularly in the front area near the active surface – can cause malfunctions and mechanical damage.

- Attach the sensor only with the factory-mounted O-rings.
- Do not use the cable as a pulling aid. The cable can tear off.
- Avoid high mechanical loads on the active surface (heavy pressure, impact, etc.) when mounting.
- Immediately replace damaged sensor (torn off cable, damaged active surface). Repairs are not possible.

A cross-section of a mounted sensor:

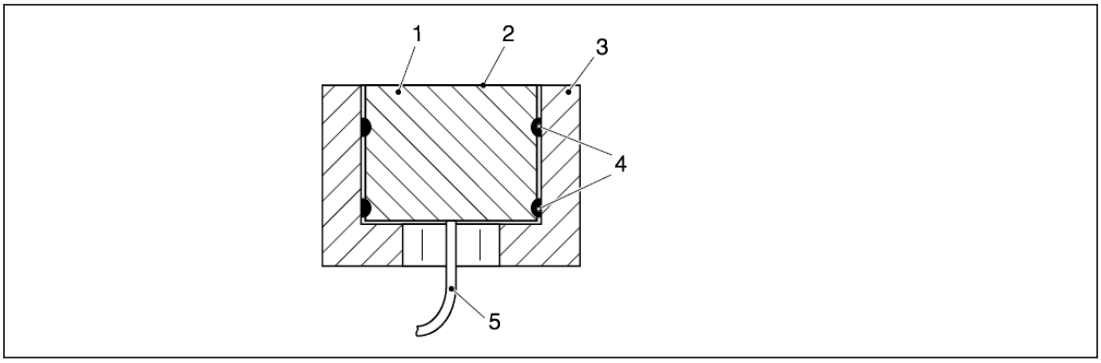



Figure 28

1 Sensor

2 Active surface

3 Optimised holder

4 O-rings

5 Cable

# 7.2. Mounting the Temperature Sensor

The temperature sensor (optional) measures the temperature of the air medium to ensure maximum performance of the USi safety. The temperature sensor should be positioned as near as possible to the sensor, and outside of the sonic lobe.

For mounting you will additionally need a suitable M3 spacer and a M3 screw connection.

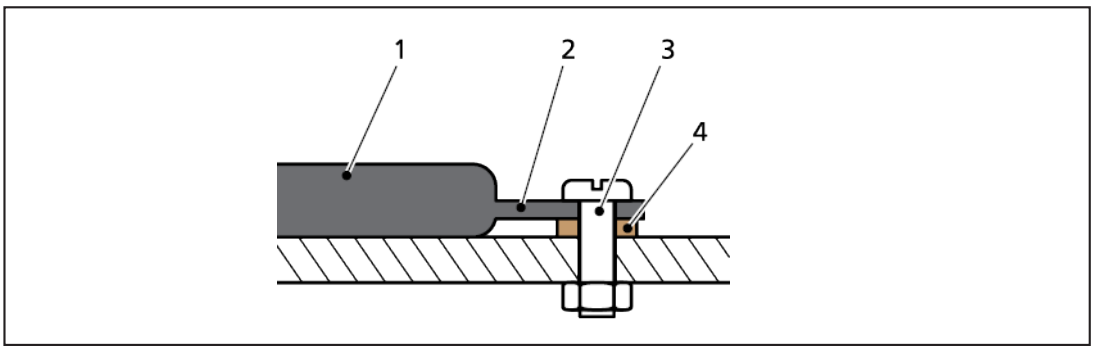



Figure 29

1 Temperature sensor

2 Mounting tab

3 M3 screw connection

4 Spacer

## 7.3. Mounting the Evaluation Unit

The evaluation unit can be mounted in any position. If the evaluation unit is to be mounted in a splash water environment, the parameter assignment situation via USB connection must be considered. If the screw plug is removed, the degree of protection drops to IP20. The opening for the USB connection should therefore be configured in such a way that it preferably faces down and not in the direction of the source of the splash water. We recommend the installation of an additional splash water protection during parameter assignment (guard plate, foil, or similar).

1. For automated guided vehicles (AGV): Take measures to ensure that the housing remains insulated from the AVG chassis.

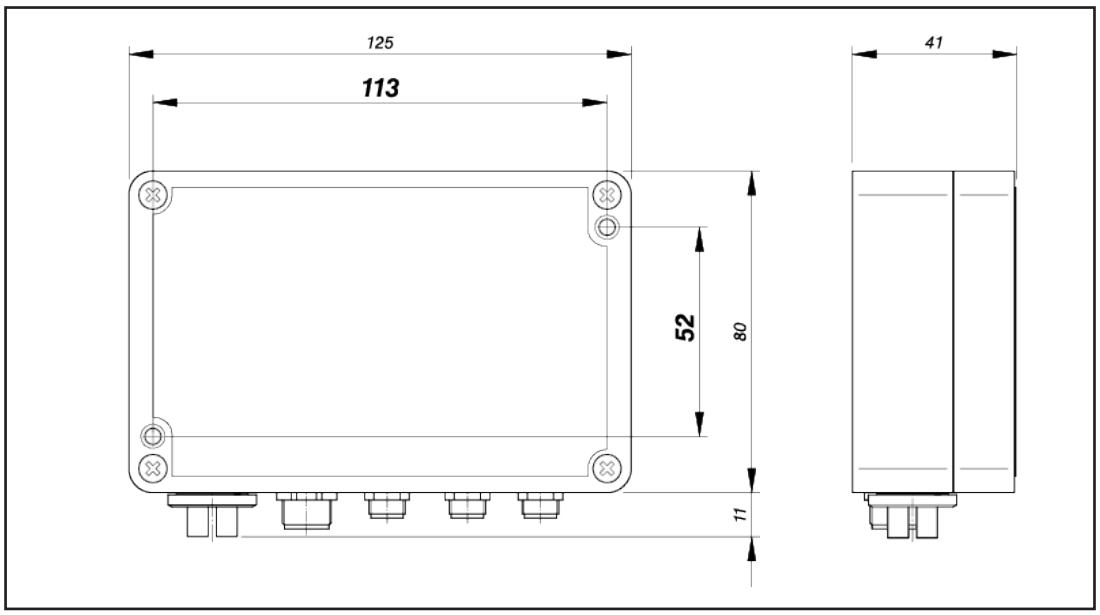



Figure 30

2. Fix the evaluation unit in any position with two screws Ø 3 mm.

### Note

Screws with Ø 4 mm are also an option. For this, the lid of the evaluation unit must be removed, the two screws inserted and the lid carefully replaced on the evaluation unit. The screws are now captive.

- When performing these actions, avoid touching and soiling the electronics.
- Ensure the correct seat of the seal in the lid.
- Put on the cover so that the designations of the connections point to the side with the connections.

## 7.4. Wiring the Unit Cable

### WARNING!

**Danger of injury due to electrocution!**

- Disconnect all devices and live parts in the immediate environment of the power supply and protect them against being switched on again (see relevant operating instructions).
- Check that all devices and parts are disconnected from the power supply.

| Core Color | Signal | USi-safety |
|---|---|---|
| Brown<br>Blue | $+U_S$<br>$-U_S$ | DC 24 V (DC 21 bis 28 V) |
| White | OSSD 1.1 | max. 150 mA / max. $U_S$ |
| Green | OSSD 1.2 | max. 150 mA / max. $U_S$ |
| Yellow | OSSD 2.1 | max. 150 mA / max. $U_S$ |
| Grey | OSSD 2.2 | max. 150 mA / max. $U_S$ |
| Pink | OUT 1 | max. 150 mA / max. $U_S$ |
| Red | OUT 2 | max. 150 mA / max. $U_S$ |

Table 8

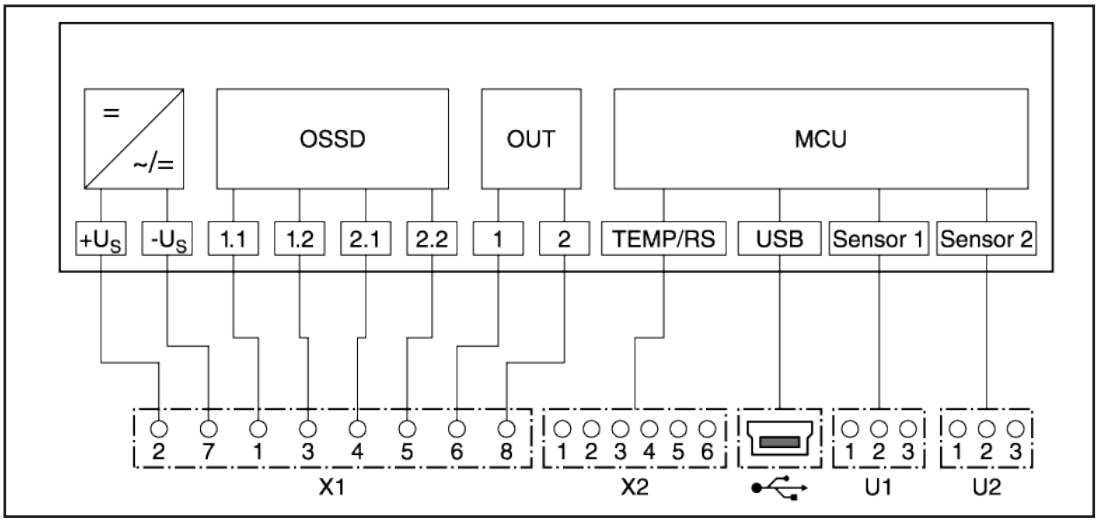



Figure 31

- Wire the cores of the unit cable.

**On machines (stationary)**

Use only voltage sources of the type SELV that you wire in the switch cabinet into a PELV power circuit.

**On AGVs (mobile)**

The following action is possible, but not absolutely necessary:

- Connect the housing (evaluation unit) and AGV chassis by means of a parallel RC element.
- Make sure to observe the requirements of EN 1175-1.

## CAUTION

**Failure due to incorrect wiring!**

- Check the wiring carefully. The shielding braid must not be connected.
- Inspect the supply voltage.
- Check the external voltage supply: Does it comply with the requirements of IEC 60204-1?

## Safe wiring of OSSDs

The OSSD safety outputs are automatically tested by the USi safety at regular intervals. The internal test pulse needed for this temporarily (< 400 µs) switches the single OSSDs to OFF state. A downstream control system must be able to tolerate these test pulses.

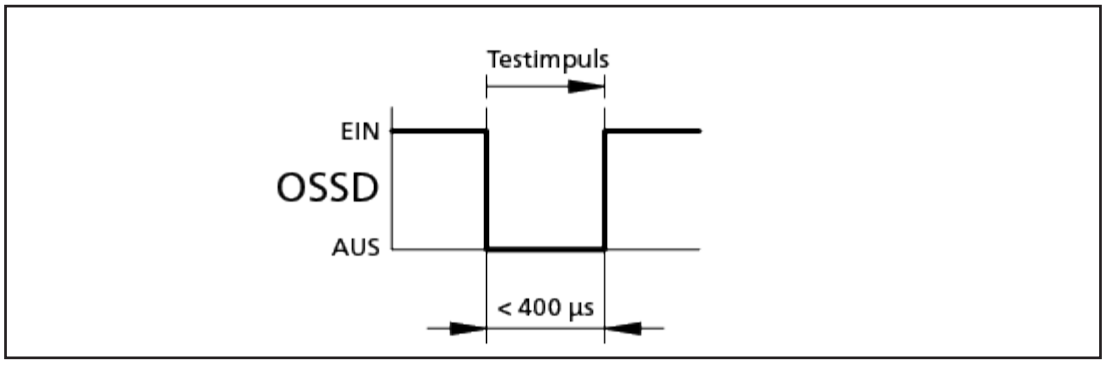



Figure 32

**The following is recommended for safe wiring of the OSSDs.**

1. Always connect the single OSSDs separately from each other.
2. Make sure that the downstream control system processes the single OSSD signals separately from each other.
3. Make sure that the downstream control system tolerates OFF states of < 400 µs.
4. Connect only one downstream safety element for each OSSD.
5. If additional safety elements are needed, choose a suitable contact duplication.
6. Make sure that downstream contactor are force-guided and monitored.

# 8. Commissioning

The evaluation unit expects that at least one sensor (ultrasonic transducer) is connected. If only one sensor (ultrasonic transducer) is used, then this must be connected to „U1“.

1. Connect the sensor (ultrasonic transducer), the temperature sensor (optional) and the unit cable with the evaluation unit.
2. Make sure that the plug connectors are firmly mounted.
3. Check the supply voltage:
   - Is this available via a PELV circuit?
   - Is the external fusing with 2 A slow-blowing set up?
4. Connect the supply voltage.

**WARNING!**

**Danger of injury due to electrocution!**

- Never disconnect terminals with the power on.
- Never unplug plug connections with the power on.

# 8.1. First commissioning

During the first commissioning, the standard passwords must be replaced with individual passwords. This transfers the responsibility to the USi safety operator. The operator is responsible for the correct setting of the safety sensor.

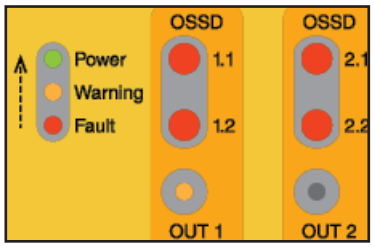



Figure 33

After applying the supply voltage, USi safety signals the readiness for first commissioning: All LEDs OSSD light up in red, the LED OUT 1 lights up in yellow, the LEDs power, warning and fault form a moving light. USi safety stays in this state until the password procedure has been completed successfully.

1. Connect USi safety to your computer via the USB interface. Insert the USB plug completely into the USB socket of USi safety applying only slight pressure.

## NOTE

**Without screw plug, only degree of protection of IP20!**

- Check the environment of the evaluation unit: Is operation with IP20 possible?
- If not: see the Chapter Installing the evaluation unit.

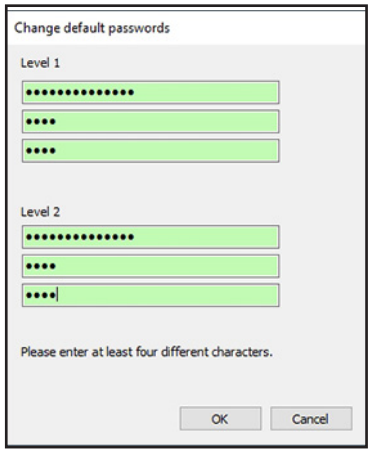



Figure 34

2. Start the USi safety GUI on your computer.
3. In the tab Log in/out, enter the password for level 2: Pepperl-Fuchs2
4. Assign new passwords for level 1 (Pepperl-Fuchs1) and level 2 (Pepperl-Fuchs2). Condition: at least four different characters. Avoid using similar passwords for level 1 and level 2.

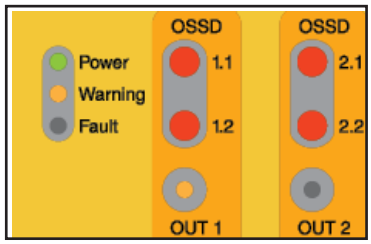



Figure 35

USi safety is now ready for the release test: The LEDs power and Warning are lit constantly, LED fault is off, the sensor cracks audibly.
The USi safety GUI has switched to the tab **Standard**.

5. Check the settings in the tab **Standard**: Do the parameters meet your requirements?
6. If not: Change the parameters appropriately.

Figure 36

7. If yes: Click **Write parameters** and carry out the release test (see Chapter Release).

The complete password procedure is required only during the first commissioning.

## 8.2. Log in

Every start of the parameterization software requires a password entry in the tab **Log in/out**, either at level 1 (Display only) or at level 2 (Display and parameterization). USi safety is already working with the parameters released last. You have to log in to view these or change specific parameters or to be able to use the diagnosis.

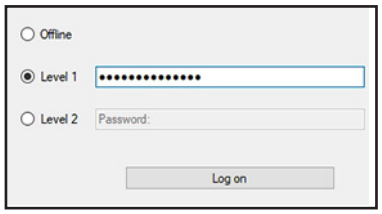


Figure 37

**How to log in at level 1**:

- In the tab **Log in/out**, enter the password for level 1 defined by the operator.

If the log-in was successful, the parameterization software shows the tab **Standard**. All settings in the tabs **Standard** and **Expert mode** (if activated) are visible, however, they **cannot** be changed.

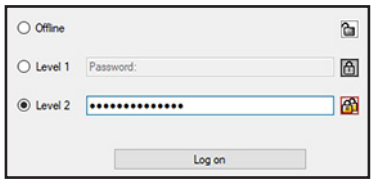


Figure 38

**How to log in at level 2:**

- In the tab Log in/out, enter the password for level 2 defined by the operator.

If the log-in was successful, the parameterization software shows the tab **Standard**. All settings in the tabs **Standard** and **Expert mode** (if activated) are visible **and** can be changed.

Changed parameters are effective only after they have been transferred to USi safety with a click on **Write parameters** and the subsequent release test was passed successfully.

### NOTE

**Password for the evaluation unit**

The entered password does not give you access to the parameterization software but to the connected evaluation unit. That means, the assigned passwords apply exclusively to the USi safety currently connected to the USB port. Other device, other password.

- Always remember the passwords in connection with the serial number (Serial No.) on the rating plate of the evaluation unit.

# 8.3. For demonstration purposes

If you do not log in and instead confirm the offline mode by clicking on **More**, then you can show the two tabs **Standard** and **Expert mode** for demonstration purposes and change all parameters. This does not affect the possibly connected USi safety. The key **Write parameters** is deactivated.

# 8.4. Approval

The release test is required in two cases: During the first commissioning and after every **parameter writing**. It comprises the functions performing a teach-in, determining transducer data and checking the protection field. To test the protection field, you need a suitable test specimen (see Chapter Determining the validation).

The release test is possible only at log-in level 2.

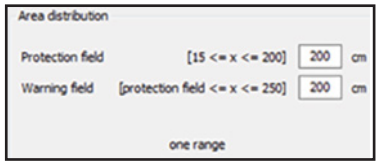



Figure 39


Figure 40


Figure 41

**How to carry out the release test**:

1. In the tab **Standard** in the group field **Area distribution**, enter the distances for the protection field and the warning field.
   Standard: Protection field 200 cm, warning field 200 cm (operating mode 1 range).
   Entries can later be corrected at any time, roughly estimated values are completely sufficient initially.
2. Click on **Write parameters**.
3. Make sure there is nothing in the detection field that normally does not belong there.
4. Switch to the tab **Release**.
5. Click on **Start release** and wait until the two check marks appear next to **Teach In** and **Setting transducer data (f0)**.

