

UDC-/UDCM-*GS*-IO* Series

Parameterization of Ultrasonic Double Sheet Sensors with IO-Link interface

Manual



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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

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

1.4 Intended Use

The ultrasonic double sheet sensors of the UDC-/UDCM-*GS-*IO* series are used wherever an automatic distinction between single layers and double layers of materials or material compositions is required to protect machines and avoid rejects. Any solid, flat materials can be used. The ultrasonic transducers used in the device are designed to decouple the ultrasound into gaseous media (ideally: air), which is why the device does not work when submerged in a liquid medium.



Note

UDC-/UDCM-*GS-*IO* series ultrasonic sensors are not safety components within the context of the EC Machinery Directive 2006/42/EC. They must not be used, for the purpose of avoiding risk to individuals or parts of the body.

Always operate the device as described in these instructions to ensure that the device and connected systems function correctly. The protection of operating personnel and 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

The ultrasonic double sheet sensors of the UDC-/UDCM-*GS-*IO* series measure the attenuation of the emitted ultrasonic signal caused by a material introduced into the measuring path between transmitter and receiver. The residual amplitude of the ultrasonic signal arriving at the receiver is evaluated in relation to the set threshold values and assigned to the corresponding state (= "air", "single sheet" or "double sheet"). The detected state is reported back via the sensor's switching outputs and the IO-Link process data. The measured amplitude is also provided as an analog value in the IO-Link process data.

Measurements can be made on any kind of flat materials such as paper, cardboard, metal sheets, plastic foils and plastic plates, glass panels, wafers, wood panels and the like. The color, transparency and surface structure of the materials do not play any role, as is usual for the technological principle of ultrasound.

Typically, ultrasonic double sheet sensors are used in a wide range of applications including:

- Double sheet detection on various machines in the packaging industry and in the printing and paper sector (e.g. printing, punching, gathering, folding machines)
- Double layer detection on machines in the areas of wood, glass and sheet metal processing, and in battery production
- Continuous quality control in the production of multi-layer web materials (e.g. corrugated cardboard, beverage packaging materials)
- Ensuring the correct number of layers in the production of multi-layer materials, such as kitchen paper, toilet paper and tissues

Depending on the application, the sensor can be operated in the following ways:

1. By selecting one of the three threshold sets used:

Each threshold set covers a very wide range of materials. This means that in most applications the sensor can be operated with only one setting and does not need to be changed or taught in again when changing materials. The threshold values of each threshold set are preset, but can be adjusted as needed. If a single threshold set cannot cover the entire material range run on the machine, it is possible to dynamically switch between the threshold sets during operation.

2. By teaching in a specific material:

In some applications, it is necessary to teach in the sensor specifically to a material or a material constellation for multi-layer materials in order to be able to monitor it very sensitively.

3. Continuous IO-Link operation:

In addition to the option of parameterizing the sensor via the IO-Link interface, it can also be used in continuous IO-Link operation. This is possible in addition to or as an alternative to the two above-mentioned operating modes. Besides the detected state, the amplitude values measured by the sensor are also made available via IO-Link. This also enables the user to evaluate these values completely in the downstream, user-side controller.

The ultrasonic double sheet sensors can be adapted to the respective application in a variety of ways via their IO-Link interface. The following properties can be adapted for this purpose:

- Selecting a threshold set or switching between threshold sets and adjusting thresholds
- Performing a teach-in
- Setting the parameters related to switching behavior, evaluation and synchronization

Programming of the ultrasonic double sheet sensors via IO-Link is possible offline using IODD or DTM and an FDT frame application (e.g. PACTware) or online using a PLC via IO-Link master and IODD.

The advantages of the UDC-/UDCM-*GS-*IO* series ultrasonic double sheet sensors are:

- Operation with only one setting for a very wide range of materials
- Simple switching of the threshold values used for evaluation possible via two sensor inputs
- Teach-in option on demand or for specific applications
- Can be automatically synchronized to avoid cross-talk between several adjacently mounted ultrasonic sensors
- Can be triggered for the sampling of specific points on the material, e.g. in the incoming scale flow of a machine or for checking for the presence of customer or credit cards on the corresponding cover letter
- Integrated visual alignment aid for easy alignment during installation
- Vertical mounting to material possible
- IO-Link 1.1 interface for service and process data, and for parameterization
- Proven cylindrical, short housing design

What Is IO-Link?

IO-Link enables seamless communication and digital data transfer from the control panel level down to the sensor level. The intelligent sensors can be used to their full potential with IO-Link, paving the way for Industry 4.0 in automation technology. The internationally standardized interface convinces with efficiency and sustainable cost reduction from system planning and installation to operation and maintenance.

Standardized device description files ("IODDs") and parameterization via software tools ensure convenient configuration and integration of IO-Link sensors. Intelligent and transparent parameter management increases application flexibility and keeps downtimes to a minimum.

Parameters can be customized quickly and easily, even for complex production and batch changes. Transparency right through to the sensor gives users access to a comprehensive range of parameterization options and device diagnostics functions, allowing them to perform predictive servicing.

The technology offers particular benefits

- In service (troubleshooting, servicing and device exchange)
- During commissioning (cloning, identification, configuration and localization)
- And during operation (job changeover, continuous parameter monitoring and online diagnostics)

Device description file (IODD)

The sensor parameters are different for each device. A standardized description of these parameters can be found in the IO Device Description (IODD). The IODD can be imported into various engineering tools from different system providers, providing they support IODD. The sensor can be configured or diagnosed using the appropriate tool.

IODDs can be integrated into a control environment to allow IO-Link devices to be used for IO-Link operation. Both programming and exchanging process data can be performed with a PLC. The IODD can also be imported into a range of engineering tools from various system providers for programming and diagnostics, provided these tools support IODD

DTM (Device Type Manager)

If a sensor is not used long-term in an IO-Link environment, but nevertheless needs to be configured, this can be done easily via a PC with installed FDT frame application (e.g. PACTware) and with the DTM (Device Type Manager, a kind of "device driver") available for the sensor. Unlike configuration via the IODD, this method provides extended functions and ensures improved graphic visualization and convenient operation. In addition, functions such as "analysis" are only available via the associated DTM.

Offline parameterization

With offline parameterization, IO-Link devices are already configured before installation. To do this, use the Pepperl+Fuchs IO-Link USB master. We recommend using the "PACTware" software as the FDT frame application and user interface.

Both an IODD and a DTM are available to the sensor. It is possible to use the IODD for offline parameterization. However, we recommend using the DTM for offline parameterization, because it offers more extensive functions and can present complex situations more easily through graphic representations. Also, some analysis options are only available in the DTM, because graphic representations are required for this.

The DTM can be used immediately after installation.

If the IODD is used for offline parameterization instead of the DTM, you must first transform the IODD using the software "IODD Interpreter DTM". "IODD Interpreter DTM" is used to transform the IODD into a tabular user interface for parameterization.

The software components required in each case are summarized in the most current version of the "IO-Link Offline Parameterization Tool" software package. The software package and the documentation on its installation and use can be found online at www.pepperl-fuchs.com.

If you use the "IO-Link Offline Parameterization Tool" software package, have active Internet access, and have connected your device via the Pepperl+Fuchs IO-Link USB master, the PACTware will automatically find the right IODD online.

Offline parameterization is considerably easier and more convenient using the DTM, which is also available (see comments in the DTM section). Please also note that some analysis options are only available via the DTM, because graphic display options are absolutely necessary for this.

The device description file (IODD) required for integration into an IO-Link system and for parameterization and diagnosis is available online. Visit www.pepperl-fuchs.com and navigate to the relevant product page for the UDC-/UDCM-*GS-*IO* sensor.

Online parameterization

When commissioning machines and plants, you must integrate master and IO-Link devices into the appropriate control environment. Depending on the components used, different software is required.

You can then configure and parameterize the devices using an IO-Link configuration tool.

During operation, you can check the parameters for the IO-Link devices and read and monitor status and diagnostic data. IO-Link data is integrated into an application program using function blocks.

2.2 Indicators

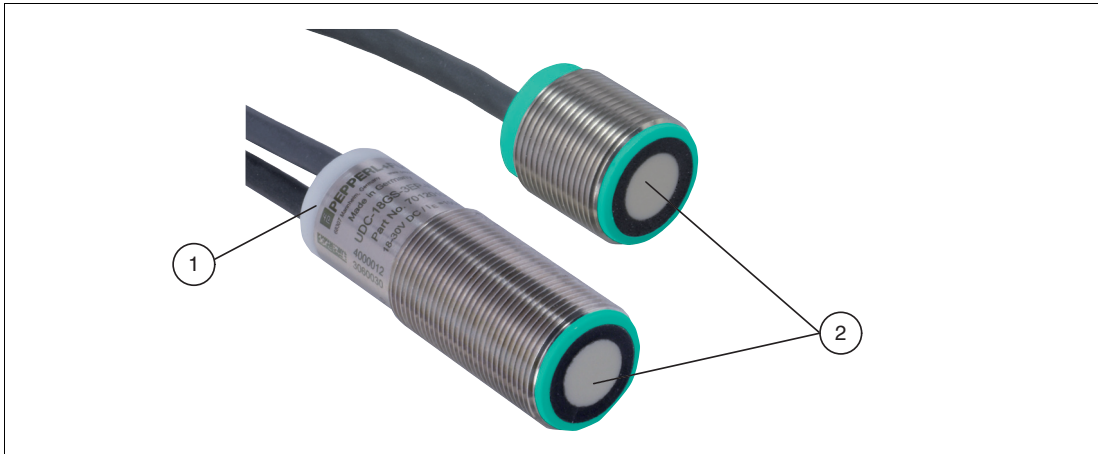


Figure 2.1 Display element on sensor (using the example of UDC-18GS-*IO* series)

- 1 LED yellow/green/red (on receiver end cap only)
- 2 Sonically-active area (on both emitter and receiver)

LED Indicators

	Green LED	Yellow LED	Red LED
In normal operation			
Detected state "air"	Off	On	Off
Detected state "single sheet"	On	Off	Off
Detected state "double sheet"	Off	Off	On
For IO-Link operation (Indication in addition to the detected state)	Flashing	Depending on the detected state	Depending on the detected state
For teach-in			
Teach-in is running	Off	Flashing	Off
Teach-in successful confirmation	Flashes 3x	Off	Off
Teach-in not successful warning	Off	Off	Flashes 3x
When the integrated alignment aid is activated			
No single sheet inserted	Off	Off	Flashing quickly
One of the following situations: <ul style="list-style-type: none"> • Alignment "poor" • Inserted single sheet too thick • Emitter not connected 	Off	Off	Flashing slowly
Alignment "moderate"	Off	Flashing (the better the alignment, the higher the flash frequency)	Off
Alignment "good"	Flashing	Off	Off

Table 2.1

2.3 Accessories

Various accessories are available.

2.3.1 Accessories For Mounting And Connection

Several components are available for mounting and connecting UDC-/UDCM-*GS-*IO* series sensors. 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:

- Mounting aid MH-UDB01 or MH-UDB02
- Extension cable for the emitter/receiver line
- Connection cable and cordset
- Mechanical alignment aid AA-UDB-18GM-01 for devices of the UD*-18GS series



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, commissioning instructions, manual. The relevant DTM also contains comprehensive context-related help texts.

2.3.2 Parameterization Aids

The following parameterization aids are available:

Designation	Description
PACTware	FDT frame application for operating IODDs and DTMs
IODD for UDC-/UDCM-*GS-*IO* series	IODD (IO Device Description) - device description for operating the sensor, integration into the system environment. IODD package for UDC-/UDCM-*GS-*IO* series. Visit www.pepperl-fuchs.com and access the product page for the relevant UDC-/UDCM-*GS-*IO* series sensor
DTM for UDC-/UDCM-*GS-*IO* series	DTM (Device Type Manager) – device description and graphic user interface for operating the sensor, integration into the system environment. DTM package for UDC-/UDCM-*GS-*IO* series. Visit www.pepperl-fuchs.com and access the product page for the relevant UDC-/UDCM-*GS-*IO* series sensor
IO-Link Offline Parameterization Tool	FDT frame application for operating IODDs and DTMs. This tool contains PACTware, IODD Interpreter DTM and IO-Link USB Master DTM. Visit www.pepperl-fuchs.com and access the product page for the relevant UDC-/UDCM-*GS-*IO* series sensor
IO-Link-Master02-USB	IO-Link USB adapter box to communicate with the IO-Link device via a PC, M12 connection for sensor
V19-G-BK0,6M-PUR-U-V1-G-YIOL	Adapter cable, 8-pin M12 to 4-pin M12, for connecting a UDC-/UDCM-*GS-*IO* series sensor to IO-Link Master02-USB

Table 2.2

3 Installation

3.1 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.

3.2 Connection

3.2.1 Wiring Diagram

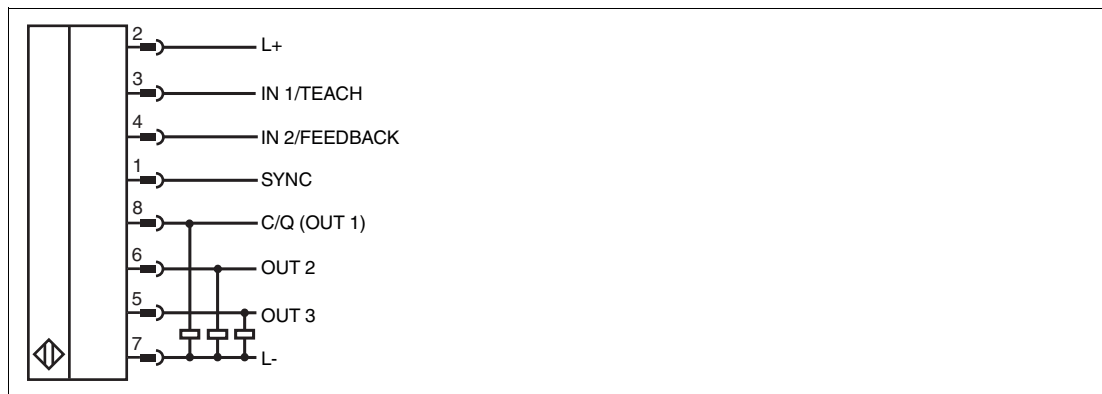


Figure 3.1

3.2.2 Connection To A Conventional Controller



Note

If the synchronization option is not used, the synchronization input should be connected to ground (0 V) when operating without IO-Link.



To connect the sensor, proceed as follows:

1. Plug a prepared connection cable onto the cable connector provided on the receiver.
2. Screw the union nut onto the cordset until it reaches the end stop. This ensures that the power cable cannot be pulled out inadvertently.
3. Connect the opposite side of the connection cable and switch on the supply voltage.
↳ The sensor is ready for operation.

3.2.3 Connecting To An IO-Link Master



Note

Use the adapter cable listed in the "Accessories" chapter, from an 8-pin to a 4-pin M12 connection, for the connection.

A 3-pin adapter cable must also be used when connecting the sensor to an IO-Link Class B master port.



Control Via IO-Link

To prepare the sensor for control via IO-Link, proceed as follows:

1. Connect the receiver to an IO-Link master using the adapter cable. Screw the union nuts onto the plug until they reach the end stop. Use a 4-strand sensor cable for the connection.
↳ The sensor is now prepared for IO-Link communication.

3.2.4 Connection Of Sensors To Be Synchronized

To operate devices in automatic multiplex or common mode, you must interconnect the SYNC connections of these sensors. This combination must not have an additional connection to L+ or L-.

To operate devices in external synchronization mode, you must connect the SYNC connections of these sensors to the external clock.



Note

If the SYNC connections of the sensors to be synchronized are wired for the first time when the supply voltage is applied, all devices in the sensor group must be briefly disconnected from the supply voltage and then reconnected ("power cycle"). Only then does the synchronization in this group run reliably according to the configured settings.

If accordingly configured devices are later added or removed in a synchronized group, the group continues to run reliably even without a "power cycle". It is only necessary to make sure that the SYNC connection of additional devices is wired first and that their supply voltage is only switched on afterwards.

3.2.5 Extending The Transmitter-Receiver Connection Cable

The length of the transmitter-receiver connection cable is designed as standard in such a way that, when the double sheet control is mounted on the edge of the sheet and the Pepperl+Fuchs mounting brackets are used as an option, there is no excess cable length that needs to be wound on the machine. If, for example, the devices are mounted in the center of the sheet or machine-specifically, the connecting cable between the transmitter and receiver must be extended appropriately.

