FACTORY AUTOMATION

MANUAL

ULTRA 3.0 SERVICE PROGRAM

INSTRUCTION SET FOR ULTRASONIC SENSORS WITH RS 232 INTERFACE

PEPPERL+FUCHS

This manual consists of three components

Ultra 3.0 Service Program

1 Introduction

1.1 General description

Ultra 3.0 is a program for servicing and setting parameters for Pepperl+Fuchs ultrasonic sensors via an RS 232 serial interface.

Ultra 3.0 is designed for communication with the following sensors:

- UC500+U9+E6/E7+R2
- UC500+U9+IUE0/E2+R2
- UC3000+U9+E6/E7+R2
- UC3000+U9+IUE0/E2+R2
- UC6000-FP-E6/E7+R2
- UC6000-FP-IUE0/E2+R2

and

- UJ3000+U1+8B+RS
- UJ3000+U1+E22+RS
- UJ3000+U1+IU+RS
- UJ6000-FP-8B+RS
- UJ6000-FP-E22+RS
- UJ6000-FP-IU+RS

and

- UC300-F43-M8-VX-R2
- UC2000-F43-M8-VX-R2

Attention

The use of sensors other than those listed above is not permitted. Pepperl+Fuchs will not accept liability for any damages, either direct or indirect, arising from such use.

1.2 Why use PC software to set parameters?

If a sensor is equipped with an RS 232 interface, then the transfer of commands and parameters to the sensor is performed via that interface. These commands can be used to output measured values, to configure the evaluation procedure, the switching outputs and/or the analog output, to set and interrogate parameters and to initiate general instrument functions. This provides the user with a tool for adjusting a sensor for optimum performance under current application conditions and for displaying parameters or measurement results.

1.3 Brief description

This program is a multi-lingual, menu-driven user interface with a comprehensive help system.

It supports up to 5 separate windows. The windows can be hidden or shown, repositioned on the screen and resized. The program notes the position and size of the windows.

Show It: Graphical representation of the measured distance. The switching points that have been set are marked. Imitation LEDs simulate the switching states of the outputs.

Parameter: All parameters can be modified here. Display or input fields allow commands or parameters to be modified rapidly with a mouse click without users being required to involve themselves intensively with the commands and their syntax.

Send instruction: As with a terminal program, commands are used here to set and interrogate the sensor parameters (as an alternative to the parameters window).

Port Monitor: Displays the commands sent to and received by the sensor.

Distance: Displays the most recently measured distance in mm.

The program parameters being used and the sensor parameters retrieved can be stored either on the hard disk or a diskette. Series of measurements can be started, their measurement data periodically queried and output on a printer or to the hard disk / diskette in the form of a log.

1.4 Safety information

Symbols used

Attention

Important warns of a possible fault. Failure to heed this warning may result in the instrument, or systems connected to it, experiencing problems including total failure.

Note

Note draws attention to important information.

2 Installation

2.1 Preparation

Check that the scope of supply is correct and complete and that your PC satisfies the system requirements.

Scope of supply:
Two diskettes (3.5",1.44 MB) containing Ultra 3.0, one RS 232 interface cable and the Ultra 3.0 software description.

System requirements:
Ultra 3.0 will run on any personal computer or laptop. It requires Windows 3.xx / 95, an EGA or VGA graphics card and a free RS 232 interface.

2.2 Connecting the sensors

Safety notes on the sensors

Attention

When connecting the sensors, attention should be paid to the details on the data sheet, in particular the terminal layout and the operating voltage range.

Attention

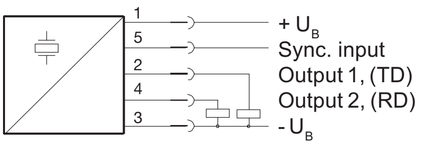
For sensors with coding switches (in the terminal housing), DIP switch 10 should be set to OFF (RS 232 mode) before the interface cable is connected. Failure to set this switch correctly can result in irreparable damage to the interface.