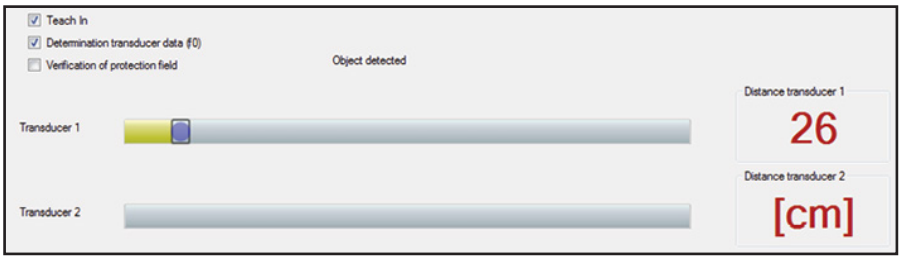



Figure 42

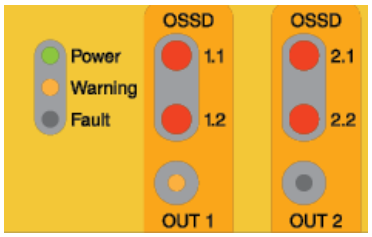



Figure 43

6. Take a suitable test specimen slowly from the outside across the switching point in the direction of sensor 1 (ultrasonic transducer). Observe the tab **Release**: Every detected partial area is hidden. If the complete protection field of sensor 1 was detected, the GUI shows a green bar as well as a red check mark in the field **Distance transducer 1**.
For verification: If the test sample is detected, the LED „OUT 1“ lights up.

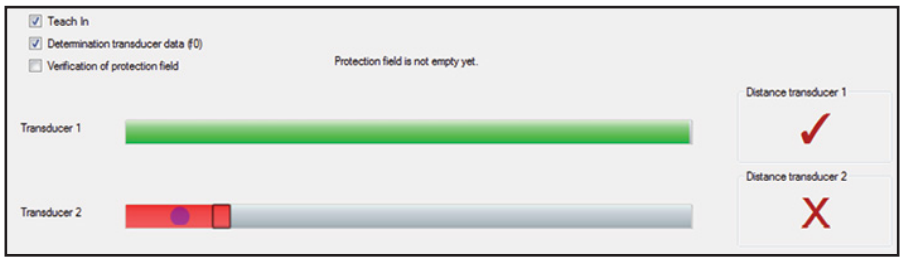



Figure 44

7. Remove the test specimen from the detection field and wait until the GUI is ready to check the protection field of sensor 2.

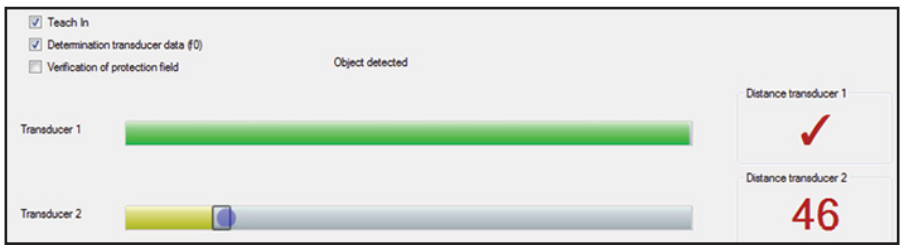



Figure 45

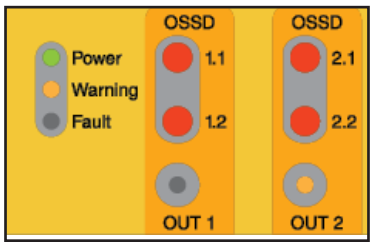



Figure 46

8. Take a suitable test specimen slowly from the outside across the switching point in the direction of sensor 2 (ultrasonic transducer). Observe the tab **Release**: Every detected partial area is hidden. If the complete protection field of sensor 2 was detected, the GUI shows a green bar as well as a red check mark in the field **Distance transducer 2**.
For verification: If the test sample is detected, the LED „OUT 2“ lights up..

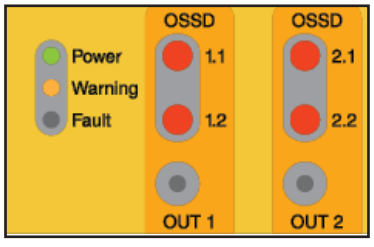



Figure 47

9. Remove the test specimen from the detection field.

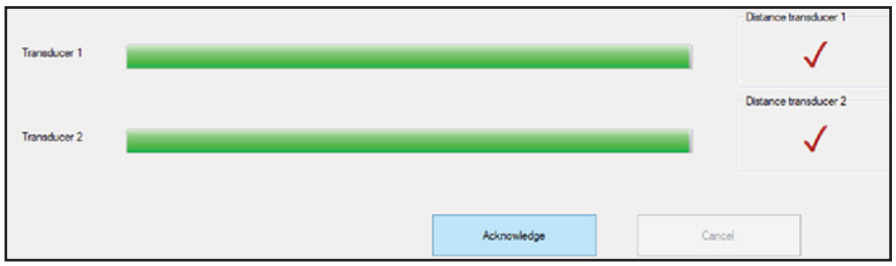



Figure 48

10. Click on **Acknowledge**.
11. Continue to keep the detection field empty until point 12 has been carried out.

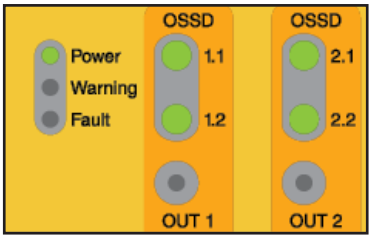



Figure 49

12. Enter your name, the type of application and the test specimen used in the following three windows.

The parameterization software uses it to automatically produce a protocol with your information and the most important parameters. The LEDs of the outputs OSSD switch from red to green. The LED "Warning" is no longer lit.
The parameterization software switches to the **Protocol** tab.


Figure 50

13. To print the protocol click **Print protocol**.
14. Sign and archive the protocol.

USi safety is now ready to monitor the set areas.
The only thing missing for safe operation is the functional test (see Chapter Function check).

# 8.5. Protection Field Testing

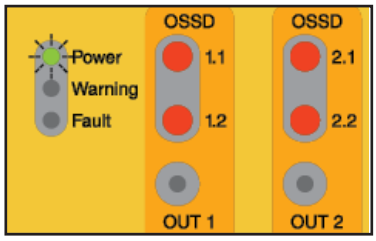



Figure 51

With every commissioning (applying of supply voltage), USi safety autonomously starts the internal system test, initialises the sensors (ultrasonic transducers) and then waits for the protection field test. This does not require the parameterization software.

The safe outputs OSSD are blocked, the LED „OSSD" are lit red. The LED „Power" flashes.

USi safety only releases the safe outputs OSSD when the protection field test was successful. USi safety is then operational.

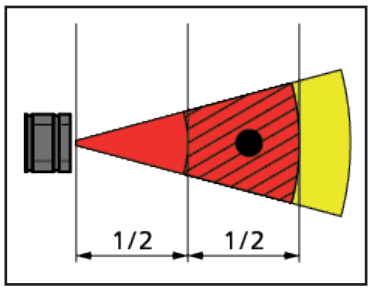



Figure 52

**How to perform a protection field test:**

1. Enter a suitable test specimen (see Chapter Determining the validation) into the second half of the protection field (see diagram).
2. Observe the signal outputs OUT: If the LEDs „OUT" and „Power" are lit permanently, USi safety has detected the test specimen.
3. Do not remove the test specimen before the green LED „Power" is lit permanently.

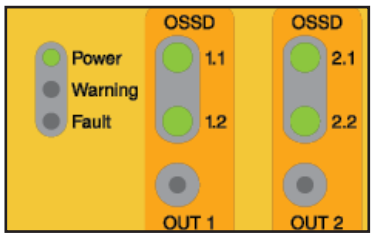



Figure 53 #

USi safety acknowledges the successful protection field test by releasing the safe outputs OSSD. The LEDs „OSSD" switch to green.

**Cancelling the protection field test**
For applications in which it is counter-productive to conduct the protection field test each time the supply voltage is applied, the protection field testing can be cancelled with the parameterization software (see Cancelling the power-on start interlock).

# 8.6. Testing

The following description applies to USi safety with two sensors and two defined areas each (warning and protection field).

For USi safety with only one sensor, the functional test is completed after Step 4.

For USi safety without warning field, steps 2 and 6 are omitted.

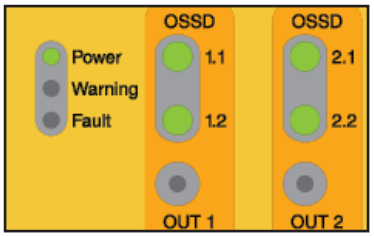



Figure 54

1. Make sure that the detection fields from sensor 1 and sensor 2 are clear.
   - green LED „Power“ is on
   - all LEDs „OSSD“ are lit green
   - all OSSD Outputs are closed

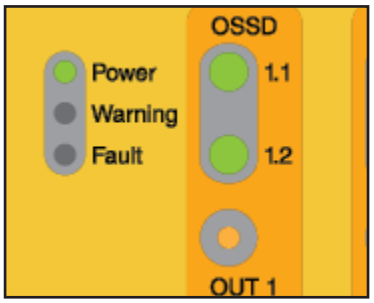



Figure 55

2. Enter an object into the **warning field** of sensor 1. Make sure that the detection field of sensor 2 remains clear.
   - green LED „Power“ is on
   - LEDs „OSSD 1.1“ and „OSSD 1.2“ are lit green
   - Outputs OSSD 1.1 and OSSD 1.2 are closed
   - yellow LED „OUT 1“ is on
   - LEDs „OSSD 2.1“ and „OUT 2.2“ are lit green
   - Outputs OSSD 2.1 and OSSD 2.2 are closed
3. Repeat step 1.

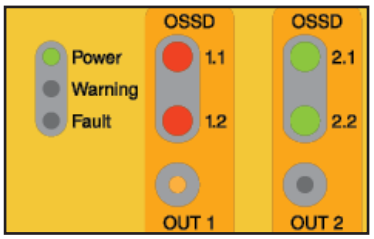



Figure 56

4. Enter an object in the **protection field** of sensor 1. Make sure that the detection field of sensor 2 remains clear.
   - green LED „Power“ is on
   - LEDs „OSSD 1.1“ and „OSSD 1.2“ are lit red
   - Outputs OSSD 1.1 and OSSD 1.2 are open
   - yellow LED „OUT 1“ is on
   - LEDs „OSSD 2.1“ and „OUT 2.2“ are lit green
   - Outputs OSSD 2.1 and OSSD 2.2 are closed
5. Repeat step 1.

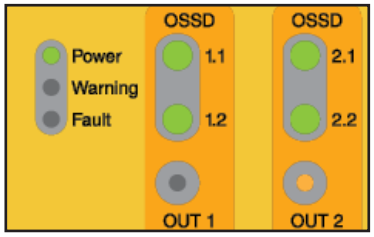


Figure 57

6. Enter an object into the **warning field** of sensor 2. Make sure that the detection field of sensor 1 remains clear.
   - green LED „Power“ is on
   - LEDs „OSSD 1.1“ and „OSSD 1.2“ are lit green
   - Outputs OSSD 1.1 and OSSD 1.2 are closed
   - LEDs „OSSD 2.1“ and „OSSD 2.2“ are lit green
   - Outputs OSSD 2.1 and OSSD 2.2 are closed
   - yellow LED „OUT 2“ is on
7. Repeat step 1.

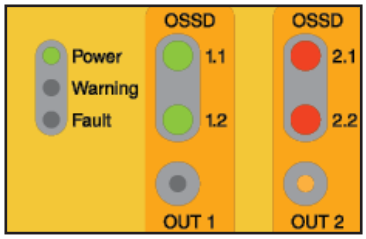


Figure 58

8. Enter an object in the **protection field** of sensor 2. Make sure that the detection field of sensor 1 remains clear.
   - green LED „Power“ is on
   - LEDs „OSSD 1.1“ and „OSSD 1.2“ are lit green
   - Outputs OSSD 1.1 and OSSD 1.2 are closed
   - LEDs „OSSD 2.1“ and „OUT 2.2“ are lit red
   - Outputs OSSD 2.1 and OSSD 2.2 are open
   - yellow LED „OUT 2“ is on

All tests passed? – If so, your USi safety is now ready for operation.

## 8.7. Recording the Protocol

Modern industrial safety management requires verifications. The USi safety GUI accommodates this demand in the tab **Protocol**. After successful release, a protocol is automatically generated here which you can finally print, sign and archive.

**Start release** and **Print protocol** are possible only at log-in level 2**.**

### How to generate a protocol:

1. Carry out the release test (see Chapter Release).
2. After clicking on **Acknowledge**, enter your name, the application and the test specimen used.

The protocol is automatically generated and displayed.

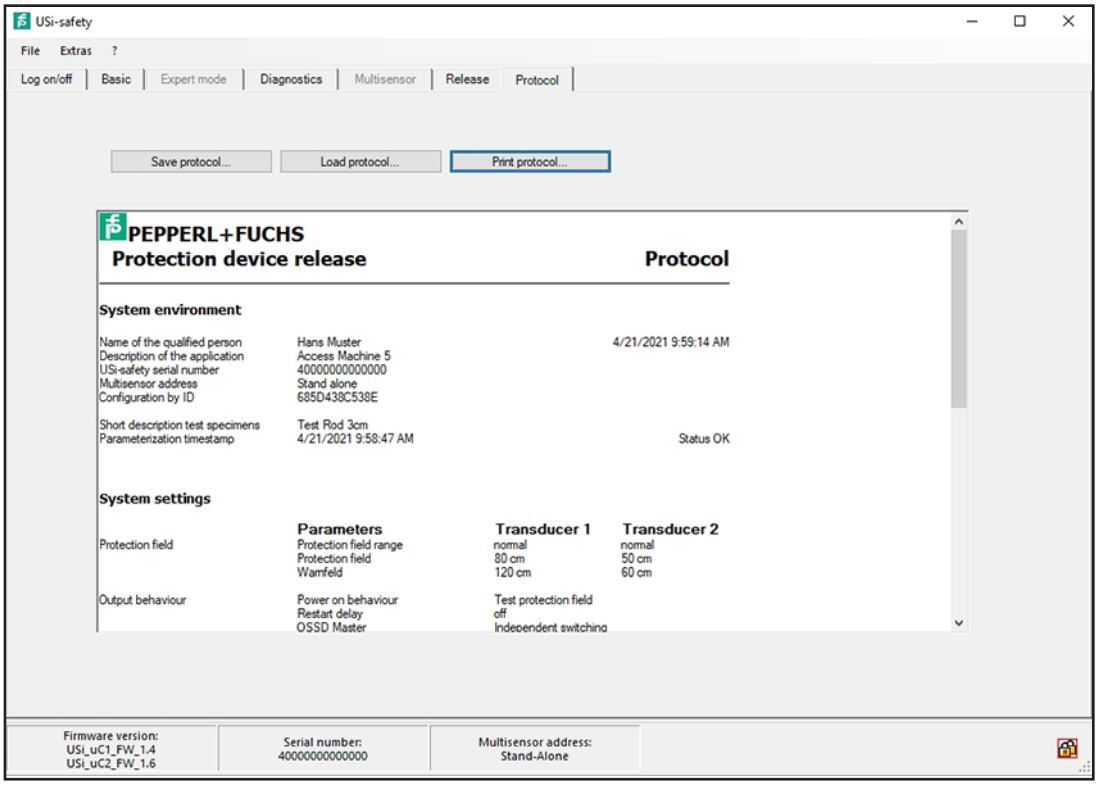


Figure 59

Figure 60

3. To print the protocol click **Print protocol**.

**Tip:** For **digital archiving**, select a PDF-generating printer, sign the PDF digitally and save it.

The protocol can also be saved in the USi proprietary format SIP. For this purpose, the Protocol tab features the button **Save protocol....** .

Figure 61

4. Click on **Save protocol.....**
5. Assign a descriptive file name, preferably including the date.

Protocols that have been saved in this way can be displayed at any time by the parameterization software in the **Protocol** tab:

Figure 62

6. Click on **Load protocol**.
7. Select the desired file.

# 8.8. System Restart

## WARNING

**Danger of injury!**

Never start your machine as long as the danger remains.

### Automatic reset

USi safety operates without reset function. As soon as the protection field is empty again, USi safety switches with a delay of $t_W$, back to the original state, the OSSD outputs are in ON state, and the OSSD LEDs light up green.

Delay $t_W$ is equivalent to the automatic restart delay. As standard, 0 measurement cycles ($t_W$ = 0 ms) are preset.

### Without reset function

When a safeguard without a reset function is used (automatic reset), the reset function must be made available in some other way.

- After the restart, check the function (see Chapter Function check).

