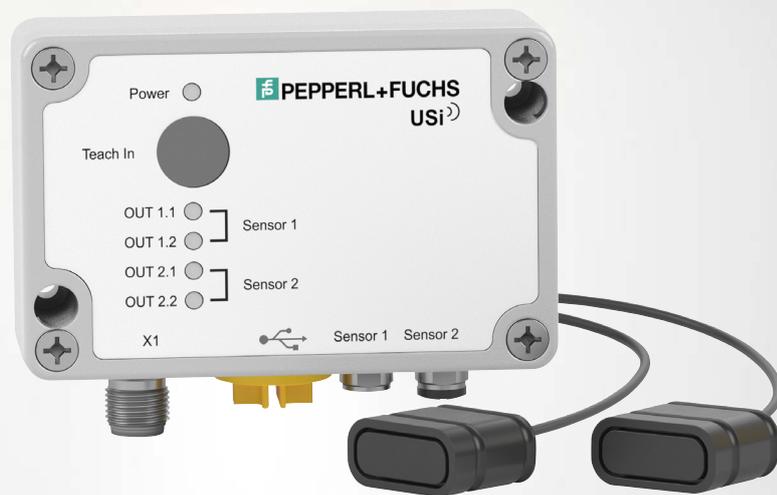


USi©-industry System Ultrasonic Sensor System

Manual



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

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1 Introduction

1.1 Content of this Document

This document contains information required to use the product in the relevant phases of the product life cycle. This may include information on the following:

- Product identification
- Delivery, transport, and storage
- Mounting and installation
- Commissioning and operation
- Maintenance and repair
- Troubleshooting
- Dismounting
- Disposal



Note

For full information on the product, refer to the further documentation on the Internet at www.pepperl-fuchs.com.



Note

For specific device information such as the year of construction, scan the QR code on the device. As an alternative, enter the serial number in the serial number search at www.pepperl-fuchs.com.

The documentation comprises the following parts:

- This document
- Datasheet

In addition, the documentation may comprise the following parts, if applicable:

- EU-type examination certificate
- EU declaration of conformity
- Attestation of conformity
- Certificates
- Control drawings
- Instruction manual
- Functional safety manual
- Other documents

1.2 Target Group, Personnel

Responsibility for planning, assembly, commissioning, operation, maintenance, and dismantling lies with the plant operator.

Only appropriately trained and qualified personnel may carry out mounting, installation, commissioning, operation, maintenance, and dismantling of the product. The personnel must have read and understood the instruction manual and the further documentation.

Prior to using the product make yourself familiar with it. Read the document carefully.

1.3 Symbols Used

This document contains symbols for the identification of warning messages and of informative messages.

Warning Messages

You will find warning messages, whenever dangers may arise from your actions. It is mandatory that you observe these warning messages for your personal safety and in order to avoid property damage.

Depending on the risk level, the warning messages are displayed in descending order as follows:



Danger!

This symbol indicates an imminent danger.

Non-observance will result in personal injury or death.



Warning!

This symbol indicates a possible fault or danger.

Non-observance may cause personal injury or serious property damage.



Caution!

This symbol indicates a possible fault.

Non-observance could interrupt the device and any connected systems and plants, or result in their complete failure.

Informative Symbols



Note

This symbol brings important information to your attention.



Action

This symbol indicates a paragraph with instructions. You are prompted to perform an action or a sequence of actions.

1.4 Intended Use

The USi©-industry ultrasonic sensor system is designed for industrial use in the air. The system consists of the evaluation unit and up to two sensor elements (ultrasonic transducers), which detect the objects using ultrasonic pulses. The sensor system emits ultrasonic waves, which are reflected by the objects, received by the sensor, and evaluated accordingly. The distance to the object is calculated from the measured sound propagation time (pulse-echo principle). The detected objects can be solid, granular, powdery, or liquid. The color and surface structure of the objects are irrelevant. Gases cannot be detected. The following functions can be implemented with the ultrasonic sensor system:

- Ultrasonic diffuse mode sensor
- Ultrasonic retro-reflective sensor
- Sound barrier
- Analog distance measurement
- Multisensor system

Ultrasonic diffuse mode sensors, ultrasonic retro-reflective sensors, and analog distance measurement are possible with individual devices and at least one ultrasonic transducer connected to them. Two ultrasonic transducers are required for a sound barrier. A synchronized multisensor system can be created from up to 10 USi-industry devices.



Note

The USi-industry ultrasonic sensor system is a standard sensor (standard component) without an independent safety certificate and is therefore not a safety component as defined by the EC Machinery Directive 2006/42/EC. As a standard sensor, it must not be used to prevent danger to persons or parts of the body.

Only operate the device as described in these instructions to ensure the correct functioning of the device and the connected systems. The protection of operating personnel and the plant is guaranteed only if the device is operated in accordance with its intended use.

The operator is responsible for complying with all local safety regulations.

Only use recommended original accessories.

1.5 General Safety Notes

Responsibility for planning, assembly, commissioning, operation, maintenance, and dismantling lies with the plant operator.

Installation and commissioning of all devices may be performed only by trained and qualified personnel.

The device is only approved for appropriate and intended use. Ignoring these instructions will void any warranty and absolve the manufacturer from any liability.

If serious faults occur, stop using the device. Secure the device against inadvertent operation. In the event of repairs, return the device to your local Pepperl+Fuchs representative or sales office.



Note

Disposal

Electronic waste is dangerous. When disposing of the equipment, observe the current statutory requirements in the relevant country of use and local regulations.

1.6 Declaration of Conformity

This product was developed and manufactured in line with the applicable European standards and directives.



Note

A declaration of conformity can be requested from the manufacturer.

The product manufacturer, Pepperl+Fuchs Group, 68307 Mannheim, Germany, has a certified quality assurance system that conforms to ISO 9001.



ISO9001

2 Product Description

2.1 Use and Application

Ultrasonic sensors are used in a wide range of industrial applications as transducers for automation tasks. As acoustic sensors in the air, they are used in various applications as proximity switches or proximity sensors or are used for level measurement, positioning, object and position detection, etc. The USi-industry can be used as a noncontact sensor system both indoors and outdoors to prevent collisions on mobile machinery such as robots and auto-guided transport systems (AGV/AGTS), and on machines and systems. Ultrasonic technology has the advantage that it is rugged and can withstand environmental influences such as dirt and moisture.

The detection field of an ultrasonic transducer is highly elliptical and therefore well suited for use in flat, spatial areas. Its length extends up to the maximum measurement distance and can be divided into different areas. These are signaled to the application controller according to the different output types of a USi-industry device. Two parameterizable outputs are assigned to each ultrasonic transducer connected to the USi-industry device.

The USi-industry ultrasonic sensor system is typically used in a variety of applications, including:

- Environment detection on material handling equipment as collision protection
- Area monitoring
- Assistance system on warehouse picking devices
- Load detection/occupancy sensor for forklift trucks
- Anti-collision system on self-driving or controlled machines
- Object detection or fill level measurement

The USi-industry ultrasonic sensor system is characterized above all by its flexibility and wide range of applications. Up to two freely positionable ultrasonic transducers can be attached to the evaluation unit, separated from each other in the smallest installation space, and parameterized independently of each other.

The advantages of the USi-industry ultrasonic sensor system are:

- Ultrasonic transducer with highly elliptical sound field, separated from the evaluation unit
- Learning of the detection environment through the teach-in function
- Reliable interference suppression of independent systems even with the same frequency of use (encounters with auto-guided transport systems, AGTS)
- Two parameter sets for both ultrasonic transducers can be toggled

Parameterization via PACTware and DTM

Using the "PACTware" or "PACTware DC" software and DTM, you can conveniently and comprehensively parameterize the USi-industry ultrasonic sensor system due to the graphical user interface of the DTM. The DTM (Device Type Manager, a type of "device driver") displays the parameters clearly and graphically, by subject, in menu items and overview tiles. The measured distances and state changes are also visualized. An analysis function makes it possible to display the received echo measurements in real time as signal characteristics in the form of an envelope curve to evaluate situations in the application.

We recommend the FTD framework program "PACTware 6.0" or higher as the user interface (downward compatible up to PACTware 5.0). The PACTware software package includes the "PACTware DC" (DC Direct Connect) version for quickly and easily establishing a connection between PACTware and the ultrasonic sensor system.

The individual software components required, such as PACTware and the device DTM in the latest available version, can be found online at www.pepperl-fuchs.com on the product page for the relevant USi-industry device. Alternatively, you can download software components via the product page in the Software section.

2.2 Ultrasonic Transducer

The ultrasonic transducer as a sensor element is not integrated in the evaluation unit, but is installed separately in the application. It has a special cable with a fixed length and is connected to the evaluation unit via an M8 plug.

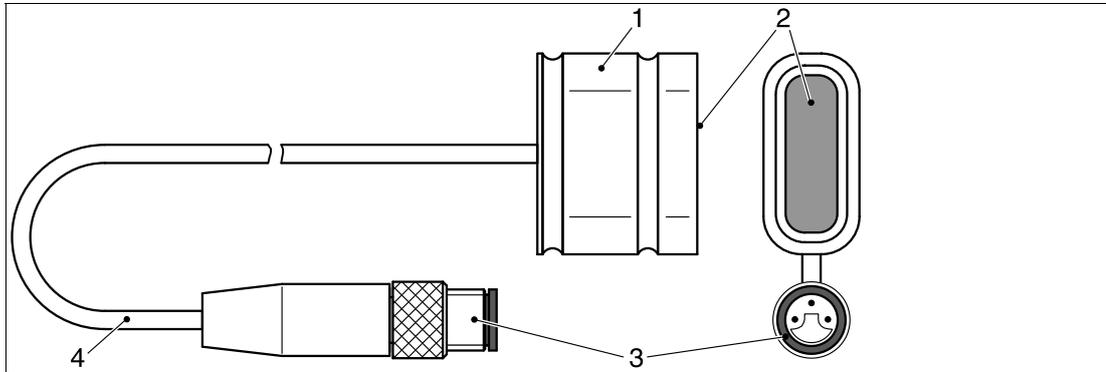


Figure 2.1

- 1 Ultrasonic transducer
- 2 Sensing face
- 3 M8 plug
- 4 Shielded cable



Caution!

Improper handling poses a risk of functional impairments!

The special cable on the ultrasonic transducer must not be modified. Depending on the version, it has a specific length and must not be lengthened or shortened.

Do not use the cable as a pulling aid. The cable may break off.

Jamming of the ultrasonic transducer, especially in the front area near the sensing face, can cause malfunctions and mechanical damage.

Only use the supplied O-rings to secure the ultrasonic transducers.

Avoid high mechanical loads on the sensing face during installation, e.g., heavy pressure, impact, etc.

Replace damaged ultrasonic transducers with torn off cable, damaged sensing face, etc. immediately. A repair is not possible.

2.3 Evaluation Unit

You can connect up to two ultrasonic transducers to the USi-industry evaluation unit. The evaluation unit is the logic of the ultrasonic sensor system, can be parameterized via USB, and forms the interface to the application. The outputs can be pure switching signals (USi-PP) or a combination (USi-AP) of analog signals 4 to 20 mA (IP) or 0 to 10 V (UP) and output additional switching signals.

2.4 Indicators and Operating Elements

The USi-industry ultrasonic sensor system has five LEDs for displaying operating and status information and a membrane button for configuring various settings.

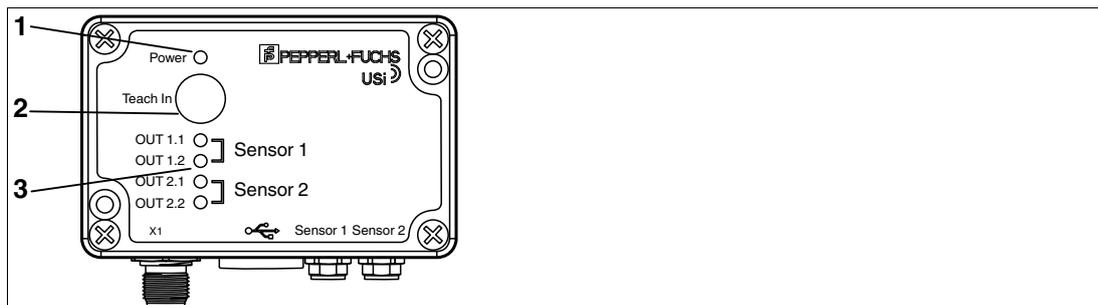


Figure 2.2

- 1 Power LED (green): operating voltage display and display of the device status
- 2 Teach-In button: teaching in the detection environment and switch points, registering and deregistering the second ultrasonic transducer, and resetting to factory settings
- 3 OUT1.1 ... 2.2 output LEDs (yellow): display the output states and correspond with the connected ultrasonic transducers.

Power LED (Green)

LED status	Description
On	Supply voltage on. The device is working as intended.
Off	No supply voltage on.
Flashes in the transmission cycle	Analysis function in the DTM -> Echograms are transmitted via USB to the DTM in real time. Warning -> Measured values outside the temperature range. -> Missing synchronization.
Flashes in the transmission cycle and with OUT LEDs	Error mode The outputs constantly signal an object: -> Indicates signal interruption to the ultrasonic transducer, e.g., cable break.
Flashes in synchronization with the OUT LEDs three times at 1.5 Hz	In the power-on state There is an error; the affected channel is signaled by the OUT LEDs. -> If a registered ultrasonic transducer has no connection to the evaluation unit when the supply voltage is switched on, this flashing behavior appears.

OUT LEDs 1.1 ... 2.2 (yellow)

LED status	Description
On	<p>In operating mode Output has switched. Depending on the parameterization, the LEDs indicate the status of the corresponding outputs according to the object detection.</p> <p>In programming mode -> The corresponding channel or ultrasonic transducer to be parameterized is displayed. -> The switch point to be parameterized is displayed: OUTx.1 for switch point 1, OUTx.2 for switch point 2, the outputs are not active.</p> <p>In error mode The affected channel is displayed</p>
Off	The output has not switched.
Flashes in synchronization with the power LED three times at 1.5 Hz	<p>In the power-on state There is an error; the affected channel is signaled by the assigned OUT LED. -> Indicates that the transducer is not connected.</p>

2.5 Accessories

Various accessories are available.

2.5.1 Accessories for Mounting and Connection

Various components are available for mounting and connecting the USi-industry ultrasonic sensor system. You will find details online at www.pepperl-fuchs.com on the product page for the relevant sensor or on the relevant datasheet.

The following types of accessories are available for order:

- Mounting brackets for the ultrasonic transducers
- Connection cable and cordset
- USB cable for parameterization

**Note**

For mounting, connection, and commissioning, the following product information is available online at www.pepperl-fuchs.com on the product page for the relevant sensor: datasheet and manual. The relevant DTM contains comprehensive context-related help texts.