The connection diagram in the data sheet shows how the interface cable provided should be connected. For sensors with a clamping space the connections should usually be made as follows:

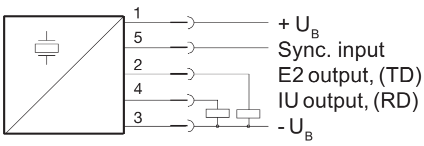
Cable colour	brown (TD	→	terminal 4 (RD)
	black (RD)	→	terminal 2 (TD)
	blue (GND)	→	terminal 3 ($-U_B$)

Connection diagrams:

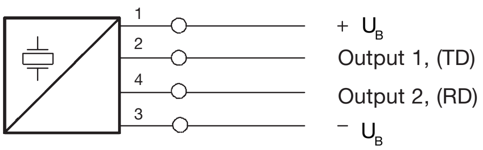
Type UC... E6/E7



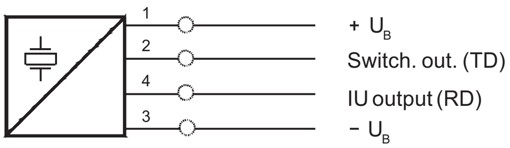
Type UC... IUE0/E2



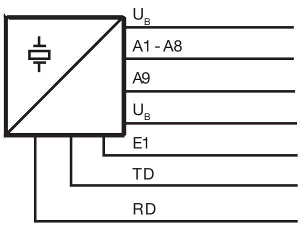
Type UJ... E22



Type UJ... IU



Typ UJ... 8B



	Cable colour:
+	brown
8 bit output	see table
Fault output	red / blue
–	blue
Test input	grey / pink
Transmit - Data	(TD) brown / green
Receive - Data	(RD) white / green

8 bit switch. output:

A1	=	white
A2	=	yellow
A3	=	pink
A4	=	red
A5	=	green
A6	=	grey
A7	=	black
A8	=	violet

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Pepperl+Fuchs Group · Tel: Germany (6 21) 7 76-11 11 · USA (3 30) 4 25 35 55 · Singapore 7 79 90 91 · Internet http://www.pepperl-fuchs.com

Note

Connection via the interface cable is only required when setting the parameters. Following this stage, the cable may be disconnected. The sensors operate independently. Remember to set DIP switch 10 back to ON.

2.3 Transmission protocol

Communication with the sensors can be handled through any terminal program, e.g. Windows Terminal (under “Accessories”). The following parameters need to be set in the terminal program under “Settings” and “Data Transmission":

Baud rate	9600 bit/s
Parity	none
Data bits	8
Stop bit	1

Com1 or Com2, according to the interface being used.

A detailed knowledge of the command syntax to set these parameters is required. This is explained under “Instruction set for ultrasonic sensors".

The Ultra 3.0 service program allows you to exploit the manifold capabilities of the sensor much more conveniently and through a more standard interface.

2.4 Program installation

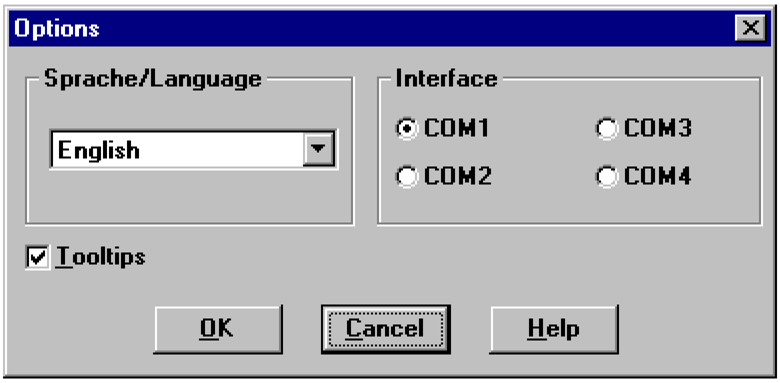
To install the software, insert diskette 1/2 in the diskette drive and run the file SETUP.EXE contained on that disk from within Windows.

Now follow the instructions in the setup program.

The Setup program suggests C:\Ultra 30 as an installation path, but a different path may be specified if required.

Messages on first use:

When using the software for the first time to access the connected ultrasonic sensor, the error message “Error on initialising serial port” may occur. Acknowledge this message by choosing "Cancel" and then select “Options” from the menu bar. A dialogue box should now appear; select the serial port to which the sensor is connected.