## Correlations

| LEDs | | | | | | | | | Meaning |
|---|---|---|---|---|---|---|---|---|---|
| Power green | Warning yellow | Fault red | OSSD 1.1 green/ red | OSSD 1.2 green/ red | OUT 1 Output 1 yellow | OSSD 2.1 green/ red | OSSD 2.2 green/ red | OUT 2 Output 2 yellow | LED off: ○ LED on: ● LED flashes: ◎ |
| ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | USi safety is without voltage supply. |
| ◎ | ◎ | ◎ | ● | ● | ● | ● | ● | ○ | After the first commissioning: LEDs “Power”, “Warning” and “Fault” flash like a moving light from the bottom to the top. USi safety now waits for the passwords for level 1 and level 2 to be entered anew. |
| ◎ | ○ | ○ | ● | ● | ○ | ● | ● | ○ | After renewed commissioning: LED “Power” flashes, LEDs “OSSD” are lit red. USi safety waits for the protection field test. |
| ● | ○ | ○ | ● | ● | ○ | ● | ● | ○ | LEDs “OSSD 1.X” are lit green, LEDs “OSSD 2.X” are lit red: USi safety is operational with one sensor. Sensor 2 is logged off. |
| ● | ○ | ○ | ● | ● | ● | ● | ● | ○ | LEDs “OSSD 1.X” are lit green, LED “OUT 1” lights up, LEDs “OSSD 2.X” are lit red: USi safety is operational with one sensor, one object is detected in the warning field. |
| ● | ○ | ○ | ● | ● | ● | ● | ● | ○ | LEDs “OSSD 1.X” are lit red, LED “OUT 1” lights up, LEDs “OSSD 2.X” are lit red: USi safety is operational with one sensor, one object is detected in the protection field. |
| ● | ○ | ○ | ● | ● | ○ | ● | ● | ○ | LEDs “Power” and “OSSD” are lit green: The USi safety is in operation with two sensors, the detection field is empty. |
| ● | ○ | ○ | ● | ● | ○ | ● | ● | ● | LEDs “Power” and “OSSD” are lit green: USi safety is operational with two sensors, one object is detected in the warning field of sensor 2. |
| ● | ○ | ○ | ● | ● | ○ | ● | ● | ● | LEDs “Power” and “OSSD” are lit green: USi safety is operational with two sensors, one object is detected in the protection field of sensor 2. |
| ● | ○ | ○ | ● | ● | ● | ● | ● | ● | LEDs “OSSD 1.X” light up green, LEDs “OSSD 2.X” light up red, LEDs “OUT 1” and “OUT 2” are on: USi safety operates with two sensors; one object is detected in the warning field of sensor 1 and another is detected in the protection field of sensor 2. |
| ● | ○ | ○ | ● | ● | ● | ● | ● | ● | LEDs “OSSD” light up red, LEDs “OUT 1“ and “OUT 2” are on: USi safety operates with two sensors; one object is detected in the protection field of sensor 1 and another is detected in the protection field of sensor 2. |
| ● | ● | ○ | ● | ● | ○ | ● | ● | ○ | LEDs “Power“ and “Warning” are lit, LEDs “OSSD” are lit red. The parameters were changed, USi safety waits for the release test. |
| ● | ◎ | ○ | ● | ● | ○ | ● | ● | ○ | LED “Warning” flashes: USi safety is operational with one sensor, a critical operating state announces itself. |
| ● | ◎ | ○ | ● | ● | ○ | ● | ● | ○ | LED “Warning” flashes: USi safety is operational with two sensors, a critical operating state announces itself. |
| ● | ○ | ● | ● | ● | ○ | ● | ● | ○ | LED “Fault” lights up, LED “Warning” is not lit, LEDs “OSSD” light up red. USi safety has detected a fatal error and went into the fail-safe mode. The parameterization software provides information on the fault under Extras/Read fault status. |

Table 9

# 9. Adjust settings

If you did not make any changes in the tab Standard during the first commissioning, you must confirm the factory settings by clicking Writing parameters. After a successful release test, USi safety starts with the factory settings (see Chapter Factory settings):

| | |
|---|---|
| Sensor | 1 |
| Protection field range | normal (up to 200 cm) |
| Protection field | 200 cm |
| Warning field | 200 cm |
| Operating mode | 1 range |
| Signal outputs OUT | NO contact (high-active) |
| Power-on start interlock | with protection field test |
| Restart delay | 0 measurement cycles |

Table 10

In very few cases will the factory settings be right for your application case. In the tab Standard, you can change all parameters listed above at any time with the exception of the second sensor. This must be logged in or out in the Extras menu (see Chapter Logging sensor 2 in and out).

In this chapter, you will find out interesting facts about:

- * Overview of the Standard tab
- * Logging sensor 2 in and out
- * Specifying the protection field range
- * Dividing an area
- * Defining signal outputs OUT
- * Cancelling the power-on start interlock
- * Specifying the restart delay

## How to change settings:

1. Connect USi safety to your computer via the USB interface. Insert the USB plug completely into the USB socket of USi safety applying only slight pressure.

### NOTE

**Without screw plug, only degree of protection of IP20!**

- Check the environment of the evaluation unit: Is operation with IP20 possible??
- If not: see the Chapter Installing the evaluation unit.

2. Start the parameterization software USi safety on your computer.
3. Log in at level 2.
4. Change random settings as described in the next chapters.

# 9.1. Overview of the Standard Tab

For most application cases it is sufficient to make the basic settings in the **Standard** tab and transmit them to USi safety with a click on **Write parameters**.

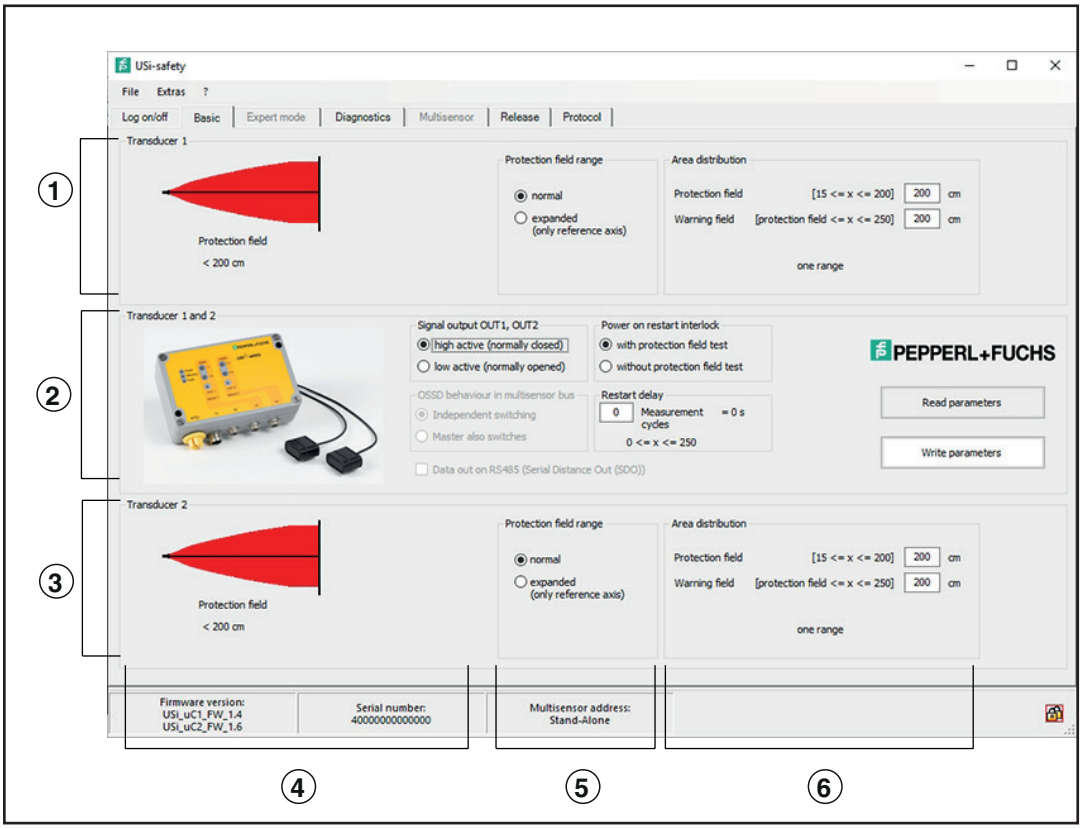



Figure 63

1 Parameters for sensor 1 (transducer 1)
2 Parameter for sensor 1 and 2 (transducers 1 and 2)
3 Parameters for sensor 2 (transducer 2)
4 Visualisation: Protection field and warning field
5 Protection field range
6 Area division

| | | |
|---|---|---|
| **1** | Sensor 1 (transducer 1) | Protection field range **5**<br>Area division **6** |
| **2** | Sensor 1 (transducer 1)<br>**and**<br>sensor 2 (transducer 2)) | Signal outputs OUT<br>Power-on start interlock<br>Restart delay |
| **3** | Sensor 2 (transducer 2) | Protection field range **5**<br>Area division **6** |

# 9.2. Logon/Logoff Sensor 2

The USi safety is preset to one sensor (ultrasonic transducer) on sensor 1 when supplied. If a second sensor (ultrasonic transducer) is required, sensor 2 must be logged on. Sensor 1 must always remain connected; it may not be logged off.

The function **Transducer 2 log** can be found in the **Extras** menu.

**This is how to logon sensor 2:**

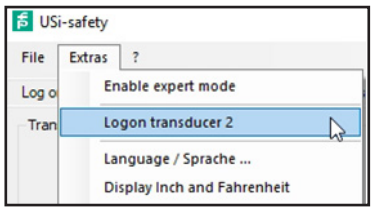



Figure 64

1. Click on Logon transducer 2 in in the **Extras** menu.

The tab **Standard** displays the group field **Transducer 2**. The parameter fields for transducer 2 are activated. The parameters set in group field **Transducers 1 and 2** now also apply to sensor 2.

2. Enter the parameters for protection and warning field for sensor 2 (see Chapter Area division).
3. Click on **Write parameters**.


Figure 65

## NOTE

**Tip:** Before you release the new settings, you can check the effects in the tab Diagnosis with fixed echo and correct the settings again, if necessary.


Figure 66

4. Carry out the release test (see Chapter Release).

USi safety immediately starts to work with two sensors.

**This is how to logoff sensor 2:**

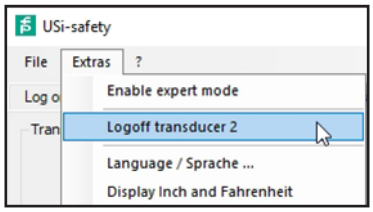



Figure 67

1. Click on Logoff transducer 2 in the **Extras** menu.

The tab **Standard** displays the group field **Transducer 2**. The parameter fields for transducer 2 are deactivated. The parameters set in group field **Transducers 1 and 2** now only apply to sensor 1.

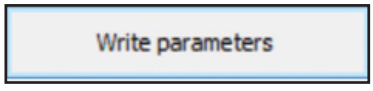



Figure 68

2. Click on **Write parameters**.

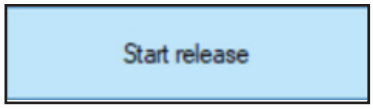



Figure 69

3. Carry out the release test (see Chapter Release).

USi safety immediately starts to work with sensor 1 only

# 9.3. Specifying the Protection Field Range

The range of the protection field is limited to 200 cm with the option **normal**. If necessary, the option can be **expanded (reference axis only)** to extend the protection field range to 250 cm. Prerequisite: The objects to be detected should be in the immediate vicinity of the reference axis.

The range of the warning field cannot be expanded. That means that depending on the protection field range, the warning field can be relatively small or completely omitted.

**Normal** is preset as standard.

How to set the protection field range:

1. Click on **Expanded (reference axis only)** in the group field **Protection field range**.

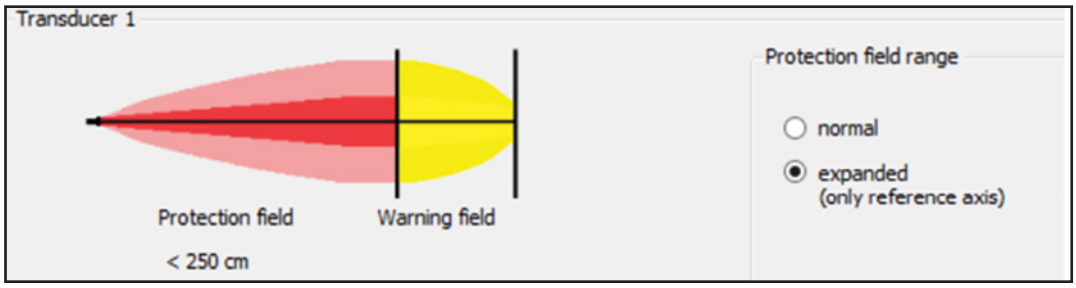



Figure 70

2. Enter the new parameters for protection and warning field (see Chapter Area division).


Figure 71


3. Click on **Write parameters**.

Figure 72

## NOTE

**Tip:** Before you release the new settings, you can check the effects in the tab **Diagnosis** with **fixed echo** and correct the settings again, if necessary.


Figure 73

4. Carry out the release test (see Chapter Release).

USi safety immediately starts to work with the expanded protection field range.

### Normal or expanded?

To implement continuous sound-absorbing curtains with multiple sensors next to each other, the default protection field range setting is **normal** (max. 200 cm). At 200 cm the expansion of the sonic lobes is wide enough for a safe evaluation. Beyond 200 cm the sonic lobes taper off drastically, so that gaps in the detection can occur.

On the other hand, the protection field range can be set to **expanded (reference axis only)** for single sensors, if the prerequisite (see above) is fulfilled.

## 9.4. Dividing an area

USi safety knows two operating modes: Operating mode 1 range and operating mode 2 ranges. If the switching points are identical (SP1 = SP2), USi safety works in operating mode 1 range – protection field only.

For the operating mode 2 ranges – protection field and warning field – the switching points for protection and warning field must differ. The switching point for the warning field must be larger than that for the protection field (SP2 > SP1).

The warning field influences only the outputs OUT. The outputs OSSD are influenced exclusively by the protection field.

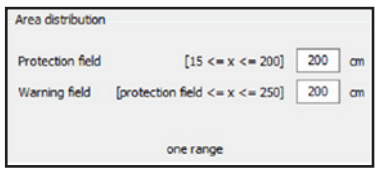



Figure 74

In the group field **Area division**, you define the switching points for protection field and warning field **in centimeters**.

- Possible values for switching point SP1 (protection field) are 15 to 200 cm.
- Possible values for switching point SP2 (warning field) are up to 250 cm.
- The switching points SP1 = **200 cm** and SP2 = **200 cm** are preset as standard for each sensor.

**How to change the area division:**


Figure 75

1. Enter the new value for SP1 in the field **Protection field**.
   - The entry must be a natural number
   - for sensor 1 in group field **Transducer 1**
   - for sensor 2 in group field **Transducer 2**

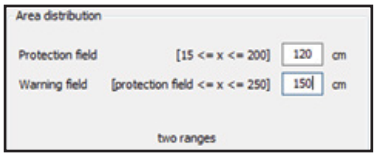



Figure 76

2. Enter the new value for SP2 in the field **Warning field**.
   - The entry must be a natural number
   - for sensor 1 in group field **Transducer 1**
   - for sensor 2 in group field **Transducer 2**


Figure 77

3. Click on **Write parameters**.

## NOTE

**Tip:** Before you release the new settings, you can check the effects in the tab Diagnosis with fixed echo and correct the settings again, if necessary.


Figure 78

4. Carry out the release test (see Chapter Release).

USi safety immediately starts to work with the newly set area division.

# 9.5. Defining Signal Outputs OUT

Every sensor (ultrasonic transducer) is assigned one signal output OUT each. This is actuated by both, from the respective protection and warning field. If an object is outside the protection field but within the warning field, then the object is detected only in the warning field. The signal output OUT changes its state; however, the safe outputs OSSD do not.

- Sensor 1: OUT1
- Sensor 2: OUT2

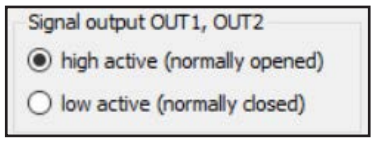



Figure 79

The signal outputs are always set jointly: as NO contact or NC contact. They are outputs of the type PNP.

The signal outputs OUT are set in the tab **Standard**.
The signal outputs OUT are preset as **NO contacts**.

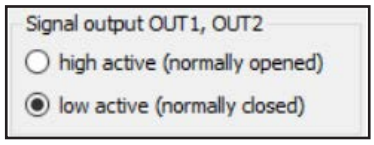



Figure 80

**How to set the signal outputs OUT:**

1. Select the option **High active (NO contact)** or **Low active (NC contact)** in the group field **Signal outputs OUT**.


Figure 81

2. Click on **Write parameters**.

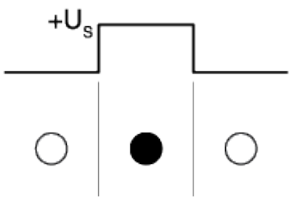
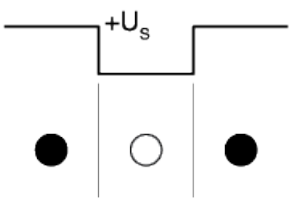

Figure 82

3. Carry out the release test (see Chapter Release).

USi safety immediately starts to work with the new setting for the signal outputs OUT.

4. Check the signal outputs OUT.

- **High active (NO contact)**: LED “OUT” lights up as soon as an object is detected in the protection or warning field.
- **Low active (NC contact)**: LED “OUT” lights up as long as protection and warning field are empty.

| | High active (NO contact) | Low active (NC contact) |
|---|---|---|
| **PNP** |   |   |
| | LED off: ○ LED on: ● | |

# 9.6. Cancelling the Power-On Start Interlock

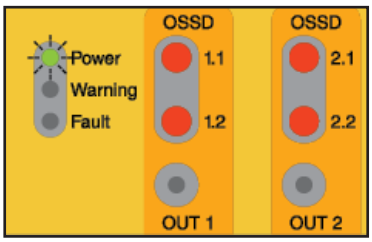


Figure 83

Each time the supply voltage is applied anew, USi safety starts up with the Power-on start interlock, after which USi-safety is locked until the detection capability has been successfully tested. All LEDs “OSSD” are lit red. The LED “Power” flashes.

This state changes only if the USi safety detects a test object between the half and full preset protection field distance. Once USi-safety has accepted the test object it must be removed from the protection field. Afterwards, the OSSDs are released. The LEDs “OSSD” are lit green. The LED “Power” is lit permanently. USi safety works with the parameters released last.

USi safety thus actively supports the demand for a regular functional test. This short test – called protection field test – does not replace the test of the detection field as it is carried out during the release test. If you want to check the complete detection field after each renewed application of the supply voltage, you can – as an alternative to the protection field test – carry out the release test in the tab **Release**.

If you manage the regular functional test in another manner, then you can cancel the power-on start interlock. USi safety then immediately starts working with the parameters released last after application of the supply voltage.

**With protection field test** is preset as standard.

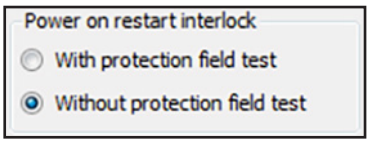


Figure 84

**How to cancel the power-on start interlock:**

1. Click on **Without protection field test** in the group field **Power-on start interlock**.

Figure 85

2. Click on **Write parameters**.

Figure 86

3. Carry out the release test (see Chapter Release)..

USi safety then immediately starts working without power-on start interlock. After renewed application of supply voltage, USi safety immediately starts the monitoring of the detection field.

# 9.7. Specifying the Restart Delay

USi safety has no input for manual reset and no input for cancelling a restart lockout. Instead, USi safety features a time-delay element – the restart delay.

With the restart delay, you can have the safe outputs OSSD stay in the safe state for a short time as soon as the previously detected object was detected as “has left the detection field”.

The delay can be specified for the range from 0 to 8.25 s. The restart delay is specified as the number of measurement cycles passed. In the factory settings, a measurement cycle is equivalent to approximately 33 ms, one second is thus equivalent to 30 measurement cycles.

As standard, 0 measurement cycles are preset.

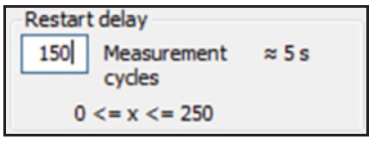


Figure 87

**How to set the restart delay:**

1. Enter the required value in the field **Restart delay**.

Figure 88

2. Click on **Write parameters**.

Figure 89

3. Carry out the release test (see Chapter Release).

USi safety immediately starts to work with the newly specified restart delay.

4. Check the LEDs „OSSD“.

- Is the delay time too short? Then increase the value.
- Is the delay time too long? Then reduce the value.