2.5.2 Parameterization Aids

The following parameterization aids are available:

Designation	Description
PACTware	FDT frame application for operating IODDs and DTMs. Includes the PACTware and PACTware DC versions. Compared to PACTware, the PACTware DC has a "plugin" for quickly and easily establishing connections between sensor and PACTware. Visit www.pepperl-fuchs.com and go to the product page for the relevant ultrasonic sensor system in the USI*-F264-*** series.
DTM package for USI*-F264-*** series	DTM (Device Type Manager) - communication driver for USB, device description, and graphical user interface for parameterization and operation of the sensor, integration into the system environment. DTM package for USI*-F264-*** series. Visit www.pepperl-fuchs.com and go to the product page for the for the relevant sensor in the USI*-F264-*** series
USB-AS-2M-PVC-USB-B	Adapter cable USB-A plug to mini-USB-B plug for connecting a sensor for communication between FDT frame application and ultrasonic sensor.

Table 2.1

3 Installation

3.1 Safety Information



Caution!

Risk of short circuit

Carrying out work while the system is energized may result in damage to the device.

- Always disconnect the supply voltage before carrying out work on the device.
 - Only connect the device to the supply voltage once all work has been completed.
-

3.2 Preparation



Unpacking the Device

1. Check the packaging and contents for damage.
↳ In the event of damage, inform the shipping company and notify the supplier.
2. Check the package contents against your order and the shipping documents to ensure that all items are present and correct.
↳ Should you have any questions, direct them to Pepperl+Fuchs.
3. Retain the original packaging in case the device is to be stored or shipped again at a later date.

3.3 Connections

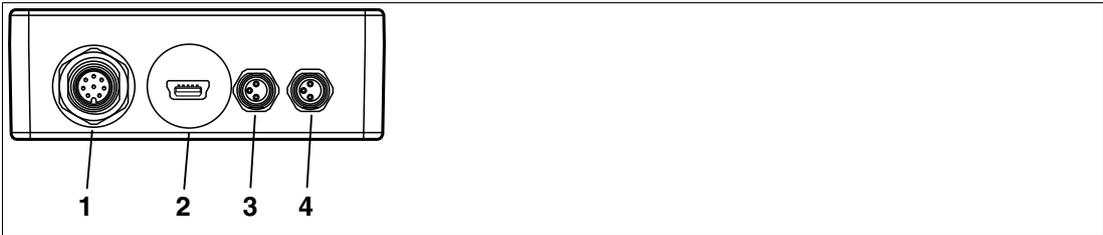


Figure 3.1

- 1 X1: M12 plug, 8-pin, for connecting the device cable for supply voltage and outputs
- 2 Mini-USB socket: covered by yellow stopping plug, for connection to parameterize the sensor
- 3 Sensor 1: M8 socket, 3-pin, for connecting ultrasonic transducer 1
- 4 Sensor 1: M8 socket, 3-pin, for connecting ultrasonic transducer 2

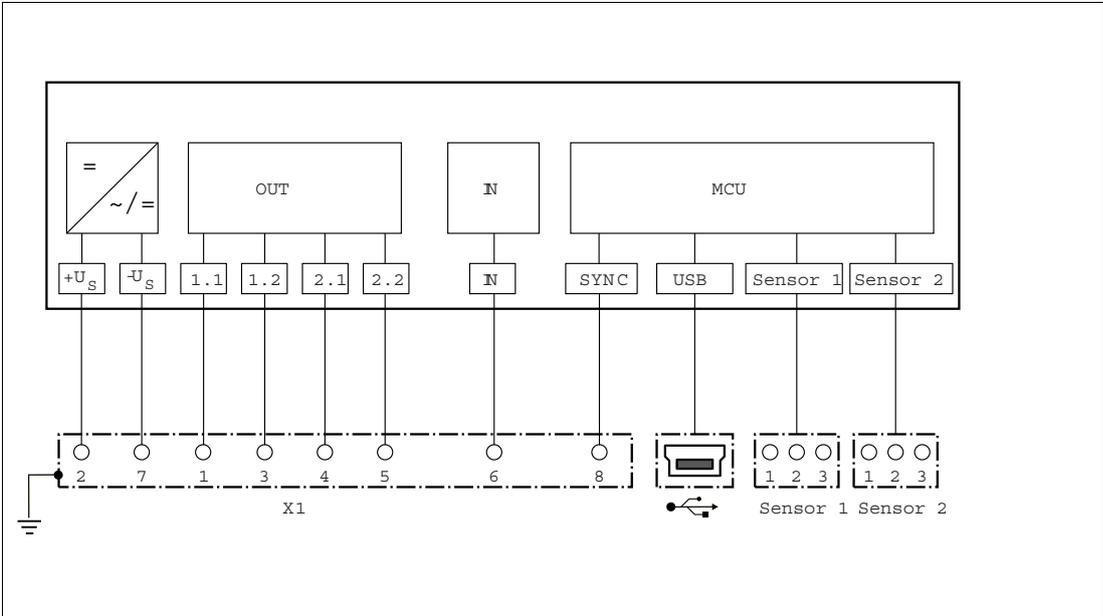


Figure 3.2

3.3.1 Connection of Ultrasonic Transducers to the Evaluation Unit

You can connect up to two ultrasonic transducers to the USi-industry ultrasonic sensor system. At least one ultrasonic transducer is essential for operation.



Connecting the Ultrasonic Transducers to the Evaluation Unit

1. Plug the connection cable of the first ultrasonic transducer with its M8 plug into the "Sensor 1" socket of the evaluation unit.
2. Turn the union nut of the M8 plug on the "Sensor 1" socket as far as it will go so that the connection cable is secured against being pulled out accidentally.
3. Optionally, connect the second ultrasonic transducer to the "Sensor 2" socket.

3.3.2 Connection to a Downstream Controller



Note

To connect the USi-industry evaluation unit, use a shielded 8-core sensor cable (min. 0.25 mm² per core) equipped with an M12 socket.

The maximum length is 30 m.

For this purpose, we recommend cables in the V19* series.



Connection of the USi-industry System via V19* Cable

To connect the evaluation unit, proceed as follows:

1. Plug the prepared connection cable into the connector plug provided on the USi-industry system.
2. Turn the union nut over the cable plug as far as it will go to prevent the supply cable from being pulled out accidentally.
3. Connect the wires of the opposite side of the connection cable in the controller accordingly and switch on the supply voltage.

↳ The ultrasonic sensor system is now ready for operation if at least one ultrasonic transducer is connected.

Plug X1	Signal	Pin	Core color	V19*: M12 cable socket, 8-pin
Supply voltage	+U _S - U _S	2 7	BN BU	
Output 1.1	OUT 1.1	1	WH	
Output 1.2	OUT 1.2	3	GN	
Output 2.1	OUT 2.1	4	YW	
Output 2.2	OUT 2.2	5	GY	
Digital input	IN	6	PK	
Synchronization	SYNC	8	RD	

Table 3.1

3.3.3 Connecting USi-industry Devices to be Synchronized

A total of up to ten USi-industry devices can be operated together in a device network. One USi-industry device must be used as the main device; the other USi-industry devices are secondary devices. The USI Industry devices are parameterized accordingly in the PACTware DTM. To operate them together in automatic common mode, you must connect the SYNC connections of these USi-industry devices to each other. This connection must not have an additional connection to the supply voltage $+U_B$ or $-U_B$.



Note

In the delivery state, each USi-industry device is parameterized as an individual device. The individual devices must therefore be registered one after the other in the device group in the PACTware DTM. The main device receives the number of secondary devices and each secondary device receives a consecutive number as an address.

The synchronization function is available on request.

3.4 Mounting

The mounting of the USi-industry ultrasonic sensor system consists of three individual parts:

1. Mounting the ultrasonic transducers
2. Mounting the evaluation unit for USi-industry
3. Wiring the device cables

3.4.1 Mounting the Ultrasonic Transducers

You can mount the ultrasonic transducers in any position up to a maximum cable length of 3 m away from the USi-industry evaluation unit.

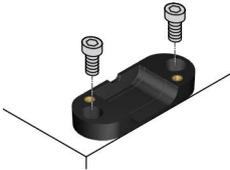
The ultrasound itself is not audible to humans. In quiet areas, however, the generation of the ultrasonic signal by the transmission burst can be perceived as a cyclical cracking noise. Therefore, if the ultrasonic transducer is mounted at head height, the orientation of the ultrasonic transducer must be assessed to ensure that this noise is not perceived as disruptive.

The ultrasonic transducers are supplied with suitable O-rings for mounting. Please note the following points during mounting:

- First check the mounting location: At which position, in which orientation, at what height is the ultrasonic sensor system to be mounted optimally and as tamper-proof?
- Avoid putting pressure on the ultrasonic transducers.
Pressure may only be exerted on the O-rings, not on the ultrasonic transducer enclosure itself.
- Avoid sources of EMC interference in the immediate vicinity of the ultrasonic transducers and their cables.
- Avoid strong sources of sound interference in the immediate vicinity of the ultrasonic transducers or at an acute angle to the sensing faces.
- Avoid large fluctuations in temperature.

Mounting in a Pepperl+Fuchs Mounting Bracket

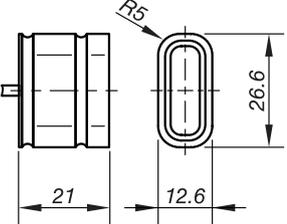
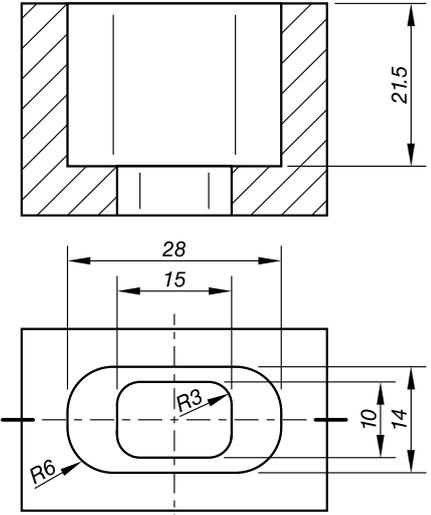
The mounting of an ultrasonic transducer in a horizontal mounting bracket is described below as an example. Additional mounting brackets for vertical mounting are also available as accessories. These brackets are mounted in the same way.

<p>1. Mount the base of the mounting bracket in the correct position. Use the supplied M5 screws to do so.</p>	
<p>2. Make sure that an O-ring is fitted in each of the two grooves of the ultrasonic transducer.</p>	
<p>3. Place the ultrasonic transducer in the base of the bracket so that the O-rings are in the grooves and the cable lies loosely in the cable duct.</p>	
<p>4. Carefully position the upper part of the bracket. 5. If the upper part of the mounting bracket lies flat and the cable is loose in the cable duct, screw the upper part to the base using the M3 screws supplied. 6. Lay the cables of the signaling devices free of tension and at a sufficient distance from sources of electromagnetic interference such as DC motors.</p>	

Own Brackets as an Alternative

Instead of the mounting brackets from Pepperl+Fuchs, you can also use your own brackets. These can be in one or two parts. However, mounting the ultrasonic transducer in a two-part bracket is easier. The ultrasonic transducer should only be fixed in the bracket using the O-rings supplied. The main function of the O-rings is acoustic decoupling.

When constructing brackets, observe the following dimensions:

<p>Dimensions of the ultrasonic transducers</p>	
<p>Installation space for ultrasonic transducers</p>	

Tolerances: ISO 2768-1 m, with O-rings 17.5 × 2.0 mm

The dimensions 28 mm and 14 mm are minimum dimensions and must only have plus tolerances.



Mounting in own bracket

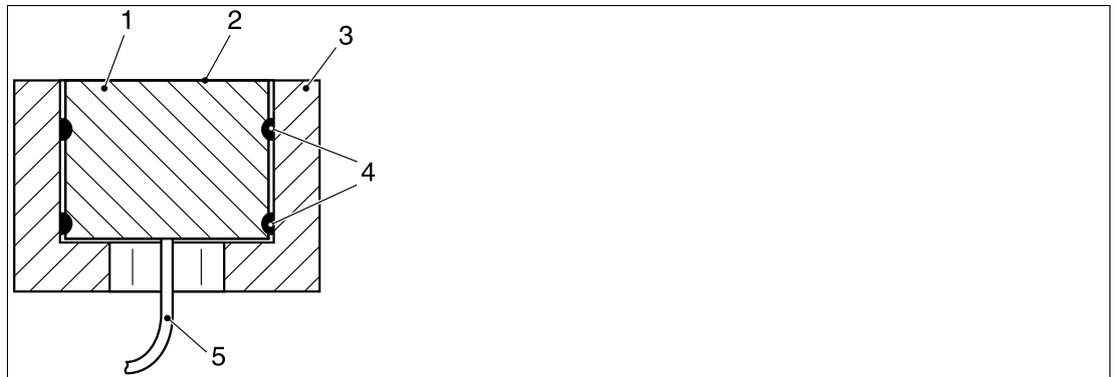


Figure 3.3

- 1 Ultrasonic transducer
- 2 Sensing face
- 3 Custom bracket
- 4 O-rings
- 5 Cable

1. Make sure that an O-ring is fitted in each of the two grooves of the ultrasonic transducer. This corresponds to the delivery condition.
2. Place the ultrasonic transducer in the bracket by inserting it (for two-part bracket) or by carefully pushing it in (for one-part bracket).



Caution!

Incorrect mounting risks functional impairment!

Jamming of the ultrasonic transducer, especially in the front area near the sensing face, can cause malfunctions and mechanical damage.

- Secure the ultrasonic transducers only with the factory-installed O-rings.
- Do not use the cable as an insertion aid. The cable may break off.
- Avoid high mechanical loads (high pressure, impact, etc.) on the sensing face during mounting.
- Replace damaged ultrasonic transducers immediately (cable torn off, sensing face damaged). A repair is not possible.
- The dimensions of the installation space for the ultrasonic transducer for one-part brackets must not exhibit any minus tolerances.

3.4.2 Mounting the Evaluation Unit

You can mount the evaluation unit in any position.



Caution!

Close the plug connector during operation to guarantee the IP degree of protection.

Ensure that either a cable plug or a protective cap is attached to each plug connector of the evaluation unit and tightened accordingly during operation of the evaluation unit. This is the only way to ensure the intended IP degree of protection and to prevent moisture ingress and possible malfunctions. Keep the protective caps if you wish to parameterize via the USB interface or connect ultrasonic transducer 2. Replace the protective caps on the connectors when you remove the cable plugs.



Note

If the evaluation unit must be installed in a splash water environment, the situation regarding parameterization via USB connection must be taken into account. If the threaded plug is removed from the USB connection, the degree of protection drops to IP20. The opening for the USB connection should therefore be aligned so that it is ideally facing downward and not toward the source of splashing water. We recommend attaching additional splash protection (guard plate, foil, etc.) during parameterization.