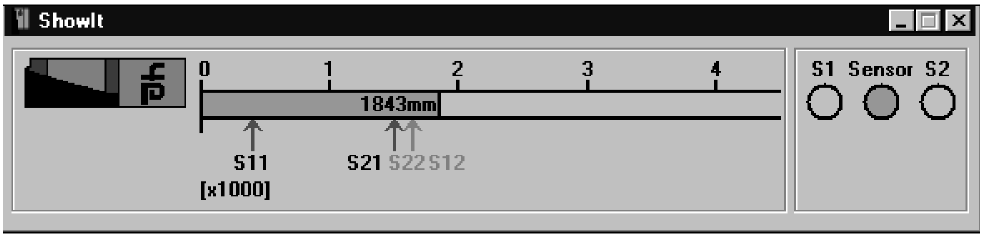
Note

Use this opportunity to select the required language in the dialogue box. As a relatively new user you should certainly also check the box to enable the help system, and you should work with the assistance of on-line help and help texts.

Exit the dialogue box by clicking OK. The serial port you selected will now be stored and will be indicated on the bottom of the screen on the left in the footer / events bar.

Checking the connection to the sensor:

Choose the “Show It” option under “Window” on the menu bar. If the sensor is connected correctly, then the imitation LED “sensor” will be displayed in green. Sensor, measurement length and target can all be seen at the same time. The green bar indicates that the sensor is sending and receiving sound signals and that the interface communication is working correctly and error-free.



To close the ShowIt Window, click the “Window” menu again or click the “ ” button (as normal) in the top right corner of the window.

2.5 Starting the Ultra 3.0 service program

Once the software has been installed successfully, the Ultra 3.0 icon will be added to your Windows desktop. Clicking on this icon will start Ultra 3.0. The program displays a title page, and a field is then overlaid on it in which the loading of data from the sensor into the software is indicated.

Following this, the user interface appears as a full screen window with a menu bar and toolbar.

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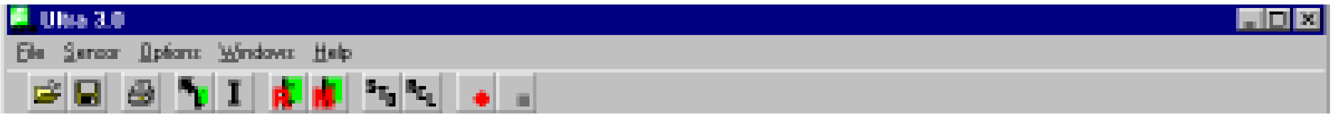
3 Software display and configuring tools

When the program is first started a menu bar, with a tool bar below it, is displayed on the screen. Most of the screen remains blank providing none of the 5 possible windows is opened.



The most important program functions from the menu bar are included again in the tool bar to make them more readily accessible. The underlined characters indicate that the menu item can also be invoked using the key combination ALT + character. From the menu, a selection can be made using just the underlined character.

Click on the pull-down menus from the **menu bar** to see which functions are available:

File	Sensor	Options	Window	Help
Open Save Print Export Exit	Read Sensor Write Sensor Reset Sensor Master Mode Save Configuration Read Configuration Log File Start Recording Sensor Info	See Below	Show It Distance Parameters Command Input Port Monitor Default Position	Contents About

As mentioned above, some of the button and menu functions are identical:

File Menu

Open	The parameters saved to hard disk or diskette using Save or Export also update the parameters in the sensor and the software.
Save	The current sensor parameter values are saved in a file of your choice on hard disk or diskette.
Print	Important data, such as type designation, year of manufacture, version number and the parameters, are printed with the date. Comments can be added before the data is printed. The button can be used to start the default printer; the menu can be used to select and set up the printer.
Export	Same as "Save“, although the data can be exported in TXT or CSV format. Exporting in CSV format is useful, for example, when inserting text in an MS Excel worksheet.
Exit	Exit the program

Menu Sensor

Read Sensor	Read the sensor parameters into the program via the interface, update the parameter window and display.
Write Sensor	Transfer data from the software to the sensor
Factory Settings	The sensor parameters are reset to the factory setting stored in the sensor and the parameter values in the program updated accordingly.
Master Device	Puts the sensor into Master Mode. The sensor will now send data continuously to the program.
Save Configuration	All current parameter values are saved to a separate location in the sensor. This function is not available for all sensors.
Recall Configuration	The data saved in the sensor using the "Save Configuration“ option is retrieved and the sensor parameters set up accordingly.
Log File	All the settings necessary for creating a log file can be entered using a comprehensive input dialogue (see description in section 5)
Start/Stop Recording	Start or Stop recording using the parameters specified under "Log File“.
Sensor Info	Display the sensor type and the version number of the software installed in the sensor.