# 9.8. Saving Settings

Is USi safety working reliably with its new settings?
Then it is high time to save these settings in order to be able to fall back on them again later on..

**How to save settings:**

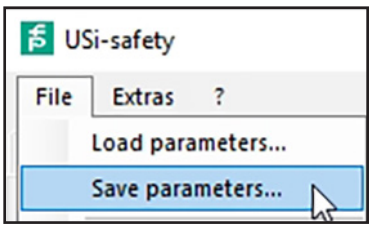


Figure 90

1. Click on **Save parameters**... in the **File** menu.

2. Select the storage location (folder).

3. Enter an unmistakable name in the field **File name** (e.g. machine type, safety hazard, position of the protective device and the like).

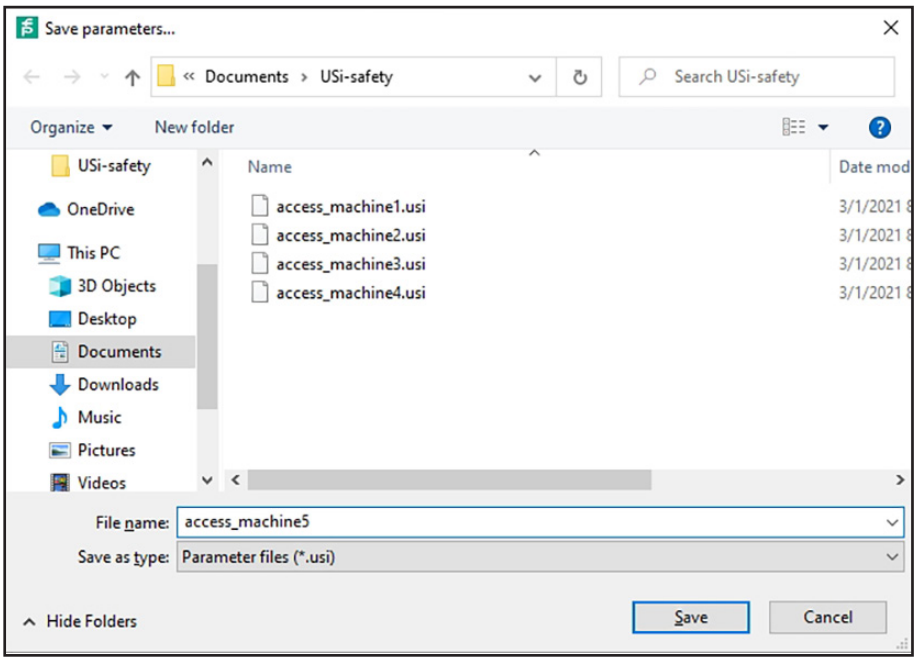



Figure 91

4. Click on **Save**.

The settings are now saved as filename.usi.

# 9.9. Loading Settings

Additional optimisation has failed. Do you want to restore the original settings?
Or do you have a small series of machine for which hazard protection is to be uniform and defined?
Then load the settings that you have previously saved into the parameterization software and transmit them to USi safety.

**How to load settings:**

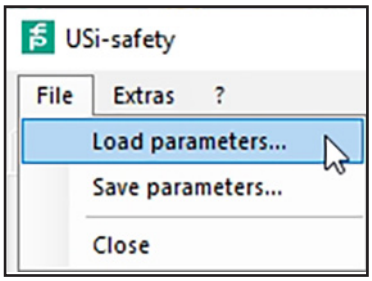



Figure 92

1. Click on **Load parameters** in the **File** menu.
2. Select the storage location (folder).
3. Select the file with the required settings.

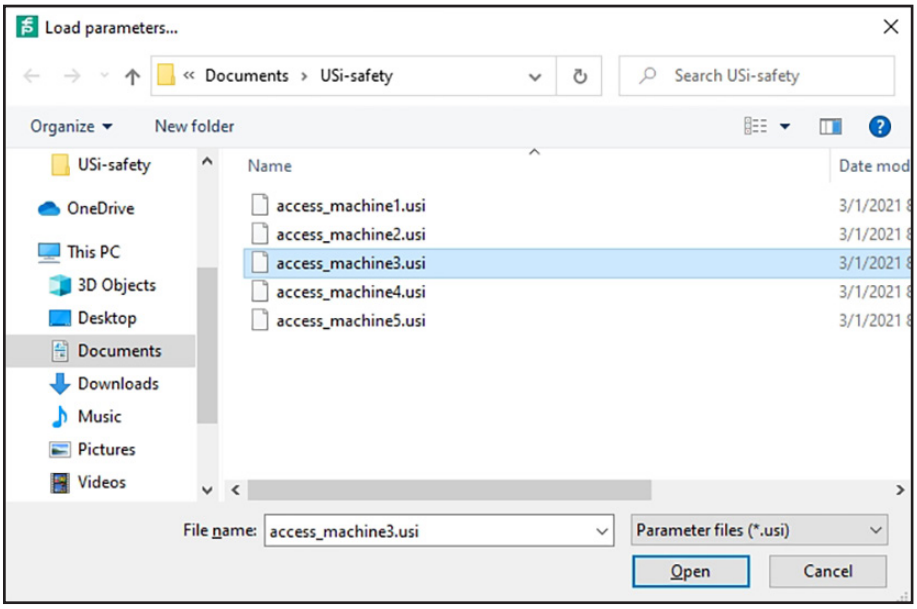



Figure 93

4. Click on **Open**.
The settings are now loaded into the parameterization software..
5. Click on **Write parameters.**
The settings are now transmitted to USi safety.

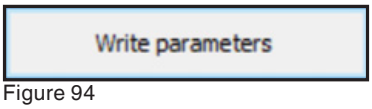



Figure 94

## 9.10. Changing the Password

As a protective device, USi safety is always subjected to the danger of manipulation.The most effective type of manipulation is the access of unauthorized persons to parameters via the level 2 password. To avoid this, the level 2 password should be changed **regularly** (tip: monthly).

During the first commissioning, you will be asked to assign new passwords for level 1 as well as level 2. You will later change either the password for level 1 or the password for level 2 – depending on the level you are currently in.

As standard, the password for level 1 is preset to be „**Pepperl-Fuchs1**“and „**Pepperl-Fuchs2**“ for level 2.

### NOTE

**Password for the Evaluation Unit**

The entered password does not give you access to the parameterization software but to the connected evaluation unit. That means, the assigned passwords apply exclusively to the USi safety currently connected to the USB port: Other device, other password!

- Always remember the passwords in connection with the serial number (Serial No.) on the rating plate of the evaluation unit.

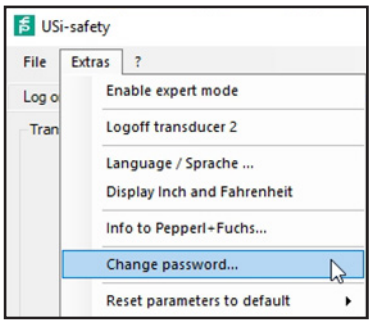



Figure 95

**How to change the password for level 2:**

1. Log in at level 2 in the tab **Log in/out**.
2. Click on **Change password** in the **Extras** menu.
3. Enter the previous password for level 2 in the first field.

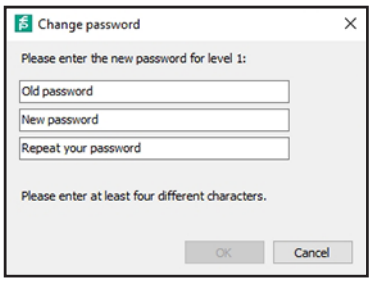



Figure 96

4. Enter the new password for level 2 in the second field.
   Condition: At least four different characters.
5. Repeat the entry in the third field.
6. Acknowledge your entry with a click on **OK**.

After that, you can log into level 2 only with the new password.

Access to USi safety via level 1 is less critical because read access only is assigned with this access. Changing parameters in level 1 is not possible..

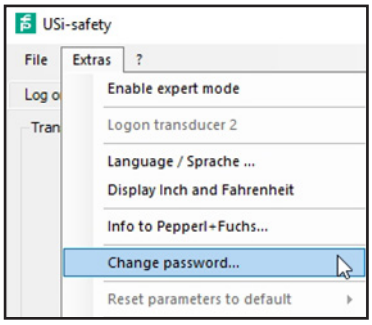



Figure 97

**How to change the password for level 1:**

1. Log in at level 1 in the tab **Log in/out**.
2. Click on **Change password** in the **Extras** menu.
3. Enter the previous password for level 1 in the first field.

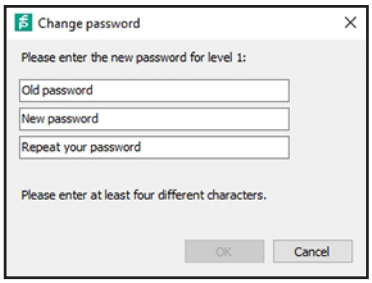



Figure 98

4. Enter the new password for level 1 in the second field.
   Condition: At least four different characters.
5. Repeat the entry in the third field.
6. Acknowledge your entry with a click on **OK**.

After that, you can log into level 1 only with the new password.

# 9.11. Reset Parameters

Did you take optimisation too far? Changed too many parameters? Lost track of the parameters which were changed last? – Sometimes, only a restart can help. USi safety supports this with the function **Reset parameters to Standard**: All parameters are reset to factory settings and the function **Write parameters** is executed. USi safety now waits only for the release.

The function Reset parameters to standard can be found in the Extras menu.

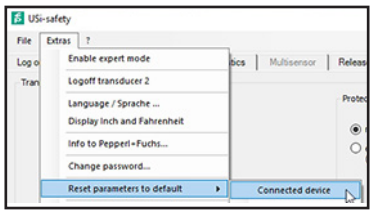



Figure 99

**How to reset the parameters:**

1. Click on **Reset parameters to standard** in the **Extras** menu.
2. Click on **connected device** in the submenu.

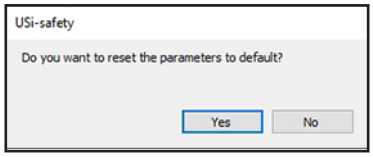



Figure 100

3. Acknowledge the confirmation prompt with **Yes**.

The GUI now replaces all parameters with the factory settings and automatically starts the function Write parameters.

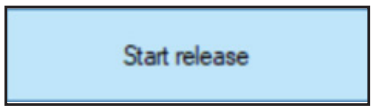



Figure 101

4. Carry out the release test (see Chapter Release).

USi safety immediately starts working with the factory settings again.

5. Restart your attempt to adjust USi safety to your application.

# 9.12. Carrying out a RESET

In rare cases, it can happen that USi safety does not exit a once entered error mode on its own. In this case, only a restart helps; during operation also called a reset. Whether the restart is initiated via hardware (disconnect supply voltage) or via software (click RESET) is not important here. In both cases, the safe outputs OSSD are de-energized, the evaluation unit starts again.

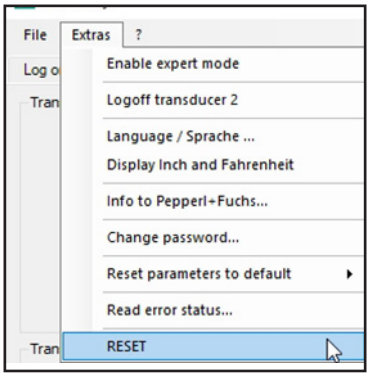



Figure 102

The function **RESET** can be found in the **Extras** menu.

**How to carry out a reset:**

1. Click on **RESET** in the **Extras** menu.

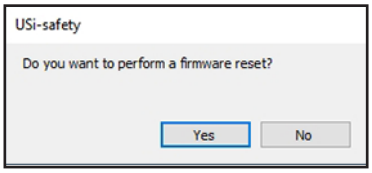



Figure 103

2. Acknowledge the confirmation prompt with Yes.
3. Carry out the release test (see Chapter Release).

USi safety now starts working with the parameter released last again.

If USi safety unexpectedly enters fault mode again:

4. Read out the fault status (see Read fault status).

## 9.13. Read Fault Status

In the case of faults for which the cause is not obvious, the function **Read fault status** may be helpful. After opening the window, the fault code, a description of the fault and a possible remedy are displayed. In addition, two routines for troubleshooting are offered: Switch to diagnosis and Delivery condition.

**Switch to diagnosis** causes USi safety to exit its fault state (no diagnosis possible) and the GUI switches to the Diagnosis tab. To make the switch, the functions Write parameters, RESET and View in the Diagnosis tab are executed in sequence. Now diagnosis is again possible.

**Delivery condition** causes all parameters in the evaluation unit to be overwritten with the factory settings. Afterwards, the evaluation unit is again in delivery condition.

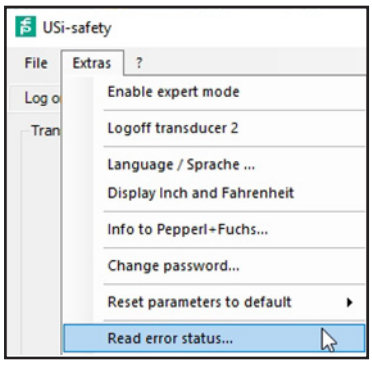



Figure 104

**How to read out the fault status:**

1. In the **Extras** menu click **Read fault status**.

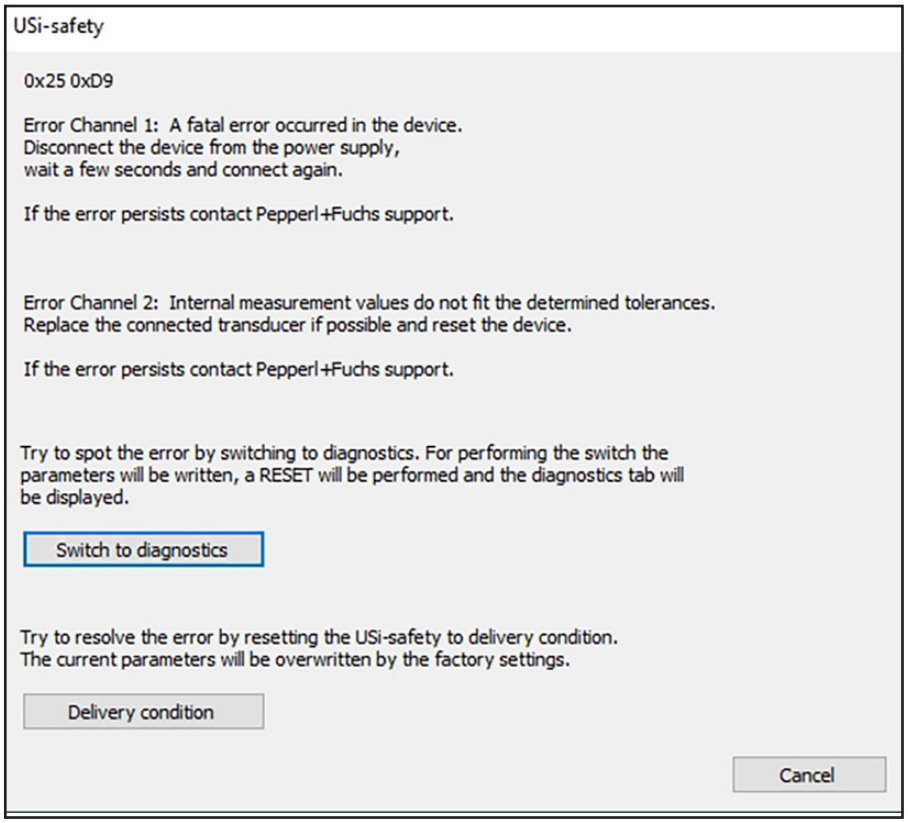



Figure 105

2. Read the fault descriptions.
3. Follow the instructions for troubleshooting.

# 9.14. Send Info to Pepperl+Fuchs

In case of persistent problems, we recommend contacting Pepperl+Fuchs-Support. In order to provide assistance for a specific problem, Pepperl+Fuchs-Support requires extensive information. For this purpose the parameterization software offers the function **Info to Pepperl+Fuchs**. This function automatically generates an e-mail with five screenshots attached. The screenshots show the tabs **Standard, Expert mode and Diagnosis** as well as the message windows for **Read fault status** and Info. To allow the user to add additional information about the particular application case, the e-mail is not sent automatically.

In order to generate the screenshots, your system's display settings must be configured for a scaling factor of 100 %.

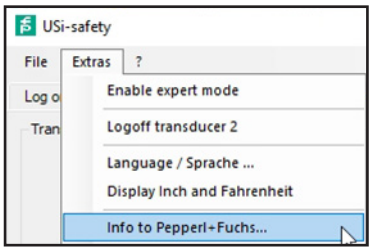



Figure 106

**How to send information to Pepperl+Fuchs:**

1. In the **Extras** menu click **Info to Pepperl+Fuchs**.

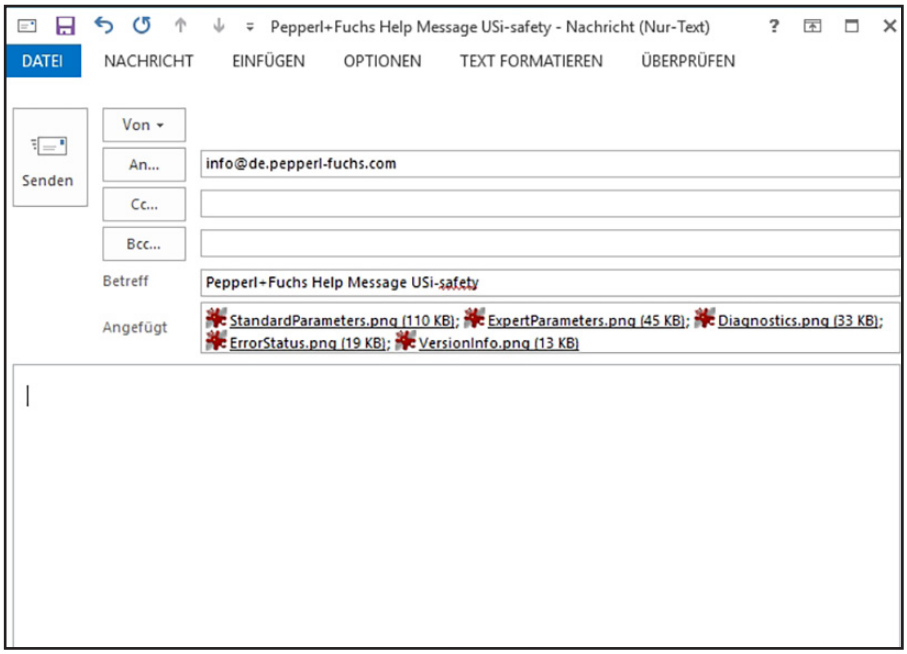



Figure 107

2. Add additional information to the generated e-mail.

3. Click on **Send**.

# 9.15. Logging out USi safety

All settings have been made. USi safety should now continue to work independently. You can then log USi safety out of the GUI (parameterization software).