Fasten the evaluation unit in any position using two Ø 4 mm screws, which you insert into the holes provided.

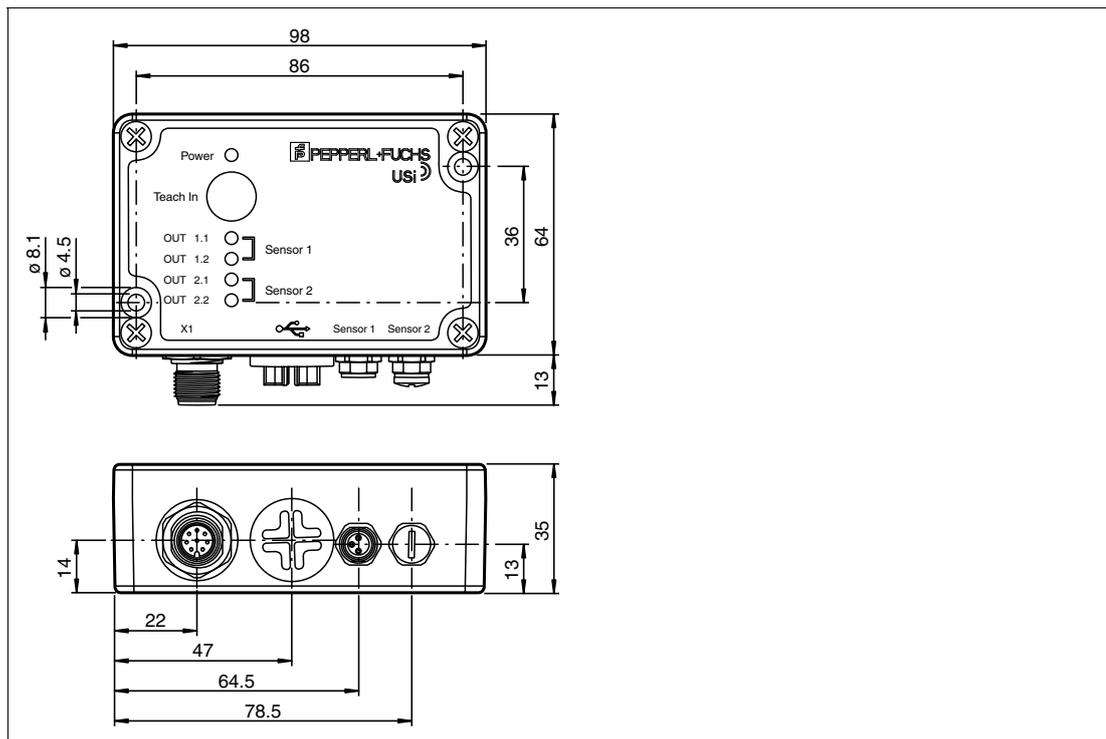


Figure 3.4

4 Commissioning

4.1 Commissioning without PACTware and DTM



Prerequisites for Commissioning

To commission the USi-industry ultrasonic sensor system, proceed as follows:

1. Make sure that at least one ultrasonic transducer is connected to the "Sensor 1" connection on the evaluation unit.
2. Make sure that the device cable is connected to "X1" on the evaluation unit and that the supply voltage is switched on.

Initialization

Once the supply voltage has been applied, the USi-industry system begins initialization immediately. It tests the internal hardware, the stored function parameters, and the connected ultrasonic transducers.

If there are no errors, the USi-industry system starts its function immediately depending on the function parameters stored in the sensor.



Note

The USi-industry system uses the factory-set default parameters at the first startup after delivery. Only one ultrasonic transducer is registered on the system and detects a range of up to 200 cm. The assigned outputs OUT1.1 and OUT1.2 are preset as normally-open.

Because the USi-industry system is not yet familiar with its working environment, the reference echo curve is not yet stored in the internal memory and the outputs for ultrasonic transducer 1 are switched. To teach in the environment, press the Teach-In button until the green power LED starts to flash and then release it immediately. The power LED now flashes faster during the teach-in process. When finished, the LED lights up continuously again and the device is ready for operation.



Note

After successful teach-in, the outputs are switched off and the corresponding yellow OUT LEDs are also off.



Function Checking

1. Check the function by placing an object in the detection range.
↳ When the object is detected, both the outputs and the LEDs turn on. If the object is removed, the outputs and LEDs switch off again.

4.1.1 Changing Settings via Teach-In

You can change the following settings using the "Teach In" button:

1. Teach in the environment
2. Set switch points
3. Register/deregister ultrasonic transducer 2
4. Restore factory settings

The settings are described in detail in the following sections.



Note

If you want to configure the settings via teach-in instead of via the DTM, you must configure the "Teach-in environment" setting. All other settings are optional, depending on the application situation.

4.1.2 Teaching In the Environment

The function of "Teach-In" in the USi-industry system is to teach in the environment within the detection field. This is necessary if the device is not yet familiar with its working environment, i.e., when it is put into operation as brand new or after a reset to factory settings. A teach-in is always required if there are other objects (e.g., columns, containers, tables, shelves, etc.) in the detection field in addition to the objects to be detected, but which are to be regarded "as a given". Teaching in the environment prevents such secondary objects from causing accidental activation.

The "Teach-in" function is available at any time when the USi is ready for operation. The USi always learns the environment of all registered ultrasonic transducers.



1. Check that all registered ultrasonic transducers are mounted.
2. Make sure that there is nothing in the detection field that does not normally belong in it (not even you or parts of your body!).
3. Press and hold the "Teach In" button until the green "Power" LED starts to flash (1 Hz).
4. Release the "Teach In" button.

↳ The green "Power" LED now flashes faster (5 Hz). This means that the USi-industry system is currently learning the environment. As soon as the green "Power" LED stops flashing, the teach-in process is completed and the USi-industry system is ready for operation again.

5. Check the result: If you bring an object into the detection field or remove one of the secondary objects, the USi-industry changes the status of the relevant outputs.



Tip

If you have already called up the "Teach In" function (green "Power" LED flashes slowly), but you do not want to teach in the environment again, keep the "Teach In" button pressed until all yellow "OUT" LEDs light up. Release the button immediately.

4.1.3 Setting Switch Points

Overview

In the factory settings of the USi-industry ultrasonic sensor system, switch points $SP1 = SP2 = 200$ cm are preset for each ultrasonic transducer as a single range. This means that objects directly in front of the ultrasonic transducer are detected and evaluated up to a distance of 200 cm. Both outputs $OUTx.1$ and $OUTx.2$ of the assigned transducer signal a detected object.

Depending on the requirements of your application, you can operate the USi-industry system in the following operating modes:

- **Single range**
In the "Single range" operating mode, switch points $SP1$ and $SP2$ are the same. The detection field extends from roughly the surface of the ultrasonic transducer to switch point 1 ($SP1$). Both outputs $OUTx.1$ and $OUTx.2$ are assigned to this range. If an object is detected in this range, both outputs $OUTx.1$ and $OUTx.2$ assigned to the transducer are set.
- **Double range**
In the "Double range" operating mode, switch points $SP1$ and $SP2$ are separated. This results in two detection areas in front of the ultrasonic transducer, both of which are defined from roughly the ultrasonic transducer surface up to switch point 1 ($SP1$) and switch point 2 ($SP2$). Each individual range is assigned its own output. If an object is detected in these ranges, outputs $OUTx.1$ and/or $OUTx.2$ assigned to the transducer are set.

The "Set switch points" function is available at any time when USi-industry is ready for operation. You can set the switch points between 15 and 250 cm using a reference object.



Tip

Switch Points and Reference Object

The longer distance is always learned first, i.e., $SP2$, and then the shorter distance for $SP1$

Switch Point 2 ($SP2$)

- $SP2$ without reference object: the maximum value of 250 cm is adopted for $SP2$
- $SP2$ with reference object: the measured distance to the reference object is adopted for $SP2$

Switch Point 1 ($SP1$)

- $SP1$ without reference object: the value of $SP2$ is adopted for $SP1$; $SP1=SP2$, single range
- $SP1$ with reference object: the measured distance to the reference object is adopted for $SP1$, double range



Note

Cancel

From step 6 onwards, the only way to abort is to disconnect the supply voltage.

1. Measure the desired distance, starting from the sensing face of the ultrasonic transducer.
2. Make sure that there is nothing in the detection field that does not normally belong in it (not even you or parts of your body!).
3. Keep a suitable reference object (e.g., a 10 × 10 cm cardboard box) handy.
4. Press and hold the "Teach-In" button and wait for the following flashing behavior.
5. The green "Power" LED flashes slowly at first (1 Hz), goes out for two seconds while the yellow "OUT" LEDs light up, flashes slowly again (1 Hz), and goes out again.

- ↳ The yellow "OUT1.x" and "OUT2.x" LEDs now light up alternately.
 - ↳ The USi-industry system awaits your decision: Do you want to set a switch point for ultrasonic transducer 1 or ultrasonic transducer 2?
- 6.** Release the "Teach In" button when the yellow "OUT" LEDs of the ultrasonic transducer for which you want to set the switch points light up.
- ↳ The yellow "OUTx.2" LED is now lit and the green "Power" LED flashes rapidly (5 Hz).
 - ↳ The USi-industry system is now waiting for your confirmation for switch point 2: Is the reference object at the desired distance in the detection field?
- 7.** Place the reference object in the detection field at the desired distance.
- ↳ If the USi-industry system detects the reference object, the green "Power" LED changes from flashing rapidly (5 Hz) to being permanently lit.
- 8.** Press the "Teach In" button (> 0.5 s) and the USi-industry will overwrite the previous switch point 2 with the determined distance to the reference object.
- ↳ The yellow "OUTx.1" LED is now lit and the green "Power" LED flashes rapidly (5 Hz).
 - ↳ The USi-industry system is waiting for your confirmation for switch point 1: Is the reference object at the desired distance in the detection field?



Tip

Single Range Operating Mode

If you confirm switch point 1 without a reference object in the detection field, the USi-industry system saves the distance from SP2 for switch point 1 and automatically switches to single range operating mode.

- 9.** Place the reference object in the detection field at the desired distance.
- ↳ If the USi-industry system detects the reference object, the green "Power" LED changes from flashing rapidly (5 Hz) to being permanently lit.
- 10.** Press the "Teach In" button (> 0.5 s) and the USi-industry will overwrite the previous switch point 1 with the determined distance to the reference object.
- ↳ The USi-industry system now operates automatically in double range operating mode.
- 11.** Check the two switch points: Move the reference object toward the USi-industry system and back again.
- ↳ When set switch point positions SP1 and SP2 are passed, a signal change should take place at the output of the evaluation unit and the relevant yellow LED for the signal output should light up.

4.1.4 Registering/Deregistering Ultrasonic Transducer 2

In the delivery state, the USi-industry system is set to one ultrasonic transducer at the sensor 1 connection by default. If a second ultrasonic transducer is required, you must register ultrasonic transducer 2 separately. Ultrasonic transducer 1 must always remain connected; it cannot be deregistered.



Note

To use the "Register/deregister ultrasonic transducer 2" function, you must switch the USi-industry system to a special mode. This function is not available for the USi-industry system that is ready for operation. The required work steps are described below.



Registering Ultrasonic Transducer 2

1. Ensure that there is no supply voltage.
2. Connect ultrasonic transducer 2 to M8 socket "Sensor 2."
3. Press and hold the "Teach In" button until step 5.
4. Switch on the supply voltage.
 - ↳ The USi-industry system signals readiness for "Register ultrasonic transducer 2" with slow flashing (1 Hz) of the green "Power" LED.
5. Release the "Teach In" button.
 - ↳ Both yellow "OUT2.1" and "OUT2.2" LEDs now flash slowly (1 Hz) at the same time. The USi-industry system expects your confirmation of registration for ultrasonic transducer 2 within 10 s.



Note

If the "Teach In" button is not pressed, the USi-industry system automatically cancels the "Register/deregister ultrasonic transducer 2" function after 10 seconds.

6. Press the "Teach In" button for > 0.5 s.
 - ↳ The USi-industry system signals "OUT" with 1 s of illuminated yellow LEDs when the ultrasonic transducer 2 is successfully registered.



Note

After registering ultrasonic transducer 2, you must teach in the detection field using the "Teach-in" function.



Deregistering Ultrasonic Transducer 2

1. Ensure that there is no supply voltage.
2. Press and hold the "Teach In" button until step 4.
3. Switch on the supply voltage.
 - ↳ The USi-industry system signals readiness for "Deregister ultrasonic transducer 2" with slow flashing (1 Hz) of the green "Power" LED.
4. Release the "Teach In" button.
 - ↳ The yellow "OUT2.1" and "OUT2.2" LEDs now light up alternately. The USi-industry system expects your confirmation of deregistration for ultrasonic transducer 2 within 10 s.



Note

If the "Teach In" button is not pressed, the USi-industry system automatically cancels the "Register/deregister ultrasonic transducer 2" function after 10 seconds.

5. Press the "Teach In" button for > 0.5 s.
 - ↳ The USi-industry system signals "OUT" with 1 s of illuminated yellow LEDs when the ultrasonic transducer 2 is successfully deregistered.
6. Disconnect the ultrasonic transducer 2 from the "Sensor 2" M8 socket on the evaluation unit.
7. Screw the protective cap back onto the M8 "Sensor 2" socket to restore the intended IP protection class.

4.1.5 Restoring Factory Settings

Sometimes a RESET proves to be the quicker way if a previously parameterized USi-industry system must be parameterized again. A RESET causes all parameters to be overwritten with the factory settings again. The USi-industry system then restarts.



Note

To use the "Reset" function, you must switch the USi-industry system to a special mode. This function is not available for the USi-industry system that is ready for operation. The required work steps are described below.



1. Ensure that there is no supply voltage.
2. Press and hold the "Teach In" button until step 4.
3. Switch on the supply voltage.
 - ↳ The green "Power" LED flashes slowly for 5 s (1 Hz), the yellow "OUT" LEDs light up continuously for 2 s. The green "Power" LED flashes slowly again (1 Hz).
4. Release the "Teach In" button.
 - ↳ All the LEDs now light up alternately from top to bottom like a running light. The USi-industry system expects your confirmation for RESET within 10 s.



Note

If the "Teach In" button is not pressed, the USi-industry system automatically cancels the "RESET" function after 10 seconds.

5. Press the "Teach In" button for > 0.5 s.
 - ↳ The USi-industry system signals that the RESET is being carried out by briefly illuminating all the "OUT" LEDs. Only ultrasonic transducer 1 is registered as a factory setting and the data of a taught-in environment is deleted. The OUT1.x outputs are set accordingly and the yellow LEDs light up.



Note

After a RESET, the detection field must be taught in again using the "Teach In" function.

4.2 Commissioning with PACTware and DTM

There is a DTM available to download to help you fully parameterize the sensor easily via the USB interface. This can be found online at www.pepperl-fuchs.com, on the product page for the USi-industry series. With this DTM, configuration and analysis with monitoring are possible.