Menu Options

Calls up a dialogue box in which the serial interface, the language options and options regarding the Help system are defined:

- The selected interface is displayed in the left of the footer. If the display is greyed, the interface cannot be initialised.
- Help texts relating to the tool bar buttons and the parameter window are displayed when the Help option is checked.
- **Help texts** regarding the button, options, functions or menus selected with the mouse cursor are called up using function key **F1**.

Quitting the dialogue by clicking on **OK** saves the options permanently; the **Cancel** button discards any changes that were made.

Window menu

Show It	Visualisation of the current measuring geometry showing sensor, signal link, specified switching points and identified target. Replica LEDs indicate the communication and switching status or analog values of the outputs: LED sensor : green - sensor interface/program communications working OK. LED S1 / S2 : yellow - output switched
Distance	Displays the current measured distance in mm. The size (incl. non-interlaced displays) and position of the display field on the screen can be selected as required.
Parameters	Header: sensor type Window: numerous parameter fields that are used to select the basic framework for the evaluation method, set the switching point, switching mode, hysteresis or measuring range limits or determine the status of the DIP switches. The input fields are clearly arranged. **They will vary depending on the type of sensor that is connected.** Editing is a very straightforward matter and no knowledge of the command syntax is required. It is useful to check everything in conjunction with the "Show It“ function, which can be open at the same time.
Command	The dialogue field that opens enables commands to be entered directly. An interpreter analyses the inputs and updates the parameter window as necessary. The last 10 commands are stored and can be called up. The response from the sensor is displayed. See "Command set for Ultrasonic sensors” for details of command syntax and their function.
Monitor	Displays all the data that is being exchanged with the sensor: W: (Write) - Data to sensor / R: (Read) - Data from sensor Static, dynamic or both types of data can be displayed on the monitor: x **static** - user inputs, i.e. entries in the parameter window or using "Send Command“ in the case of command input x **dynamic** - The commands sent from time to time to the sensor from the opened "ShowIt“ or "Distance“ window are displayed. The Clear button clears the displays. The Port Monitor stores the last 100 communication actions.
Set Default Position	Restores the display to its default settings. In situations where all the windows are open and perhaps overlap, they can be tidied up using this option. (see explanation under section 4.1).