**How to log out the USi safety:**

1. Click on Log off in the tab Log in/out.


Figure 108

2. Disconnect the USB connection.

USi safety is now logged out.

A restored USB connection becomes effective only after you have logged in the tab Log in/out once and logged back into level 1 or level 2.

3. Carefully screw on the screw plug.

The evaluation unit now has the degree of protection of IP65 again.

## Note

**Functional impairment through missing screw plug!**

- Check the environment of the evaluation unit: Is operation with IP20 possible?
- If not: Deactivate the device.
- Replace a damaged or lost screw plug only with original Pepperl+Fuchs plugs.

**Automatic log-out**

As soon as you have logged into the parameterization software, a countdown of 5 minutes starts. Each activity in the peripheral equipment (e.g. mouse or keyboard) of your computer restarts this countdown from the beginning.

When the countdown is elapsed, i.e. your computer has had no activity in the peripheral equipment for 5 minutes, USi safety will be logged out automatically for safety reasons.

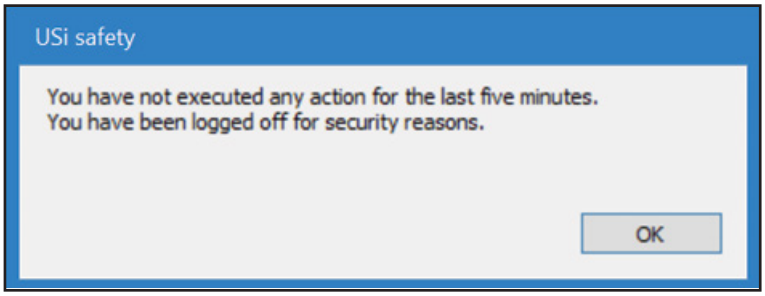



Figure 109

# 9.16. Changing the Default Language

The GUI of the parameterization software starts up in German if German was set as the standard language in the system settings during installation of the software. If German was not set as the standard language during installation, it starts up in English.

The GUI can also be displayed in other languages. It always starts up in the last language that was selected.

Possible languages are **German** and **English**.

**How to change the language:**

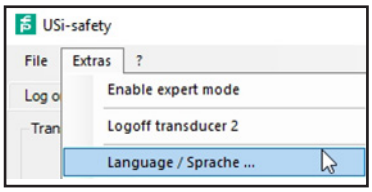



Figure 110

1. Click on **Language/Sprache** in the **Extras** menu.

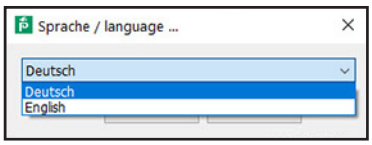



Figure 111

2. Select the required language in the window Sprache/Language.
3. Acknowledge your selection with a click on **OK**.

The GUI display immediately switches to the selected language.

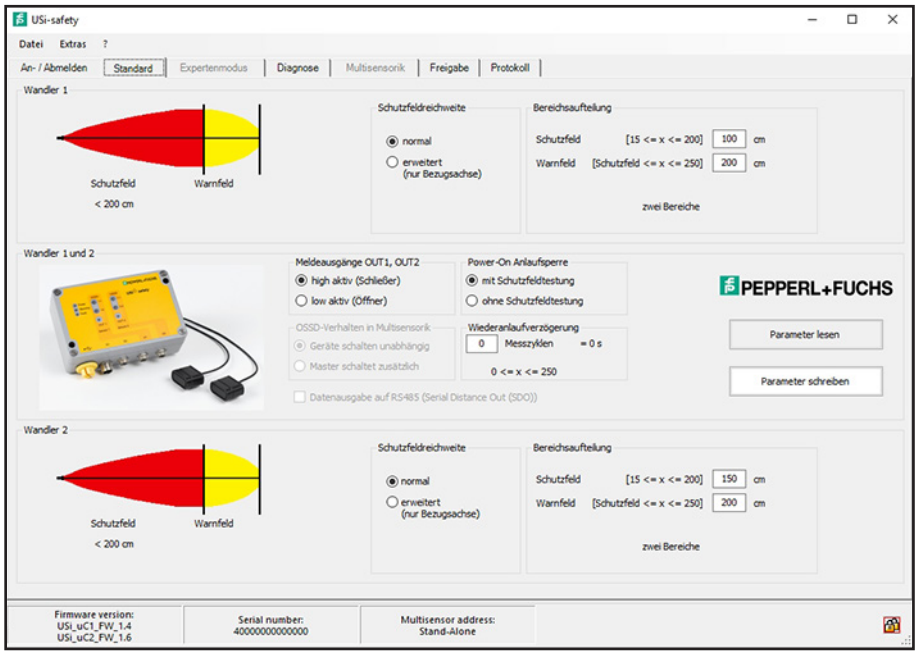



Figure 112

# 9.17. Display Inch and Fahrenheit

USi parameters are always stored as metric values. Inch and Fahrenheit values can be displayed after the metric fields. However, parameters are always entered as metric values.

The function **Display Inch and Fahrenheit** is available only if the parameterization software is set to English. In the **Extras** menu the function is then shown under **Language / Sprache**. The menu item functions like a switch. If it is switched on, a check mark is shown in front of the menu item. If it is switched off, the check mark in front of the menu item disappears.

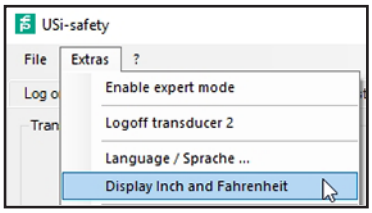



Figure 113

**How to display inches and Fahrenheit:**

- In the **Extras** menu click **Display Inch and Fahrenheit.**

A check mark is set in front of the menu item.
All tabs then additionally display the corresponding values in inches and Fahrenheit.

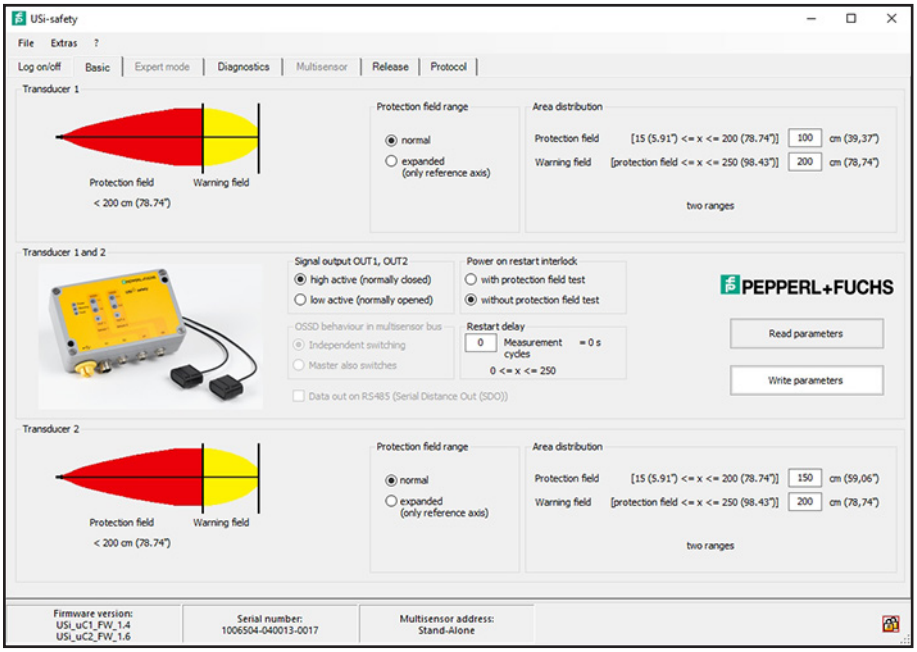



Figure 114

**How to cancel the display:**

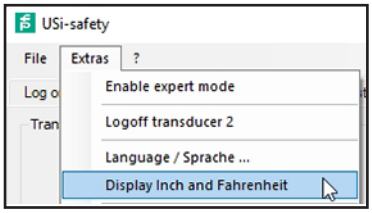



Figure 115

- Click **Display Inch and Fahrenheit** again.

The check mark in front of the menu item is removed.

All tabs then display only metric values.

# 10. Advanced Settings for Experts

With the setting options in the Standard tab, most common applications can surely be detected successfully. However, more complex applications require more complex setting options. These are provided in the parameterization software in the tab Expert mode.

## 10.1. Activate expert mode

The tab Expert mode cannot be called as standard. This is intended to prevent provoking a senseless state of USi safety through uncontrolled parameter changes. In order to be able to use the expert mode, it must first be activated in the Extras menu.

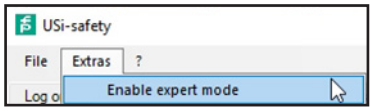



Figure 116

**How to enable the expert mode:**

- Click on **Enable expert mode** in the **Extras** menu.

The expert mode is activated, the **Expert mode** tab appears. The menu item is now called **Disable expert mode**.

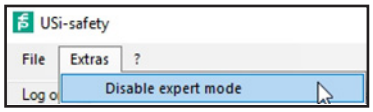



Figure 117

**How to disable the expert mode:**

- In the **Extras** menu click **disable expert mode**.

Expert mode is deactivated, and the **Standard** tab is displayed. The menu item is now called **Enable expert mode**.

# 10.2. Overview of the Expert Mode Tab

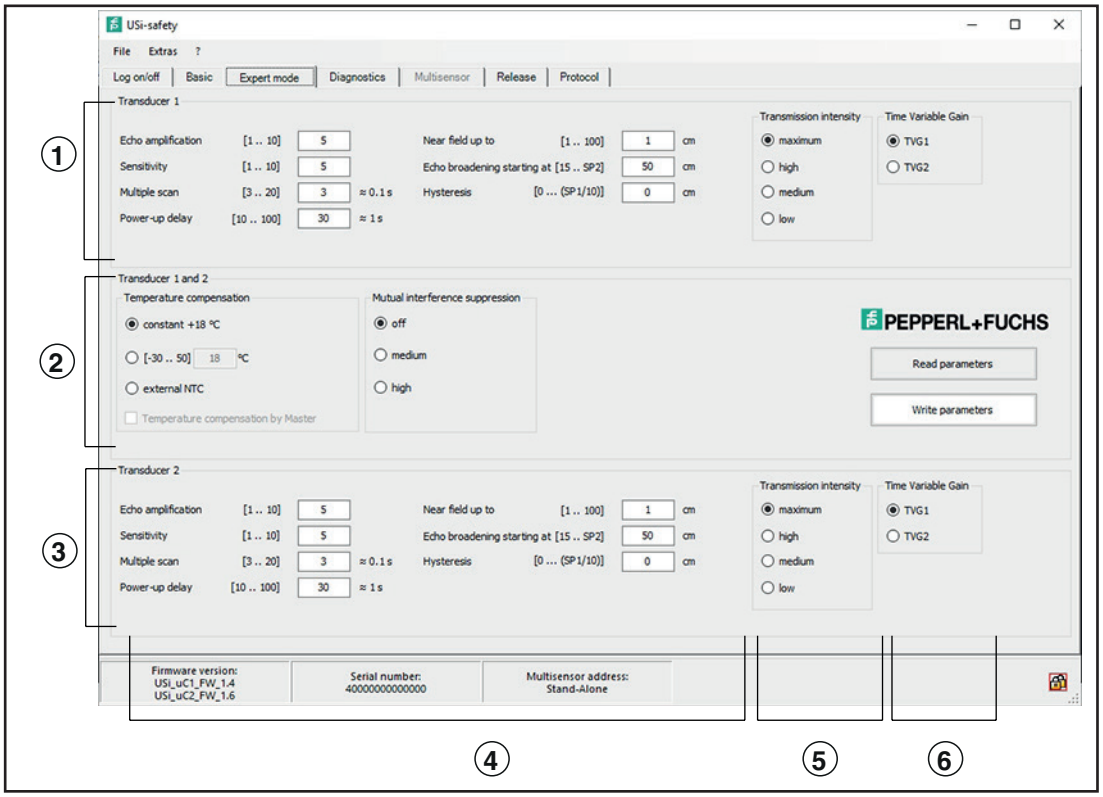



Figure 118

1 Parameters for sensor 1 (transducer 1)
2 Parameters for sensor 1 and 2 (transducers 1 and 2)
3 Parameters for sensor 2 (transducer 2)
4 7 direct parameters (incl. hysteresis)
5 Transmission intensity
6 Time Variable Gain (TVG)

# 10.3. Typical Procedure

**Typical procedure:**

1. Adapting parameters: objects to be detected
2. Check TVG
3. Check transmission intensity

In **step 1** the size of the objects to be detected is analysed.

What is the size of the majority of the objects?

How large is the largest object? How small is the smallest object?

Recommended initial settings:

| Size | Echo gain | Sensitivity |
|---|---|---|
| high | 3 | 4 |
| medium | 5 | 5 |
| low | 7 | 8 |

Table 11

In **step 2** the runtime-dependent gain is checked and determined (see chapter Determining the TVG).

In **step 3** the transmission intensity is checked and selected (see chapter Select transmission intensity).

Step 2 and step 3 have greater effects on the detection result than step 1. After steps 2 and 3 it is therefore recommended to start the 7 direct entries with the factory settings and to approach the detection situation step for step.

And remember: Changed options or parameters are initially changed in the parameterization software only, but not in USi safety. To transmit the changes to USi safety, click the **Write parameters** button.


Figure 119

## 10.4. Echo Amplification

Depending on distance, object form and surface of the object, the echoes can be clearer or weaker. In order to receive usable input signals, it is possible to increase the incoming (analogue) echo with the parameter **Echo amplification**. Sometimes more (up to coefficient 10×), sometimes less (up to coefficient 1×). The parameter value has no unit and indicates the amplification factor.

The parameter **Echo amplification** is the hardware-side counterpart to the software-side parameter **Sensitivity**.

Possible parameter values are **1** to **10**.

As standard, **5** – medium amplification – is preset.

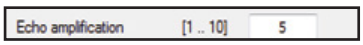



Figure 120

**How to set echo amplification:**

1. Enter a new value in the field **Echo amplification**.
   - for sensor 1 in group field **Transducer 1**
   - for sensor 2 in group field **Transducer 2**

Figure 121

2. Click on **Write parameters**.
3. Check the result in the **Diagnosis** tab, if necessary.

Figure 122

4. Carry out the release test (see Chapter Release).

USi safety immediately starts to work with the new value for Echo amplification.

## CAUTION

**Functional impairment through increased EMC interference!**

EMV interference is also increased with echo amplification. In some circumstances, strong enough for the OSSD outputs to also be stuck in the OFF state. EMC interference resistance was checked and confirmed with the factory settings.

Try to keep echo amplification as low as possible!

## NOTE

**Echo amplification influences TVG!**

TVG is multiplied with the parameter Echo amplification. The yellow characteristic line TVG in the Diagnosis tab is applied with precisely this coefficient. I.e. every coefficient <5 moves the yellow TVG characteristic line down while every coefficient >5 moves it up. Reason: 5 is the standard setting.

# 10.5. Sensitivity

In addition to the echo amplification, echo evaluation can also be influenced with the parameter **Sensitivity.** Unlike the echo amplification, the parameter **Sensitivity** does not affect the incoming (analogue) echo signal, but the digitalized echo signal before the internal detection process. In order to receive usable echo signals, the threshold value for the “Detection of a change in the detection field” is raised or lowered with the parameter **Sensitivity**. Parameter values >5 raise the threshold value, parameter values <5 lower the threshold value. The parameter value has no unit and indicates the sensitivity.

The parameter **Sensitivity** is the software-side counterpart to the hardware-side parameter **Echo amplification**.

Possible parameter values are **1 to 10**.

As standard, **5** – medium sensitivity – is preset.

Figure 123

**How to set the sensitivity:**

1. Enter a new value in the field **Sensitivity**.
   - for sensor 1 in group field **Transducer 1**
   - for sensor 2 in group field **Transducer 2**
2. Click on **Write parameter**s.

Figure 124

3. Check the result in the **Diagnosis** tab, if necessary.

4. Carry out the release test (see Chapter Release).

Figure 125

USi safety immediately starts to work with the new value for sensitivity.

## 10.6. Multiple Scan

With the parameter **Multiple scan**, you determine the number of required identical detections until USi safety verifies an object as “newly added” and opens the OSSD outputs. Low parameter values make USi safety “more sensitive” or “speedy”. High parameter values make USi safety “more tolerant” or “inactive”.

**Multiple scan** is the counterpiece to power-up delay. The multiple scan can therefore also be called power-off delay.

The parameter Multiple scan directly influences the response time: The higher the multiple scan, the longer the response time. Per unit of multiple scan, 33 ms can be anticipated. For simplification purposes, GUI indicates the anticipated response time in seconds behind the entered parameter value.

The parameter value has no unit and indicates the number of detections.

Possible parameter values are **3** to **20**.

As standard, **3** is preset.

**How to set the multiple scan:**

Figure 126

1. Enter the required value in the field Multiple scan.
   - for sensor 1 in group field **Transducer 1**
   - for sensor 2 in group field **Transducer 2**
2. Click on **Write parameters**.

Figure 127

3. Check the result in the **Diagnosis** tab, if necessary.

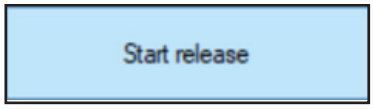



Figure 128

4. Carry out the release test (see Chapter Release).

USi safety immediately starts to work with the new value for multiple scans.

## 10.7. Power-up Delay

With the parameter **Power-up delay**, you determine the number of required identical detections until USi safety verifies an object that was previously verified as existent as “removed again” and closes the OSSD outputs. Low parameter values make USi safety “more sensitive” or “speedy”. High parameter values make USi safety “more tolerant” or “inactive”.

The **power-up delay** is the counterpiece to the multiple scan, the power-off delay.

The parameter Power-up delay directly influences the renewed readiness time: The higher the power-up delay, the longer the renewed readiness time. Per unit of power-up delay, 33 ms can be anticipated. For simplification purposes, GUI indicates the anticipated response time in seconds behind the entered parameter value.

Parameter values below 30 can be useful if a PLC is connected downstream.

The parameter value has no unit and indicates the number of detections.

Possible parameter values are **10** to **100**.

As standard, **30** is preset.

How to set the power-up delay:


Figure 129

1. Enter a new value in the field **Power-up delay**.
   - for sensor 1 in group field **Transducer 1**
   - for sensor 2 in group field **Transducer 2**
2. Click on **Write parameters**.


Figure 130

3. Check the result in the **Diagnosis** tab, if necessary.


Figure 131

4. Carry out the release test (see Chapter Release).

USi safety immediately starts to work with the new value for power-up delay.