Note

A mini-USB connecting cable is required to connect the sensor to the PC. You can find this cable by visiting www.pepperl-fuchs.com and clicking on the product page for the relevant sensor.

The evaluation unit has a mini-USB socket, which you can find under the yellow stopping plug. To connect the USB cable, remove the gland and keep it in a safe place.



Caution!

Screw the yellow stopping plug back in after parameterization!

After you have completed the parameterization or analysis of the sensor, pull out the USB cable. Screw the yellow stopping plug back into the evaluation unit and tighten it carefully. This is the only way to ensure impermeability and to avoid malfunctions.



Prerequisites for Commissioning

To address the USi-industry ultrasonic sensor system using the "PACTware" or "PACTware DC" software and the associated DTM (Device Type Manager), proceed as follows:

1. Make sure that at least one ultrasonic transducer is connected to the "Sensor 1" connection on the evaluation unit.
2. Make sure that the device cable is connected to "X1" on the evaluation unit and that the supply voltage is switched on.
3. Ensure that PACTware DC and the necessary DTMs (Device Type Manager) such as the communication DTM and device DTM for USi-industry are installed.
4. Remove the yellow stopping plug from the mini-USB socket. Keep the stopping plug in a safe place.
5. Connect the evaluation unit to a USB connection on your PC using the USB connecting cable.



Setting up Sensor Communication Using PACTware DC

1. Launch PACTware DC by double-clicking the PACTware DC icon.

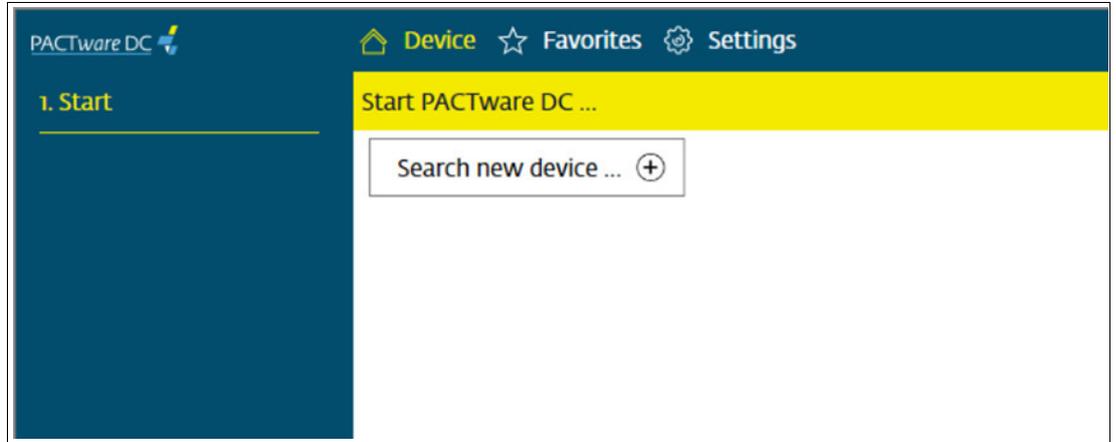


Figure 4.1

2. Click "Search new device" at the top.

↳ If the evaluation unit is connected to the PC via USB, it is recognized by the PACTware DC.

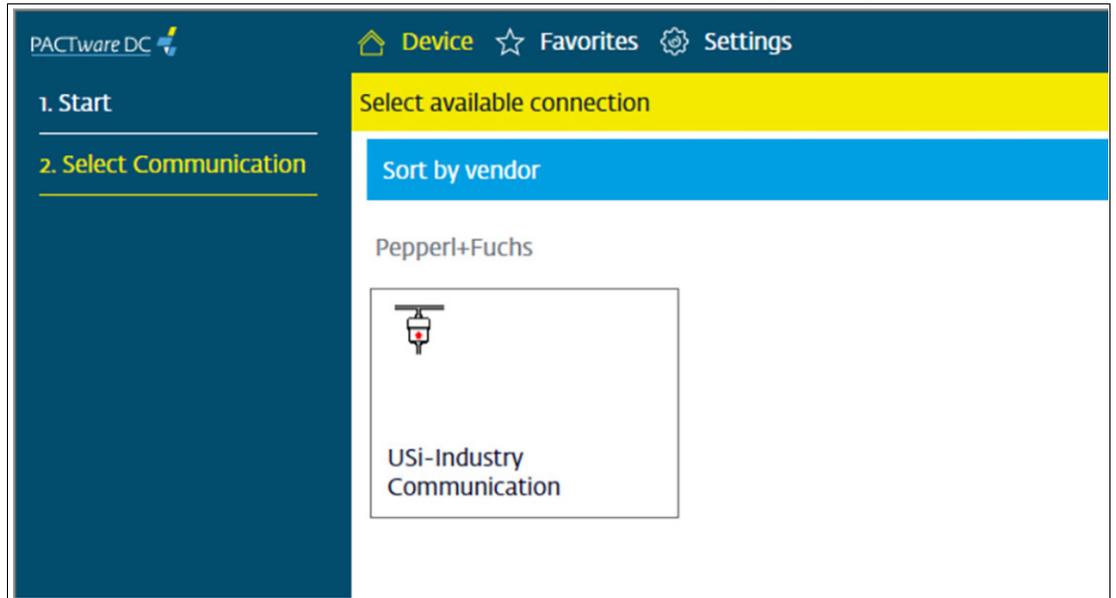


Figure 4.2

3. In the project, click on **USi-Industry Communication**.

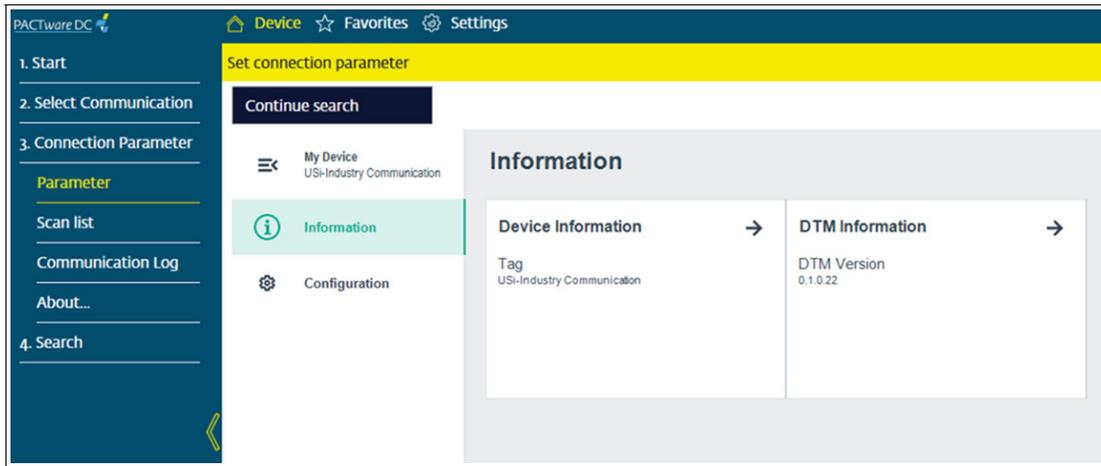


Figure 4.3

4. If the connected sensor is not yet detected, click on **Continue Search**.

↳ Once the evaluation unit has been recognized, the PACTWare DC automatically establishes the connection to the evaluation unit.

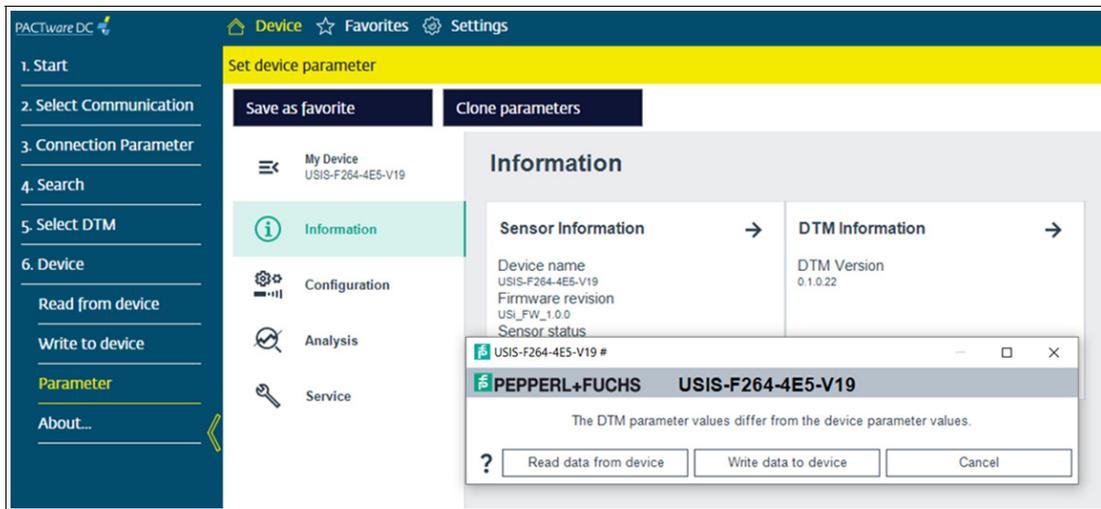


Figure 4.4

5. Select **Read data from sensor**.

↳ The PACTware DC reads and transfers the parameter values from the evaluation unit to the DTM and starts the continuous data exchange with the evaluation unit.



Note

If the USi-industry system is not yet familiar with its working environment because no reference curve has been stored in the internal memory, you can now teach in the environment using the Teach-In button.

This is also possible with the DTM by selecting the "Analysis" menu item and pressing the "Teach-in" button below.

The teach-in is performed for all connected ultrasonic transducers.

5 Parameterization and Analysis with DTM

5.1 Overview

The parameters of the USi-industry ultrasonic sensor systems are device-specific. In the DTM (Device Type Manager), these parameters are described in a well-structured way and partly supported with graphics. The DTM can be imported into various engineering tools from different system providers, providing they support DTM. The ultrasonic sensor system can be parameterized or analyzed using the corresponding tool (e.g., PACTware). The DTM menus are outlined below on the basis of the "PACTware" FDT frame application being used.

The DTM (Device Type Manager) described below offers you a wide range of options for simple and comprehensive parameterization of the ultrasonic sensor system via the USB connection and analysis of the sensor system behavior.

In addition to parameterizing the ultrasonic sensor system, you can use the **Analysis** menu to display the sensor system behavior during operation to set it optimally for your application.



Note

The following screenshots of the DTM in the PACTware framework program are examples based on the USIM-F264-4E5-V19 and USIS-F264-IU3E5-V19 devices, but are also valid for all other versions in the USi-industry series.



Caution!

Screw the yellow stopping plug back in after parameterization!

After you have completed the parameterization or analysis of the sensor, pull out the USB cable. Screw the yellow stopping plug back into the evaluation unit and tighten it carefully. This is the only way to ensure impermeability and to avoid malfunctions.

General Information on the Device Type Manager DTM

The user interface of the DTM (Device Type Manager) is divided into different areas.