Either one or a cascade of the extension cables offered by Pepperl+Fuchs for this purpose can be used to extend the transmitter-receiver connection cable. Depending on the device used, the maximum permissible extension length of the connection cable must be taken into account:

- UDC-18GS*-*IO* series Permitted extension by a maximum of 6 m.
- UDC(M)-30GS*-*IO* series: Permitted extension by a maximum of 12 m.



Note

Use only the cables designated by Pepperl+Fuchs for this purpose to extend the connection cable between the transmitter and receiver of the ultrasonic double sheet controls. The use of other cables leads to impairment of the sensor function up to loss of function.

**Caution!**

Risk of loss of function if cable is shortened by the user!

The user must not shorten or otherwise modify the connection cable between the transmitter and receiver or the extension pieces of the connection cable. Otherwise, this can lead to a reduction in the sensor function or even to a loss of function.

3.3 Alignment And Mounting

3.3.1 Alignment

**Note**

To achieve the full performance of the double sheet sensor, exact alignment and mounting of the transmitter and receiver are required. When using Pepperl+Fuchs mounting brackets MH-UDB01 or MH-UDB02, optimum alignment is guaranteed. For all other mounting situations, observe the following information regarding alignment accuracy, distances and minimum overlaps. For easy alignment, you can enable and use the integrated visual alignment aid on the receiver.

**Note**

If two machine parts with their supports for each of the UDC-18GS-*IO-* sensor parts are to be positioned precisely to one another, the mechanical alignment aid AA-UDB-18GM-01 listed in the sensor accessories can be used. With this aid, the machine parts can be perfectly aligned even before the sensor is mounted, so that the sensor only needs to be fixed in the corresponding machine mountings. For details on how to use this mechanical alignment aid, refer to its datasheet.

Alignment Accuracy

The following figure shows the maximum permissible angle and sensor offset of the transmitter and receiver.

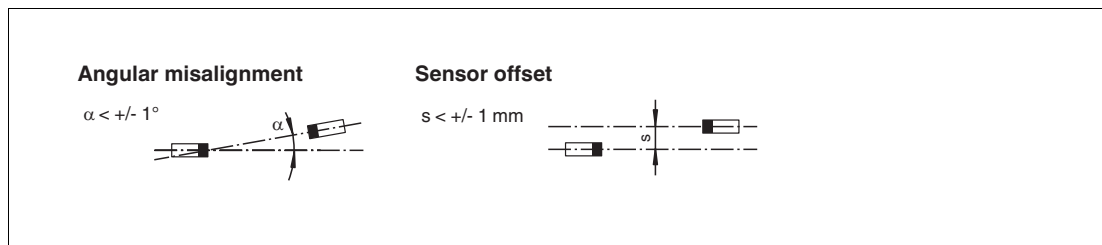


Figure 3.2

Distances And Minimum Overlaps

Also observe the minimum distances, minimum material widths and minimum overlaps required for reliable operation, which can be found in the following figures depending on the device used.

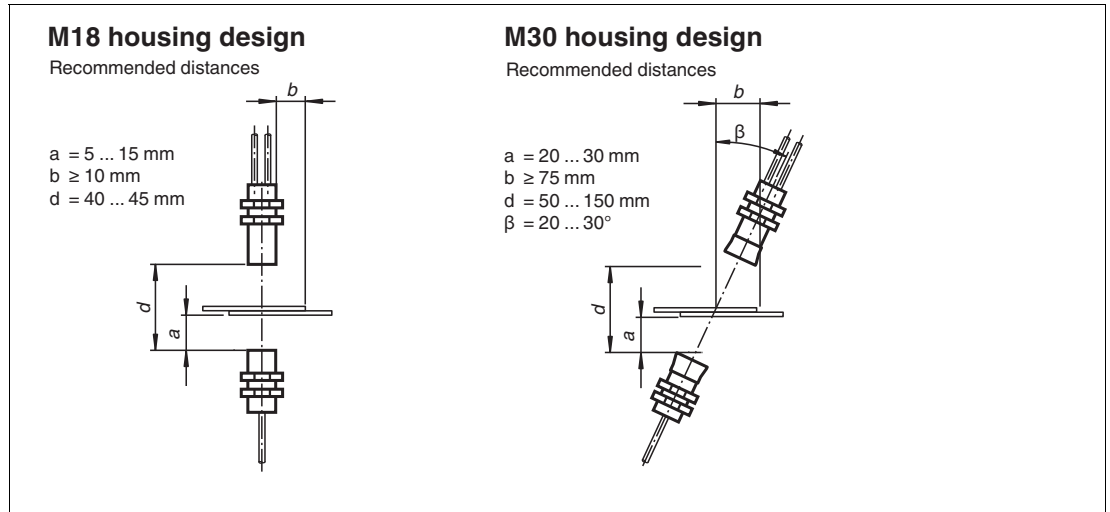


Figure 3.3

In general, due to the pulsed operation, vertical mounting of the double sheet controls over the material is possible.

For vertically mounted M18 devices, the response time must be at least 6 ms.

However, depending on the material under detection, it may be helpful or even necessary to align the sensor at a certain angle to the material-perpendicular.

Especially for thicker papers and cardboard, we recommend an inclined position of the M18 devices with an angle of $\beta = \text{approx. } 20\text{-}35^\circ$ to the material-perpendicular (see following figure).

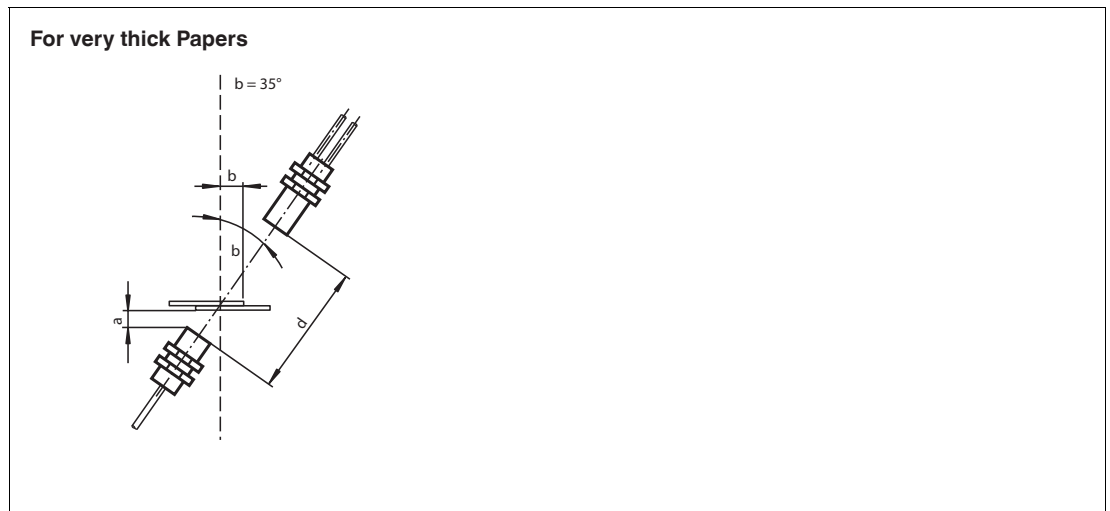


Figure 3.4

If you are using an M30 device, we recommend that the device be tilted at an angle of at least 20° to the material-perpendicular (see the figure above for the M30 design).

3.3.2 Mounting



Note

Please observe the information on alignment accuracy in the "Alignment" chapter if you are not using the Pepperl+Fuchs mounting brackets MH-UDB01 or MH-UDB02 for mounting.

In this case, ensure that the sensor parts are correctly aligned with each other. You can do this using the integrated visual alignment aid. Alternatively, you can verify and ensure the correct alignment of the sensor parts with respect to each other using the DTM.



Caution!

Malfunction possible if M30 devices are incorrectly mounted

When mounting the M30 devices, each device part must not be mounted against the ultrasonic transducer. Installation is only permitted using two nuts for mounting in front of and behind the bracket for each device part. Otherwise, the device may malfunction.



Mounting With Mounting Brackets

1. Secure both parts of the sensor with the supplied nuts in the intended mounting position using the mounting brackets.
2. Tighten the bolts. Observe the maximum permissible torque according to the data sheet of the respective sensor.



Mounting With Customer Mounting Device And Integrated Visual Alignment Aid On Receiver

1. Fasten both parts of the sensor loosely with the supplied nuts in the intended mounting position. Do not tighten the bolts/nuts yet so that you can still align the parts with each other.
2. For UDC-18GS devices: Insert one sheet of commercially available copy paper (grammage approx. 60 ... 90 g/m²) into the sensor between the transmitter and receiver.
For UDC(M)-30GS devices: Place two sheets of commercially available copy paper (grammage approx. 60 ... 90 g/m²) into the sensor between the transmitter and receiver.
3. Activate the alignment aid by connecting IN1 and IN2 with L+ at the same time. Alternatively, you can also activate the alignment aid using IO-Link via the DTM in the "Service" menu item.(see chapter 7.7).
 - ↳ The previously lit LED now starts to flash and indicates the current alignment quality. The following sequence applies:
 - Flashing red
 - Flashing yellow slowly then quickly
 - Flashing green
4. Align the transmitter and receiver so that the green LED flashes.
 - ↳ The transmitter and receiver are optimally aligned to each other if the green LED flashes with the alignment aid activated and the single sheet inserted.
5. Screw the device into the correct position so it is optimally aligned. Observe the maximum permissible torque for the nuts according to the datasheet of the respective sensor.



Note

If only the red LED flashes despite good alignment, either no single sheet has been inserted, or the sensor transmitter is not connected or is not working correctly.

In the first case, insert a single sheet into the double sheet control and reactivate the alignment aid.

In the second case, check the cabling between the transmitter and receiver before activating the alignment aid again.



Note

When the integrated alignment aid is activated, the sensor outputs retain their previous states.

4 Information Regarding Cybersecurity and Decommissioning

Information Regarding Cybersecurity

From the security point-of-view, the responsible plant operator requires to take the following measures:

- Provide physical protection of the IO-Link device from unauthorized third-party access.
- Ensure that the IO-Link device communicates in a point-to-point connection to the counter station.

The product features a proprietary Pepperl+Fuchs service interface that uses the existing connection lines. This interface is solely intended for initial upload and update of the firmware during manufacturing. After starting up, the interface is deactivated after 20 s.

Decommissioning

The device saves adjustable parameter data, temperature information and the operating time. Parameter data can be deleted by resetting to the factory settings.

The operating time counter and the temperature information cannot be deleted. To delete this data, the device must be physically destroyed.

5 Commissioning Without IO-Link



1. Switch on the supply voltage.
 - ↳ Depending on the current detected status ("air", "single sheet", "double sheet"), one of the three LED display colors will light up on the sensor.
 - ↳ The sensor will now function using the preset parameters.

6 Commissioning Via PACTware And DTM

There is a DTM available to download to help you fully configure the sensor easily via IO-Link. Visit www.pepperl-fuchs.com and access the product page for the relevant UDC-/UDCM-*GS*-*IO* series sensor. With this DTM, configuration and diagnosis of the device and in-depth analyses of the damping behavior of the respective materials are possible.

This manual sets out how to configure using the "PACTware" FDT frame application in which the DTM (Device Type Manager) is loaded. In principle, you can also use other appropriate FDT frame applications. It is also possible to use the appropriate IODD for configuration instead of using the DTM. However, some analysis options are not available because they require graphic representations.

6.1 Commissioning Via IO-Link



Note

An M12 cordset is necessary to connect the sensor to the IO-Link master. You can find suitable cordsets by visiting www.pepperl-fuchs.com and clicking on the product page for the relevant sensor.



Prerequisites For Commissioning

Proceed as follows to communicate with the sensor via IO-Link using the "PACTware DC" software and the associated DTM (Device Type Manager):

1. Make sure that PACTware DC and the necessary DTMs (Device Type Managers), or the device description IODD for the sensor and the IO-Link master are installed.
2. Connect the sensor via an M12 cordset to an IO-Link USB master.
3. Connect the IO-Link USB master to a USB connection on your PC via a USB cable.



Setting Up Sensor Communication Using PACTware DC

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

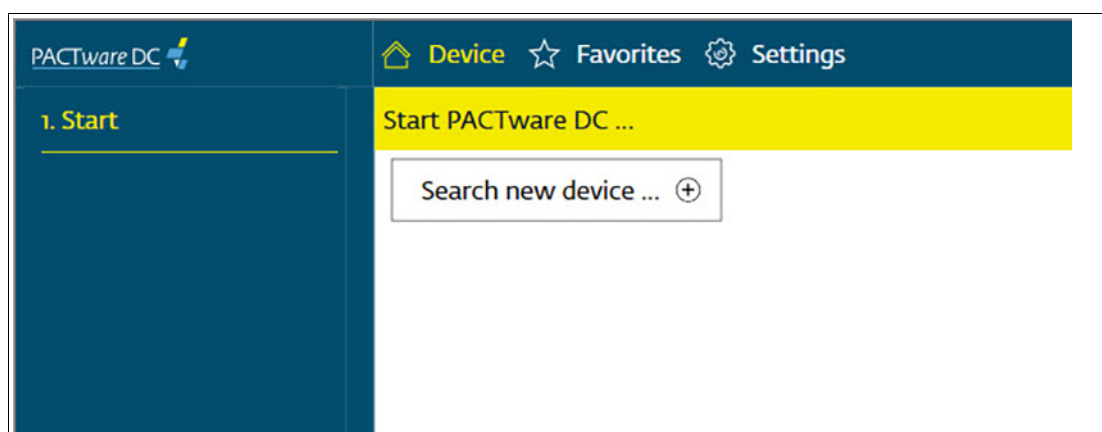


Figure 6.1

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

↳ The IO-Link USB master will be detected by the PACTware DC if it is connected to the PC.

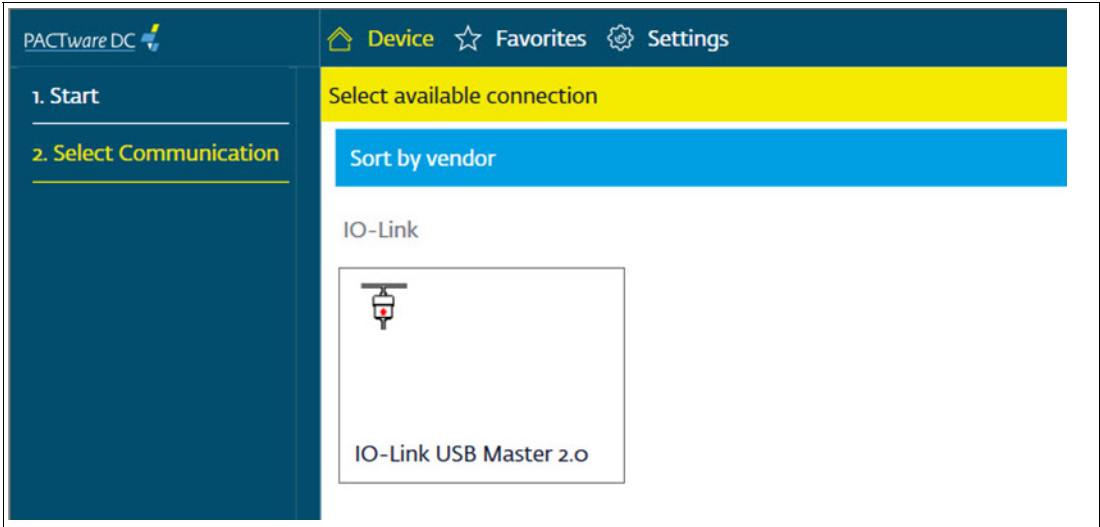


Figure 6.2

3. In the project, click **IO-Link USB Master...**

↳ PACTware DC automatically establishes the connection to the sensor if the ultrasonic sensor is connected to the IO-Link USB master.