# 10.8. Near Field up to

A near field describes that sensor-close area of the detection field that is protected against possible overmodulation of the echo signal by reducing echo amplification. The parameter **Near field up to** thus indicates the distance up to which the reduced echo amplification applies. The parameterised echo amplification is applied to any distance that is higher than the specified parameter value **Near field up to**.

The parameter **Near eld up to** can be used to minimise influencing factors due to the installation of the sensor (transducer). For a stable system behavior, this parameter value is preset to 15. If a higher performance is required, this value can be reduced.

The parameter value is provided in whole-cm steps.

Possible parameter values are **1** to **100**. As standard, **15** is preset.

Figure 132

**How to set the near field:**

1. Enter the required value in the field **Near field up to**.
   - for sensor 1 in group field **Transducer 1**
   - for sensor 2 in group field **Transducer 2**

Figure 133

2. Click on **Write parameter**s.
3. Check the result in the **Diagnosis** tab, if necessary.

Figure 134

4. Carry out the release test (see Chapter Release).

USi safety immediately starts to work with the new value for the near field.

# 10.9. Echo Broadening Starting at

The parameter **Echo broadening starting at** specifies the distance from which the echo envelope curve is broadened in the USi safety-internal signal processing. Any distance that is higher than the specified parameter value **Echo broadening starting at**, is applied with the echo broadening. The broadening factor itself is specified internally and cannot be changed. The echo broadening helps to detect reliably even smaller objects at larger distances.

The parameter value is provided in whole-cm steps.

Possible parameter values are **15** to **250** (= maximum measuring distance).

As standard, **50** is preset.


Figure 135

**How to set the echo broadening:**

1. Enter a new value in the field **Echo broadening starting at**.
   - for sensor 1 in group field **Transducer 1**
   - for sensor 2 in group field **Transducer 2**
2. Click on **Write parameters**.


Figure 136

3. Check the result in the **Diagnosis** tab, if necessary.
4. Carry out the release test (see Chapter Release).


Figure 137

USi safety immediately starts to work with the new value for echo broadening.

## 10.10. Hysteresis

A special feature of USi safety is its high repeating precision. USi safety thus works quasi without hysteresis. That means that the predefined switching points are adhered to exactly. With the approach as well as the moving away of the same object.

In some application cases, however, hysteresis is readily used as a type of tolerance range. With a sensor without hysteresis, such as e.g. USi safety, this is not possible. The function „Hysteresis“ was therefore specially implemented in USi safety. This function is activated by entering the **Hysteresis** parameter value for switch point SP1 only.

Exceptions:

- If the parameter value is 0 (zero), then the function „Hysteresis“ is deactivated.
- If the switching points SP1 and SP2 are identical, then the function „Hysteresis“ is deactivated, also if the parameter value is greater than 0 (zero).

In the protection field (SP1) the **Hysteresis** parameter value causes delayed switching of the OSSD safety outputs to an ON state when removed. There is no plus-minus hysteresis here. The **Hysteresis** parameter value has no effect on the warning field (SP2). Switch point SP2 switches without a hysteresis both during approach and removal. Activation of the function “Hysteresis” results in the following hysteresis image:

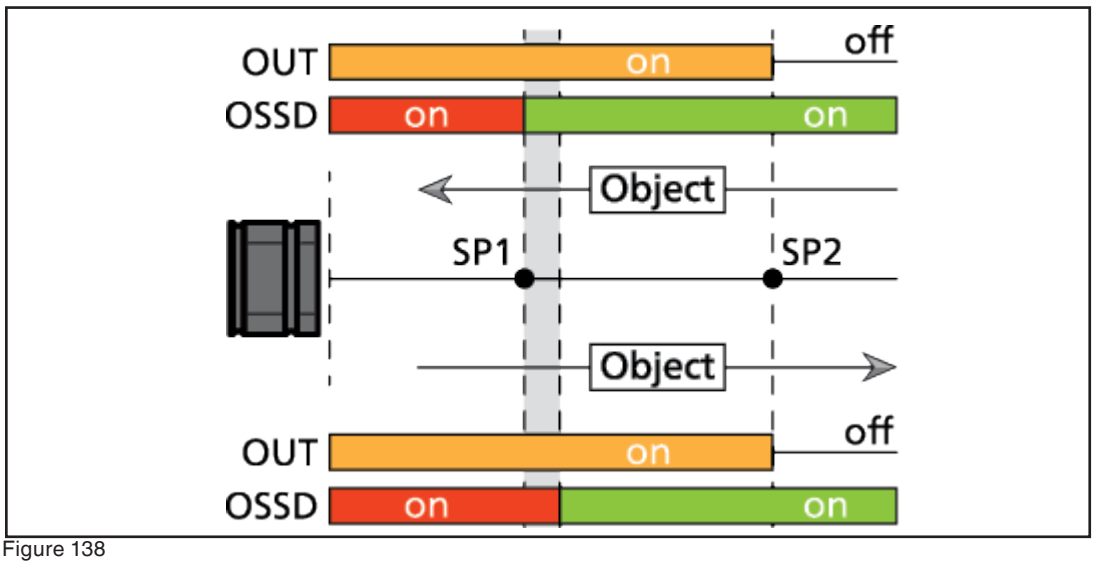



Figure 138

The parameter value is provided in whole-cm steps.

Possible parameter values are

**0** to **SP1/10**, if SP1/10 < (SP2 - SP1), or

**0** to **(SP2 - SP1)**, if (SP2 - SP1) < SP1/10.

As standard, **0** is preset.


Figure 139

**How to set the hysteresis**:

1. Enter a new value in the field **Hysteresis.**
   - for sensor 1 in group field **Transducer 1**
   - for sensor 2 in group field **Transducer 2**


Figure 140

2. Click on **Write parameters**.
3. Check the result in the **Diagnosis** tab, if necessary.

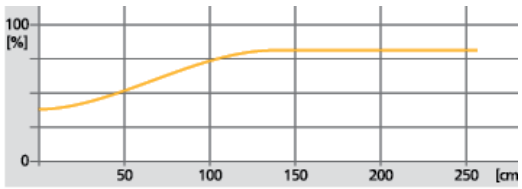
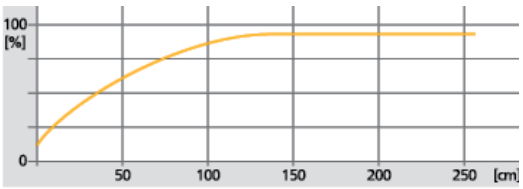

Figure 141

4. Carry out the release test (see Chapter Release).

USi safety immediately starts to work with the new value for hysteresis.

# 10.11. Determining the TVG

TVG stands for Time Variable Gain and means the runtime-dependant gain. TVG compensates the damping factor that is typical for the medium air.

| TVG1 | TVG2 |
|---|---|
| with initial gain | without initial gain |
|  |  |
| high sensitivity, even in the immediate vicinity of the sensor | high sensitivity, except in the vicinity of the sensor, in order to prevent possible overmodulation there |

As standard, **TVG1** is preset.

**How to set TVG:**

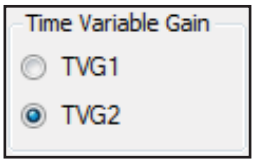



Figure 142

1. Select the option **TVG1** or **TVG2** in the group field **Time Variable Gain**.
   - ffor sensor 1 in group field **Transsducer 1**
   - o for sensor 2 in group field **Transducer 2**


Figure 143

2. Click on **Write parameters**.


Figure 144

3. Carry out the release test (see Chapter Release).

USi safety immediately starts to work with the new specification for TVG.

# 10.12. Select Transmission Intensity

The „volume“ of the transmission burst is determined with the selection in the group field **Transmission intensity**. The louder, the clearer the echo. For the highest performance, transmission intensity is therefore preset to maximum. A must for applications with a softer environment (panels in a textile setting), sometimes counterproductive in harder environments (steel shelf with steel containers) though. The selection of the transmission intensity can be crucial here.

The transmission intensity directly affects the geometry of the sonic lobe: The smaller the transmission intensity, the narrower the sonic lobe.

Steps: maximum – high - medium - low

**Maximum** is preset as standard.

**How to select the transmission intensity:**

1. Click first on **Single echo** or **Fixed echo** in the **Diagnosis** tab.
Does USi safety seem to detect more objects than you do with the naked eye? Is the oscillogram unusually „jittery“?

2. Click on **Continuous echo** again to stop the continuous echo.

3. Switch to the **Expert mode** tab.

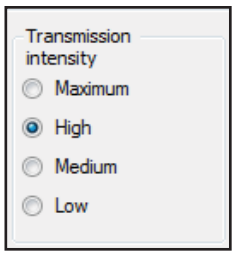


Figure 145

4. Select the option **high** in the group field **Transmission** intensity.
   - for sensor 1 in group field **Transducer 1**
   - for sensor 2 in group field **Transducer 2**

5. Click on **Write parameters**.

Figure 146

6. Switch to the **Diagnosis** tab.

7. Click on **Single echo** or **Fixed echo**.

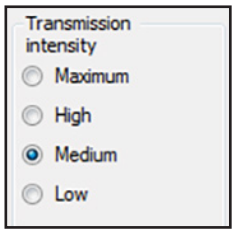


Figure 147

8. If the displayed oscillogram is clearly “less jittery” then you are finished.

9. If the oscillogram is nearly the same, repeat the procedure starting at step 2 and select the next-lower transmission intensity.

10. Carry out the release test (see Chapter Release).

Figure 148

## CAUTION!

**Hazard to hearing through high sound pressure!**

With the settings medium and low, the transmission burst is hardly noticeable. However, USi safety continues to transmit with high sound pressure.

Keep a sufficient distance (> 50 cm) to the sensors.

## NOTE

The selection of the transmission intensity can also be used to reduce the acoustic load: the lower the transmission intensity, the lower the sound pressure level (SPL). The safe function of the protective device should always have priority though.

| Transmission intensity | Sound pressure level (SPL)* |
|---|---|
| maximal | 132 dB |
| high | 130 dB |
| medium | 126 dB |
| low | 122 dB |

* on the reference axis at 1 m distance

Table 12

# 10.13. Setting Temperature Compensation

The speed of sound in air is a constant that depends greatly on the temperature. For correct results, the prevailing air temperature must always be taken into consideration (see Chapter Considering the temperature).

In closed rooms, the air temperature is relatively consistent. It is enough here to set the temperature once. USi safety is preset to a constant temperature value of +18 °C as standard. That complies with the average anticipated temperature in the industrial field.

In areas with highly fluctuating temperatures, the repeating precision is impaired. Automatic temperature compensation (external NTC) is pre-destined for this case: The temperature currently prevailing on the sensor (ultrasonic transducer) is measured continuously and the temperature compensation set appropriately. You are thus always on the safe side even with highly fluctuating temperatures.

Possible parameters are **-30** to **50** [°C]. In the positive area of the temperature scale, the plus sign is omitted.

As standard, **constant +18 °C** is preset.

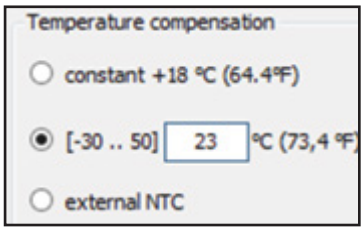


Figure 149

**How to set the temperature compensation:**

1. In the **Temperature compensation** group box enter a new temperature value in degrees Celsius in the °**C** field.

Figure 150

2. Click on **Write parameters**.

Figure 151

3. Carry out the release test (see Chapter Release).

USi safety immediately starts to work with the new specification for temperature compensation.

**How to activate automatic temperature compensation:**

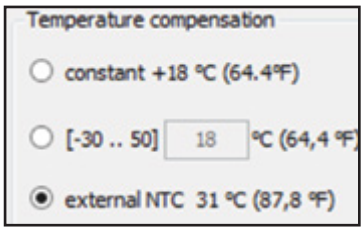


Figure 152

1. Click on **extern NTC** in the group field **Temperature compensation**.

Figure 153

2. Click on **Write parameters**.

Figure 154

3. Carry out the release test (see Chapter Release).

USi safety immediately starts to work with automatic temperature compensation.

## NOTE

If you work with a **reference object and constant** temperature compensation, then the reference object can “wander away” from its position because of a strong temperature drift. USi safety then expects the reference object at another position. The current detection image no longer matches the reference image, USi safety detects this and switches the safe outputs OSSD off.

# 10.14. Setting Reciprocal Interference Suppression

If multiple sources of ultrasonic waves are used in one area, they can influence each other. In the worst case, reciprocal interference occurs between two automated guided vehicles (AGVs) when they meet. Technical measures are available to prevent reciprocal interference. In the case of USi safety, interference suppression is achieved by means of a complex software algorithm that is reflected in the duration of the measurement cycle.

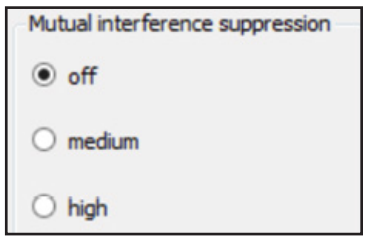



Figure 155

| Reciprocal interference suppression | Measurement cycle, typical | Measurement cycle, maximum |
|---|---|---|
| off | 33 ms | – |
| medium | 44 ms | 58 ms |
| high | 50 ms | 71 ms |

Table 13

The time data next to the fields

- Restart delay (in Standard tab),
- Multiple scan (in Expert mode tab) and
- Power-on delay (in Expert mode tab)

is adjusted automatically.

## Disabling reciprocal interference suppression

There are two cases where reciprocal interference suppression is not necessary:

- If only one USi safety is used in the monitored area.
- If multiple USi safety units are used in the monitored area, but the sonic lobes do not overlap and their echoes cannot cause reciprocal interference.

In these cases, reciprocal interference suppression should be disabled to achieve a shorter measurement cycle.

Possible parameter values are **off, medium** and **high**.

The default value is **off.**

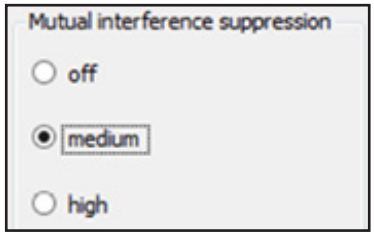



Figure 156

**How to set the interference suppression:**

1. In the group box **Mutual interference suppression** select the option **off**, **medium** or **high**.

- off: no suppression of reciprocal interference
- medium: medium suppression of reciprocal interference
- high: high suppression of reciprocal interference


Figure 157

2. Click on **Write parameters**.

3. Check the result in the **Diagnosis** tab.


Figure 158

4. Carry out the release test (see chapter Release).

USi safety immediately starts using the new value for the reciprocal interference suppression.

# 11. Checking the Detection Field

Different parameters were changed and transferred to USi safety. Now you want to be able to evaluate the new settings **before** you carry out release test repeatedly? Or an already released USi safety suddenly seems to detect unexplainable things and you would like to see what the USi safety “sees”?

Fast and result-oriented support is provided by the parameterization software in the **Diagnosis** tab. Here you can

- view the echo signals in oscillograms
- read out the detected distances in the numerical display
- display the reference image
- show the difference to the reference image
- carry out renewed teach in
- display and hide individual curves

The full scope of the Diagnosis tab is available in both log-in levels – level 1 and level 2.

# 11.1. Overview of the Diagnosis Tab

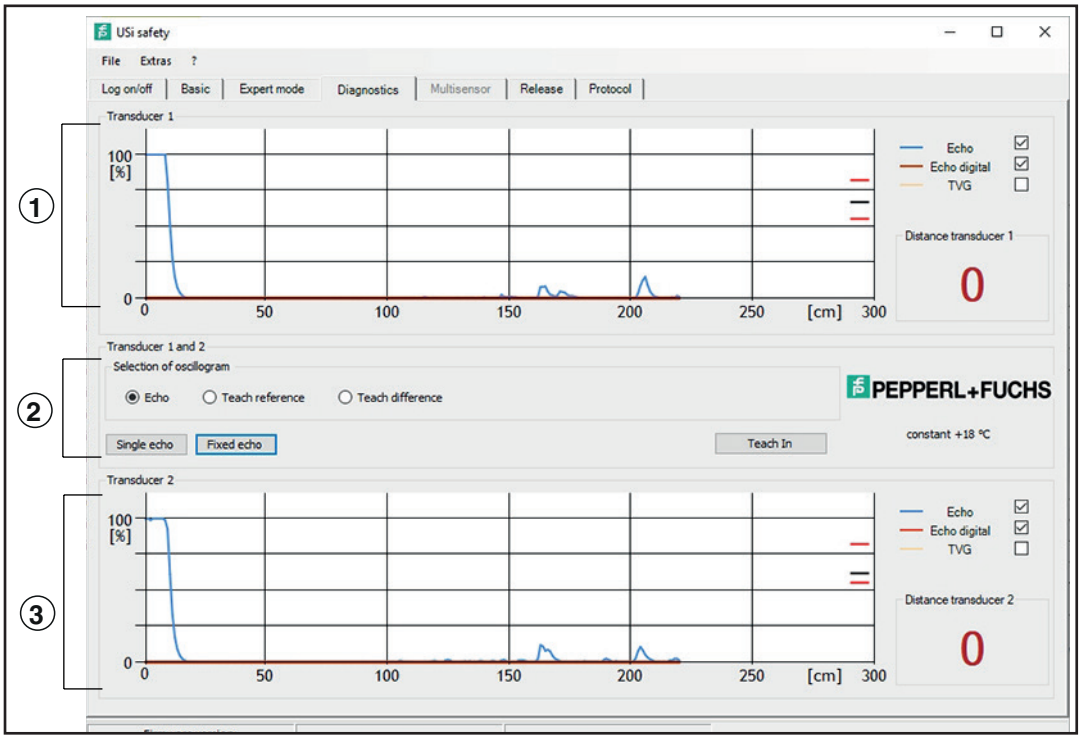



Figure 159

1 Oscillogram, characteristic curve selection and distance display for sensor 1 (transducer 1)

2 Selection of oscillogram for sensor 1 and 2 (transducers 1 and 2):
Echo, teach reference and teach difference.
Buttons for single echo, fixed echo and teach in.

3 Oscillogram, characteristic curve selection and distance display for sensor 2 (transducer 2)

Depending on the selection in the group field **Selection of oscillogram**, up to three characteristic curves are marked with different colours in the oscillograms.

Blue: Echo

Red: Red: Echo digital, teach reference or teach difference

Yellow: TVG (standard: hidden)

The individual characteristic curves can be displayed or hidden with the check box behind the legend.

# 11.2. Teach in: Teaching the Environment in again

Has an environment that is to be viewed “as given” changed since the last teach in?

Was the position of the sensor (ultrasonic transducer) changed?

Minimal changes can already have a great impact. Therefore finish every change, however small, with a renewed teach in.