Help menu

Contents	Contents of the online Help
About	Information about the software

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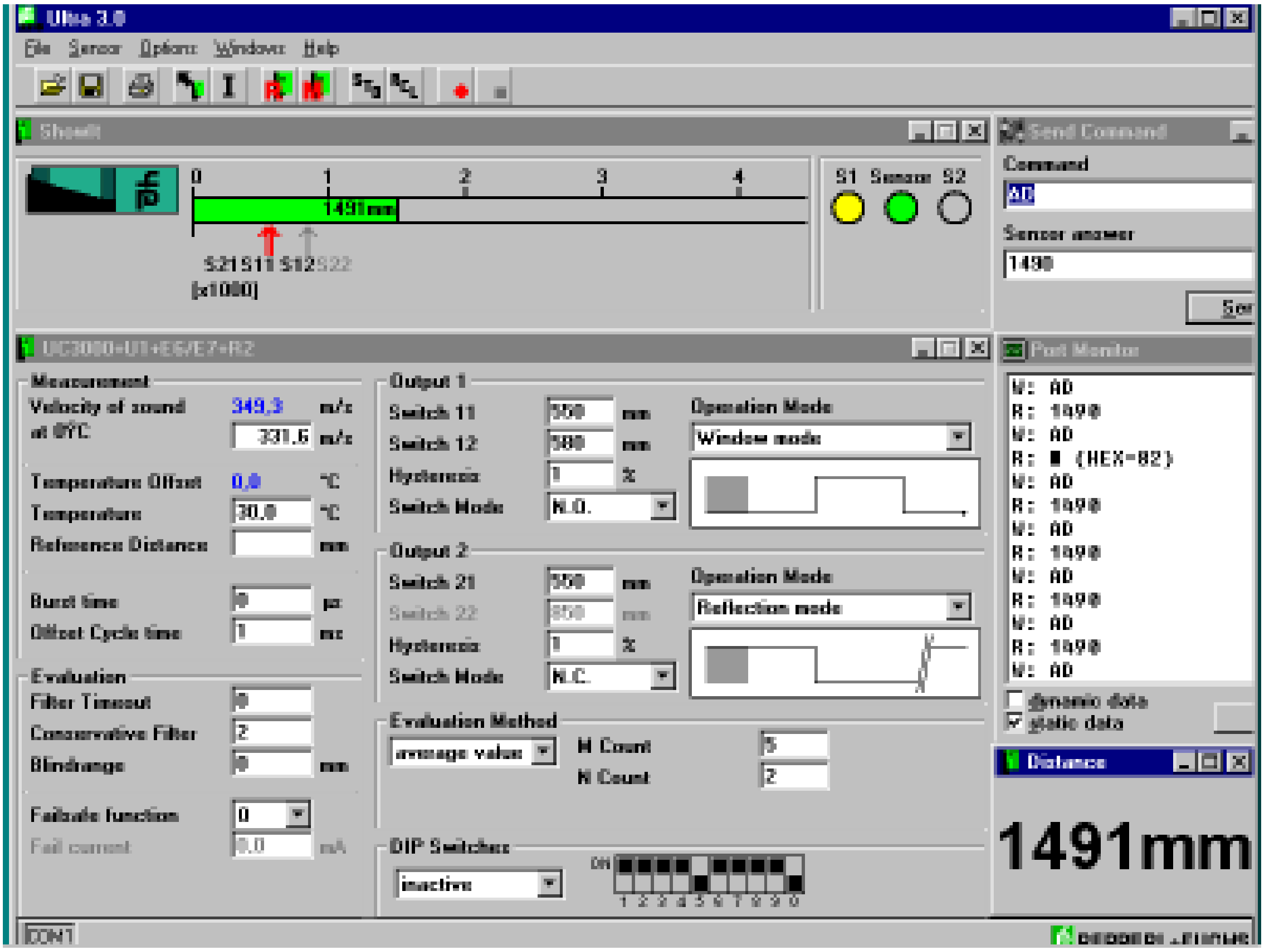

4 Using the extensive display and parameter setting options

4.1 Arrangement on the screen

The multitude of possible displays makes it tempting to open all the windows simultaneously. This, however, would be immediately unintelligible. Only those windows that are definitely required should be used.

If all the windows are important, an arrangement is possible as shown on our template. If everything starts overlapping when the fields are moved, don't panic! By clicking on the option “Default Position” in the “ Window ” menu, the windows will be rearranged in a clear and logical manner.

Note

In the case of a small screen, the option exists after opening all the windows of superimposing a full-screen parameter setting window over the combined “Show It”, ”Port Monitor”, ”Send Command” and “Distance” menus. The latter windows are only visible when the parameter setting window is closed or moved.

Note

All windows can be minimised.