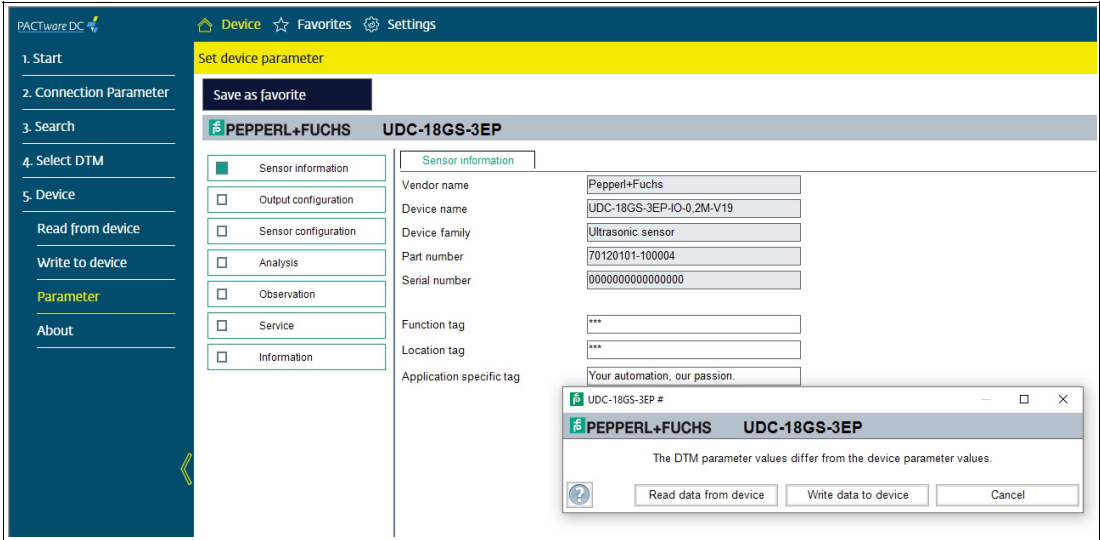


Figure 6.3

4. Select **Read data from sensor.**

↳ The PACTware DC reads and transfers the parameter values from the sensor into the DTM and starts the continuous data exchange with the sensor.

7 Configuration and Analysis with DTM via IO-Link

7.1 Overview

The sensor parameters are different for each device. 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 sensor can then be configured or diagnosed using the appropriate tool (e.g. PACTware). The DTM menus are outlined below on the basis of the "PACTware" FDT frame application being used.

For simple and comprehensive parameterization of the sensor via IO-Link and analysis of the sensor behavior, the DTM (Device Type Manager) described below offers you a wide range of options.

In addition to configuring the sensor, you can use the **Analysis** and **Observation** menus to display and record the sensor behavior during operation to adapt it in the best way possible to your application.

Note

The following screenshots of the DTM in the framework program PACTware have been created on the basis of the UDC-18GS-3EP-IO-V19 device as an example, but are also valid for all other variants of the double sheet series UDC-18GS-* and UDC*-30GS-*

Context-Related Help Texts Via F1

In the DTM, you can access context-related help texts by clicking on the "?" icon in the displayed menu or by clicking on the required parameter and then pressing the F1 key. A display will then open showing information about the setting options of the relevant menu and its parameters.

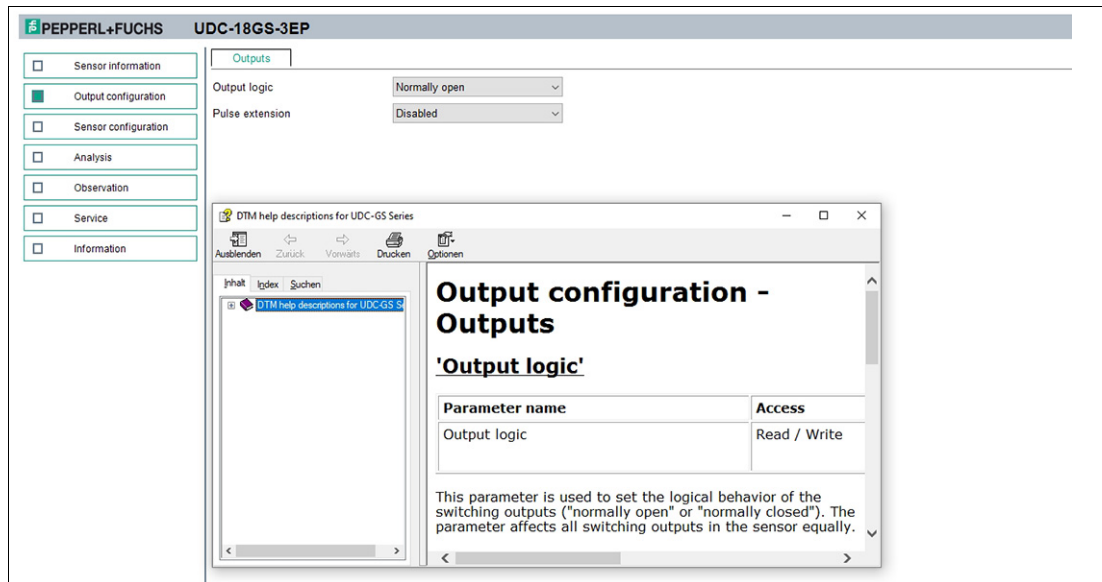


Figure 7.1

7.2 Sensor Information Menu Item

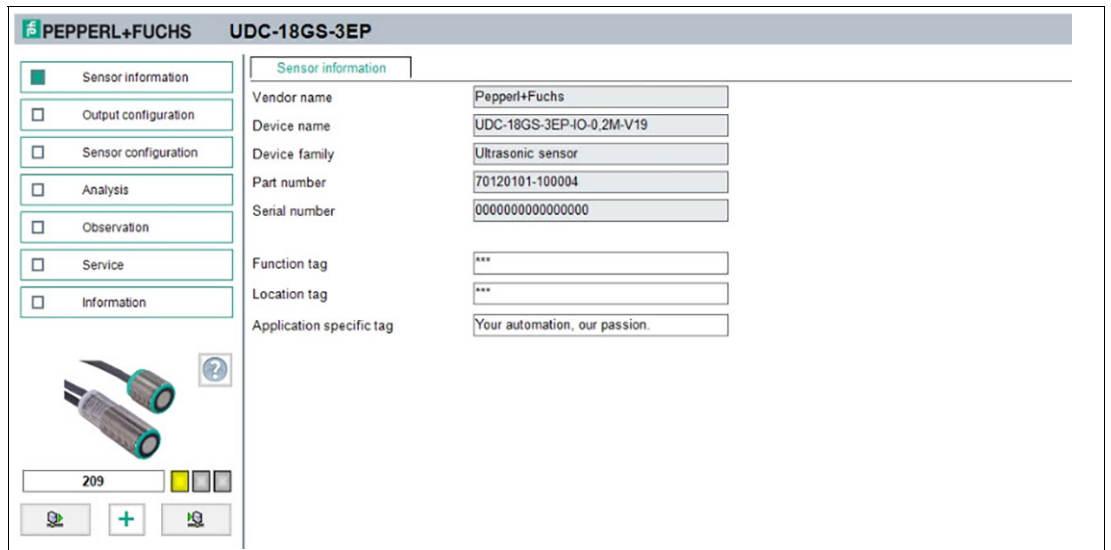


Figure 7.2

In the **Sensor information** menu item,

- hard-coded manufacturer and device information is displayed. These are read-only fields.
- you can input application-specific IDs to identify and mark your sensor in the system environment. Text information (strings) can be input in the "Function tag", "Location tag" and "Application specific tag" fields.

7.3 Output Configuration Menu Item

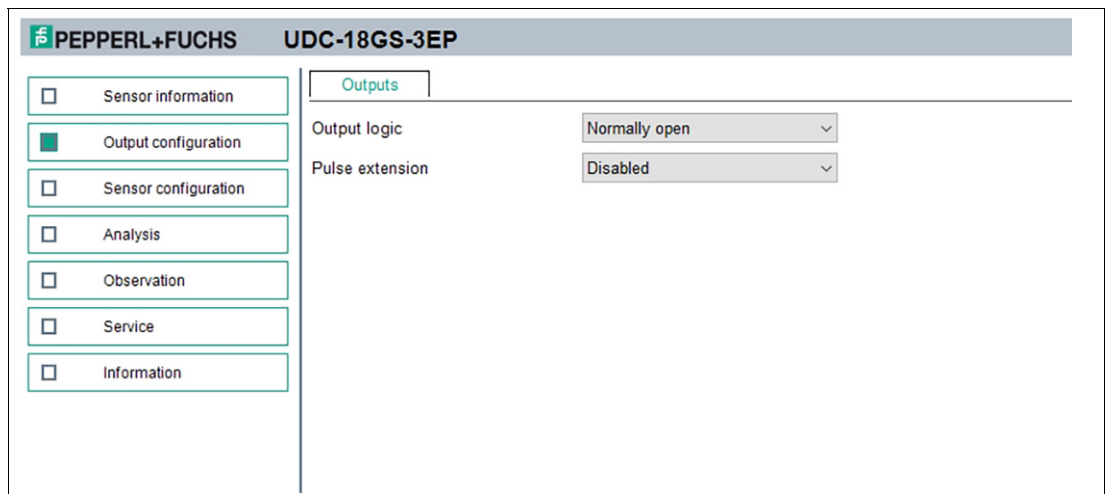


Figure 7.3

In the **Output configuration** menu item, you can set the output behavior and an output pulse extension.

7.4 Sensor Configuration Menu Item

Overview Of The Sensor Configuration Menu Item

Thresholds	Upper threshold	Lower threshold
Set 1	160	50
Set 2	160	15
Set 3	160	100
Set 4 / Teach-In	160	50

Figure 7.4

The **Sensor configuration** menu item consists of five tabs:

- Threshold configuration
- Teach-in
- Evaluation
- Synchronization
- Local controls

Threshold Configuration Tab

Thresholds	Upper threshold	Lower threshold
Set 1	160	50
Set 2	160	15
Set 3	160	100
Set 4 / Teach-In	160	50

Figure 7.5

In the **Threshold configuration** tab, you can see the thresholds available in the sensor and change them if necessary. In addition, you can specify in which operating mode the sensor is used (selection of a threshold set, teach-in mode, operation via IO-Link) and whether the two sensor inputs are active. You can also set the threshold hysteresis.

Teach-in Tab

You can teach in the connected device to a specific material via the **Teach-in** tab. In addition, it is possible to obtain more detailed information about the amplitude values recorded during teach-in. You can save this information to a file along with the device parameter values. Data sets saved in this way can also be reloaded in this tab for further evaluation.

Evaluation Tab

Figure 7.6

In the **Evaluation** tab, you can set the functions which impact evaluation logic with sensor measurement.

Synchronization Tab

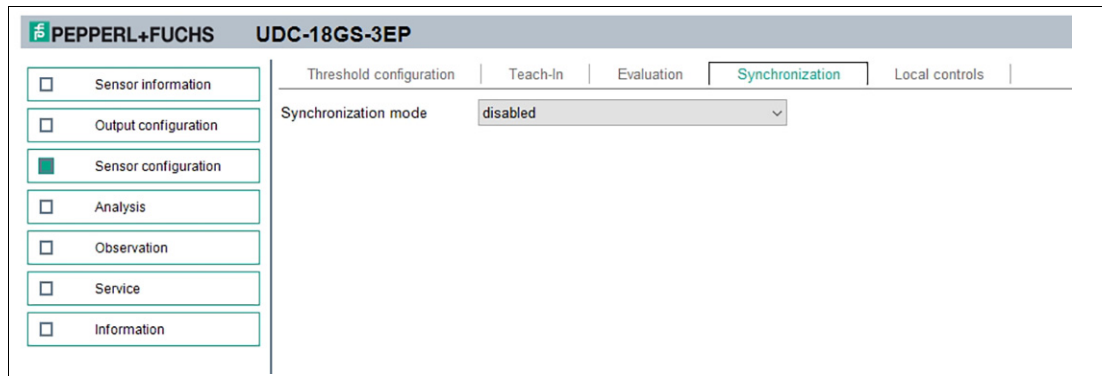


Figure 7.7

In the Synchronization tab, you can set the desired synchronization type if you want to suppress cross-talk when operating several ultrasonic sensors of the same type. Details of the individual synchronization modes can be found in the chapter "Synchronizing Multiple Sensors".

Local Controls Tab

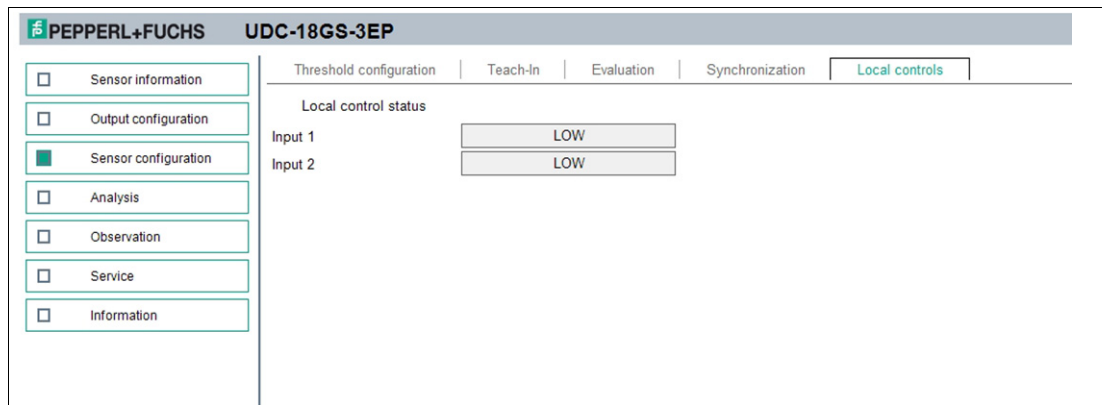


Figure 7.8

In the **Local controls** tab, you can check the correct electrical function of the two sensor connections IN1/TEACH and IN2/FEEDBACK.

7.5 Analysis Menu Item

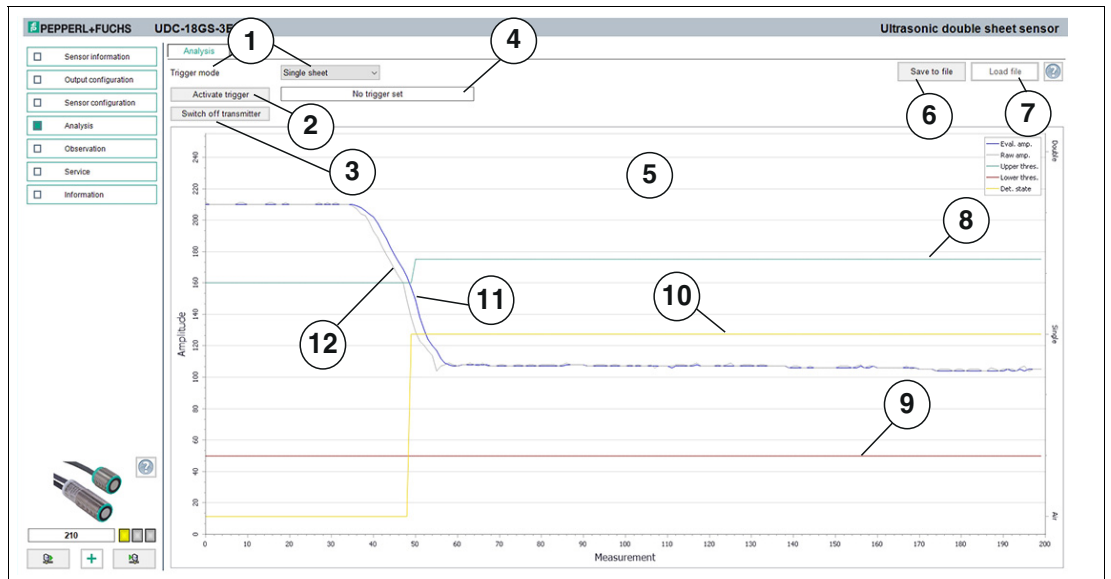


Figure 7.9

The information and functions provided in the "Analysis" menu item enable the user to perform the following analyses:

- Assessment of a material with regard to its damping behavior on the ultrasonic signal
- Investigation of the cause of any occurring, or possibly only sporadically occurring, accidental activations during machine operation
- Analysis of the application situation for possible external interference (e.g. EMC, other ultrasonic signals) that interfere with the measurement of the double sheet sensor.

The analysis graph shows the following data:

- Raw amplitude "Raw amp."
- Evaluated amplitude "Eval. amp."
- Threshold values for "Upper thres.", "Lower thres."
- Detected state "Det. state"

The relationships between these sets of data are as follows:

For each measurement, a new amplitude value is acquired by the sensor, which is the "raw amplitude" (Raw amp.). This newly acquired amplitude value is calculated by the sensor according to the set parameter values in the "Evaluation" area with the raw amplitude values from the previous measurements. The resulting amplitude value is the "evaluated amplitude" (Eval. amp.). This is now considered by the sensor in relation to the set threshold values and the "detected state" (Det. state) is derived from this.