**How to teach in the environment again:**

1. Make sure that there is nothing in the detection field that normally does not belong there (including you and your limbs).

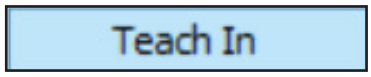



Figure 160

2. Click on **Teach in** in the **Diagnosis** tab.
   Wait until the teach in is completed.


Figure 161

3. Check the result: Generate oscillograms of the type Echo. The teach in was successful if all peaks are without a red border.


Figure 162

4. Carry out the release test (see Chapter Release).

# 11.3. Generating Oscillograms

The parameterization software offers two options to generate oscillograms: **Single echo** and **fixed echo.**

| | Single echo | Fixed echo |
|---|---|---|
| What for? | ■ Quick check after teach in<br>■ Detailed observation “at rest” | ■ „Live“ check of the detection field<br>■ Dynamic observation<br>■ Distance display |
| Start | Button **Single echo** | Button **Fixed echo** |
| Oscillogram type | static (snapshot) | dynamic („Live“ image) |
| Distance display | static | dynamic |
| End | automatic | Button **Fixed echo** |
| The oscillogram shows | the same static image | image displayed last |

Table 14


Figure 163


Figure 164

Whether it is **single echo** or **fixed echo**, both can be executed in parallel to normal operation without influencing the protective function of USi safety.

## Preselection for the Oscillogram

Before you generate an oscillogram, you have the choice between

- Echo
- Teach reference
- Teach difference

With the preselection, you determine what is to be displayed in the oscillogram with the red characteristic line. Yellow characteristic line: Time Variable Gain (TVG).

**Echo** is preset as standard.


Figure 165

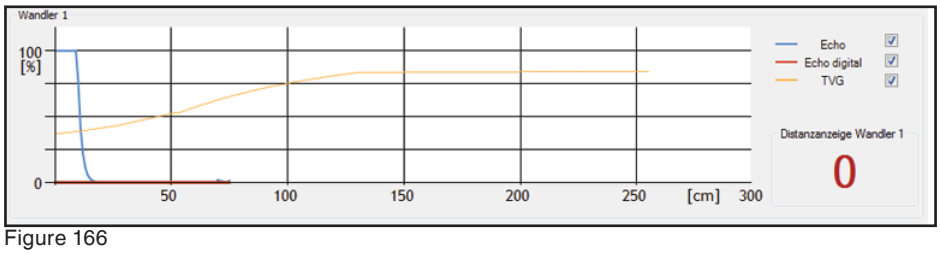



Figure 166

Shows - next to the blue characteristic line (Echo) - the digitalized and evaluated echo (Echo digital) as a red characteristic line.


Figure 167

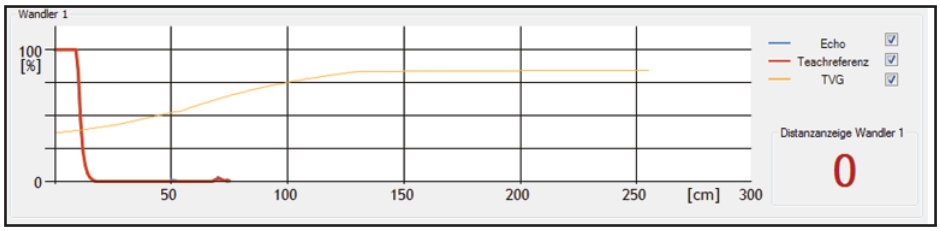



Figure 168

Shows - next the blue characteristic line (Echo) - the reference image recorded through a **teach in** as a red characteristic line.


Figure 169

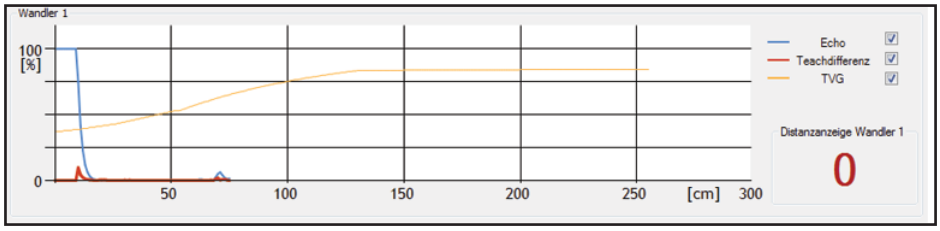



Figure 170

Shows - next the blue characteristic line (Echo) - the difference to the recorded reference image as a red characteristic line.

## 11.4. Interpreting Oscillograms

Whether it is a static single echo or a dynamic fixed echo, the oscillogram delivers easily interpreted diagrams for the invisible detection field.

The **blue** characteristic line shows the analogue incoming echo signals depending on their signal strength (Y axis) and distance (X axis) at which they were reflected.

The **yellow** characteristic line shows the currently set TVG characteristic line depending on its thickness (Y axis) at a specific distance (X axis). It changes its appearance only during the switch from TVG1 to TVG2 and if the parameter **Echo amplification** (in the expert mode) is changed.

The **red** characteristic line shows the evaluated and digitalized echo. If the analogue echo signal exceeds a preset level, USi safety rates this as a detected object and envelopes this peak with a rectangular curve.

The following example is to train you to the extent that you can clearly evaluate

your special application case and unerringly find the optimal setting.

**Example 1:**
**Empty detection field**

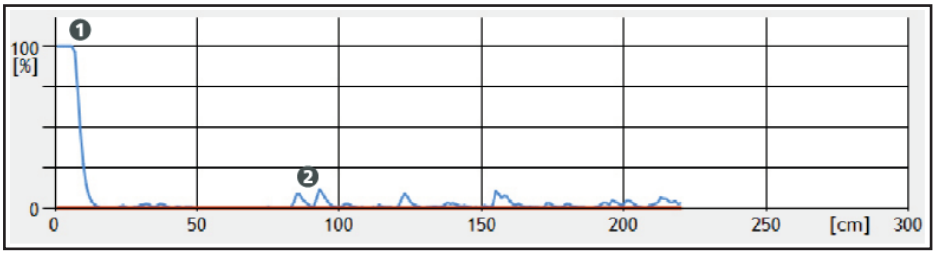



Abbildung 15.

The oscillogram should look like this if the detection field is empty. The plateau ❶ on the left edge shows the normal oscillation of the sensor (ultrasonic transducer). Smaller peaks at ❷ are insignificant reflections that are caused e.g. by uneven surfaces. With the standard setting, such minimal reflections are ignored by USi safety. This shows you that the red characteristic line (Echo digital) does not envelope the peaks.

**Example 2:**
**Object detected**

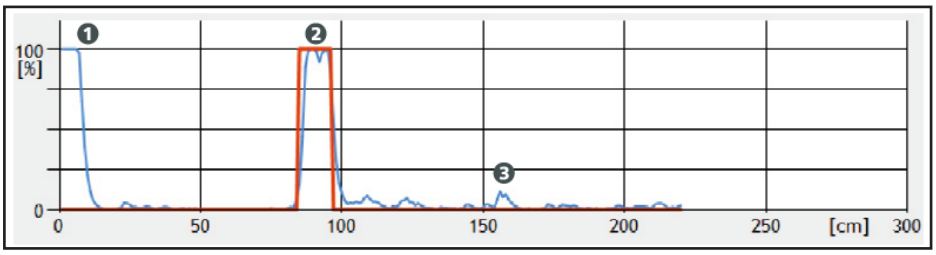



Figure 171

The plateau ❶ on the left edge shows the normal oscillation of the sensor (ultrasonic transducer). The high peak ❷ at approx. 80 cm distance shows a clear echo. The red characteristic line (Echo digital) envelopes the blue characteristic line (echo) at this position. That indicates that USi safety rates the analogue echo at this position as a detected object. The small peak at ❸ is an insignificant reflection.

**Example 3:**
**Object taught in as reference object**

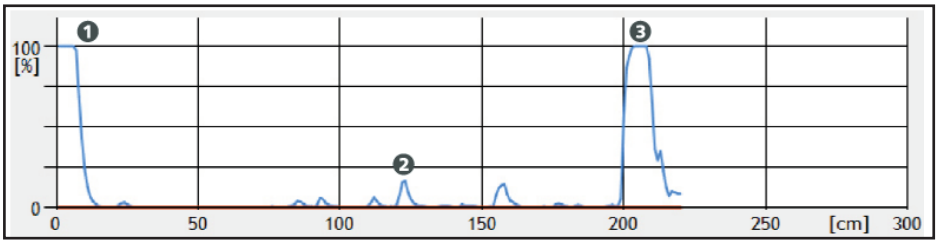



Figure 172

The plateau ❶ on the left edge shows the normal oscillation of the sensor (ultrasonic transducer). The small peak at ❷ is an insignificant reflection. The high peak at ❸ at about 210 cm distance shows a reference object that is accepted as given after the teach in. Unlike with “Object detected”, the peak of the blue characteristic line (Echo) here is not enveloped by the red characteristic line (Echo digital).

**Example 4:**
**Detection field empty, reference object missing**

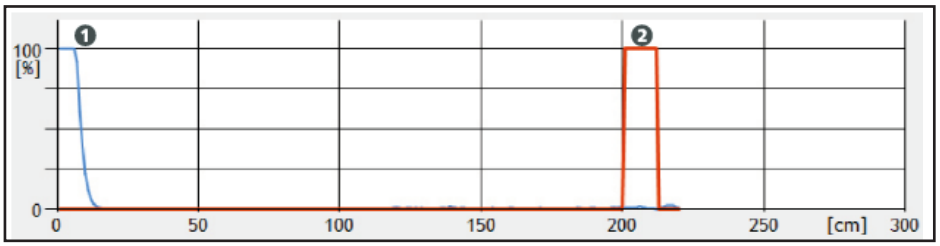



Figure 173

The plateau ❶ on the left edge shows the normal oscillation of the sensor (ultrasonic transducer). The empty red envelope curve at ❷ indicates that the reference object is missing. An empty red envelope curve generally indicates that a taught in object is no longer in the same place or no longer has the same alignment to the sensor as it did at the time of the teach in.

**Example 5:**
**one object detected, reference object missing**

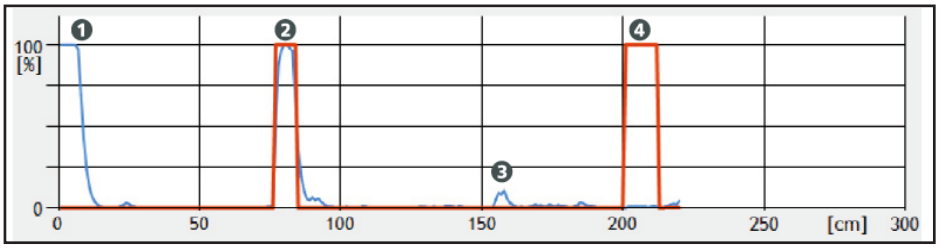



Figure 174

The plateau ❶ on the left edge shows the normal oscillation of the sensor (ultrasonic transducer). The high peak ❷ is enveloped by a red characteristic line (Echo digital). This indicates that USi safety has detected an object. The small peak at ❸ is an insignificant reflection. The empty red envelope curve at ❹ indicates that the reference object is not detected. Reason: The reference object is either covered by the object detected at ❷ or it is no longer in the same place or no longer has the same alignment to the sensor as it did at the time of the teach in.

# 12.Troubleshooting and Remedies

Prerequisite: The evaluation unit is connected to the supply voltage. There is at least one sensor connected. Only taught-in objects are located in the detection field.

**Tip:** The Chapter Relationships lists possible LED displays and their significance.

| Fault display | Possible cause | Elimination |
|---|---|---|
| Green LED „POWER“ is off | No or incorrect supply voltage | • Check the supply voltage: Does it comply with the type plate?<br>• Check the terminal assignment: correctly connected? |
| | If supply voltage is correctly connected: Evaluation unit faulty | Replace the evaluation unit |
| Yellow LED „Warning“ flashes | Sensor (ultrasonic transducer) soiled | Check the active surface of the sensor: Clean and empty? |
| | With clean and empty active surface: Sensor (ultrasonic transducer) defective | Replace the sensor |
| Yellow LED “Warning” is lit permanently | New parameter were written but no release test carried out | • Connect the evaluation unit with the parameterization software<br>• Perform a release test |
| Occasional switching of the outputs for no apparent reasons | EMC noise source in the immediate vicinity of the sensor or its cable | • Check the cabling between sensor and evaluation unit: Too close to noise sources?<br>• Shield evaluation unit, sensors and their cables against electromagnetic noise sources |
| | Temperature striations within the detection field | Check the detection field: Are there heat or cold sources? |
| | Occasional compressed air blasts | Check the environment: Compressed air noises in the direction of the detection field? |
| | Transverse reflections or reflections due to overreach | Activate reciprocal interference suppression |
| The oscillogram (Diagnosis tab) shows clearly increased ambient noise or<br>yellow LED “Warning” flickers | Shielding on the device cable is connected | Cut off the stripped shielding of the device cable |
| | No PELV circuit used | Wire the voltage supply into a PELV circuit |

| Fault display | Possible cause | Elimination |
|---|---|---|
| Red LED „Fault“ is on | Round connectors have loose contacts | Tighten the nuts of the round connectors |
| | USi safety is in error mode | • Connect the evaluation unit with the parameterization software<br>• Wait for the reaction after the log in: Useful note?<br>• Disconnect the supply voltage for at least 5 s |
| | USi safety still stays in error mode: internal error | • In the Extras menu click Read fault status to receive information about the fault<br>• In the Extras menu click Info to Pepperl+Fuchs to receive direct help<br>• Replace the evaluation unit |
| The oscillogram shows extended oscillation | Sensor is severely jammed | Check the installation position of the sensor: (Clamping) forces may act on the O-rings only |
| | Sensor is slightly jammed | If possible, increase the parameter value in Near field up to |
| Yellow LED „OUT X“ (normally open contact) is on, although there is no variable object in the detection field | Taught-in detection field has changed | Perform a release test |
| | The reference object was removed | • Position the reference object again<br>• Perform a release test |
| Yellow LED „OUT X“ (normally open contact) is off, although objects in the detection field are apparently changing | The objects are actually outside of the detection field | • Observe the maximum measurement distance of 250 cm<br>• Observe the exit angle of the sonic lobe: ±17° and ±5° |
| | Switch points are incorrectly defined | Reset the switching points |
| No signal at output | Output connections have been switched | Check the lead colours on the unit cable<br>Wire the outputs correctly |
| The object is not detected | The object is outside of the detection field | Check the limits of the detection field with a test object |
| | Object has sound-absorbing structure | • Check the acoustic quality of the object<br>• Rethink the position of the sensor |
| | Object with sound-dividing shape; sound is deflected | • Check the acoustic quality of the object<br>• Rethink the position of the sensor |
| | Transmission intensity setting is too weak | Increase the transmission intensity |
| | Exchange air for a different medium or vacuum | Check the entire sound path to the object: Is there air available along the entire path as transmission medium? |

| Fault display | Possible cause | Elimination |
|---|---|---|
| Static object is sometimes detected, sometimes not detected | The object is on the boundary of the detection field | • Change the corresponding switch point<br>• Reconfigure the sensor |
| | Object has sound-absorbing structure | • Check the acoustic quality of the object<br>• Rethink the position of the sensor |
| | Object with sound-dividing shape; sound is deflected | • Check the acoustic quality of the object<br>• Rethink the position of the sensor |
| | Parameters are set borderline | • Check the parameters<br>• Check the settings for transmission intensity and TVG |
| Occasional false activation | Sources of acoustic interference (e.g. escaping compressed air) | • Remove the source of interference<br>• Shield the sensors from the sources of acoustic interference<br>• Reconfigure the sensor |
| | Acoustic transverse reflections from other ultrasonic sources | • Activate reciprocal interference suppression<br>• Readjust the sensor |
| | Reflections due to overreach of the sensor | • Activate reciprocal interference suppression<br>• Readjust the sensor |
| | Reciprocal interference from sensors | • Activate reciprocal interference suppression<br>• Reconfigure the sensor |
| | Electromagnetic interference | • Check the cable laying between the sensor and the evaluation unit: Too close to the source of interference?<br>• Shield evaluation unit, sensors and their cables against electromagnetic noise sources |
| | Too extreme temperature fluctuations within too short a time period | Give the USi safety sufficient time (> 10 min) to acclimatise. |

Table 16

The fault can still not be removed?

- Contact your local Pepperl+Fuchs office.
- Use the Info to Pepperl+Fuchs function in the Extras menu.
- In case of queries, have the data on the type plate at hand.

# 13.Replacement Parts

Some parts of the system are available as replacement parts. Contact Pepperl+-Fuchs if there is a need.

## CAUTION

**Overall safety endangered!**

Malfunctions can occur if third-party replacement parts are installed instead of original parts from Pepperl+Fuchs.

Only use original parts from Pepperl+Fuchs.

# 14.Accessories

## CAUTION

**Overall safety endangered!**

Malfunctions can occur if third-party accessories are installed instead of original parts from Pepperl+Fuchs.

Only use original parts from Pepperl+Fuchs

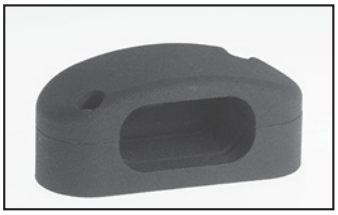
| Product Photo | Description |
|---|---|
|  Figure 175 | Enclosure set for horizontal mounting of the sensor, including cable bushing |
|  Figure 176 | Enclosure set for vertical mounting of the sensor, including cable bushing |
|  Figure 177 | Unit cable M12x8 |
|  Figure 178 | Temperature sensor with mounting tab, for evaluation unit, cut-to-size with 1.5 m cable and 6-pin M8 plug |

Table 17

# 15.Maintenance and Cleaning

## 15.1. Maintenance

USi safety is maintenance-free for the most part.

- Check the protective device daily for manipulation if you let USi safety work without a reference object.
- Repeat the release monthly.
  Check also downstream warning devices.
- Replace the O-rings at the latest after 5 years.
- Replace the sensors at the latest after 10 years.

## 15.2. Cleaning

**WARNING!**

**Danger of injury due to electrocution!**

- Disconnect all devices and live parts in the immediate environment of the power supply and protect them against being switched on again (see relevant operating instructions).
- Check that all devices and parts are disconnected from the power supply.

Clean the outside of the enclosure with a dry cloth.

## 15.3. Decommissioning

**WARNING!**

**Danger of injury due to electrocution!**

If the wiring is detached while the evaluation unit is still connected to the supply voltage, current can flow to 1 A.

It is imperative to follow the sequence of instructions.