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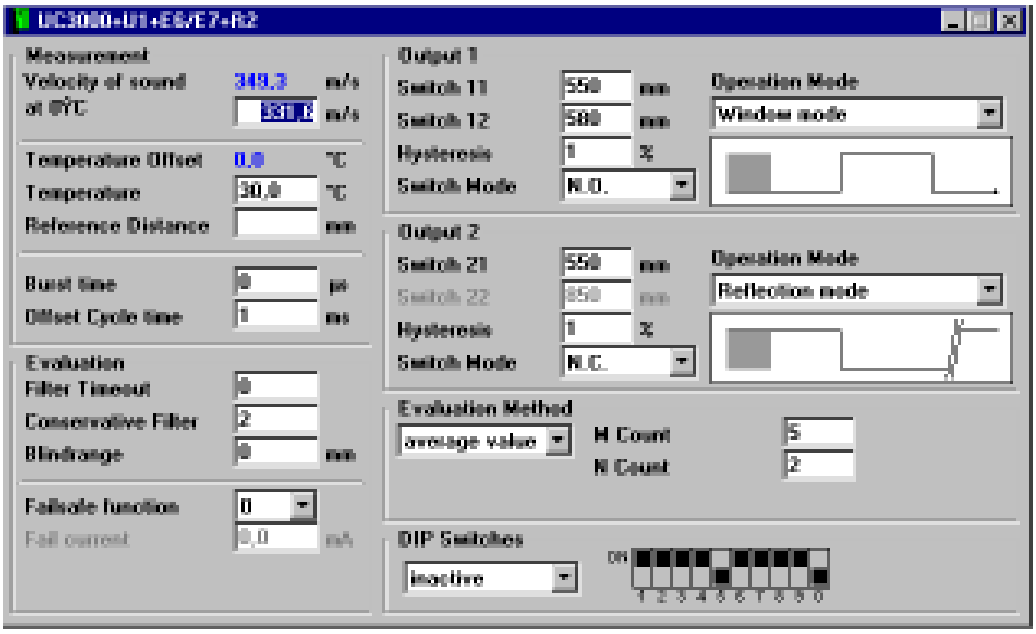
4.2 Parameter setting window



The choice of displays for each of the connected sensor types varies according to the parameter setting options. The type key for the connected ultrasonic sensor is displayed in the header of the parameter setting window.

Attention

If the connected sensor and the type key displayed do not agree (e.g. after replacing a sensor), the sensor data must be re-entered :

Button or "Read sensor" option from the "Sensor" menu.

Online Help

The comprehensive nature of the extensive parameter setting options sometimes necessitates special knowledge of the instructions and the effect they have on the sensor. The instructions are described in the "Instruction set for ultrasonic sensors".

For newcomers to the system, the online Help offers valuable explanations of the options, parameters and their application. The sometimes specific details always refer to the connected sensor, and are therefore also indispensable to the expert.

The online Help supplies important information in various ways:

Note

1. The online Help is activated when the cursor is located in a field and the F1 key is pressed at the same time. The text field that appears provides clear explanations of the option, method, parameter, etc., selected with the cursor.

This applies to all windows.

Note

2. When the cursor is located on a field, an explanation of that is displayed below in the event field. In the case of parameter values, the relevant value range of that parameter for the connected sensor is also displayed.

If the information stated in section 2. does not appear, the online Help is not activated (point 2.4).

Open the "Option" menu and highlight the "Help Settings" prompt in the dialog box that appears. Select OK to close the dialog box.

Modifying parameter values

Note

The parameter values are modified directly in the corresponding field. Press the “Enter” key or click on a different input field to confirm the value.

The software will reject invalid parameters.

If the operation of a sensor has become unreliable, perhaps as the result of an incorrect parameter setting, all basic functions can be restored by resetting the default values.
Button  *or “Reset Sensor” option from the “Sensor” menu.*

4.3 "Send Instruction" and "Port Monitor" windows

Opening both these windows simultaneously is the ideal way of sending instruction parameters to the sensors.

To see the effect of the instruction straight away, open the parameter setting window as well.

An interpreter supports the **"Send Instruction"** window, converts all text inputs into upper case and transmits the instructions to the sensor. The last 10 commands are stored in the input, from where they can be retrieved as required and re-used using the “Send” key.

The response to the instruction appears in the “Sensor Response” field. This may be an error message, the interrogated evaluation mode, parameter values or coded information concerning the status of the sensors, outputs, etc.

Modifications to the parameters are displayed in the parameter window after the transfer has taken place.

All data that is exchanged with the sensor is displayed in the **"Port Monitor"** window. Data transmitted to the sensor begins with W : (Write)..

Data from the sensor begins with R: (Read).

Note

Instructions to the sensor terminate with <CR>, carriage return; outputs from the sensor terminate with <CR> and <LF>, line feed. This means that instructions and responses can be easily distinguished from each another.

The Port Monitor stores the last 100 communication actions. It is useful, therefore, to increase the window height slightly.