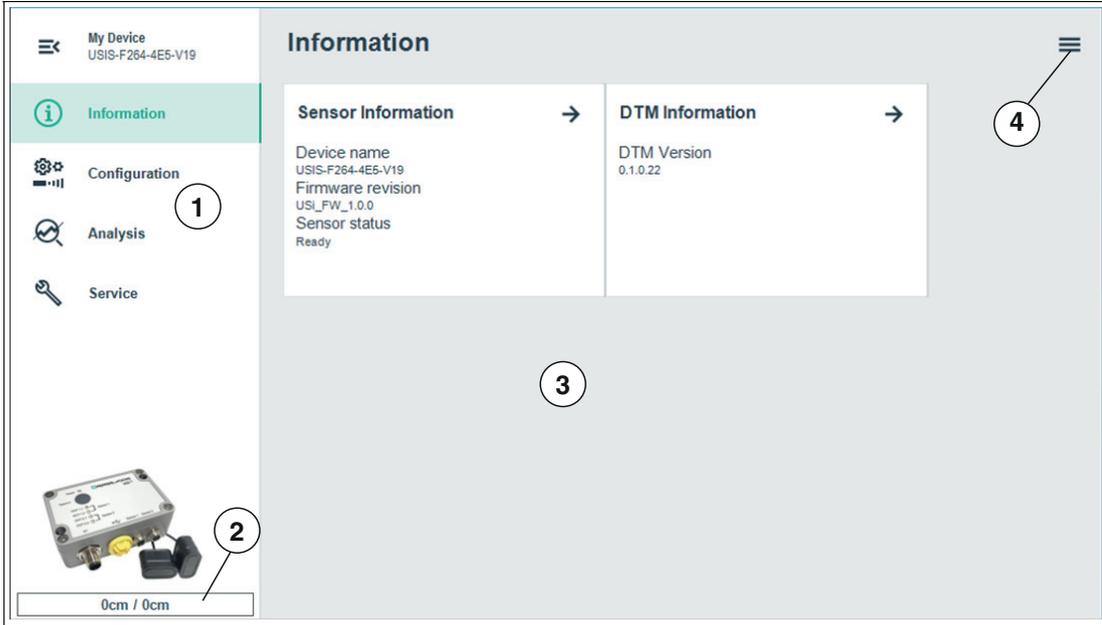


Figure 5.1

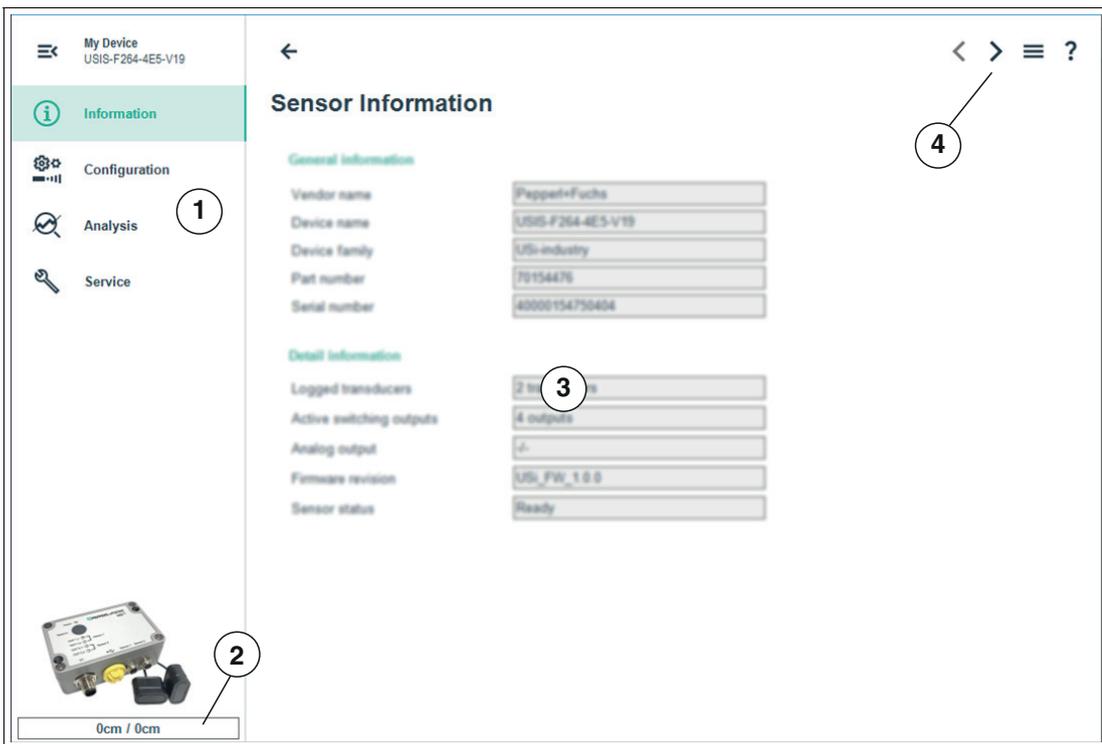


Figure 5.2

Number	Area	Description
1	Main Menu	The DTM consists of four main menu items, which are used to branch to further submenus. These are displayed as tiles with the most important tooltips in area three.
2	Measurement Value Display	The current measured values in "cm" or "mm" are displayed below the product image. The left part represents the measured value of ultrasonic transducer 1 and the right part of ultrasonic transducer 2. The information of a "non-evaluation" of an echo is output as "0" or possible fault states of the respective channels.
3	Main working area	This screen displays other selections as tiles with the most important tooltips. Selecting a tile displays all the detailed information available for this topic. You can also change the associated parameters there.
4	Navigation controls	Additional controls are located in the upper line of the DTM user interface. The arrow to the left "←" takes you back to the tile display of the respective menu item. With a smaller "<" or larger ">", you can navigate forward or backward step by step from tile to tile. The underlying content is displayed. The three horizontal lines "☰", known as the hamburger menu, provide additional functions.
☰	Hamburger menu	This menu contains the following options: <ul style="list-style-type: none"> • Load the parameters from the sensor • Transfer parameters to the sensor • Read parameters from file • Write parameters to file • Print parameters • Display DTM help Detailed help can also be found on the individual menu pages by selecting "?" in the upper right corner.

Table 5.1

Main Menu Items of the Device Type Manager DTM

The main menu of the DTM contains four options.

- **Information**
There are two tiles under Information: **Sensor information** and **DTM information**. By selecting a tile, the relevant information is displayed below it.
- **Configuration**
The Configuration menu item contains all the tiles with which you can define the desired sensor behavior for the application. The individual selection options relate to the **inputs, outputs, sensor settings**, and a variety of **evaluation parameters**.
- **Analysis**
The **Analysis** allows you to check the ultrasound sensor system. For each connected ultrasonic transducer, the ultrasonic echo signal is visualized in the form of an oscillogram and the distance to the nearest objects is displayed.
- **Service**
Under this menu item you can carry out **service functions** on the ultrasonic sensor system and call up additional product data via the Pepperl+Fuchs website.

5.2 Menu Item Information

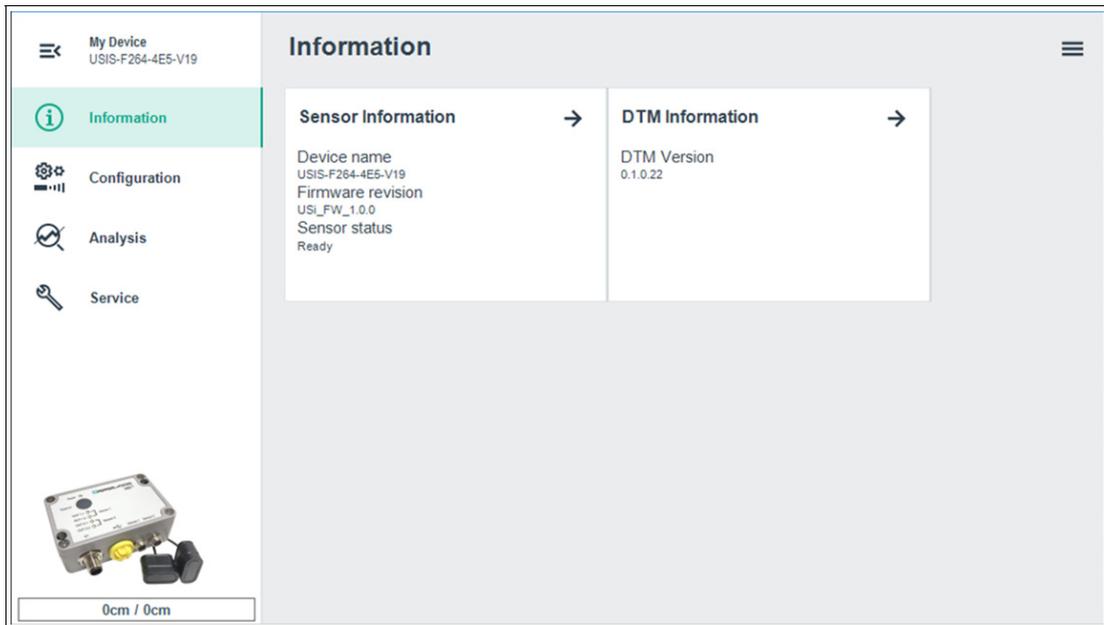


Figure 5.3

Relevant sensor information and DTM information is displayed under the **Information** menu item. By selecting a tile, the relevant information is displayed below it.

- Sensor information: fixed manufacturer information about the device is displayed, and basic settings and firmware details.
- Sensor information—sensor status: The sensor status indicates the status of the ultrasonic sensor system. If everything is OK, "Ready" is displayed. Otherwise, an error code is output at this point. For an overview of the error codes, refer to the "Troubleshooting" chapter; see chapter 7.2.
- DTM information: relevant information on the DTM, such as affected device series, DTM version and creation date, is displayed.

5.3 Menu Item Configuration

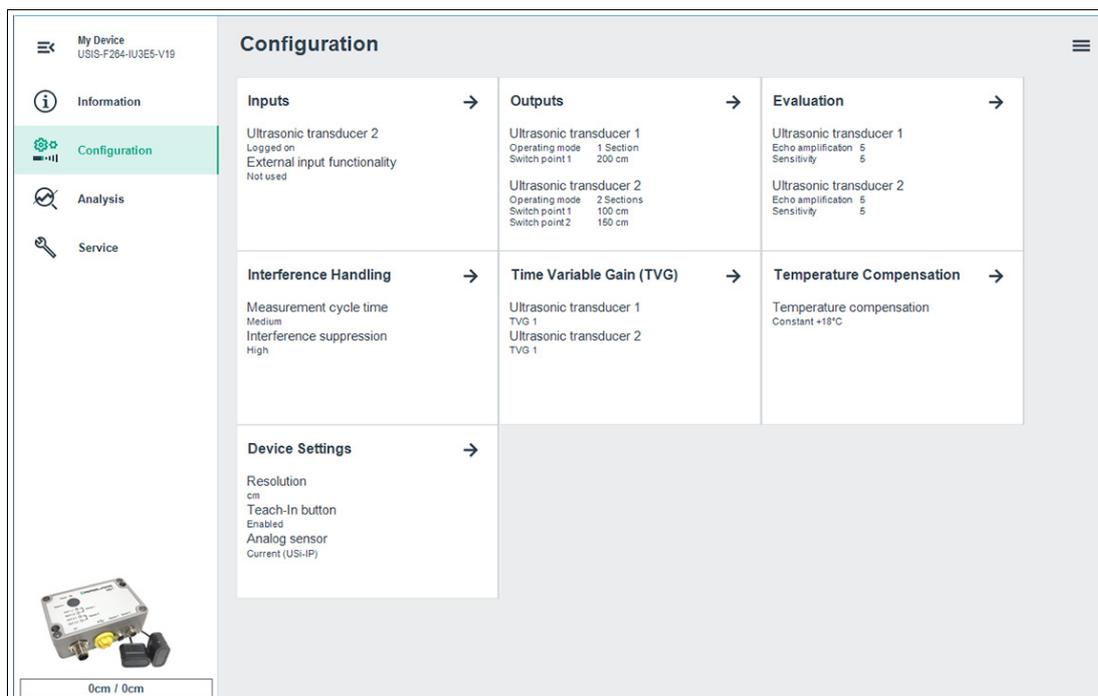


Figure 5.4

You can configure or display the basic settings of the USi-industry ultrasonic sensor system via the **Configuration** menu item.

The following seven tiles are organized according to technical contexts:

- Inputs
- Outputs
- Evaluation
- Interference Handling
- Time Variable Gain (TVG)
- Temperature Compensation
- Device Settings

You can select the individual parameters directly with the mouse or use the TAB key to move from one parameter to the next. You can change the parameters within their limits and selection options. A change is shown in green, but is not immediately available in the sensor.

As soon as a parameter is changed, the "Transfer parameters to the sensor" button appears in the DTM. All parameters of the USi-industry system are always transferred.

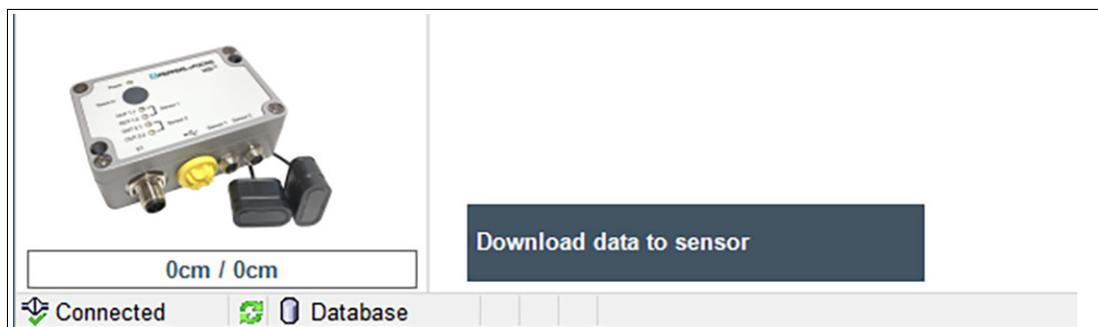


Figure 5.5

It is not necessary to transfer an individual parameter to the USi-industry system every time a change is made. You can change several parameters across the individual tiles and finally transfer all parameters together via this button.

5.3.1 Inputs Tile

Ultrasonic Transducer 2

With USi-industry, up to two ultrasonic transducers can be operated independently of each other on one evaluation unit. Ultrasonic transducer 1 is always registered and therefore cannot be deregistered.

With a selection, you can set or delete the parameter for the second ultrasonic transducer:

- **Registered**
This selection allows you to register ultrasonic transducer 2.
- **Deregistered**
This selection allows you to deregister ultrasonic transducer 2.

Factory setting: deregistered

Note

Before registering ultrasonic transducer 2, it must be connected to the "Sensor 2" slot.

External Input Function

The USi-industry system has a digital input that you can parameterize for the following tasks:

- **Not used**
No function is assigned to the input and it is deactivated.
- **Switch off outputs**
This function can be used to switch off all outputs as long as a high signal is present at the input. The switching outputs switch to the off state.
The analog outputs are 0 mA for the current sensor and 0 V for the voltage sensor.
- **Toggle between parameter set 1, 2**
If this function is selected, the USi-industry system has two individual sets with all parameters and teach-in reference curves for both ultrasonic transducers.
 - If the input is low active, parameter set 1 is selected
 - If the input is high active, parameter set 2 is selected
- **External teach-in**
The USi-industry system can learn its environment in three ways:
 - Via the button on the device
 - Via the button in the DTM
 - Via the digital inputIf this function is selected, the teach-in process is triggered with a high signal at the input.

Factory setting: not used



5.3.2 Outputs Tile

Each ultrasonic transducer connected to the USi-industry system and registered is assigned two outputs:

- Ultrasonic transducer 1: OUT1.1, OUT1.2
- Ultrasonic transducer 2: OUT2.1, OUT2.2

The USi-industry version with analog output USI*-IU3E5-* has one analog output and three switching outputs. By default, ultrasonic transducer 1 always controls analog output OUT1.1 and switching output OUT1.2. A special setting can also be used to output an analog value to OUT1.1 for ultrasonic transducer 2 via a multiplex method. For details, see section "USI*-IU3E5-*: OUT2.1 behavior" below

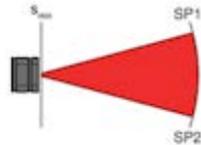
You can set the behavior of the outputs using the parameters described below.

Operating Mode

The "Operating mode" parameter influences the division of the detection field into ranges and therefore the assignment of the outputs to the individual ranges. This determines when the switching outputs must switch. The slope of the linear curve at the analog output is also defined.

The following ranges can be set:

- **Single range [SP1 = SP2]**



This selection combines the SP1 and SP2 switch points. The detection field extends from roughly the surface of the ultrasonic transducer to switch point SP1. Both programmable outputs are assigned to this range. If an object is detected in this range, both outputs OUTx.1 and OUTx.2 assigned to the transducer are set.

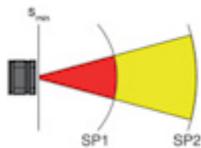
For the "Single range" operating mode, the following behavior applies at the analog output:

- Resolution (I) = 16 mA / (SP2 - 15 cm) in mA/cm
- Resolution (U) = 10 V / (SP2 - 15 cm) in V/cm

The analog value for an object at position x is calculated using the following mathematical functions:

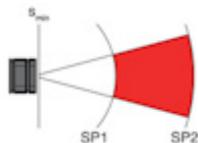
- $I(x) = \text{Resolution (I)} * (x - 15 \text{ cm}) + 4 \text{ mA}$
- $U(x) = \text{Resolution (U)} * (x - 15 \text{ cm})$

- **Double range [SP1 < SP2]**



With this selection, switch points SP1 and SP2 are separate and can be parameterized differently. This results in two detection ranges in front of the ultrasonic transducer, both of which are defined from roughly the ultrasonic transducer surface up to switch point SP1 and switch point SP2. A parameterizable output is assigned to each individual range. If an object is detected in these ranges, outputs OUTx.1 and/or OUTx.2 assigned to the transducer are set. This selection is not available for an analog output.

- **Window range [SP1 < SP2]**



With this selection, switch points 1 and 2 are separate and you can parameterize them differently. In this operating mode, a detection range is defined that extends from SP1 to SP2.

Both programmable outputs are assigned to this range. If an object is detected in this range, both outputs OUTx.1 and OUTx.2 assigned to the transducer are set. The range from the ultrasonic transducer surface to switch point 1 is hidden.