You can record the data directly by means of the "Immediate" trigger. After the recording, this is then displayed immediately in the graphic. In addition, you can trigger the following events to have the data regarding this event displayed:

- No sheet = Air
- One sheet = Single sheet
- Multiple sheets = Double sheet

Menu Description

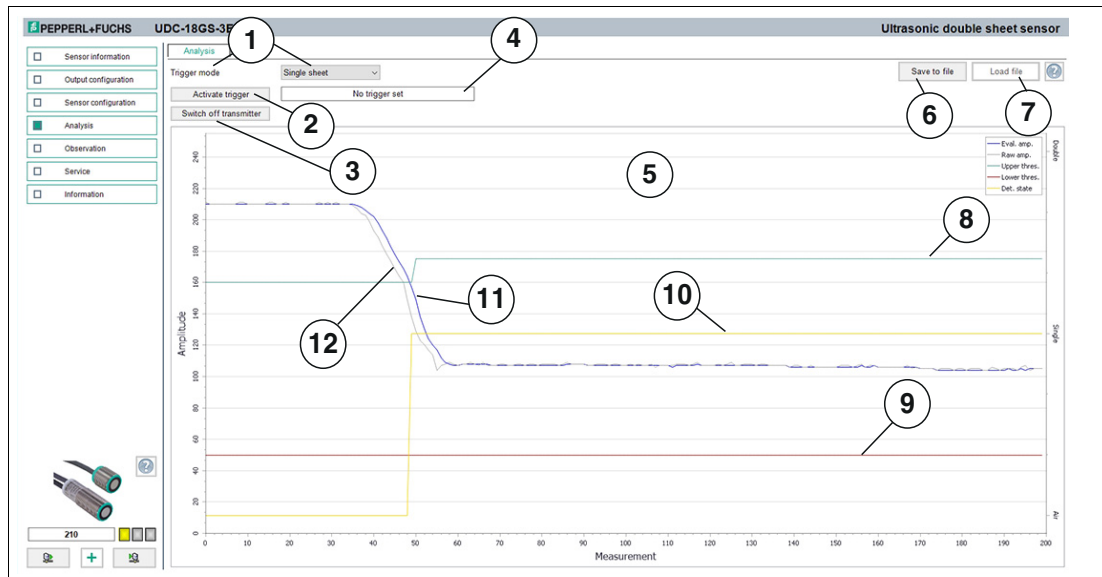


Figure 7.10

No.	Name	Description
1	Trigger mode	You can use this parameter to select whether data recorded by the sensor is provided in the graphic "immediately" or when an appropriate event occurs ("air", "single sheet," "double sheet"). The data shown is 200 consistent items of data. This means that 200 items of data are displayed, which were continuously recorded by the sensor for the corresponding event. Due to the high measuring rate of the sensor, this measurement consistency is of great importance for the subsequent assessment of the data.
2	"Activate trigger" button	Pressing this button activates the selected trigger mode in the sensor.
3	Switch transmitter on/off	You can use this button to switch the transmitter of the sensor off and on again. This is necessary for some analysis purposes, such as the analysis of the application situation for external interference. Note: When changing to another DTM menu item or when disconnecting the sensor from the DTM, the transmitter is automatically switched on again.
4	Feedback	This field displays the current trigger status for the sensor's recording of measured values.
5	Display in graphic	Here, 200 measured values recorded around the corresponding event as well as further information are displayed. The following are displayed: <ul style="list-style-type: none"> The new amplitude value measured in the corresponding measurement ("Raw amp." = gray line). The "evaluated amplitude value" ("Eval. amp." = blue line). The upper and lower switching thresholds ("Upper thres." = green line and "Lower thres." = red line). The state detected by the sensor ("Det. state" = yellow line).
6	Save file	You can save the recorded signal sequences as a .CSV file, .XML file or .TXT file by pressing the "Save file" button. In addition to this data, sensor settings (parameter values) will also be saved. This means it is possible to evaluate recorded data later "offline".

No.	Name	Description
7	Load file	You can load previously saved recorded signal sequences, including the associated sensor settings, in the DTM by pressing the "Load file" button, which allows you to assess or evaluate the samples. Note Loading a saved file is only possible when disconnected from the sensor.
8	Upper threshold (green line)	The green line in the graphic shows the active upper threshold according to the selected threshold set, i.e. the switching threshold between the "air" and "single sheet" states.
9	Lower threshold (red line)	The red line in the graphic shows the active lower threshold according to the selected threshold set, i.e. the switching threshold between the "single sheet" and "double sheet" states.
10	Detected state (yellow line)	The yellow line shows the state detected by the sensor during the respective measurement ("air", "single sheet", "double sheet").
11	Evaluated amplitude (blue line)	The blue line shows the newly determined "evaluated amplitude value" in the respective measurement, using the set evaluation parameters.
12	Raw amplitude (gray line)	The gray line represents the new amplitude value recorded by the sensor in the respective measurement. This is the "raw" amplitude value that has not yet been evaluated by the evaluation algorithm.

Table 7.1

7.6 Observation Menu Item

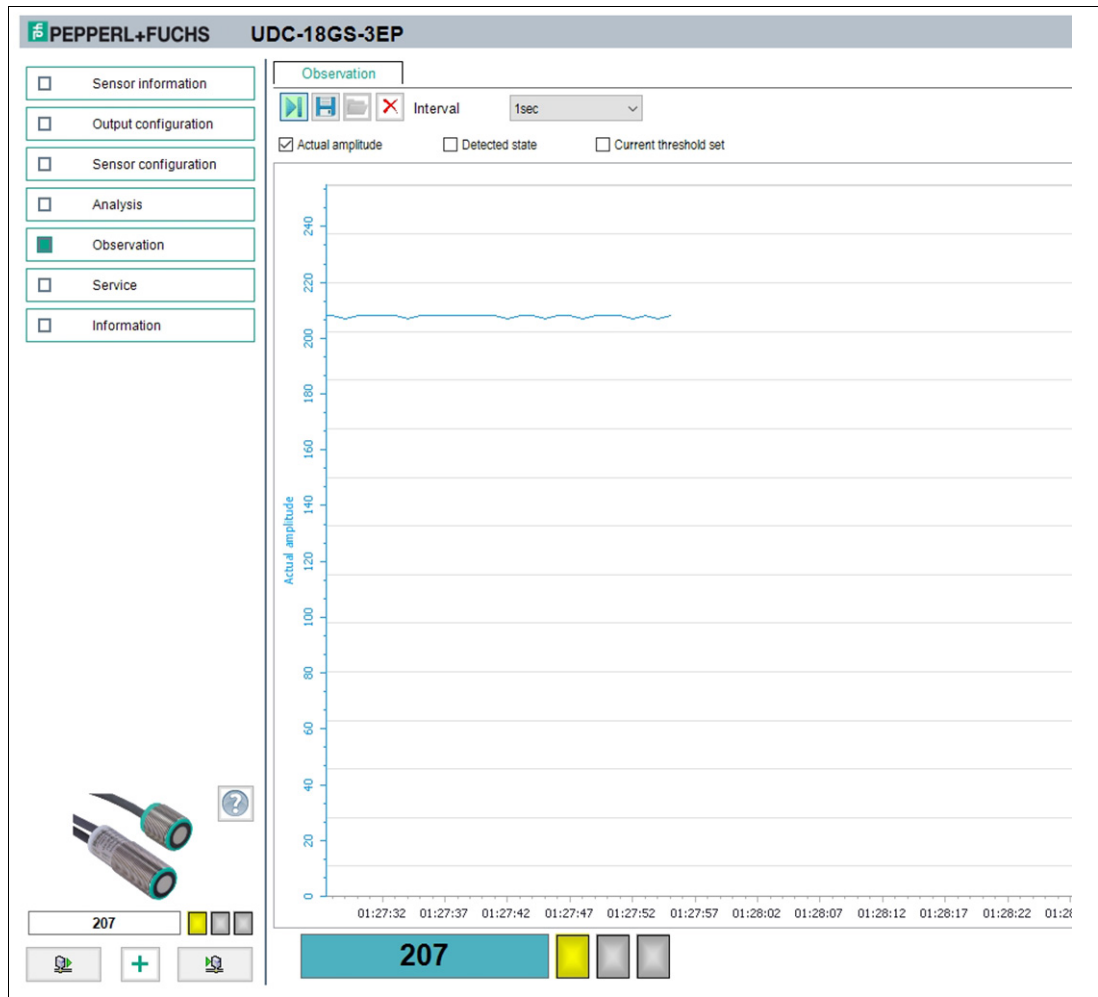


Figure 7.11

In the **Observation** menu item, you can track and record the data for the ultrasonic double sheet sensor over time, as well as the detected state and threshold set used for this evaluation. This can be very helpful, for example, when commissioning the sensor to determine whether the sensor behaves as intended.

Note

The measured values shown in this graph are not consistent, i.e. consecutive measured values. Rather, the diagram shows individual snapshots taken at fixed, longer intervals. Due to its high measurement repetition rate, the sensor performs a large number of further measurements between 2 measured values shown in this graphic. This diagram is therefore used purely for the qualitative, possibly longer-term observation of the general amplitude level of a material.

Generally unsuitable for:

- Evaluating a material for its ultrasonic attenuation
- Root cause analysis in the event of intermittent accidental activation during machine operation
- Root cause analysis for possible external interference.

For all of these cases, extensive tools and target-oriented options are available under the "Analysis" menu item. For more details on analyzing material and application environment, see chapter 9.

When you first access the **Observation** menu item in the DTM, automatic recording of data will start in the graphic. From this point in time, recording will run continuously in the background. The data display works according to the "follow-mode" principle. It will always track the current measured value in accordance with the rescale settings in the x-axis and make sure it is visible in the display. You can save the data displayed in this trend graphic in a file in various file formats for evaluation at a later stage. Placing the check mark in front of the available measured variables or output statuses selects which data will appear in the graphic.

Menu Description

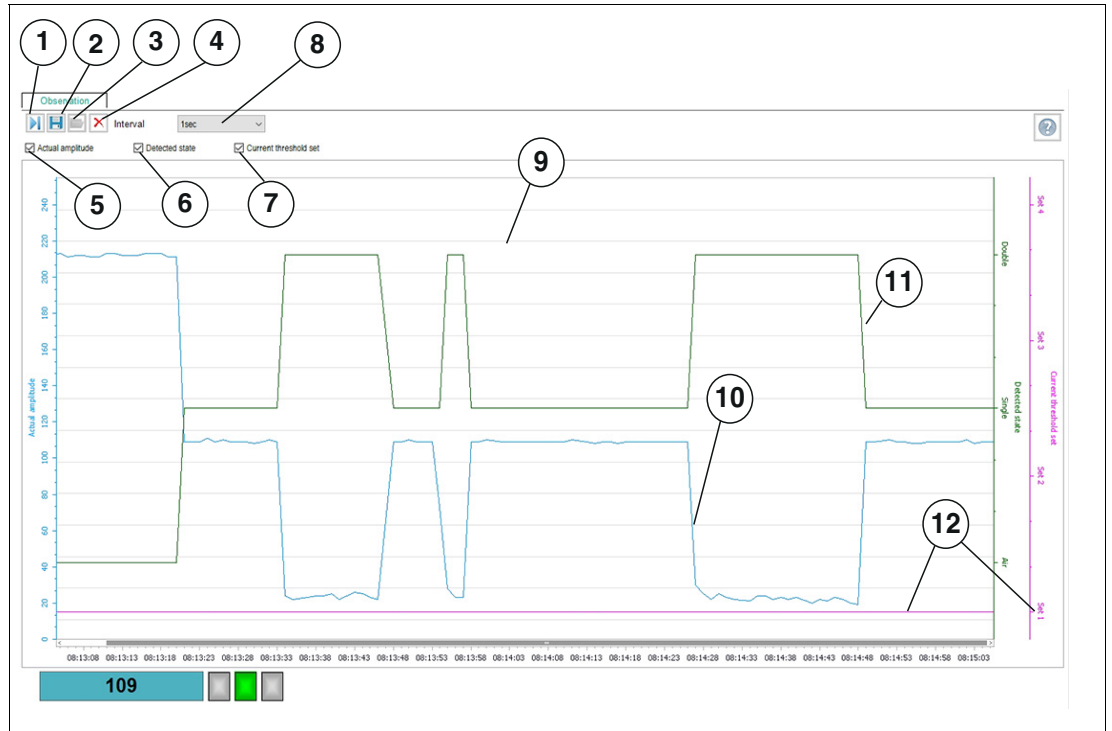


Figure 7.12

No.	Name	Description
1	Follow mode on/off	If follow mode is "On", data is displayed in accordance with the current rescale setting of the x-axis. The measured value is visible in the display. If follow mode is "Off", the data stops being continuously displayed. When follow mode is restarted, data recorded in the background in the meantime is added to the graphic.
2	Save trend data to file	You can save data recorded via follow mode in one of three available file formats (.csv, .xml, or .txt) by pressing the "Save trend data to file" button. In addition to this data, sensor settings (parameter values) will also be saved. This means it is possible to evaluate recorded data later "offline".
3	Load trend data from file	You can load the saved trend data in the DTM again by pressing the "Load trend data from file" button, which allows you to assess or evaluate it. Files with recorded data combined with the parameter settings can be very useful for discussing issues with our experts. Note: You can only load a saved file when disconnected from the sensor.
4	Delete	Pressing the "Delete" button allows you to delete all data in the display area (9). All data recorded up to this point is discarded and the display is cleared. Recording automatically restarts from scratch.

No.	Name	Description
5	Actual amplitude	By clicking on the check box, you can enable or disable the display of the amplitude values in the display area in the form of a blue line.
6	Detected state	By clicking on the check box, you can enable or disable the display of the detected state ("air", "single sheet", "double sheet") in the display area in the form of a green line.
7	Current threshold set	By clicking on the check box, you can enable or disable the display of the used threshold set in the display area in the form of a pink line.
8	Interval	You can use the "Interval" selection function to specify the time interval at which data is recorded in the graphic. There are several fixed intervals available between 1s and 1 min.
9	Display area	The display area displays the variables and output states selected using the "Actual amplitude" and "Detected state" and "Current threshold set" check boxes in the form of line diagrams.
10	Current amplitude value (blue line)	The blue line shows the amplitude value measured by the sensor (left y-axis).
11	Detected state (green line)	The green line indicates the state detected by the sensor based on the current amplitude with the current threshold set (right y-axis "Detected state").
12	Current threshold set (pink line)	The pink line indicates the threshold set used by the sensor when evaluating the measurement (right y-axis "Current threshold set").

Table 7.2

Scaling The X-Axis And Navigating To Significant Data

Depending on the input device used and the input options available with it, you can zoom in and out of the recorded diagram and move the view in different ways. The DTM takes into account operation via keys on a keyboard, via mouse with scroll wheel or via touch screen equally, as long as the respective function is reasonably applicable in each case.

Zooming to an area in the diagram

Operation via	How does it work?
Keyboard	The keyboard allows you to zoom in 20% increments within the diagram. To do this, hold down the "CTRL" key and press the "+" key to zoom in, or the "-" key to zoom out. You can also use the "CTRL+Z" key combination to jump back from a currently active zoom level in the diagram to the previous one.
Mouse	You can also zoom in and out of the diagram in 20% increments using the mouse. To do this, position the mouse pointer on the diagram and rotate the scroll wheel in the desired direction. If your mouse does not have a scroll wheel, you can simply click on the diagram while holding down the SHIFT key. In this way, you can zoom into the diagram in three steps. If you hold down the "ALT" key instead of the "SHIFT" key, you can zoom out of the diagram again. Alternatively, you can use the mouse to enlarge a defined area in the diagram. To do this, hold down the "SHIFT" key and select the relevant area while holding down the left mouse button.
Touch	Diagonal pinching in or out with two fingers on the relevant area (= the zoom gesture commonly used on smartphones/tablets).

Table 7.3

Scrolling/moving the visible section of the diagram

Operation via	How does it work?
Keyboard	Hold down the "CTRL" key and use the arrow keys to move the cutout in the desired direction.
Mouse	Move the mouse pointer over the diagram. Hold down the left mouse button and move the cutout in the desired direction. Alternatively, you can move the scroll bar of the x-axis.
Touch	Touch the diagram with one finger and slide the cutout in the desired direction (= the move/scroll gesture commonly used on smartphones/tablets).