The operator can influence the visible output via the two selection fields “Dynamic Data” and “Static Data”:

Dynamic Data All data concerning the processes running in the background is displayed.

The “Show It” and “Distance” windows transmit instructions to the sensor at periodic intervals. These instructions can be visualised via this option.

Static Data This filter controls the logging of operator inputs. All inputs which are made in the “Send Instruction” or parameter setting windows are displayed using this option.

Note

The effects of individual instructions on the sensor and its responses can be checked most easily if you only enable the display “Static Data” in the "Port Monitor" and delete its display field beforehand.

5 Logging measurement series

One important feature of this software is its ability to configure measurement series and record the results. The corresponding “log file” option, which is used for defining typical values for the measurement series and the log, can be found in the “Sensor” menu.

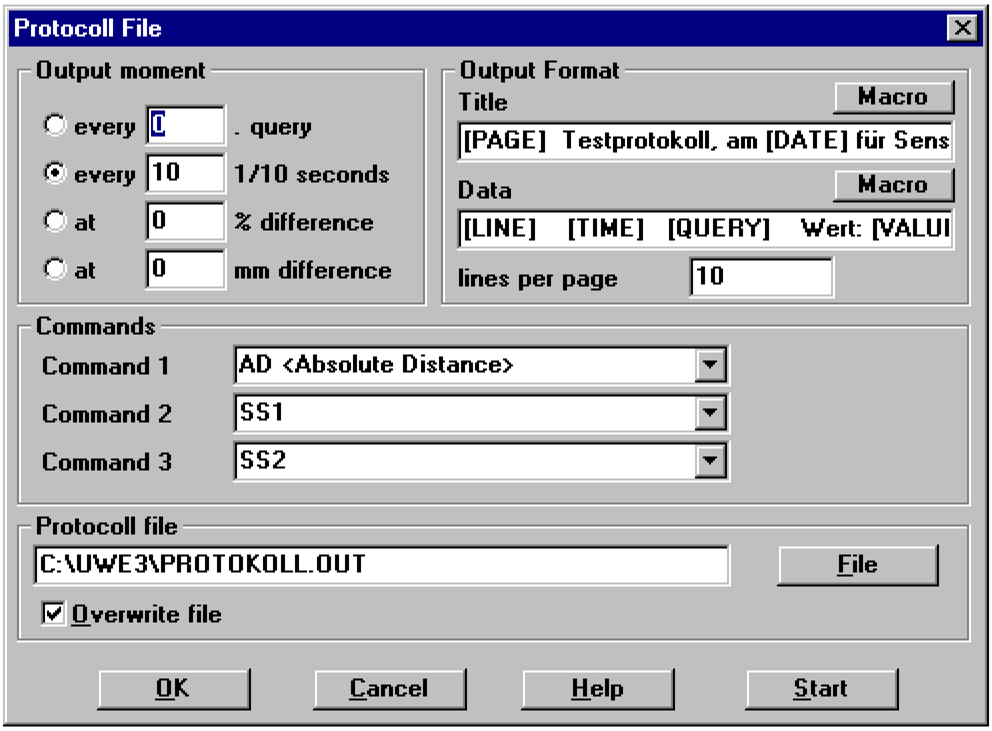
It does not make sense to start logging until the measurement task and recording method have been defined via the extensive “Log File” dialog box. Logging can be started as follows:

- with the "Start Recording option in the “Sensor” menu,
- with the “Start” button in the dialog box or
- with the button containing the red diamond, which is then greyed out.

Recording can only be terminated using the adjacent button with the black square.

Format of the log file:

The left-hand field, “Output time”, and the middle field, “Instructions”, define which values are to be tested.



Output time:

The criteria for deciding what data is to be logged are selected in this field. The first two options specify a point in time, options 3 and 4 deviation from a comparison value.

The time specified is regarded as the minimum required. The period of time between two measurements may be greater because MS Windows is not a real-time operating system.

The % and mm details in the “Difference” input fields refer to the command in the first line of the instruction field. The commands in the subsequent lines will only be evaluated if the condition for this command is fulfilled in the first instruction field.

Instructions:

All three command lines contain an instruction set whose instructions can be overwritten by others as necessary. The command syntax must be appropriate for the connected sensor.