For the "Window range" operating mode, the following behavior applies to the analog output:

- Resolution (I) = 16 mA / (SP2 - SP1) in mA/cm
- Resolution (U) = 10V / (SP2 - SP1) in V/cm

The analog value for an object at position x is calculated using the following mathematical functions:

- $I(x) = \text{Resolution (I)} * (x - \text{SP1}) + 4 \text{ mA}$
- $U(x) = \text{Resolution (U)} * (x - \text{SP1})$

Note

If an object in the hidden range generates multiple echoes that hit the window range, these can be evaluated as valid objects in the window range.

Value range:

- Single range
- Double range
- Window range

Factory setting: Single range

Switch Point 1 (SP1)

Switch point 1 is the first switch point from the ultrasonic transducer and influences output OUTx.1. It is entered in cm or mm according to the selected resolution. Switch point 1 can be freely entered in all operating modes and must be less than the value for switch point 2.

Value range: 15 ... 250 cm or 150 ... 2500 mm

Factory setting: 200 cm

Switch Point 2 (SP2)

Switch point 2 is the farthest switching point from the ultrasonic transducer, i.e., the end of the evaluated sensing range and influences output OUT x.2. It is entered in cm or mm according to the selected resolution. Switch point 2 can be freely entered in the double range and window range operating modes and must be greater than the value for switch point 1.

Value range: 15 ... 250 cm or 150 ... 2500 mm

Factory setting: 200 cm

Note

In the "Single range" operating mode, it is not possible to enter switch point 2 and therefore this cannot be changed. In this operating mode, SP1 = SP2.

After selecting the "Double range" or "Window range" operating mode, you must check the values for the switch points for SP1 < SP2.



Switching Hysteresis

With switching hysteresis, you can define an adjustable hysteresis for the switch points. It minimizes output fluctuations and the switching frequency that can occur at the switch points when evaluating "object detected - object not detected". This leads to an improvement in system stability.

The hysteresis is specified as a distance value for switch point 2, the maximum value of the detection range. This value is therefore applied negatively to switch point 2 (SP2 - hysteresis). The hysteresis value for switch point 1 is determined by the percentage for switch point 2 and is applied positively to switch point 1 (SP1 + hysteresis%).

In single range operating mode, $SP1 = SP2$. The maximum valid value is $SP2/10$.

In the "Double range" and "Window range" operating modes, the hysteresis for switch point 1 is converted into a percentage. The ratio of SP2 and hysteresis value is calculated and applied to SP1. If the value is outside the limits, the smallest hysteresis value for SP1 is set to 1 cm for cm resolution or 5 mm for mm resolution.

Value range: 0, 1 ... 10 % of SP2 [cm] or 5 ... 10 % of SP2 [mm]

Factory setting: 0

OUT1.1 Behavior

OUT1.1 is the first of two outputs that is controlled by ultrasonic transducer 1 according to the selected operating mode and the set switch points.

The output behaves according to the USi-industry device type and the output parametrization:

- USI*-4E5-*: OUT1.1 is a switching output (PNP) and can be parameterized as "normally-open", "normally-closed", or "off."
- USI*-IU3E5-*: OUT1.1 is an analog output and can be defined as "Current output (I)" or "Voltage output (U)"; see "Sensor settings" tile.
 - Current output: If current output is selected, it issues data depending on the distance of the detected object. These are in the range 4 to 20 mA or inverted from 20 to 4 mA.
At 0 mA, there is an error or the output is disabled.
 - Voltage output: If voltage output is selected, it issues data depending on the distance of the detected object. These are in the range 0 to 10 V or inverted from 10 to 0 V.
At 0 V, it is not possible to distinguish between a measured value, an error, or a deactivated output.

"Switching output" value range:

- Normally-open
- Normally-closed
- Off

"Analog output" value range:

- For current output: 4 ... 20 mA or 20 ... 4 mA
- For voltage output: 0 to 10 V or 10 ... 0 V

Factory setting: normally-open and 4 ... 20 mA

OUT1.2 Behavior

OUT1.2 is the second of two outputs that is controlled by ultrasonic transducer 1 according to the selected operating mode and the set switch points.

It is a switching output (PNP) for all USi industry device types and can be parameterize as normally-open, normally-closed, or "off."

"Switching output" value range:

- Normally-open
- Normally-closed
- Off

Factory setting: Normally-open

OUT2.1 Behavior

OUT2.1 is the first of two outputs that is controlled by ultrasonic transducer 2 according to the selected operating mode and the set switch points.

It is a switching output (PNP) for all USi industry device types and can be parameterize as normally-open, normally-closed, or "off."

Switching output value range:

- Normally-open
- Normally-closed
- Off

Factory setting: Normally-open

USI*-IU3E5-*: OUT2.1 Behavior

The USi-industry system analog output USI*-IU3E5-* has one analog output and three switching outputs.

- Ultrasonic transducer 1 always controls analog output OUT1.1 and switching output OUT1.2 by default.
- Ultrasonic transducer 2, which can be optionally connected, is assigned to switching outputs OUT2.1 and OUT2.2. If analog values are to be output for ultrasonic transducer 2, this can be done via OUT1.1 by multiplexing this analog output.
This means that the "Analog output" or "Digital output" options are available for ultrasonic transducer 2.
- **Analog output**
Data from ultrasonic transducer 2 are output via OUT1.1 by multiplexing it. The OUT2.1 switching output becomes the clock output for the downstream controller. The time specified for this clock is specified in the value field.
 - OUT2.1 low active: analog measured value at OUT1.1 belongs to ultrasonic transducer 1
 - OUT2.1 high active: analog measured value at OUT1.1 belongs to ultrasonic transducer 2
- **Digital output**
The OUT2.x outputs are defined as switching outputs. They are influenced according to the evaluated results of the ultrasonic transducer 2, the selected operating mode and switch points, and the behavior of the outputs.
In this case, analog output OUT1.1 only remains for ultrasonic transducer 1.

Time range toggle: 0.1 ... 4 s (in 0.1 s increments)

Factory setting: Digital output

OUT2.2 Behavior

Output OUT2.2 is the second of two outputs that is controlled by ultrasonic transducer 2 according to the selected operating mode and the set switch points.

It is a switching output (PNP) for all USi industry device types and can be parameterize as normally-open, normally-closed, or "off."

Switching output value range:

- Normally-open
- Normally-closed
- Off

Factory setting: Normally-open

Switch-on Delay

The "switch-on delay" parameter defines the number of required measuring cycles in which identical detections must occur for the USi-industry system to verify an object as valid and to control the outputs accordingly. This achieves delayed switching, for example to suppress short switching pulses caused by possible interferences and to provide a stable output signal.

Which signal change is viewed as the switch-on process depends on the setting of the "OUTx.x" behavior.

- If the output is set to "normally-open," the switch-on delay acts when the output status changes from "open" to "closed."
- If the output is set to "normally-closed," the switch-on delay acts when the output status changes from "closed" to "open."

Value range: 1 ... 100 cycles

Factory setting: 3 cycles



Note

The time of the switch-on delay is determined by the product of "Measuring cycles x measuring cycle time."

This parameter influences the response time of the sensor.

Switch-Off Delay

The "switch-off delay" parameter defines the number of measuring cycles, i.e., the number of consecutive times that an object previously detected as valid no longer needs to be detected so that the outputs are reset. This results in a delayed switch-off, for example to make events available for a longer period for downstream controllers.

Which signal change is viewed as the switch-off process depends on the setting of the "OUTx.x" behavior.

- If the output is set to "normally-open," the switch-off delay acts when the output status changes from "closed" to "open."
- If the output is set to "normally-closed," the switch-off delay acts when the output status changes from "open" to "closed."

Value range: 1 ... 100 cycles

Factory setting: 10 cycles



Note

The time of the switch-off delay is determined by the product of "Measuring cycles x measuring cycle time".

This parameter influences the response time of the sensor.

USI*-4E5-*: Output Logic

With USi-industry only with switching outputs USI*-4E5-*, you can use the "output logic" parameter to control the switching outputs as permanently switched (like a switch) or clocked (like a button) as long as an object is detected.

- Selecting "constant" selects the output logic corresponding to a switch. As long as an object is recognized as valid, the outputs remain set
- Selecting "clocked" selects the output logic corresponding to a button.
"T_on" determines the time for which the outputs remain set when an object is recognized as valid and then reset for the "T_off" time. This process is repeated as long as a valid object is detected in the detection range.

Value range: constant, clocked

Time range T_on: 0.1 ... 4 s (in 0.1 s increments)

Time range T_off: 0.1 ... 4 s (in 0.1 s increments)

Factory setting: constant

5.3.3 Evaluation Tile

Ultrasonic Transducer 1/Ultrasonic Transducer 2

You can evaluate ultrasonic transducers 1 and 2 connected and registered to the USi-industry system independently of each other and differently. You can use the parameters described below to define the transmitting and receiving behavior of the ultrasonic transducers. These options allow you to influence the result of the evaluation by optimally adjusting the parameters for your application.

Echo Gain

Depending on the distance, size, shape, and surface of an object, the echoes may be more pronounced or weaker. To change the amplitude of the input signals, the incoming analog echoes can be amplified using the "echo gain" parameter.

This is possible in 10 stages, with 1 being a low amplification and 10 being a high amplification. The parameter value has no unit and indicates the amplification factor that directly affects the electronics.

Value range: 1 ... 10

Factory setting: 5

Sensitivity

As with the echo gain, the "Sensitivity" parameter also influences the echo evaluation of the USi-industry system.

The parameter determines the software sensitivity threshold for the received echoes in ten stages and therefore the behavior of the outputs. Here, 1 is the lowest and 10 is the highest sensitivity. The parameter value has no unit and specifies the threshold value for the echo evaluation in the software.

Value range: 1 ... 10

Factory setting: 5

Near Range Low Gain

The "Near range low gain" parameter defines a distance at which a low amplification is used to evaluate the echo signal. The distance is from the surface of the ultrasonic transducer to a specified distance value.

This makes it possible to reduce disruptive effects in this near range of the ultrasonic transducer, which can be caused, for example, by influences from the transducer mounting, side lobes, etc. After this range, the default echo gain is applied.

Value range: 1 ... 100 cm or 10 ... 1000 mm

Factory setting: 15 cm

Echo Signal Widening

The "Echo signal widening" parameter specifies the distance from which the received echo signal is widened using an internal calculation.

This process increases the reliability of detecting small objects at great distances and evaluating them accordingly.

Value range: 1 ... SP2 in cm or 10 ... SP2 in mm

Factory setting: 50 cm

Object Detection

The "Object detection" parameter can be used to detect and evaluate objects according to their state of motion, preferably in the longitudinal direction.

- **Automatic**
By default, the USi-industry system detects both stationary (static) and moving (dynamic) objects.
- **Static**
The USi-industry system only evaluates objects if their state of motion is static.
- **Dynamic**
The USi-industry system only evaluates objects if their state of motion is dynamic.



Note

If "static" is selected, we recommend selecting a long measuring cycle time and reducing the amplification as far as possible. Increasing the switch-on delay and reducing the switch-off delay can improve functionality.

If "dynamic" is selected, we recommend selecting a short measuring cycle time. The amplification can also be reduced. Reducing the switch-on delay and increasing the switch-off delay can improve functionality.

Value range: automatic, static, dynamic

Factory setting: automatic

Object Evaluation

The USi-industry system always compares its received echo signal with the reference curve stored as a teach image. The "Object evaluation" parameter defines which change in the detection field should be responded to.

- **All**
The USi-industry system recognizes whether a new object has been added and whether a learned object is missing. This means that all changes in the detection field lead to a corresponding evaluation.
- **Negative only**
If "negative only" objects are selected when choosing the parameter, only missing objects in the detection area will lead to a corresponding evaluation with regard to the reference curve.
- **Positive only**
If "positive only" objects are selected when choosing the parameter, only additional objects in the detection area will lead to a corresponding evaluation with regard to the reference curve.

Value range: all, negative only, positive only

Factory setting: all

Sensor Mode

Ultrasonic transducers can generally be used as emitters and/or receivers. The "Sensor mode" parameter defines how the connected ultrasonic transducer should be operated.

Emitter-receiver mode is the preferred setting for the ultrasonic sensor system. This means that the system operates in reflection mode. The ultrasonic wave travels to the object and back again, covering twice the distance. The USi-industry system always uses this as a basis for determining the object distance.

The operation of the ultrasonic sensor system as a sound barrier or thru-beam sensor doubles the detection range, since the ultrasonic wave only has to travel the measuring distance to the receiver. Operation as a thru-beam sensor is not used for distance measurement but for detecting objects passing through the barrier. The information content is merely a yes/no statement.

The following settings are possible:

- **Emitter/receiver**
With this selection, the USi-industry system operates in emitter-receiver mode
- **Emitter**
The connected ultrasonic transducer only operates as an emitter.

- **Receiver**

The connected ultrasonic transducer only operates as a receiver.



Note

In the DTM, only half the distance between emitter and receiver is displayed, since the DTM originally assumes a scanning sensor. In this sensor mode, the ultrasonic transducers can be up to twice as far apart as the maximum detection range.

We recommend checking the transmission intensity, amplification, and sensitivity and reducing them if necessary. This is especially necessary for smaller objects and where there is a shorter distance between the emitter and receiver, so that these are also detected as an interruption of the thru-beam sensor. Otherwise, small objects will not be detected, since they are surrounded by the wide ultrasonic beam of the emitter and therefore the receiver is not completely covered.

Value range: emitter/receiver, emitter, receiver

Factory setting: emitter/receiver

Transducer Priority

In the USi-industry system, ultrasonic transducers 1 and 2 are operated alternately. The "Transducer priority" parameter can be used to change this to speed up the detection of objects. This can shorten the reaction time of the system by prioritizing one ultrasound transducer.

The available settings are:

- Off
- Number

This parameter depends on the largest switch-on delay (multiple scan) of an ultrasonic transducer. As soon as an object is detected by only one ultrasonic transducer, this is given priority for the following measuring cycles of the value entered under "Number." During this time, the other ultrasonic transducer remains inactive

Once the value specified under "Transducer priority" has elapsed, the inactive ultrasonic transducer is activated and evaluated. If the status of both ultrasonic transducers is the same, i.e., both ultrasonic transducers detect an object or do not detect an object, the priority is not executed and both ultrasonic transducers operate alternately again.

Value range: off, number ≤ largest switch-on delay

Factory setting: off

Transmission Intensity

You can set the transmission intensity for ultrasonic transducers 1 and 2 in four stages. This allows the system to be adapted to the properties of sound reflecting or sound absorbing objects or environments. This influences the "volume" of the ultrasonic transducers. By default, the transmission intensity is set to "maximum" and you can reduce the setting in steps. There are four steps available for this.

Value range:

- Low
- Medium
- High
- Maximum

Factory setting: maximum



Note

Selecting the transmission intensity also changes the detection capacity in relation to the sonic lobe width and the sensing range.