Table 7.4

7.7 Service Menu Item

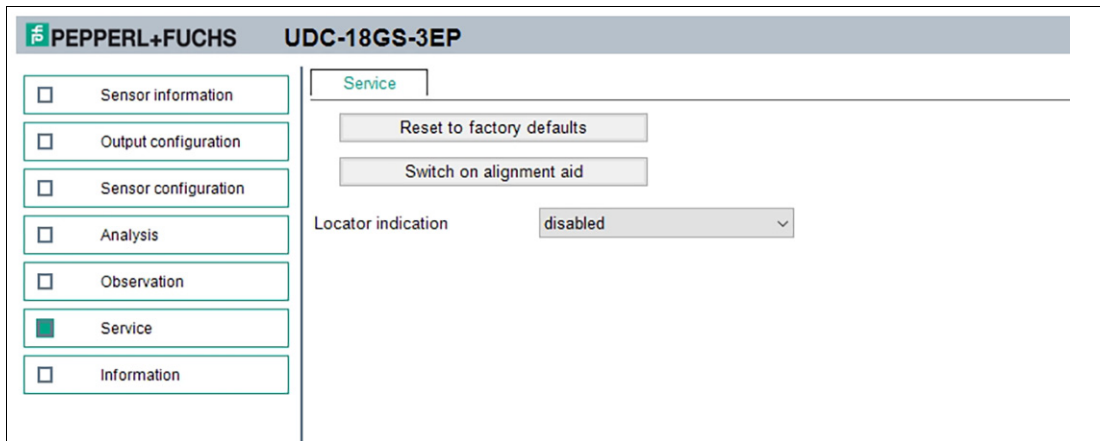


Figure 7.13

The following service functions are available in the **Service** menu item:

- **Reset to factory defaults:** Pressing the button and confirming the subsequent security prompt will reset the sensor to the factory settings. All previous parameter changes are lost as a result of this.
- **Switch on alignment aid:** By pressing this button, the alignment aid integrated in the sensor is switched on. If the alignment aid is activated in the sensor, the text for the button changes to "Switch off alignment aid". Pressing the button again switches the alignment aid off again. When changing to another menu item of the DTM or when disconnecting the sensor from the DTM, the alignment aid is automatically switched off again.
- **Locator indication:** Setting the "locator indication" to "enabled" makes the LEDs flash simultaneously. This function can be used to locate a sensor in a plant or machine more easily. This function is disabled by default, which means that the LEDs indicate status and diagnostic information.

7.8 Information Menu Item

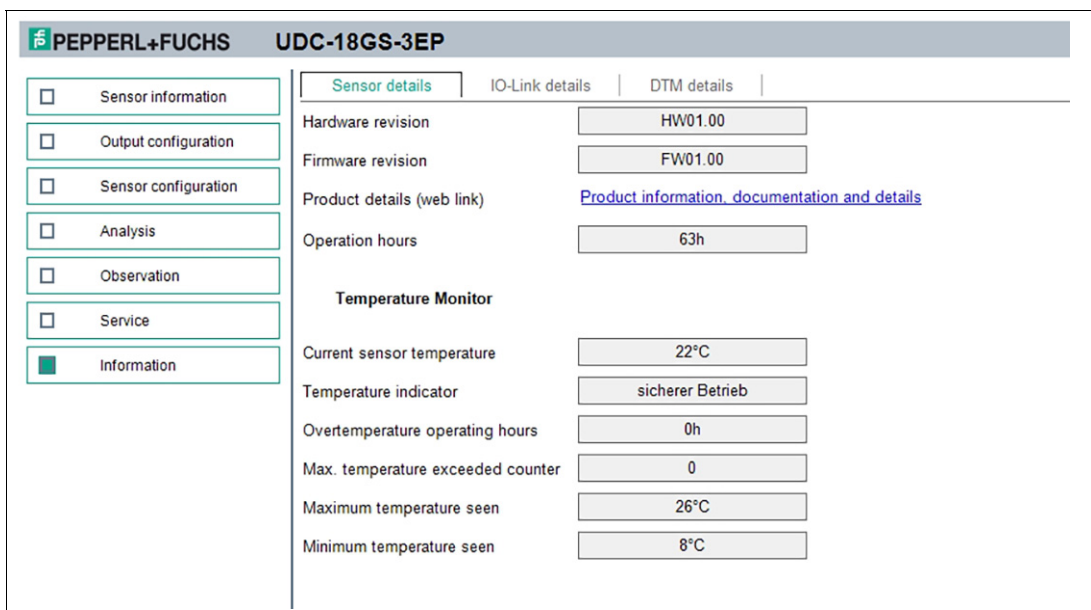


Figure 7.14

The **Information** menu item consists of three tabs:

- **Sensor details:** Information on hardware and software version, operating hours and temperature monitoring
- **IO-Link details:** Information about the device ID, vendor ID and information about the IO-Link communication parameters
- **DTM details:** Information on DTM version

Sensor Details Tab

Product details

In addition to information on the hardware and software used in the sensor, you can also go directly to the Pepperl+Fuchs product page of this device by clicking on the link under "Product details". There you will find the following information:

- Datasheet
- Commissioning instructions
- Manual
- as well as other information and files pertaining to your device.

Operating hours indicator

The operating hours indicator shows how many hours your device has been powered up and has been in operation.

Temperature monitoring:

The data from temperature monitoring can be used to determine how high the thermal loads of your device are and have been in its application environment. All values listed in this block are based on the temperatures measured by the sensor's built-in temperature sensor.

The current sensor temperature and the temperature indicator show the current thermal actual status in the device, including the corresponding rating.

The remaining values in the temperature monitoring show the thermal history. These values provide the following information:

- How many hours your sensor has been operated in the overtemperature range
- How often changes from the specified to the overtemperature range occurred
- and the lowest and highest temperature measured in the sensor during the sensor life to date.

8 Operation Via Threshold Sets Or Teach-in

8.1 Operation Via Selection Of A Threshold Set

You can operate the sensor by selecting a threshold set. A threshold set is a pair of threshold values that are selected in such a way that they take into account the individual damping behavior of different materials in equal measure. In many applications, it is therefore possible to reliably detect the complete range of materials run on the machine with only one setting, and to classify them into the states "air"/"single sheet"/"double sheet".

If the range of material run on a machine is too wide for a single setting, the sensor offers the possibility of simply switching between different threshold sets during operation.

There are three threshold sets available, with thresholds that can be individually configured if required. Ex works, the thresholds of the three threshold sets are selected in such a way that they each cover a defined, wide material spectrum and together cover the complete material spectrum range of the sensor. In addition, there is a 4th threshold set, with thresholds that can also be changed via teach-in, see chapter 8.2.

The threshold set used in the sensor for evaluation can be selected in three ways:

- Direct selection of the desired threshold set via a sensor parameter
- Selection of a threshold set depending on the levels at the sensor inputs IN1 and IN2
- Selection of a threshold set depending on two bits in the IO-Link process output data

8.1.1 Selecting Threshold Sets Via Sensor Parameter

The "Selected threshold set" sensor parameter allows you to directly select one of the threshold sets 1 to 3. The sensor then uses the corresponding threshold values to evaluate the measured amplitude values and classify them as "air"/"single sheet"/"double sheet".

You can also select "Threshold set 4/Teach-in". In addition to parameterization via IO-Link, the threshold values of this threshold set can also be changed via teach-in, see chapter 8.2.

Selecting a threshold set directly via the "Selected threshold set" parameter is suitable for any application where a threshold set can be used permanently. It is also suitable for applications in which it is rarely necessary to switch between threshold sets.

Note that any change to the threshold set via this parameter will result in EEPROM write access to a memory cell. Since the write cycle count is typically limited for EEPROMs, for applications with frequent threshold changes, we recommend that you select the appropriate threshold set using either of the following methods:

- Select threshold sets via sensor inputs
- Select threshold sets via IO-Link process output data

These methods are described in the following two subchapters.

8.1.2 Selecting Threshold Sets Via Sensor Inputs

A threshold set can be selected IO-controlled via the levels at sensor inputs IN1 and IN2. To operate the sensor in this way, two sensor parameters must be set as follows:

- "Selected threshold set" parameter to "IO-controlled"
- "Sensor inputs usage" parameter to "Threshold set selection"

The following overview shows which levels at the two sensor inputs IN1 and IN2 are used to select which threshold set:

IN1	IN2	Selected threshold set
0	0	Threshold set 1
0	1	Threshold set 2
1	0	Threshold set 3

Table 8.1

2022-09

A threshold set selected via the levels becomes active immediately in the sensor. This means that the new thresholds are used for evaluation immediately at the next measurement.

The threshold set can be changed dynamically, even during operation of the plant, at any time and as often as necessary. The selected threshold set is not permanently stored in the sensor. Therefore, in IO-controlled operation, there are no negative effects with regard to the maximum possible write accesses to the EEPROM in the sensor.



Note

The combination IN1=1 and IN2=1 does not result in the selection of "Threshold set 4/Teach-in". Instead, the integrated visual alignment aid is activated. Details see chapter 3.3.



Note

Non-connected inputs are equivalent to state 0.

8.1.3 Selecting Threshold Sets Via IO-Link Process Output Data

As an alternative to the two options described above, you can also select a threshold set via two bits in the IO-Link process output data. This mode of operation requires a permanent IO-Link connection, because only in this case is process data continuously exchanged between the sensor and IO-Link master.

To operate the sensor in this way, set the sensor parameter "Selected threshold set" to "PDO-controlled".

The following relationship applies between the states of the two bits in the process output data and the selected threshold set:

Bit 1	Bit 2	Selected threshold set
0	0	Threshold set 1
0	1	Threshold set 2
1	0	Threshold set 3
1	1	Threshold set 4/Teach-in

Table 8.2

A threshold set selected in the process data via the two bits becomes active immediately in the sensor. This means that the new thresholds are used for evaluation immediately at the next measurement.

The threshold set can be changed dynamically, even during operation of the plant, at any time and as often as necessary. The selected threshold set is not permanently stored in the sensor. Therefore, in PDO-controlled operation, there are no negative effects with regard to the maximum possible write accesses to the EEPROM in the sensor.



Note

In the case of PDO-controlled operation of the sensor, the states at the two sensor inputs IN1 and IN2 do not play any role and are ignored. To have a logically consistent parameter set and to avoid any external influences, we recommend to set the "Sensor inputs usage" parameter to "disabled" in this case.

Note that in this case the integrated visual alignment aid can no longer be activated via the sensor inputs.

Activation of the visual alignment aid via IO-Link remains possible.

8.2 Operation in Teach-in Mode

In addition to operating the sensor via a selected threshold set as described in the previous chapter, it is also possible to operate the sensor in teach-in mode. Via teach-in, the threshold values used for evaluation are set specifically to the material currently being run.

In most cases, in this operating mode, the teach-in procedure must be performed again each time the material is changed to ensure the threshold settings are always suitable for the respective material. The threshold values found are stored in the "Threshold set 4/Teach-in".

It may be useful to operate the sensor in teach-in mode in the following cases:

- When it is necessary to teach in the double sheet sensor very sensitively on specific, often thin materials.
- When a machine is used to run a very wide range of materials with a wide range of damping behaviors. For this purpose, teaching in the respective material of the machine sequence may seem easier than the specific selection of a threshold set for each material.
- In the case of a retrofit where the machine was previously operated in this operating mode and needs to be maintained in this basic machine operating mode.
- If extremely inhomogeneous damping materials with a selected threshold set cannot be easily detected, e.g. single sheet is recognized as double sheet in places. Especially when the user wants to avoid time-consuming analyses of the damping behavior with subsequent selection of a suitable threshold set.

Note

When delivered, the parameters of the double sheet sensor are configured to operate the sensor via threshold set selection. To operate the sensor in teach-in mode, you must first make adjustments to some sensor parameters. This requires a connection to the sensor via IO-Link.

The settings to be implemented in the sensor parameters depend on the method by which the teach-in process will be performed in machine operation:

- Via the sensor connections IN1/TEACH and IN2/FEEDBACK
- Via IO-Link using IODD or DTM

8.2.1 Performing Teach-in Via The Sensor Connections

The use of the two sensor connections IN1/TEACH and IN2/FEEDBACK is advisable if the teach-in process is to be carried out from a PLC, for example, and the success of the teach-in process is also to be checked automatically.

To use the sensor connections for this purpose, you must set two sensor parameters as follows:

- "Selected threshold set" parameter to "Threshold set 4/Teach-in"
- "Sensor inputs usage" parameter to "Teach-in"

By setting these parameter values, the sensor connection IN1/TEACH becomes an input via which a new teach-in process in the sensor can be triggered.

The sensor connection IN2/FEEDBACK becomes an output that signals whether or not the teach-in process was successful after a teach-in process has been completed.

Note

You can find the above-mentioned parameters in the DTM under the "Sensor configuration" menu item on the "Threshold configuration" tab.



Connection

For details on the electrical wiring of the sensor, refer to either the commissioning instructions supplied with the sensor or see chapter 3.2.2.

To be able to carry out the teach-in from a controller, such as a PLC, you also connect

- the sensor connection IN1/TEACH with a controller digital output
- and the sensor connection IN2/FEEDBACK with a controller digital input.



Teach-in Process With IN1/TEACH And IN2/FEEDBACK

1. Insert a single sheet of the material to be taught in into the double sheet sensor.



Note

To perform a teach-in, a single sheet of the material to be taught in must be located between the transmitter and receiver of the double sheet sensor. If a multi-layer material is to be taught in, e.g. 3-layer kitchen paper or similar, the material to be classified as "good material"/"good condition" for the application must be inserted.

2. Apply a HIGH level to the IN1/TEACH sensor input via the control output. The teach-in process starts with a delay of 1 s.
3. Move the single sheet material within the sensor.



Note

By moving the single sheet material within the double sheet sensor during the teach-in process, the sensor always receives the spectrum of amplitudes actually occurring in the material, especially with materials that are inhomogeneous from an ultrasonic point of view, such as paper or cardboard. As a result, the sensor can usually set the threshold to match the material very well after the teach-in process.

Make sure that the material to be taught in does not leave the detection area of the double sheet sensor at any time during the teach-in process. Otherwise, successful completion of the teach-in process is not possible, because the data lies within the amplitude range for the "air" state and therefore no meaningful threshold can be set.

4. After the sensor has recorded sufficient amplitude values on the material, terminate the teach-in process by setting the level of sensor input IN1/TEACH to LOW.



Note

The time it takes for the sensor to record sufficient amplitude values depends on the cycle time of the sensor. For example, with a sensor cycle time of 3.3 ms, a duration of approx. 5 s can be expected. If the cycle time is long, it may take considerably longer to record a sufficient amount of data.

5. After the teach-in process has been completed, feedback whether or not the teach-in process was successful is provided via the LED and the IN2/FEEDBACK output of the sensor.
 - If the teach-in process was successful, the green LED flashes three times. In the same sequence, the IN2/FEEDBACK output provides corresponding HIGH levels. The new thresholds are immediately active in the sensor.
 - If the teach-in process was not successful, the red LED flashes three times and the voltage level of the IN2/FEEDBACK output remains permanently LOW. In this case, the previous thresholds remain unchanged.

8.2.2 Performing Teach-in Via IO-Link

If the sensor in the plant is connected to an IO-Link master, it is advisable to trigger the teach-in process via IO-Link.

To always use the taught-in threshold values for evaluation when operating the sensor in teach-in mode, you must set the following parameter setting in the sensor:

- "Selected threshold set" parameter to "Threshold set 4/Teach-in"

In some applications, it may make sense to teach in specifically to a material only in exceptional cases. Therefore, it may make more sense to select one of the available threshold sets 1 ... 3 covering a wide material range each. Specific teach-in to a material may be required for exceptionally inhomogeneously damping materials that cannot be properly detected with any of the three defined threshold sets. If the sensor is intended to be completely controlled via IO-Link in this application scenario, set the "Selected threshold set" parameter to "PDO-controlled". With this setting, the threshold set used for evaluation in the sensor can be selected and dynamically changed via 2 bits in the process output data. Depending on the combination of bit states, one of the threshold sets 1 ... 3 or threshold set 4 (Teach-in) is active.



Note

In the case of PDO-controlled operation of the sensor, the states at the two sensor inputs IN1 and IN2 do not play any role and are ignored. To have a logically consistent parameter set and to avoid any external influences, we recommend to set the "Sensor inputs usage" parameter to "disabled" in this case.

Note that in this case the integrated visual alignment aid can no longer be activated via the sensor inputs.

Activation of the visual alignment aid via IO-Link remains possible.



Note

You can find all the parameters mentioned in the DTM under the "Sensor configuration" menu item on the "Threshold configuration" tab.

Connection

For details on the electrical connection of the sensor to an IO-Link master see chapter 3.2.3.



Teach-in Procedure Via IO-Link Using The DTM



Note

A teach-in can also be carried out via IO-Link using the IODD. For details, refer to the IO-Link parameter datasheet of the sensor. The sequence of a teach-in process when using the IODD is identical to that when using the DTM. However, the IODD does not offer any graphic elements, which is why it is not possible to display the teach histogram data graphically. This function can therefore only be found in the DTM.

1. Establish the connection with the sensor via IO-Link and switch to the "Teach-in" tab in the DTM under the "Sensor configuration" menu item.
2. Insert a single sheet of the material to be taught in into the double sheet sensor.