1. Remove the supply voltage.
2. Disconnect the wiring.

# 16. Disposal

The devices produced by Pepperl+Fuchs  are professional electronic tools exclusively intended for commercial use (so-called B2B devices). Unlike devices mainly used in private households (B2C), they may not be disposed of at the collection centres of public sector disposal organisations (e.g. municipal recycling depots). At the end of their useful life, the devices may be returned to us for disposal.

# 17. Conformity

This product has been developed and manufactured in compliance with applicable European standards and directives.

The design type of the product complies with the basic requirements of the following directives:

- 2006/42/EG (Safety of machinery)
- 2011/65/EU (RoHS)
- 2014/30/EU (EMC)

**Note**

The declaration of conformity is available via Internet from the product page of the product: https://www.pepperl-fuchs.com

## 17.1. EC Type Examination

The product was tested by an independent institute.

An EC type examination certificate confirms conformity.

**Note**

The EC type examination certificate is available via Internet from the product page of the product:
https://www.pepperl-fuchs.com

# 18.Factory settings

The function **Reset parameters to standard** resets USi safety to the delivery condition. The factory settings saved in USi safety hereby overwrite all current parameters.

The standard values apply respectively for sensor 1 and sensor 2.

| Display Tab | Parameter | Standard Value |
|---|---|---|
| Standard | Protection field range | normal |
| | Protection field | 200 [cm] |
| | Warning field | 200 [cm] |
| | Operating mode | 1 range |
| | Signal output OUT | high active (Normally open contact) |
| | Protection field testing | with |
| | Restart delay | 0 [Measurement cycles ] |
| Expert mode | Echo gain | 5 [–] |
| | Sensitivity | 5 [–] |
| | Multiple scan | 3 [–] |
| | Power-on delay | 30 [–] |
| | Near field up to | 15 [cm] |
| | Echo distribution from | 50 [cm] |
| | Hysteresis | 0 [cm] |
| | Transmitting intensity | maximum |
| | Time Variable Gain | TVG1 |
| | Temperature compensation | constant +18 °C |
| | Reciprocal interference suppression | off |
| Diagnosis | Graph line echo | activated |
| | Graph line echo digital | activated |
| | Graph line teach reference | hidden |
| | Graph line teach difference | hidden |
| | Graph line TVG | deactivated |
| | Select oscillogram | Echo |

Table 18

# 19.Technical data

The “typ.” information refers to USi-safety in the delivery condition. If parameters are changed, these values change. The then possible range is specified in brackets with the “up to” information.

| **USi-safety** | |
|---|---|
| Testing basis | IEC 60204-1, IEC 60947-5-2*,<br>IEC 61326-3-1**, ISO 13849 |
| **Connecting voltage $U_S$** | |
| Nominal voltage<br>Voltage tolerance<br>Rated current<br>External protection<br>Power consumption | PELV: DC 24 V<br>DC 21 to 28 V<br>150 mA<br>2 A inert<br>< 3,6 W |
| **Times** | |
| Reaction time $t_a$<br>Re-start time $t_w$ | typ. 100 ms (99 to 660 ms)<br>typ. 990 ms (330 to 3300 ms) |
| **Safety classifications** | |
| ISO 13849-1:2015<br>$MTTF_d$<br>DCavg<br>CCF<br>interference transmission in compliance with | Category 3 PL d<br>316 a<br>87 %<br>Requirement accomplished<br>IEC/CISPR 11 Group 1, Class A |
| **Detection functions** | |
| Measurement method<br>Sound frequency<br>Sound pressure level (max.)<br>Measurement frequency<br>Measurement distance (max.)<br>Blind zone<br>Opening angle sonic lobe<br>horizontal<br>vertical<br>Resolution<br>Object detection<br>Size (min.)<br>Speed, axial (max.)<br>Repeatability<br>Hysteresis<br>Temperature compensation<br>with<br>without = Temperature drift | Ultrasonic pulse-echo procedure<br>typ. 103 kHz<br>typ. 132 dB SPL at 1 m<br>30 Hz<br>typ. 200 cm (1 to 250 cm)<br>1 cm<br>(see chapter Sonic lobe)<br>±17°<br>±5°<br>1 cm<br><br>typ. Ø 1 cm<br>typ. 2 m/s (up to 2,5 m/s)<br>±0 cm<br>typ. 0 cm (0 up to SP1/10)<br><br>automatic/manual<br>0,17 %/K |

| USi-safety | |
|---|---|
| **Input** | |
| Sensor 1 and 2 | U1 and U2 |
| Connection | M8, 3-pin |
| Line length | 1,5 m or 3,0 m |
| Temperature sensor | X2 |
| Connection | M8, 6-pin |
| Line length | 1,5 m |
| USB | |
| Version | 2.0 |
| Type | USB-Mini-B |
| **Outputs** | |
| Unit cable | X1 |
| Connection | M12, 8-pin, min. 0,25 mm2 |
| Line length (max.) | 30 m |
| Safe outputs OSSD | NC contact, Power FET PNP |
| Safe output OSSD 1.1 | Pin 1 |
| Safe output OSSD 1.2 | Pin 3 |
| Safe output OSSD 2.1 | Pin 4 |
| Safe output OSSD 2.2 | Pin 5 |
| switching current (max.) | 150 mA per output |
| switching voltage (max.) | $U_S$ |
| Signal outputs OUT | NO contact, Power FET PNP |
| Signal output OUT 1 | Pin 6 |
| Signal output OUT 2 | Pin 8 |
| Switching current (max.) | 150 mA per output |
| Switching voltage (max.) | $U_S$ |
| **Mechanical operating conditions** | |
| Material, enclosure | |
| Evaluation unit | Aluminium die casting |
| Sensor | PA 6.6, PBT |
| IEC 60529: Degree of protection | |
| Evaluation unit | IP65 |
| Sensor | IP69 |
| ISO 20653: Degree of protection | |
| Evaluation unit | IP65 |
| Sensor | IP69K |
| max. humidity (23 °C) | 99 % |
| Operating temperature | -30 to +50 °C |
| Storage temperature | -40 to +85 °C |
| Dimensions (W × H × D) | |
| Evaluation unit | 125 × 91 × 41 mm |
| Sensor | 12,6 × 26,6 × 21 mm |
| Weight | |
| Evaluation unit | 450 g |
| Sensor (incl. cable) | 25 g |

Table 19

* The tensile force of the sensor cable (ultrasonic transducer) deviates from the standard. Therefore, do not subject the cable to tensile forces > 20 N and do not use it as a pull-in aid during installation.

** With sensor (ultrasonic transducer) 70131323 or 70131324 the USi safety deviates from evaluation criterion A in the range from 100 kHz to 170 kHz: instead of exhibiting normal operating behaviour, the USi safety switches to fail-safe mode.

# 20. Flow chart

# 20.1. Start

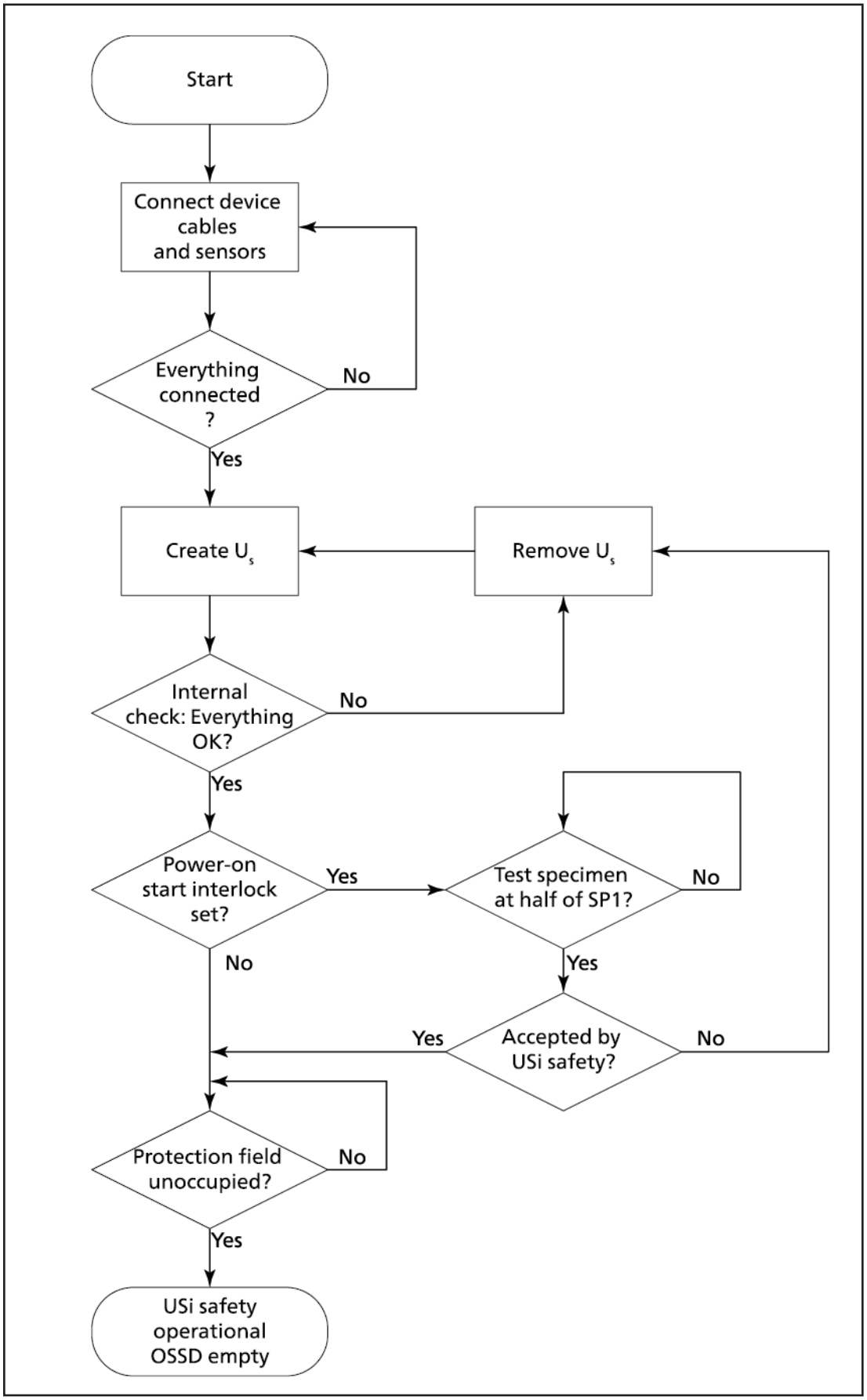



Figure 179

## 20.2. Detection

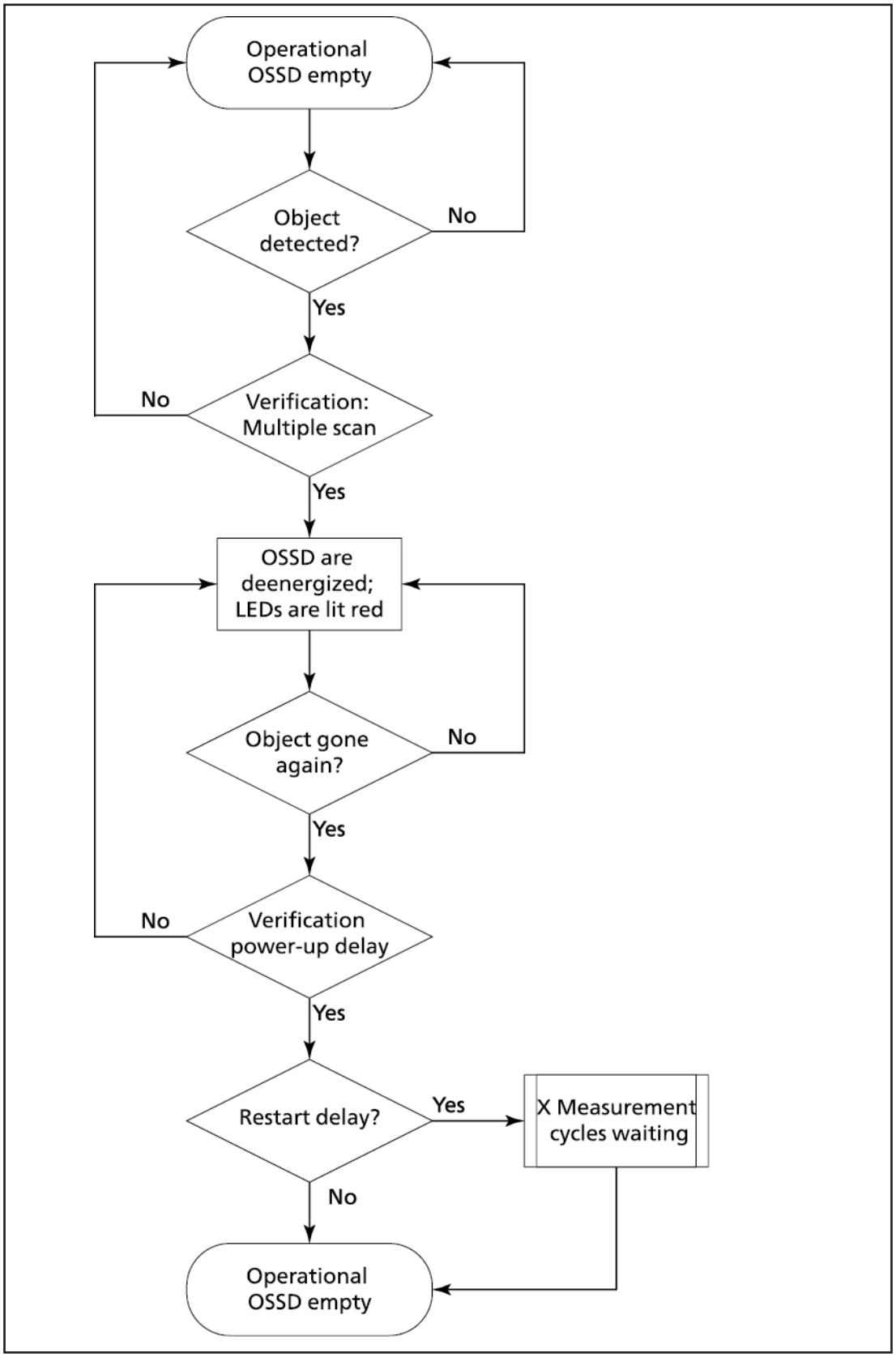



Figure 180

## 20.3. Parameterising

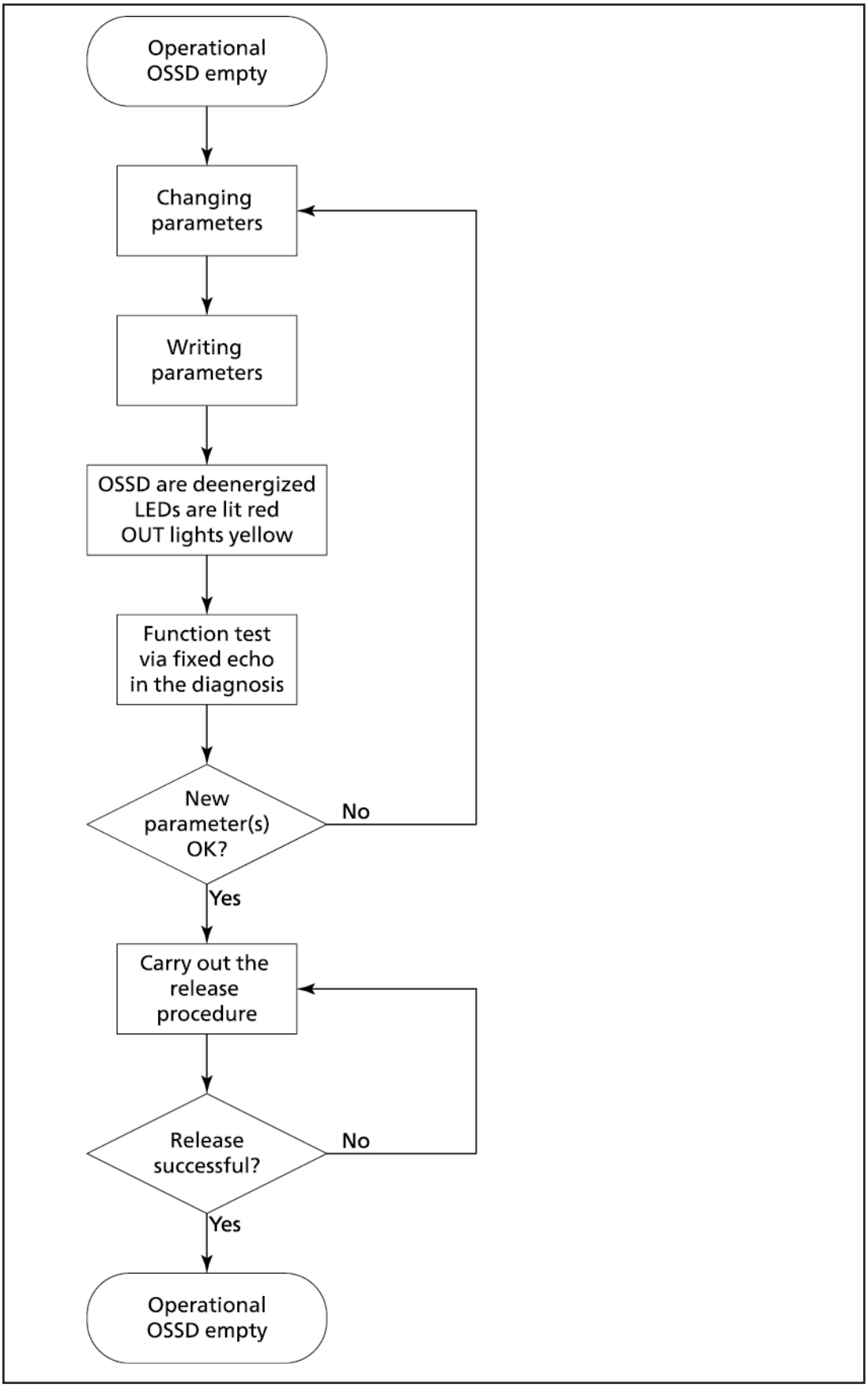



Figure 181

# Your automation, our passion.

## Explosion Protection

- Intrinsic Safety Barriers
- Signal Conditioners
- FieldConnex® Fieldbus
- Remote I/O Systems
- Electrical Ex Equipment
- Purge and Pressurization
- Industrial HMI
- Mobile Computing and Communications
- HART Interface Solutions
- Surge Protection
- Wireless Solutions
- Level Measurement

## Industrial Sensors

- Proximity Sensors
- Photoelectric Sensors
- Industrial Vision
- Ultrasonic Sensors
- Rotary Encoders
- Positioning Systems
- Inclination and Acceleration Sensors
- Fieldbus Modules
- AS-Interface
- Identification Systems
- Displays and Signal Processing
- Connectivity

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