Ultrasonic Burst

You can use the "Ultrasonic burst" parameter to define the frequency of the transmission pulse for ultrasonic transducers 1 and 2. The "Single frequency" and "Multiple frequency" options are available here.

- **Single frequency**

The ultrasonic transducers are set to their resonance frequency of 103 kHz.

- **Multiple frequency**

With this setting, the ultrasonic transducers operate with several frequencies adjacent to the resonance frequency to prevent single frequencies from being canceled out. This can increase the detection capacity of poorly reflective objects, for example.

Value range: single frequency, multiple frequency

Factory setting: Single frequency



Tip

If an unstable detection capability occurs in the lower or upper temperature limit range, you can bring about a possible improvement by selecting "Multiple frequency."

5.3.4 Interference Handling Tile

With the USi-industry system, various options for interference suppression can be selected for the evaluation.

Noise Suppression

For "noise suppression," you have three levels to choose from and the option of setting the "time" for a delay period in which an interference is tolerated and does not affect the outputs:

- Off
- Medium
- High

If a noise is present for longer than defined and this action remains ineffective, the outputs can behave randomly.

This function is usually used when external sources of interference, such as compressed air valves, can interfere with the USi system.

Value range: off, medium, high

Time: 0 to 4 s in 0.1s increments

Factory setting: high and 1 s

Interference Echo Suppression

"Interference echo suppression" is a special function and you can select one of the following settings:

- Off
- Medium
- High

"Interference echo suppression" is used primarily when identical systems can interfere asynchronously with each other. Such interference occurs either through direct interference or through multiple and cross-reflections, for example when AGVs/AGTS meet each other.

When a function is selected, it is only active in the evaluation if the sensor detects possible interference.

Value range: off, medium, high

Factory setting: off



Note

Selecting this function affects the measuring cycle time in the event of detected interference. This can double at most.

Measuring cycle time

The "measuring cycle time" defines the duration for the transmission pulse and subsequent echo evaluation that two ultrasonic transducers connected to the USi require. If only one ultrasonic transducer is used, the time is added for the second one.

You can choose from the following three fixed settings or set a user-defined time:

- Short (33 ms)
- Medium (50 ms)
- Long (100 ms)
- User-defined value from 10 ms to 200 ms

Value range: short, medium, long, 10 to 200 ms

Factory setting: medium



Note

The measuring cycle time is the total transmission and evaluation time and always refers to both ultrasonic transducers. User-defined values depend on the maximum measurement distance.



Note

In the event of interference, it can be useful to synchronize hardware devices via the sync line. This is possible on request. All versions of the USi-industry system are parameterized as a single device. Therefore, synchronization with the current USi-industry system status is only implemented using the "Interference echo suppression" software parameter.

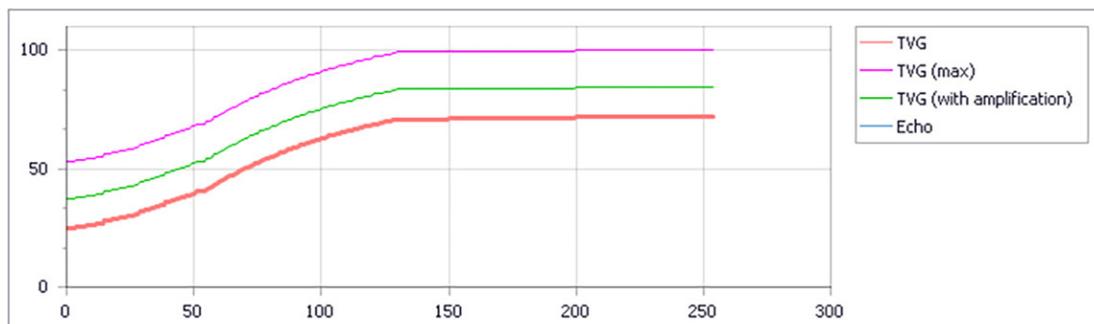
5.3.5 Time Variable Gain (TVG) Tile

The TVG characteristic curve (Time Variable Gain) maps the runtime-dependent gain and is increased by the factor of the "echo gain" parameter. The basic characteristic curve, at echo gain 1, is shown in red. The maximum characteristic curve is obtained by shifting by the factor of the maximum echo gain 10 and is shown in purple in the diagram. The gain characteristic curve valid in the sensor is shown in green in the diagram.

TVG Characteristic Curves

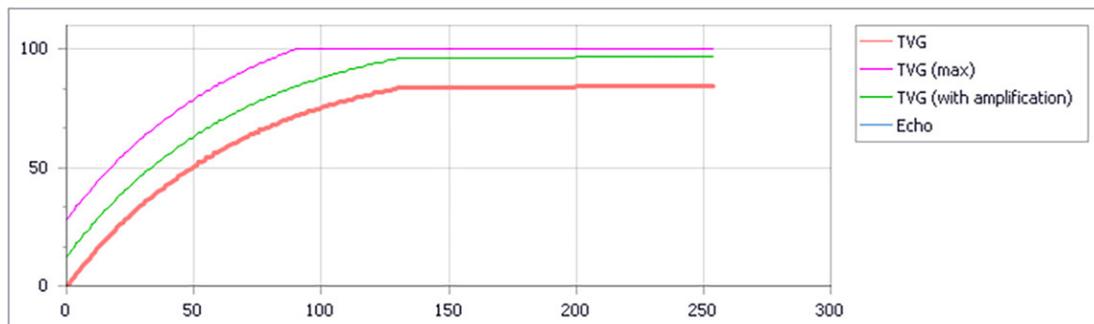
You can choose between two predefined and one user-defined TVG characteristic curve.

- **TVG 1: Characteristic curve with initial amplification**



With this characteristic curve, a high detection capability is achieved for the entire system, even in the immediate vicinity of the ultrasonic transducer.

- **TVG 2: Characteristic curve without initial amplification**

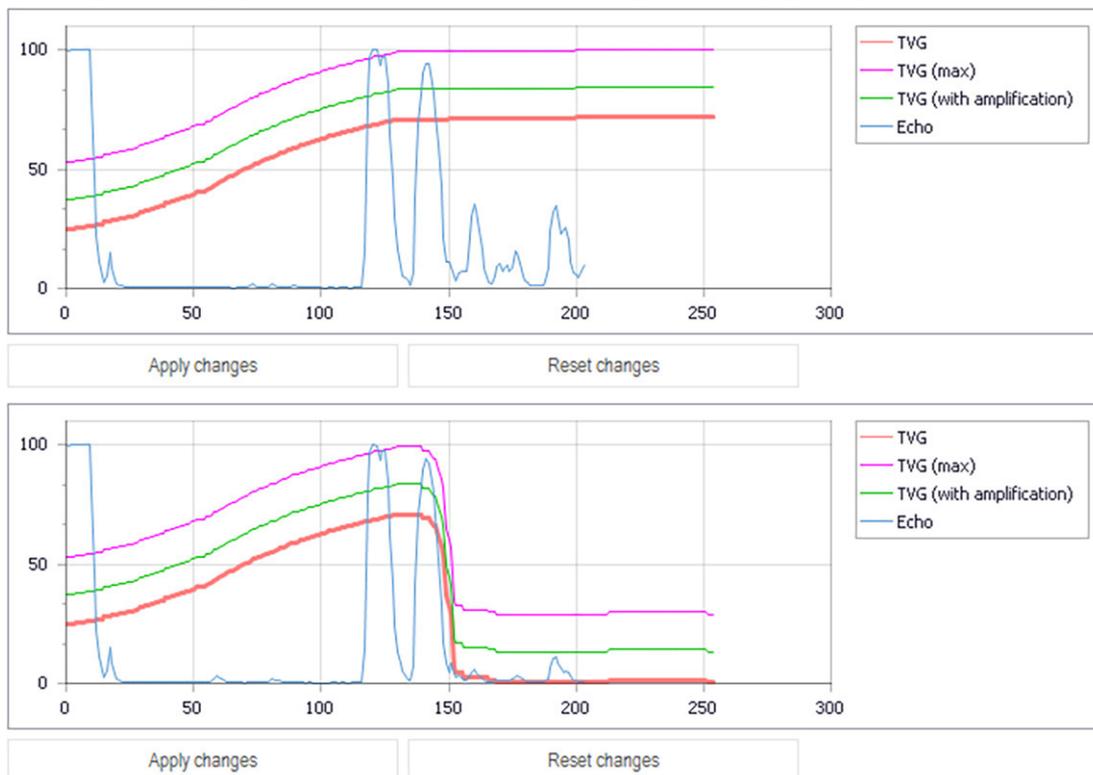


With this characteristic curve, a lower detection capacity is achieved for the entire system in the initial range and potential override of the amplification is prevented. A higher amplification is defined in the further course of the characteristic curve and therefore a higher detection capability is provided at a greater distance.

- **User-defined: Freely defining a characteristic curve**

This function can be used, for example, to selectively adjust the evaluation of individual ranges where unwanted echoes occur. The TVG, echo gain, and sensitivity parameters are again crucial for the detection capability of the overall system.

By selecting "User-defined," you can freely define the characteristic curve according to your own requirements. The mouse pointer is positioned on the red characteristic curve. The characteristic curve is drawn by holding down the left mouse button. The ultrasound echo signal is displayed as a blue waveform in the diagram to help guide you.



Click "Reset changes" to discard the drawn characteristic curve and display the original TVG characteristic curve.

"Apply changes" completes the drawing process and allows the data to be transferred to the USi-industry system.

Value range: TVG 1, TVG 2, user-defined

Factory setting: TVG 1

TVG File ...

You can archive the TVG characteristic curves as a *.usi file.

- **Load TVG file**

You can use this button to load a TVG characteristic curve stored as a *.usi file from a data carrier. This is displayed in the diagram and can be adopted and transferred to the USi-industry system.

- **Save TVG file**

You can use this button to save the currently displayed TVG characteristic curve as a *.usi file on a data carrier.

5.3.6 Temperature Compensation Tile

Changes in the ambient temperature influence the speed of sound and therefore the distance-dependent measurement data of the USi-industry system.



Note

The temperature sensor is installed within the USi-industry evaluation unit and uses a device-specific correction table to determine the ambient temperature. When the ultrasonic sensor system is switched on, the difference between the inside and outside temperature can be large, but is reduced by self-heating of the evaluation unit. This deviation between the internal temperature of the device and the ambient temperature is equalized after approx. 30 minutes of operating time at the latest.

This temperature measurement can also be falsely influenced during operation by external influences that cause the device enclosure to heat up or cool down.

Depending on the system, the evaluation unit and ultrasonic transducer are separate components that can be mounted in different positions. Therefore, they may be subject to different temperature influences.

You can choose between three options for temperature compensation via the "Temperature compensation" parameter:

- **Constant + 18 °C**
For applications that are not critical in terms of temperature fluctuations, the USi-industry system uses a constant value of +18 °C. This corresponds to the average temperature to be expected in the industrial sector.
- **Input value**
If the USi-industry system is used in a different temperature-constant working environment, you can enter a freely defined temperature between -30 ... +70 °C.
- **Internal NTC**
You can achieve automatic temperature compensation by selecting "Internal NTC." The USi-industry system uses an internal temperature sensor to determine the temperature.

Range of values: constant + 18 °C, input value, internal NTC

Factory setting: constant + 18 °C

5.3.7 Sensor Settings Tile

You can use the "Sensor settings" to configure the following system settings for the USi-industry ultrasonic sensor system on the evaluation unit.

Resolution

- **cm**
With this selection, the USi-industry system uses a measurement resolution in centimeters.
- **mm**
With this selection, the USi-industry system uses a measurement resolution in millimeters.

Value range: cm, mm

Factory setting: cm

Teach-In Button

The evaluation unit has a teach-in button on the enclosure that can be used for various functions. You can deactivate the button to prevent it from being pressed unintentionally.

- **Disabled**
This selection deactivates the teach-in button.
- **Enabled**
This selection activates the teach-in button.

Value range: deactivated, activated

Factory setting: activated

Note

If the teach-in button is deactivated, it is no longer possible to reset to factory settings using this button. The teach-in button can only be activated via the DTM.

Analog Sensor

The analog output of the USi-industry system can be defined as a current or voltage output.

- **Current (USi-IP)**
This selection switches the analog output to current output. It supplies a current of 4 ... 20 mA.
- **Voltage (USi-UP)**
This selection switches the analog output to voltage output. It supplies a voltage of 0 ... 10 V.

Value range: Current (USi-IP), voltage (USi-UP)

Factory setting: Current (USi-IP)

Note

The behavior of the current output "4 ... 20 mA" or inverted "20 ... 4 mA", and the voltage output "0 ... 10 V" or inverted "10 ... 0 V" is defined in the "Outputs" tile under "OUT1.1 behavior."



5.4 Menu Item Analysis

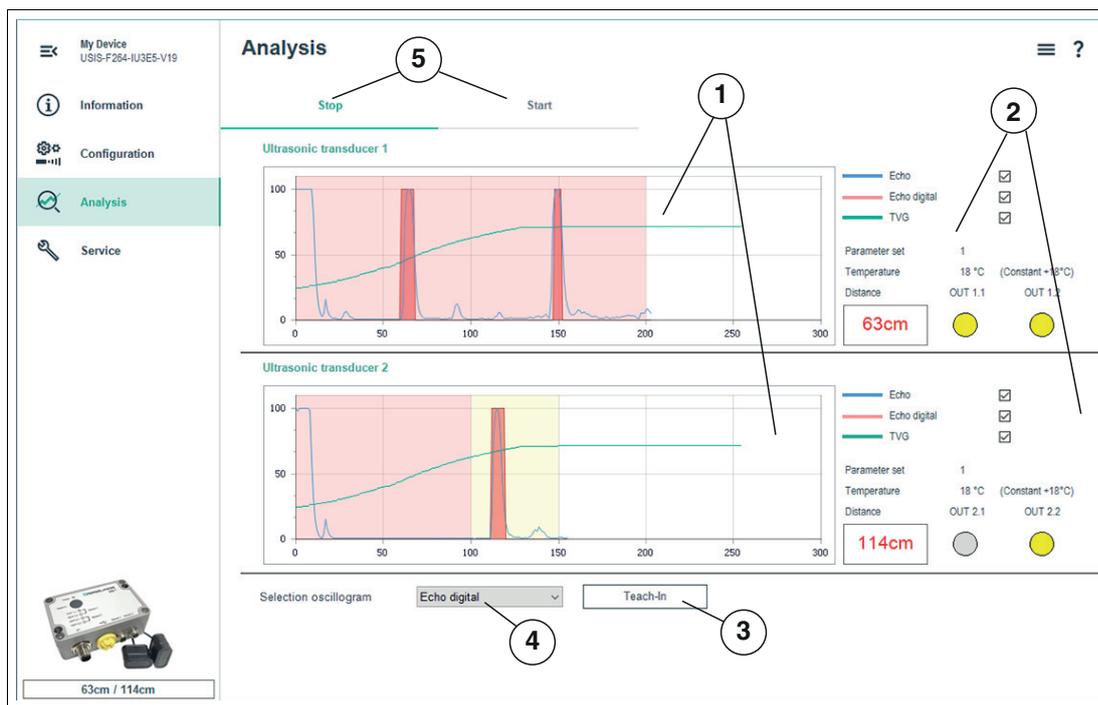


Figure 5.6

You can check the ultrasonic sensor system under the **Analysis** menu item. The ultrasonic echo signals are visualized in the form of an oscillogram display, showing distances and outputs.