Note

To perform a teach-in, a single sheet of the material to be taught in must be located between the transmitter and receiver of the double sheet sensor. If a multi-layer material is to be taught in, e.g. 3-layer kitchen paper or similar, the material to be classified as "good material"/"good condition" for the application must be inserted.

3. Press the "Start teach-in" button in the DTM.
↳ The teach-in process is now running. This is also indicated in the DTM in the field next to the buttons by the yellow message "Teach-in active – not enough values yet".
4. Move the single sheet material within the sensor.



Note

By moving the single sheet material within the double sheet sensor during the teach-in process, the sensor always receives the spectrum of amplitudes actually occurring in the material, especially with materials that are inhomogeneous from an ultrasonic point of view, such as paper or cardboard. As a result, the sensor can usually set the threshold to match the material very well after the teach-in process.

Make sure that the material to be taught in does not leave the detection area of the double sheet sensor at any time during the teach-in process. Otherwise, successful completion of the teach-in process is not possible, because the data lies within the amplitude range for the "air" state and therefore no meaningful threshold can be set.

5. When the sensor has recorded enough values, the display next to the buttons changes to "Teach-in active – enough values". At the same time, the background color of the display field changes to blue.



Note

The time it takes for the sensor to record sufficient amplitude values depends on the cycle time of the sensor. For example, with a sensor cycle time of 3.3 ms, a duration of approx. 5 s can be expected. If the cycle time is long, it may take considerably longer to record a sufficient amount of data.

Canceling A Current Teach-in Process

You can cancel a teach-in process started via the DTM at any time by pressing the "Cancel teach-in" button. The threshold values are not changed and remain at the same values as before the teach-in attempt.

Interpreting The Teach-in Histogram

After a successful teach-in process via the DTM, the graphic on the "Teach-in" tab shows the amplitude values that occurred during the teach-in with their respective frequency. From this representation you can read:

- How extreme the fluctuation range is on the taught-in material. This determines whether the material should be regarded as "homogeneous" or "inhomogeneous" in terms of its damping from an ultrasound perspective.
- Whether there is a center of gravity for the amplitudes or whether the amplitude values actually fluctuate over the entire bandwidth.
- How the amplitude values that have occurred lie in relation to the switching thresholds and measuring range limits of the device. The last two pieces of information make it possible to estimate the operating reserve and also the reliability of the sensor in the application in relation to the respective material.

All in all, you can use this data to determine whether or not stable detection of the respective material is possible with the sensor.



Note

If no teach-in has been performed since the last time the sensor was connected to the DTM or since the last time the sensor was switched on, the diagram is empty. The histogram data is not stored permanently in the sensor.

The histogram graphic is only available in the DTM and not in the IODD.

9 Analyzing Material And Application Environment

9.1 Assessing A Material with Regard to its Ultrasonic Signal Attenuation

The assessment of one or more materials with regard to their damping behavior on the ultrasonic signal is particularly useful in double sheet applications for the following reasons:

- To verify that the thresholds are appropriate for the materials.
- To assess the operating reserve of the sensor for different materials run on the machine.
- To check whether all materials run on the machine can be reliably detected with only one threshold set setting, or whether more than one threshold set must be used.
- To analyze whether a material is more likely to show constant or fluctuating ultrasonic signal attenuation across the entire surface of the sheet.

A material is therefore always analyzed in two ways:

- Firstly, the absolute amplitude level is considered in relation to the switching thresholds.
- Secondly, the homogeneity of a material is assessed in relation to its ultrasonic signal attenuation.

Although many materials may appear "homogeneous" or "uniform" to the human eye, some do not attenuate the ultrasound signal equally in all areas of the material. This is especially the case for papers. Here, the damping behavior varies due to the fiber arrangement within the material. There are therefore places in papers with higher damping and with lower damping. Depending on the grammage, recycling percentage and volume, the differences in the signal attenuation of a paper are more or less significant. Films and sheets, on the other hand, tend to dampen very evenly. They are therefore considered to be "homogeneous" from an ultrasonic damping point of view.

Ultimately, both aspects - the absolute amplitude levels and the homogeneity of a material - play an important role in selecting a threshold set suitable for the application or in setting the thresholds adequately.



To collect the appropriate analysis data, proceed as follows:

1. Insert a single layer of the material under examination between the transmitter and receiver of the double sheet sensor.
2. In the DTM, select the "Immediate" trigger mode and activate the trigger in the sensor by pressing the "Activate trigger" button.
3. Move the material back and forth within the double sheet sensor during the measured value recording so that as many parts of the material as possible are recorded.
4. Analyze the data.



Note

When moving the material during the measured value recording, make sure that the material does not leave the sound path between the transmitter and receiver and that the minimum coverage and minimum distances are maintained at all times (see chapter 3.3.1).



Note

Note that the angle of the double sheet sensor to the material also has a decisive influence on the measured amplitude values and, if necessary, their fluctuation range. Depending on the material, you may want to experiment with different angles of the sensor to the material in your analysis to find the best possible alignment and adjustment.



Note

You can also record the analysis data for the damping behavior of a material using the "single sheet" trigger mode. Measurement data recorded in this way also includes the run-in moment of the sheet edge. In most cases, this moment is not critical, because any effects on the received sound amplitude are suppressed by the evaluation active in the sensor. In individual cases, however, it may be interesting to examine this moment more closely based on the measured data, e.g. if no evaluation algorithms are used in the device >> Evaluation method = "None".

If you want to record data in the "single sheet" trigger mode, first remove the material from the double sheet sensor and activate the trigger in the sensor. Then insert the material into the sound path between the transmitter and receiver. Move the sheet back and forth during the measured value recording to obtain readings from several places on the sheet of material.

9.2 Root Cause Analysis of Accidental Activations During Machine Operation

If accidental activations occur during machine operation, investigating the causes can be very complex, especially if the accidental activation only occurs sporadically.

Accidental activations occur, for example, if the double sheet sensor occasionally

- detects a single layer of a material as a double sheet during operation of the machine,
- does not detect a double sheet as a double layer, but only as a single layer.

The causes of each case can be manifold and are not always directly and easily recognizable. In these cases, if an assessment of the material in terms of ultrasonic attenuation does not provide any information, you can use the analysis trigger function to take measurements for the event during live operation of the machine. Based on this consistent measurement data from the original machine operation, the cause of the accidental activation can often be traced – if necessary with the help of Pepperl+Fuchs experts.



To do so, proceed as follows:

1. Select the trigger suitable for the accidental activation that occurs and activate this in the sensor. If, for example, a single layer is occasionally incorrectly detected as a double sheet, the "double sheet" trigger mode must be selected.
2. Wait until the trigger has been triggered and the data has been transferred to the DTM.
3. Analyze the data.



Note

If possible, the corresponding trigger should be activated and triggered during machine operation under original operating conditions. This provides the most meaningful database for an appropriate analysis, as the data is real live data.

9.3 Analysis Of Possible External Interferences

In many applications, external interferences occur that can cause malfunctions of the double sheet sensor. For example, due to strong external ultrasonic signals or also strong EMC effects, a double sheet sensor cannot detect a double sheet as such and therefore reports the double sheet as a "single sheet". External ultrasonic signals can be produced, among other things, from non-synchronized, other ultrasonic sensors with a similar ultrasonic transducer frequency in the immediate vicinity, or also, for example, from rubbing metal on metal with insufficient lubrication in a broadband frequency spectrum. Despite a narrow bandpass filter around the ultrasonic transducer frequency, which is naturally present in the sensor, such an influence cannot be completely suppressed.

In most cases with external interference, the double sheet sensor measures an increased amplitude at its receiver. This is higher than it should be based purely on the signal emitted by the transmitter and damped by the material in between. The signal caused by the interference therefore superimposes the actual measuring signal. Therefore, it is recommended that the sensor transmitter is switched off for such analyses. If the transmitter is disabled, only the interference signals that occur in the application that influence the measurement are received at the sensor receiver. Also their effects on the measured amplitudes over time are now visible.



To collect the appropriate analysis data, proceed as follows:

1. Switch off the transmitter by pressing the "Switch off transmitter" button in the DTM.
2. Select the trigger mode "Immediate" and activate the trigger by pressing the "Activate trigger" button.
3. Wait until the sensor has recorded its data.
4. Analyze the data.
5. Switch the transmitter back on by pressing the "Switch on transmitter" button in the DTM.



Note

In some cases, it may be useful to take several recordings of the signals with the transmitter switched off, and to compare them with each other. In this way, the cyclic repetitive interference, or typical signal characteristics of the interference can be determined. This information can often be helpful in finding the cause of the interference.



Note

The transmitter can also be disabled by disconnecting the connector in the transmitter/receiver line. If, however, the EMC influences connect via this cable and/or the transmitter head in the sensor, these influences cannot be recorded when the transmitter/receiver line is disconnected and do not appear in the analysis diagram. For this reason, switching off the transmitter via the button in the DTM is, in most cases, preferable to disconnecting the cable connection.



Note

If the transmitter has not been switched on again in the DTM after the analyses have been completed using the "Switch on transmitter" button, it can also be reactivated by briefly disconnecting the sensor from the supply voltage (power cycle).

10 Description of Sensor Parameters

10.1 Sensor Information

Function Tag

Parameter name	Access	Value range
Function tag	Read/write	32 alphanumeric characters

Table 10.1

You can use this parameter to assign any identification to the sensor, e.g. "double sheet sensor paper feed".

Location Tag

Parameter name	Access	Value range
Location tag	Read/write	32 alphanumeric characters

Table 10.2

You can use this parameter to assign any identification to the sensor, e.g. name of the company and location of the customer in whose plant the sensor is installed.

Application Specific Tag

Parameter name	Access	Value range
Application specific tag	Read/write	32 alphanumeric characters

Table 10.3

You can use this parameter to assign any identification to the sensor, e.g. "Feed 2" or to tag the sensor in the plant design.

10.2 Output Configuration

10.2.1 Output Logic

Parameter name	Access	Value range
Output logic	Read/write	<ul style="list-style-type: none"> Normally-open Normally-closed

Table 10.4

You can use this parameter to set the logic of the switching outputs. The parameter acts equally on all sensor switching outputs.

10.2.2 Output Pulse Extension

Parameter name	Access	Value range
Output pulse extension	Read/write	<ul style="list-style-type: none"> • Disabled • IO-Link master cycle time • 100 ms

Table 10.5

By default, the output pulse length corresponds to the length of the actual event (output pulse extension = disabled). This means, for example, that the output associated with the "Double sheet" state remains active as long as the sensor detects the "Double sheet" state. In fast applications, this time can be very short. An IO-Link master or a controller that may be downstream in the communication chain may no longer be able to perceive this short pulse or may not be able to detect it reliably. You can therefore use this parameter to extend the output pulse.

When set to "IO-Link master cycle time", it is ensured that a subsequent IO-Link master can reliably detect a change in the status bits in the cyclic process data.

The setting "100 ms" ensures that a downstream controller can reliably detect the pulse.

Note

This parameter affects both the switching outputs physically present in the sensor and the status bits in the cyclic IO-Link process data.

Note

If the output pulse extension is activated, systems with faster state changes (air/single sheet/double sheet) can have more than 1 switching output active at the same time or more than 1 state bit set in the IO-Link process data.

10.3 Sensor Configuration - Threshold Configuration

10.3.1 Selected Threshold Set

Parameter name	Access	Value range
Selected threshold set	Read/write	<ul style="list-style-type: none"> • Threshold set 1 • Threshold set 2 • Threshold set 3 • Threshold set 4/Teach-in • PDO-controlled • IO-controlled

This parameter allows you to directly select a threshold set. Alternatively, you can use the sensor in teach-in mode. Another option is to select the threshold set externally via the IO-Link process data or the two sensor inputs IN1 and IN2.

Direct selection of a threshold set (threshold sets 1 to 3)

If an application only needs one fixed threshold set, you can set it directly using this parameter. In this case, threshold sets 1 ... 3 can be selected.

You can change the directly selected threshold set at any time via IO-Link access to this parameter. Each time, however, the memory cell in the EEPROM is newly written. For applications with very frequent changes to the selected threshold set, we therefore recommend selecting the threshold set either via the IO-Link process output data or via the sensor inputs IN1 and IN2.



Note

If you select a threshold set directly via this parameter, both the threshold set bits in the process output data and the states at the two sensor inputs IN1 and IN2 are irrelevant and are ignored. However, to have a logically consistent parameter set, and to avoid any external influences, you can set the "Sensor inputs usage" parameter to "disabled" for this operating scenario. Note that in this case the visual alignment aid of the sensor can no longer be activated via the sensor inputs.

Teach-in Mode (Threshold Set 4/Teach-in)

If an application requires very precise, individual adjustment of the sensor to a particular material, we recommend teach-in mode. To operate the sensor in this mode, select the "Threshold set 4/Teach-in" as the "Selected threshold set".

The sensor is always taught in to a single sheet of the respective material. The single sheet must be between the transmitter and receiver of the double sheet sensor during the teach-in process. The teach-in process itself can be initiated either via sensor input IN1 or via the IO-Link interface.

Feedback is then provided as to whether or not the teach-in process was successful:

- If sensor input IN1 is used, the feedback is provided via the FEEDBACK output.
- In the case of teach-in via IO-Link, the feedback is provided via the associated status information.

Details and further information on the use of the sensor in teach-in mode see chapter 10.4



Note

To use the sensor in teach-in mode via connections IN1 and IN2, you must first set the "Sensor inputs usage" parameter to "Teach-in". If a teach-in process of the sensor is only possible via the IO-Link interface, you can disable the two connections IN1 and IN2. This is done by setting the parameter "Sensor inputs usage" to "disabled".

Note that in this case the integrated visual alignment aid can no longer be activated via the sensor inputs.

Selection Of The Threshold Set Via IO-Link Process Output Data (PDO-controlled)

By setting the "Selected threshold set" parameter to "PDO-controlled", the threshold set used in the sensor for evaluation is finally selected via the two bits in the IO-Link process output data. This means that you can also dynamically change the threshold set via IO-Link, even during plant operation, at any time and as often as necessary.

In PDO-controlled operation, there are no negative effects with regard to the maximum possible write accesses to the EEPROM installed in the sensor, because the selected threshold set is not permanently stored in the sensor.

The following relationship applies between the states of the two bits in the process output data and the selected threshold set:

Bit 1	Bit 2	Selected threshold set
0	0	Threshold set 1
0	1	Threshold set 2
1	0	Threshold set 3
1	1	Threshold set 4/Teach-in

Table 10.6

Note

PDO-controlled operation of the sensor is only possible if the sensor is permanently integrated into the system via IO-Link. The measurement results of the sensor in this constellation can be recorded and processed by the controller via the IO-Link process data. In particularly fast applications, however, time conflicts may occur at this point. This is possible, for example, if the application requires a sensor response delay of only 1.5 ms due to an extremely short reaction time, but the IO-Link master cycle time is considerably slower. This problem can be solved by wiring the other sensor switching outputs to normal control inputs in addition to the wiring required for IO-Link operation with the IO-Link master. These switching outputs retain their normally short response time, even if the sensor is communicating in parallel via IO-Link.

Note

In the case of PDO-controlled operation of the sensor, the states at the two sensor inputs IN1 and IN2 do not play any role and are ignored. To have a logically consistent parameter set and to avoid any external influences, we recommend to set the "Sensor inputs usage" parameter to "disabled" in this case.

Note that in this case the integrated visual alignment aid can no longer be activated via the sensor inputs.

Activation of the visual alignment aid via IO-Link remains possible.

Selection Of The Threshold Set Via The Two Sensor Inputs IN1 And IN2 (IO-controlled)

By setting the "Selected threshold set" parameter to "IO-controlled", the threshold set used in the sensor for evaluation is selected via the states at the two sensor inputs IN1 and IN2. This means that you can dynamically change the threshold set, even during plant operation, at any time and as often as necessary. In IO-controlled operation, there are no negative effects with regard to the maximum possible write accesses to the EEPROM installed in the sensor, because the selected threshold set is not permanently stored in the sensor.

The following relationship applies between the states at the two sensor outputs and the selected threshold set:

IN1	IN2	Selected threshold set
0	0	Threshold set 1
0	1	Threshold set 2
1	0	Threshold set 3

Table 10.7



Note

In contrast to PDO-controlled operation and the corresponding coding, the combination IN1=1 and IN2=1 does not result in the selection of threshold set 4, but instead activates the alignment aid installed in the sensor (see chapter 3.3).



Note

To enable IO-controlled operation of the sensor, you must set the "Sensor inputs usage" parameter to "Threshold set selection".

10.3.2 Sensor Inputs Usage

Parameter name	Access	Value range
Sensor inputs usage	Read/write	<ul style="list-style-type: none"> • Disabled • Threshold set selection • Teach-in

Table 10.8

This parameter determines whether the two sensor connections "IN1/TEACH" and "IN2/FEED-BACK" are activated and, if so, in which mode they are used.

There are three options to choose from:

- Disabled
- Threshold set selection
- Teach-in

Disabled

If the parameter is set to "disabled", the two connections IN1 and IN2 are switched off and do not function.

Threshold set selection

If the "Threshold set selection" option is selected as "Sensor inputs usage", the two connections IN1 and IN2 of the sensor are both used as inputs. One of the threshold sets 1 to 3 can be selected via these inputs in the IO-controlled operation of the sensor. For details on how it works, see the previous chapter "Selected Threshold Set" - see "IO-controlled" option.

Note

To enable IO-controlled operation of the sensor, the "Selected threshold set" parameter must be set to "IO-controlled".

Teach-in

If the "Teach-in" option is selected as "Sensor inputs usage", IN1 is used as the input. This can be used to initiate a new teach-in process. IN2 becomes an output via which, after the teach-in procedure has been carried out, it is reported whether or not the teach-in procedure was successful. This mode of operation enables automated teach-in via a PLC.

Further details and information on teach-in can be found in the "Teach-in" and the "Selected Threshold Set" chapters in the "Teach-in Operation (Threshold Set 4/Teach-in)" section.

Note

To use the sensor in teach-in mode, you must select one of the following options via the "Selected threshold set" parameter:

- "Selected threshold set 4/Teach-in" option: Here, the threshold set intended for teach-in operation is directly selected.
- "PDO-controlled" option: In this case, the threshold set is selected depending on the two bits in the IO-Link process output data. These must both be set to "1" to select the threshold set intended for teach-in mode.

10.3.3 Thresholds of Set 1 To Set 4 (Upper/Lower Threshold)

Each threshold set has an upper and a lower threshold. In the device DTM these are represented in the following form:

Thresholds	Upper threshold	Lower threshold
Set 1	160	50
Set 2	160	15
Set 3	160	100
Set 4 / Teach-In	160	50

Figure 10.1

The "upper threshold" represents the switchover threshold from the "AIR" state to "SINGLE SHEET". The "lower threshold" represents the switchover threshold from the "SINGLE SHEET" state to "DOUBLE SHEET". By selecting a threshold set, the associated thresholds in the sensor are used for evaluation.

The possible value ranges for the upper and lower thresholds depend on the device used (design M18 or M30) and the relevant threshold set. The "Threshold set 4/Teach-in" allows a larger setting range than sets 1 to 3 with certain restrictions. See the "Teach-in" chapter or alternatively the DTM help for the "Sensor Configuration – Teach-in" section.



Note

The upper threshold should be set higher than the lower threshold to allow logically correct assignment. If this point is not observed by the user, the sensor automatically swaps the entered threshold values during its evaluation. This ensures the correct function of the sensor. The values entered for the respective parameters are not changed or swapped and continue to appear logically as "incorrectly assigned".

10.3.4 Threshold Hysteresis

Parameter name	Access	Value range
Threshold hysteresis	Read/write	<ul style="list-style-type: none"> • Low • Medium (standard) • High

Table 10.9

To reliably report a detected status even at amplitudes in the switchover range between two different states such as "AIR/SINGLE SHEET" or "SINGLE SHEET/DOUBLE SHEET", the sensor uses a hysteresis for the switching threshold values. This hysteresis is added to the respective value of the "Lower threshold" or "Upper threshold". This means that a state change occurs, for example, from "AIR" to "SINGLE SHEET" at exactly the amplitude defined via the value of the "Upper threshold." However, a change from "SINGLE SHEET" back to "AIR" takes place only at a correspondingly higher amplitude value, which corresponds to the value of the "Upper threshold" + the selected threshold hysteresis.

The same applies to a change of state from "SINGLE SHEET" to "DOUBLE SHEET" and in connection with the relevant "Lower threshold" that is parameterized there. Here too, the hysteresis is added to the defined value of the "Lower threshold." This means that when changing back from "DOUBLE SHEET" to "SINGLE SHEET" at least one amplitude value must be reached that corresponds to the value of the "Lower threshold" + the selected threshold hysteresis.

This parameter determines how high the hysteresis is and by how much the amplitude must increase again above the defined thresholds before the sensor changes state.

The following three options are available:

- Low
- Medium (standard)
- High

In most applications, "medium (standard)" is a useful setting.

Setting the hysteresis to "low" can be advantageous in special applications where a very close or sensitive test on the material is required. This applies, for example, to multi-layer detection applications, such as in the production of tissues, toilet paper and diapers or respirators.

A "high" hysteresis can be advantageous in applications where extremely inhomogeneous materials with amplitude values close to the threshold values occur from an ultrasonic damping perspective. The higher hysteresis prevents or better counteracts continuous toggling of the sensor.

Note

Threshold hysteresis only works when using one of the threshold sets 1 to 3.



10.4 Sensor Configuration - Teach-in

10.4.1 Sensor Configuration = Teach-in Mode

Parameter name	Access	Value range
Teach-in mode	Read/write	<ul style="list-style-type: none"> Standard Extended

Table 10.10

You can use this parameter to set whether the standard amplitude value range or the extended amplitude value range is permitted and used for the teach-in process.

- The use of the standard amplitude value range ensures the correct sensor function across all operating states and specified ambient conditions.
- When using the extended amplitude range, you can also successfully teach in materials that are very close to the sensor's measurement limits in terms of their amplitude values. However, this may result in limitations in the permissible ambient and operating conditions. If you have any questions about this, please contact our application specialists with further details about your application.



Note

The following materials may not be taught in successfully in the standard amplitude value range:

- Very sound-permeable materials that result in only a low attenuation of the ultrasonic signal and thus very high amplitude values.
- Very strongly sound-absorbing materials, which result in a very strong attenuation of the ultrasonic signal and thus very low amplitude values.

10.4.2 Threshold Distance

Parameter name	Access	Value range
Threshold distance	Read/write	<ul style="list-style-type: none"> Standard Narrow Minimum

Table 10.11

You can use this parameter to set how close the upper and lower thresholds are to the amplitude value range recorded during a teach-in process.

With the "Standard" setting, the two thresholds are set around the amplitude range recorded during the teach-in process, with sufficient reserve for most applications. This ensures the safe response of the double sheet sensor under all the operating conditions specified in the data-sheet.

If the amplitude values for the "single sheet" and "double sheet" states of the material to be detected are closer together, it is possible that even after a successful teach-in process, the double sheet state of the material to be detected is not, or not always reliably detected. In this case, it may be necessary to set the threshold distance to "narrow."



Note

When teaching in such materials, ensure that the material is moved within the double sheet sensor during the teach-in process. This is the only way to ensure that the sensor can record a sufficient amplitude value spectrum of the material and subsequently set the thresholds accordingly.

If the application is a so-called multi-layer application with very sound-permeable materials, it will most likely be necessary to set the threshold distance to "minimum". An example of this is the monitoring of the correct number of layers of very sound-permeable materials, such as tissues, toilet paper or dust masks. This setting may also be necessary for other applications if the amplitude values for the "single sheet" and "double sheet" states of the material to be detected are very close together.



Note

Note that when using the "minimum" setting, there is almost no operating reserve when setting the thresholds. In this case, even with slightly changing amplitude values, incorrect detection states may occur. It is therefore essential to teach in the material again regularly in the event of changes in working conditions to ensure continued operation. These can be changing ambient conditions, such as temperature changes, or even slight changes in the damping behavior of the material used, e.g. after a material roll change.

10.5 Sensor Configuration – Evaluation

10.5.1 Sensor Configuration - Evaluation Method

Parameter name	Access	Value range
Evaluation method	Read/write	<ul style="list-style-type: none"> • Average value • Low pass • None

Table 10.12

Using this parameter, you can set the extent to which values of previous measurements are included in the evaluation of the current measurement. The objective is to ensure a stable measuring signal even in the event of brief interference (e.g. compressed air), or in the case of materials that are highly inhomogeneous from an ultrasonic point of view.

Average value

In most applications, the "Average value" setting has proven most useful. This involves calculating a floating arithmetic average value over the latest data in accordance with the setting of the "Averages & skip count" parameter.

Low Pass

With this evaluation method, previous data is included when determining the current amplitude value according to the "Weighting of former measurement", "Allowed deviation to former measurement" and "Skip time" parameters. The evaluation produces a typical low pass behavior, i.e. the amplitude value output by the sensor follows the actual measured value, and the sensor response time is delayed accordingly. In addition, significant changes to the measured value are only taken into account if they occur repeatedly and/or longer than a certain time.

None

With the "None" setting, each individual measured value is output directly at the output. This setting is not recommended for most applications as faulty measurements resulting from external influences immediately have an effect on the output. When using the evaluation method, filtering and/or validation of the data by downstream logic controllers, e.g. a programmable logic controller (PLC) is recommended.

10.5.2 Averages & Skip Count



Note

This parameter is only relevant and visible in the DTM if the "Evaluation method" is set to "Average value."

Parameter name	Access	Value range
Averages & skip count	Read/write	<ul style="list-style-type: none"> • M=2, N=0 • M=3, N=0 • M=3, N=1 • M=4, N=0 • M=4, N=1 • M=5, N=0 • M=5, N=1 • M=5, N=2 • M=6, N=0 • M=6, N=1 • M=6, N=2 • M=7, N=0 • M=7, N=1 • M=7, N=2 • M=7, N=3 • M=8, N=0 • M=8, N=1 • M=8, N=2 • M=8, N=3

Table 10.13

You can use this parameter to control the depths of the average determination. M defines the total number of measurements which are used to generate average determination. N defines the number of measurements from the number of M which are not taken into account for average determination. These are the value/values with the greatest deviation from the measurement result most recently determined. The current measurement result is calculated arithmetically from the remaining data.

10.5.3 Weighting of Former Measurement



Note

This parameter is only relevant and visible in the DTM if the "Evaluation method" parameter is set to "Low pass."

Parameter name	Access	Value range
Weighting of former measurement	Read/write	1 ... 99 [%]

Table 10.14

This parameter determines how much weighting in percentage terms the result of the previous measurement result is given in the current evaluation.

The following formula applies:

$$\text{Res}_N = (\text{Res}_{N-1} \times W + \text{Meas} \times (100 - W)) / 100$$

Res = result

W = "weighting of previous measurement" factor

Meas = current measured value

This means that the less the "Weighting of former measurement" value, the closer the sensor's output follows the real distance.

10.5.4 Allowed Deviation to the Former Measurement



Note

This parameter is only relevant and visible in the DTM if the "Evaluation method" parameter is set to "Low pass."

Parameter name	Access	Value range
Allowed deviation to the former measurement	Read/write	10 ... 50 [%]

Table 10.15

Together with the "Skip time" parameter, you can use this parameter to define an acceptance filter to filter short disturbances, so that the measured result is not changed.

The "Allowed deviation to the former measurement" parameter defines the value by which the new measured value may deviate at most from the previous measurement result. Only measured values with allowed deviation will be included in the calculation of the new measurement results. If the deviation is exceeded, the measured values are ignored until the set skip time is reached (see "Skip time" parameter).

10.5.5 Skip Time



Note

This parameter is only relevant and visible in the DTM if the "Evaluation method" parameter is set to "Low pass."

Parameter name	Access	Value range
Skip time	Read/write	0 ... 60000 [ms]

Table 10.16

Together with the "Allowed deviation to former measurement," this parameter lets you define an acceptance filter to filter short disturbances, so that the measured result is not changed.

The "Allowed deviation to former measurement" parameter defines the value by which the new measured value may deviate at most from the previous measurement result. Only measured values with allowed deviation will be included in the calculation of the new measurement results. If the deviation is exceeded, the measured values are ignored until the set skip time is reached.

10.5.6 Sensor Cycle Time

Parameter name	Access	Value range
Sensor cycle time	Read/write	<min. cycle time> ... 6000 [100 µs]

Table 10.17



Note

The minimum cycle time depends on the ultrasonic transducer of the sensor. If values that are too small are entered in the DTM, a corresponding message will appear stating the minimum allowable value for the selected sensor.

The value range unit for this parameter is [100 µs]. This means that the value entered here for the parameter should be multiplied by 100 µs to obtain the final sensor cycle time.

You can use the "Sensor cycle time" parameter to specify the length of a measuring cycle. If the sensor is not operated at the minimum cycle time, the sensor pauses after its measurement until the set time has expired, before the next measurement starts.

The factory setting is selected in such a way that the operation of the sensor is ensured under all conditions and usage scenarios specified in the sensor specification. A reduction of the standard sensor cycle time may be necessary, especially in fast applications. However, a shorter sensor cycle time than the one set at the factory may result in conditions for mounting the sensors, aligning them with the material or similar. In these cases, these must be observed in order to ensure reliable operation.

Increasing the factory set sensor cycle time can also be helpful in some very slow applications or applications that are very subject to interference. As a result, there are usually no requirements for mounting, etc. that go beyond the standard specification of the sensor.

10.5.7 Automatic Distance Detection (Transmitter - Receiver)

Parameter name	Access	Value range
Automatic distance detection (transmitter - receiver)	Read/write	<ul style="list-style-type: none"> Disabled Enabled

Table 10.18

The sensor samples the received amplitude signal at a certain point in time after the ultrasound packet has been emitted. This sampling time must match the actual mounting distance from transmitter to receiver in order to achieve the full performance of the sensor.

To deal with this situation as easily as possible and therefore always ensure the highest performance of the devices, the double sheet sensors are equipped with automatic distance detection:

- If this is enabled, the current distance between the transmitter and receiver is automatically re-recorded and saved each time the supply voltage is switched on without any material being inserted ("air" state).
- If it is disabled, the operating distance between transmitter and receiver provided by the "Fixed operating distance" parameter is used, and the device sampling time is set accordingly.

10.5.8 Fixed Operating Distance

Parameter name	Access	Value range
Fixed operating distance	Read/write	<ul style="list-style-type: none"> UDC-18GS: 20 ... 60 mm UDC(M)-30GS: 50 ... 150 mm

Table 10.19

When automatic distance detection is disabled, the value specified here is used as the value for the distance between the transmitter and receiver, and the performance of the device is set accordingly. See parameter "Automatic distance detection (transmitter - receiver)."

Note

If the actual distance between the transmitter and receiver in the application deviates from the value parametrized here, this leads to losses in device performance. In this case, the sampling time and other performance parameters are no longer set appropriately.



10.6 Sensor Configuration – Synchronization



Note

In addition to setting the "Synchronization mode" parameter, further measures are necessary for synchronization to be successful. For example, this includes appropriately wiring the devices to each other. Details see chapter 11.

Synchronization Mode

Parameter name	Access	Value range
Synchronization mode	Read/write	<ul style="list-style-type: none"> • Disabled • Automatic multiplex mode • Automatic common mode • Externally controlled

Table 10.20

In applications where multiple ultrasonic sensors are operated in close proximity to each other, we must prevent these sensors from mutually influencing each other. Otherwise it can result in individual devices providing incorrect measurements. The easiest way to solve this problem is by synchronizing the devices.

You can set the type of synchronization by using the "Synchronization mode" parameter. Below are the various synchronization modes in detail.

Disabled

Synchronization is disabled. With this setting, all sensors work unsynchronized, i.e. each in its own clock. Several sensors mounted and operated in close proximity to each other can result in cross-talk.

Automatic Multiplex Mode

The synchronized sensors self-synchronize in succession, i.e. there is always just one sensor transmitting at any one time. The measuring cycles of the individual sensors run in succession in a chronological sequence.

Advantage: Cross-talk is completely avoided.

Disadvantage: Extension of the response time of the sensors by factor n .

(n = number of synchronized sensors; the smallest possible cycle time per sensor in synchronized operation is 4.3 ms (UDC-18GS-...) or 7 ms (UDC(M)-30GS-...))

This type of synchronization is recommended for all applications with sensors operated in close proximity to each other, within which cross-talk must be completely avoided. This operating mode is also very helpful when operating several devices with different mountings in one enclosed (machine) room. At the same time, the extended response time of the synchronized devices due to automatic multiplexing must not be a problem in all cases.

Automatic Common Mode

The synchronized sensors work in a self-synchronized way at the same time, i.e. all sensors always send their ultrasound pulse at the same time.

Advantage: The response time of the individual sensors is significantly shorter than in multiplexing mode. It is only slightly longer than in unsynchronized stand-alone mode. The smallest possible cycle time of the sensors in synchronized operation is 4.3 ms (UDC-18GS-...) or 7 ms (UDC(M)-30GS-...).