The display consists of five areas.

(1) Oscillogram

The key element is the display of the signal characteristics for the ultrasonic transducers in the form of an oscillogram.

The signals of ultrasonic transducer 1 are displayed in the upper part and those of the optionally registered ultrasonic transducer 2 in the lower part in real time.

The oscillograms use lines to provide information about the parameterized detection capability of the ultrasonic sensor system in the application:

- Blue: signal characteristics of the echo
- Red (digital echo): evaluated digital echo of the detected valid echoes as rectangular areas that lead to evaluation and modification of the outputs.
 Red (teach reference): taught-in echo image as a colored curve.
 Red (teach difference): Differential echo image as a colored curve.
- Green: TVG gain characteristic curve

The sizes of the detection or measurement areas active for the evaluation are entered and highlighted in color according to the selected operating mode.

- **White background**
 Echoes are not signaled to the outputs in this area.
- **Red background**
 - In the single range defined by the ultrasonic transducer up to switch point 1 (= switch point 2), all valid echoes marked in dark red are signaled to both outputs OUTx.1 and OUTx.2 assigned to the transducer.
 - In the double range, the red-highlighted area is defined from the transducer to switch point 1. The valid echoes are signaled at OUTx.1.
 - In the window range, the area highlighted in red extends from switch point 1 to switch point 2. The echoes valid in this measurement window are signaled at OUTx.1 and OUTx.2.

- **Yellow background**

The area highlighted in yellow is only available in "Double range" mode. This is represented from switch point 1 to switch point 2, in which the echoes up to SP2 are evaluated. The valid echoes are signaled at OUTx.2.

(2) Data/Outputs

The display of the signal characteristics "Echo" (blue), "Echo digital" (red), and "TVG" (green) can be switched on or off by checking or unchecking the respective box.

The information about selected parameter set 1 or 2, and the temperature display with the current temperature value and its source (constant, input value, NTC) can be found below.

The current distance to the first valid object (first echo, which is different from the taught echo signal characteristics) appears in the box and is displayed in "cm" or "mm" depending on the parameterization of the resolution. The smallest valid measured value is "15 cm" or "150 mm." If an object is detected in the near field, i.e., in the area between the ultrasonic transducer and the smallest measured value, this value is output and the assigned switching output is set.

Note

The value "0" is not a measured value, but means that no object is being evaluated.

The value "-/-" means that there is no active connection between the DTM and the sensor.

OUT1.1, OUT1.2, OUT2.1, OUT2.2

OUT as a representation of the LEDs provides information about the status of the corresponding outputs on the device.

(3) Teach-In Button

Pressing this button triggers the USi-industry teach-in function. In doing so, the sensor learns the current situation in the detection area at that moment.

Note

The teach-in function is only available if no data transmission is active, i.e., the selection in area (5) must be set to "Stop."

You must perform a teach-in when commissioning the device after delivery or after resetting the parameters to the factory settings.

(4) Oscillogram Type

This function allows the oscillogram type to be selected for the signal characteristics colored in dark red.

- **Echo digital**

Echo digital displays the locations where objects or missing objects are detected and evaluated in a red area surrounding the blue signal characteristics of the echo. The USi-industry system compares the received echo with the stored teach-in image and sets its outputs accordingly.

- **Teach reference**

Teach reference shows the echo signal characteristics as they were stored as a reference at the time of the teach-in process.

- **Teach difference**

Teach difference shows the signal characteristics as an amount that is generated when the signal characteristics of the echo are subtracted from that of the taught in reference curve.

(5) Data Transmission Start/Stop

Pressing the "Start" or "Stop" button starts or stops the real-time display of the ultrasonic echo signals as an oscillogram in area (1). When the digital input is used to switch two sets of parameters, the "Start" button is divided into three options.

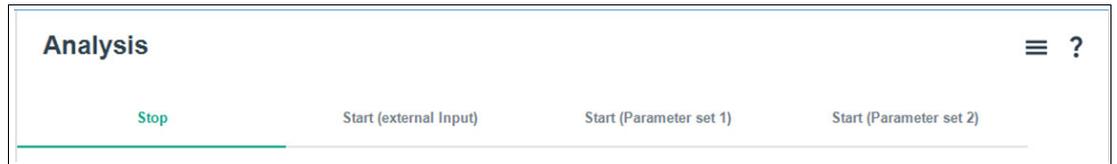


Figure 5.7

- **Start (external input)**
The oscillogram uses the parameter set according to the signal present at the digital input for display.
 - Input low active: parameter set 1 is used
 - Input high active: parameter set 2 is used
- **Start (parameter set 1)**
The oscillogram uses parameter set 1 for display, regardless of the input configuration.
- **Start (parameter set 2)**
The oscillogram uses parameter set 2 for display, regardless of the input configuration.



Note

Avoid triggering the teach-in function via the button on the device during data transmission. This could cause a malfunction in the DTM.

An active data transmission in analysis mode is indicated by the flashing green "Power" LED in the transmission cycle. When the analysis is stopped, the LED lights up continuously again.

The teach-in function via the "Teach-In" button (3) is only available if no data transmission is active, i.e., the selection in the area (5) must be set to "Stop."

The teach-in function for parameter sets 1 or 2 cannot be chosen selectively via the DTM. This means that the corresponding signal for the desired parameter set must be present at the input of the USi-industry evaluation unit before the detection field can be taught in using the "Teach-In" button.

During commissioning after delivery or after resetting the parameters to the factory settings, you must perform a teach-in for the corresponding parameter sets.

5.5 Menu Item Service

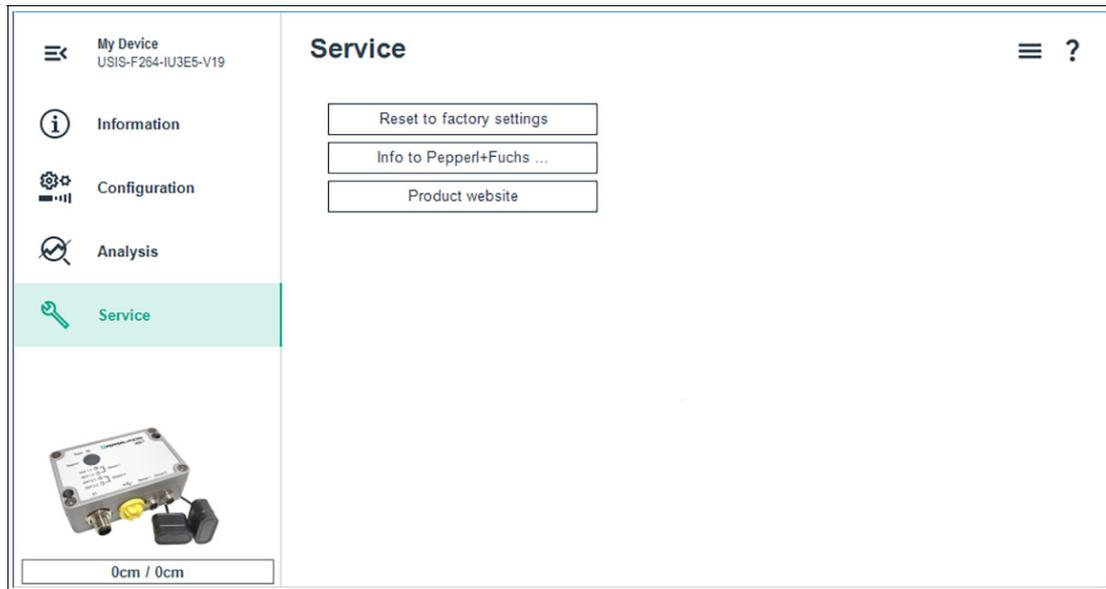


Figure 5.8

You can call up further functions for the ultrasonic sensor system under the **Service** menu item.

Service Functions

The following service functions are available and can be accessed by clicking on the respective buttons.

- Reset to factory settings**
 Clicking on this button resets the sensor to its factory settings after a confirmation prompt. Please note that the taught-in reference curves are also deleted and the outputs are set accordingly. You must carry out a teach-in for a new parameterization.
- Info to Pepperl+Fuchs ...**
 This function is primarily intended for customer support. It creates a file with the parameters currently set in the ultrasonic sensor system and an image of the analysis display. This information is automatically added to an email as an attachment. In the text field, you can enter additional information about the application or problem description. You must complete the recipient field of the email before sending it. This provides customer service with important information about the system and enables them to provide assistance quickly.
- Product website**
 Clicking on this button opens the Pepperl+Fuchs website and displays the USi-industry product page.

6 Maintenance and Repair

6.1 Maintenance Work

The USi-industry ultrasonic sensor system itself is maintenance-free. For this reason, regular adjustments and maintenance work on the components of the ultrasonic sensor system are not necessary.

However, check that the components of the ultrasonic sensor system and the connectors are securely in place as part of normal maintenance intervals. You may also want to check that the connection cable is installed and intact. Finally, we recommend a functional inspection.

6.2 Cleaning

Cleaning is only necessary in applications in which the transducer surface is exposed to dirt or build-up.

In general, the following applies as far as cleaning is concerned:

- Only with water without chemicals
- Without pressure/high pressure
- Only by using a soft cloth
- No abrasive cleaning, scratching, or scrubbing

7 Troubleshooting

What to Do in Case of Fault

In case of fault, check whether there is a fault in the ultrasonic sensor system either via the LED displays on the evaluation unit or via the DTM in the "Information" menu item.

- LED indicators: For more information on the flash codes and troubleshooting, refer to the checklist in the following chapter; see chapter 7.1.
- DTM, menu item "Information", tile "Sensor information" under entry "Sensor status": For more information on the error codes displayed, refer to the next chapter; see chapter 7.2.

If none of the information provided in the checklist solves the problem, contact Pepperl+Fuchs via your sales office with any queries. If possible, have the model number and firmware version of the sensor to hand.

Using the "Service" menu item, you can obtain additional, summarized information about your parameterization and analysis images of the echo signal characteristics via the "Info to Pepperl+Fuchs ..." function, see chapter 5.5.

7.1 Troubleshooting Using LED Indicators

In case of fault, use the following checklist to determine whether you can rectify a fault in the ultrasonic sensor system.

Checklist

Fault	Cause	Remedy
Green "Power" LED does not light up	The voltage supply is switched off.	Check whether there is a reason why the voltage supply is switched off (installation or maintenance work, etc.). Switch on the voltage supply if appropriate.
	The M12 plug is not correctly connected to connector X1 of the evaluation unit.	Connect the M12 plug to the sensor and tighten the union nut by hand.
	An incorrect supply voltage has been selected.	Check the supply voltage according to the nameplate or datasheet. Check the pinout of the connection cables.
	Faulty wiring in the splitter or switch cabinet.	Check the wiring carefully and repair any faults.
	The connection cable to the evaluation unit is damaged.	Replace the damaged connection cable.
	If the voltage supply and the wiring are correct: the evaluation unit is faulty.	Replace the evaluation unit.
Green "Power" LED and all yellow "OUT" LEDs flash three times at 1.5 Hz, only the yellow "OUT 1.1" and "OUT 1.2" LEDs light up	Ultrasonic transducer 1 is not connected correctly.	Connect ultrasonic transducer 1. Check the cable connection of the ultrasonic transducer.
	When the ultrasonic transducer is connected correctly: supply line or ultrasonic transducer may be faulty.	Replace ultrasonic transducer 1.

Fault	Cause	Remedy
Green "Power" LED and all yellow "OUT" LEDs flash three times at 1.5 Hz, only the yellow "OUT2.1" and "OUT2.2" LEDs light up	Ultrasonic transducer 2 is not connected correctly.	Connect ultrasonic transducer 2. Check the cable connection of the ultrasonic transducer.
	When the ultrasonic transducer is connected correctly: supply line or ultrasonic transducer may be faulty.	Replace ultrasonic transducer 2.
Green "Power" LED and all yellow "OUT" LEDs flash three times at 1.5 Hz, then all yellow "OUT" LEDs light up	Ultrasonic transducers 1 and 2 are not connected correctly.	Connect both ultrasonic transducers. Check the cable connections of the ultrasonic transducers.
	If the ultrasonic transducers are connected correctly: supply lines or ultrasonic transducer may be faulty.	Replace both ultrasonic transducers.
Yellow "OUTx.x" (normally-open) LED lights up although there is no moving object in the detection field	The device is not familiar with its environment. No teach-in was performed during commissioning.	Perform a "teach-in."
	The learned detection field has changed.	Perform a "teach-in."
Green "Power" LED flashes in the transmission cycle, yellow "OUT" LEDs flash according to a detected object	Ultrasonic transducer or supply line faulty during operation.	Check both the corresponding ultrasonic transducer and the cable connection.
Green "Power" LED flashes in the transmission cycle	Warning that temperature measurement NTC is outside the defined range.	Check the parameterized temperature compensation in the DTM. This behavior does not generate an error message, but serves as an indication.
Green "Power" LED flashes > 10 Hz	Electromagnetic interference	Check the cable routing between the ultrasonic transducers and the evaluation unit for strong sources of interference. Ground the evaluation unit if necessary.
	Acoustic noise	If possible, eliminate the interference. Depending on the application, try to improve the situation by: <ul style="list-style-type: none"> • Realigning the ultrasonic transducers. • Moving the ultrasonic transducers. • Using a bracket with a sound funnel. • Parameterizing the noise suppression.

Table 7.1

7.2 Troubleshooting Using the DTM (Error Codes)

In case of fault, use the following error code list to check whether you can rectify a fault in the ultrasonic sensor system.

The error codes are displayed in the "Information" menu item, "Sensor information" tile under "Sensor status" entry; see chapter 5.2.

Error Codes in the DTM

Error	Meaning	Comment
0	Ready	Operating state
1	No connection to ultrasonic transducer 1	Fault during operation
2	No connection to ultrasonic transducer 2	Fault during operation
3	No connection to ultrasonic transducers 1 and 2	Fault during operation
129	No connection to ultrasonic transducer 1	Error during power on
130	No connection to ultrasonic transducer 2	Error during power on
131	No connection to ultrasonic transducers 1 and 2	Error during power on
4	Warning, temperature measurement NTC outside limits	Message disappears as soon as temperature measurement is OK again
8	Synchronization error	Currently unavailable

Table 7.2

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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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