Disadvantage: Cross-talk cannot be completely ruled out. However, it is very unlikely with double sheet sensors mounted side by side.

Synchronization in common mode is suitable for all applications in which several double sheet sensors are used in a row for monitoring e.g. a complete material web width. All devices typically have the same mounting orientation, the same distance from transmitter to receiver and the same distance and angle to the material web. Due to the similar mounting of the devices operated in the same mode, cross-talk is very unlikely. At the same time, common mode does not result in any loss in response time, despite the large number of sensors. Only the cycle time of the sensors increases in synchronized operation to at least 4.3 ms (UDC-18GS-...) or 7 ms (UDC(M)-30GS-...). This means that the complete web width can be reliably monitored even in fast applications.

Externally controlled

The synchronized sensors are triggered in parallel by an external square-wave signal, e.g. a PLC output, and work synchronously. This means that all sensors always send out their ultrasonic pulse at the same time.

Externally controlled synchronization is only necessary

- if more than the maximum number of sensors specified in the datasheet are being synchronized
- or if the sensors need to be triggered in a unique, application-specific sequence.

10.7 Sensor Configuration – Local Controls

Local Control Status

Parameter name	Access	Value range
Input 1 status	Read	<ul style="list-style-type: none"> • Low • High
Input 2 status	Read	<ul style="list-style-type: none"> • Low • High

Table 10.21

You can use this parameter to check the correct assignment and function of the sensor inputs IN1 and IN2. If, despite a signal change at the sensor input, no change in the parameter value can be detected, this indicates a possible wiring error or a defect in the sensor input.

The "Input 1 status" parameter refers to sensor input IN1, the "Input 2 status" parameter to sensor input IN2.

10.8 Analysis

10.8.1 Trigger Mode

Status of Operating Elements

Parameter name	Access	Value range
Trigger mode	Read/write	<ul style="list-style-type: none"> • Double sheet • Single sheet • Air • Immediate

Table 10.22

You can use this parameter to set whether 200 items of data are "immediately" read from the sensor or which of the three events (AIR, SINGLE SHEET or DOUBLE SHEET) should be used as the trigger.



Note

For a detailed description of how to handle this parameter and how to perform analyses see chapter 9.

10.8.2 Switching the Transmitter Off/On

Use this button to switch the transmitter of the ultrasonic double sheet sensor off or on again. When the transmitter is off, the rest of the sensor will still work. In this case, it is therefore possible to evaluate the relevance of any interference sources in the vicinity of the sensor as well as possible interference from adjacent, non-synchronized sensors.



Note

This parameter is controlled via a button in the DTM. Usually, the transmitter of the sensor is temporarily switched off for analysis purposes, for which a graphic representation of the measured data is advantageous. We therefore recommend carrying out these tests in the DTM. However, the parameter for switching the transmitter on and off is also available via the IODD.



Note

For further information and explanations on the analysis options associated with this parameter see chapter 9.

10.9 Service

10.9.1 Reset To Factory Defaults

By pressing the "Reset to factory defaults" button, you can reset all sensor parameters to their factory settings after a safety prompt.



Note

In the DTM, this parameter is controlled via a button, and actually resets all sensor parameter values to their factory settings. The connection to the DTM remains available even after the reset.

If the button is actuated in the DTM while the DTM is not connected to a sensor, pressing this button resets all parameter values in the DTM to their default values after a safety prompt.

If a sensor needs to be reset to factory settings via the IO-Link system command "Back-to-box" must be executed there. IO-Link communication is interrupted after this command has been executed. Before the communication connection can be re-established, the sensor must be disconnected from the supply voltage and reconnected.

10.9.2 Switching Alignment Aid On/Off

By pressing this button you can switch the sensor-internal optical alignment aid on and off. When activated, the LEDs of the sensor indicate to the user the alignment accuracy of the transmitter to the receiver when the single sheet is inserted.



Note

For details on how it works and helpful tips see chapter 3.3.

10.9.3 Locator Indication

Parameter name	Access	Value range
Locator indication	Read/write	<ul style="list-style-type: none"> • Disabled • Enabled

Table 10.23

You can use this parameter to switch the locator indication on and off. When the locator indication is enabled, the yellow and green LEDs on the sensor flash at the same time with a specific flashing sequence.

The purpose of the locator indication is to uniquely identify the sensor that has just been addressed via IO-Link in a plant environment. This can be very advantageous if several sensors are installed in the system and the actual assignment is in doubt.

10.10 Information - Sensor Details

10.10.1 Product Details

This is a web link to the device-specific product page at Pepperl+Fuchs. All the documents for the device are available there, such as:

- Technical documentation (datasheet, commissioning instructions and manual)
- Certificates and approvals
- CAD models
- Software components (IODD, IO-Link offline parameterization tool (incl. PACTware and DTM))

10.10.2 Operating Hours

This parameter indicates the number of hours for which the sensor has already been in operation, i.e. has been supplied with voltage.

10.10.3 Temperature Monitoring

The parameters grouped under "Temperature monitoring" provide information about the thermal load and history of the connected device.

The "current sensor temperature" is the temperature currently measured by the sensor.

The "Temperature indicator" parameter is used to indicate whether or not the sensor is currently being operated within its permissible temperature range:

- If it is being operated within its permissible temperature range, the parameter outputs the "safe operation" message.
- If the sensor is currently being operated outside its permissible temperature range, the parameter outputs the "close to upper limit", "overtemperature", "close to lower limit" or "undertemperature" message, depending on the case in question.

The value "Overtemperature operating hours" indicates the total number of hours for which the sensor has been operated above its maximum permissible operating temperature.

The "Max. temperature exceeded counter" value indicates how often a temperature transition from the permissible to the overtemperature range has occurred. This counts how many temperature cycles the sensor has experienced in which the overtemperature range was reached.

The two parameters "Maximum temperature seen" and "Minimum temperature seen" are used to display the extreme temperature values to which the sensor was previously exposed during its operating time.

11 Synchronizing Multiple Sensors

In applications where multiple ultrasonic sensors are operated in close proximity to each other, we must prevent these from mutually influencing each other. Otherwise, this can result in individual devices providing incorrect measurements. The easiest way to solve this problem is by synchronizing the devices. You can set the type of synchronization by using the "Synchronization mode" parameter, see chapter 10.6.

The following synchronization options are available:

- Automatic multiplex mode
- Automatic common mode
- Externally controlled

Automatic Multiplex Mode

Multiple sensors (see datasheet for the maximum number) can be synchronized by simply connecting the synchronization connections on the sensors and setting the synchronization mode to "Automatic multiplex mode" via the IO-Link interface. In this case, the sensors operate self-synchronized one after the other in multiplex mode.

Only one sensor sends signals at any one time. The measuring cycles of the individual sensors run in succession in a chronological sequence. This also increases the response time of the sensors in proportion to the number of sensors in the synchronization group.

Automatic Common Mode

Multiple sensors (see datasheet for the maximum number) can be synchronized by simply connecting the synchronization connections on the sensors and setting the synchronization mode to "Automatic common mode" via the IO-Link interface. In this case, the sensors operate self-synchronized at the same time, i.e. all sensors always transmit their ultrasonic pulse at the same time.

Externally controlled

Multiple sensors can be jointly controlled by an external square-wave signal, e.g. a PLC output. The maximum number depends on the driver capabilities of the external device to be used for synchronization. In this case, the sensors are triggered in parallel and operate synchronously, i.e. at the same time. All sensors must be configured via the IO-Link interface to the "Externally controlled" synchronization mode.

The necessary minimum pulse duration must be observed (see datasheet). At the same time, make sure that the pulse duration of the synchronization pulse selected is shorter than the sensor cycle time active in the sensor (see "cycle time" parameter). Pulse and pause duration of the synchronization pulse must be selected together at least 100µs longer than the cycle time set in the sensor. This prevents the sensor from carrying out more than one measurement or from being permanently active due to inappropriate timing of the synchronization pulses.

If the level at the synchronization connection changes to a high level, the sensor will still complete its current measurement. After the measurement is complete, the sensor sets the corresponding output states and maintains them as long as the high level is present at the synchronization input.

If a high level is present on the synchronization connection for longer than 1 second, the sensor goes into standby mode (green LED is flashing).

The synchronization connection of the sensors supplies an output current in the case of a low level, and generates an input impedance in the case of a high level. Please note that the device used for external synchronization must have the following driver capability:

- Driver current to $+UB > n \times$ (high level/input impedance)
- Driver current to $0V > n \times$ output current

(n = number of sensors to be synchronized)

**Note**

By default, the synchronization function of the sensors is disabled and is only enabled in each device to be synchronized by setting the "Synchronization mode" parameter via IO-Link to the desired synchronization type.

**Note**

If changes are made to the "Synchronization mode" parameter setting in a synchronized sensor group for one or more devices, all devices in the sensor network must be briefly disconnected from the supply voltage and then reconnected ("power cycle"). Only then will the new settings for synchronization in the devices actually be applied within the group.

11.1**Connection Of Sensors To Be Synchronized**

To operate devices in automatic multiplex or common mode, you must interconnect the SYNC connections of these sensors. This combination must not have an additional connection to L+ or L-.

To operate devices in external synchronization mode, you must connect the SYNC connections of these sensors to the external clock.

**Note**

If the SYNC connections of the sensors to be synchronized are wired for the first time when the supply voltage is applied, all devices in the sensor group must be briefly disconnected from the supply voltage and then reconnected ("power cycle"). Only then does the synchronization in this group run reliably according to the configured settings.

If accordingly configured devices are later added or removed in a synchronized group, the group continues to run reliably even without a "power cycle". It is only necessary to make sure that the SYNC connection of additional devices is wired first and that their supply voltage is only switched on afterwards.

11.2**Teaching In Sensors In The Synchronization Group**

When a teach-in is performed on a sensor that is operated in an automatically synchronized group, the teach-in process may start with a delay. The remaining sensors in the automatically synchronized group go into standby mode for the duration of the teach-in process and do not carry out any measurements.

**Caution!**

Incorrect measurements during teach-in in an externally synchronized sensor group!

A teach-in of one or more sensors must not be carried out in an externally synchronized sensor group. The reason for this is that every sensor that switches to teach-in mode can no longer react simultaneously to the signals on its synchronization port.

During the teach-in process, the sensor runs "freely" in its own cycle. Due to the small but existing and usual time tolerances in the μ C program execution in the individual devices, cross-talk occurs after a very short time, especially in combination with the very high measuring rate of the double sheet sensors. This influences the measurement of the sensors to be taught in. No valid data can be recorded.

12 Maintenance and Repair

12.1 Maintenance Work

The sensor itself is maintenance-free. For this reason, it is not necessary to carry out regular adjustments or maintenance work on the sensor itself.

However, check that the sensor and connector are tight within the scope of routine maintenance intervals. You may also want to check that the connection cable is installed and intact.

12.2 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

13 Troubleshooting

13.1 What To Do In The Event Of A Fault

In the event of a fault, use the following checklist to determine whether a fault with the sensor can be remedied.

If none of the information specified in the checklist solves the problem, in the event of queries contact Pepperl+Fuchs via your sales office. Have details of the model number and firmware version of the sensor ready if possible.

Checklist

Error	Cause	Remedy
No LEDs light up on the device	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 plug is not connected to the connector on the sensor.	Connect the plug to the sensor and tighten the union nut by hand.
	Faulty wiring in the splitter or switch cabinet.	Check the wiring carefully and repair any faults.
	Supply cable to the sensor is damaged.	If the damaged area is between the sensor and the sensor plug, replace the complete sensor (emitter and receiver) with one that is not damaged. If the damage is to the sensor supply cable, replace the damaged cable.
No IO-Link connection to device	The communication port on the sensor is not connected to the IO-Link master.	Make sure that the communication port on the sensor is connected to the IO-Link master.
	No voltage supply	Check whether there is a reason for the absence of the voltage supply (installation or maintenance work, etc.). Switch on the voltage supply if appropriate.
Device displays "single sheet" (green LED lights up) even though no material is loaded	Sensor emitter and receiver are poorly aligned.	Align the emitter and receiver correctly and precisely. For details about how to proceed, see chapter 3.3.
	Machine parts protrude into the space between emitter and receiver.	Remove the machine parts. If the machine parts are, for example, diaphragms for the targeted detection of small material points, set the threshold values of the sensor to suit the conditions of the application.

Error	Cause	Remedy
Device displays "double sheet" (red LED lights up) even though no material is loaded	Emitter is not connected to the sensor receiver.	Connect the two sensor parts to each other via the connecting cable.
	Connecting cable between emitter and receiver is damaged.	Replace the complete sensor consisting of emitter and receiver with one that is undamaged. If the damaged area is in an extension cable piece of the connecting cable, replace this section of the cable.
	Sensor emitter and receiver are poorly aligned.	Align the emitter and receiver correctly and precisely. For details about how to proceed, see chapter 3.3.
	Emitter is defective.	Send the complete sensor (emitter and receiver) to Pepperl+Fuchs for inspection.
	Machine parts protrude into the space between emitter and receiver.	Remove the machine parts. If the machine parts are, for example, diaphragms for the targeted detection of small material points, set the threshold values of the sensor to suit the conditions of the application.
Device displays "double sheet" (red LED lights up), even though only one layer of material is loaded	The sensor emitter and receiver are poorly aligned.	Align the emitter and receiver correctly and precisely. For details about how to proceed, see chapter 3.3.
	Threshold values in the device do not match the material	Use the analysis options provided by the DTM and set the thresholds appropriately. For details on how to proceed and helpful tips see chapter 7.5 and see chapter 9.1.
Device displays "single sheet" (green LED lights up), even though a double layer of material is loaded	Threshold values in the device do not match the material	Use the analysis options provided by the DTM and set the thresholds appropriately. For details on how to proceed and helpful tips see chapter 7.5 and see chapter 9.1.
The green LED flashes continuously and the sensor does not react to changed material situations.	Sensor is in standby mode. The pulse and pause of the flashing sequence are approximately the same length.	Remove the HIGH level at the synchronization input of the sensor.
The integrated visual alignment aid cannot be activated via IN1 and IN2.	Faulty wiring in the splitter or switch cabinet.	Check the wiring carefully and repair any faults.
	Sensor IN1/TEACH and IN2/FEEDBACK connections have been disabled in the sensor.	Connect to the sensor via IO-Link and check the "Sensor inputs usage" parameter. Set this to a setting other than "disabled", if necessary, temporarily.

Error	Cause	Remedy
Teach-in cannot be carried out successfully	No material has been inserted for the teach-in.	Insert a single layer of the material to be taught in and repeat the teach-in procedure. When using a multi-layer material, insert the target condition to be monitored.
	The material has left the space between the emitter and receiver during the teach-in process.	During the teach-in process, the material to be taught in must never leave the space between the emitter and receiver. Carry out the teach-in process again, taking this situation into account.
	The teach-in process was too short.	The sensor requires at least 1000 items of data for a successful teach-in. The minimum time required for a teach-in process therefore depends on the sensor cycle time set. For example, with a UDC-18GS device with the default setting, the teach-in time should not be less than approx. 5 s.
	The material does not dampen the ultrasonic signal enough.	Check whether an extension of the amplitude range accepted during the teach-in process is possible in your application. Details see chapter 10.4. If a teach-in process with an extended amplitude value range also leads to an unsuccessful teach-in, the material is not suitable for detection with the sensor.
	The material dampens the ultrasonic signal too much.	Check whether an extension of the amplitude range accepted during the teach-in process is possible in your application. Details see chapter 10.4. If a teach-in process with an extended amplitude value range also leads to an unsuccessful teach-in, the material is not suitable for detection with the sensor.

Error	Cause	Remedy
Despite the successful teach-in, the material is not (no longer) reliably detected	Material was not moved in the control during the teach-in process.	Perform the teach-in process again. Move the material back and forth within the detection area so that the sensor can measure as many points of the material as possible. Make sure that the material does not leave the space between the emitter and receiver at any time.
	A material change has taken place and the material to be detected is no longer the material that was previously taught in.	Carry out the teach-in process for the new material.
	The alignment of emitter to receiver was changed after the teach-in process.	Align the emitter and receiver correctly and precisely. For details about how to proceed, see chapter 3.3. Then perform the teach-in process again.
	The threshold values associated with the teach-in operating mode are not used for evaluation.	Connect to the sensor via IO-Link and ensure that the "Selected threshold set" parameter is set to "Threshold set 4/Teach-in".
	The damping difference between a single layer and a double layer of the material is very slight.	Connect to the sensor via IO-Link and adjust the "Threshold distance" parameter. For details and helpful tips see chapter 10.4.2.

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