The three lines enable three different commands to be logged. The point in time of the output always refers to command 1.

The upper right-hand field “Output format” determines the format and style of the log.

Output format:

The "Title bar" input field specifies which text is to appear at the start of the log and on each new page. The „Data lines" input field refers to each line. These two input fields determine how the log will look on the page.

Six text macros are available :

[PAGE]	Insert the current page number
[LINE]	Insert the current line number. The line number is reset at the start of a new page.
[DATE]	Insert the date
[TIME]	Insert the time
[QUERY]	Insert the command. The processed command from the three instruction fields is inserted here
[VALUE]	Insert the result of the last executed command.

The text macros can be entered directly into the two text input fields or by using the two macro buttons at the top right hand side. Use upper case letters when entering text macros.

Additional text strings, which improve the appearance of the logs, may also be entered. In the simple example shown here (see screenshot and extracts from log), the string "Test log, on........" has been added to the page header and the word "Value" on each line.

The fields have been deliberately separated with spaces.

In the example, the distance from an object and the switching state of both outputs is logged every 3 seconds.

The „Lines per page" input field specifies the number of lines on each page. Depending on the number entered a <Form feed> character (page break) is inserted. 60 lines per page is a good number.

The lower third of the dialog box enables the names and memory location of the data file to be specified.

Log file field:

The name of the log file is specified in this input field. If no absolute path is entered, the current Ultra 3.0 program directory is used.

In order to maintain strict separation of the service program and the log file, you can create a special file for logging purposes using File Manager or Explorer prior to creating the log. This is facilitated by using the "File" button in the dialog box.

The "File" button initiates a further file selection dialog in which the path, filename, file type and drive can be selected.

Whether to overwrite the existing log file each time a new log is created or append the new data to the end of the previous log file is determined using the "Overwrite file" option.

Sample log: (see screenshot on page 13)

1 Test log, on 05.03.98 for sensor UC3000+U1+E6+R2

1	14:08:13	AD	value: 1842
2	14:08:13	SS1	value: 0
3	14:08:13	SS2	value: 1
4	14:08:16	AD	value: 754
5	14:08:16	SS1	value: 0
6	14:08:16	SS2	value: 1
7	14:08:19	AD	value: 646
8	14:08:19	SS1	value: 0
9	14:08:19	SS2	value: 1

--Page Break---

2 Test log, on 05.03.98 for sensor UC3000+U1+E6+R2

1	14:08:22	AD	value: 944
2	14:08:22	SS1	value: 0
3	14:08:22	SS2	value: 1
4	14:08:25	AD	value: 325
5	14:08:25	SS1	value: 1
6	14:08:25	SS2	value: 1
7	14:08:28	AD	value: 754

Description and Instruction Set of Sensors

UC500	+U9+E6/E7	+R2
UC500	+U9+IUE0/E2	+R2
UC3000	+U9+E6/E7	+R2
UC3000	+U9+IUE0/E2	+R2
UC6000	-FP-E6/E7	+R2
UC6000	-FP-IUE0/E2	+R2

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Description and Instruction Sets of UC Sensors

Instruction

1 Introduction

Connection via RS 232 interface

For ultrasonic sensors with an RS 232 interface, parameters can easily be assigned via that interface. Transmission is performed using the following **transmission protocol:**

Bit rate	9600 Baud
Parity	none
Data bits	8
Stop bit	1

Com x according to which port is used.

This, however, demands a detailed knowledge of the commands and the effect they have on sensor response. Older sensors with an RS 232 interface have a command format with an analog structure and a partially matching instruction set. However, individual commands have either changed in terms of meaning, functionality or syntax, while others no longer exist. The most important features of the new sensors are explained further below.

Instruction format:

Instructions consist of
two letters,
three letters
or two letters and a number.

If appropriate, one or more parameters separated by commas can be appended to this instruction.

There are pure **Query** instructions for querying measurement results or non-variable sensor data, instructions for **defining parameters** (which can be used without parameters for querying) and instructions for **trimming / adjusting**.
(see “Overview of all instructions”, table on page 26).

All characters are sent in ASCII code (example: the number 1 as 31h or the letter A as 41h), while on the other hand the numeric parameters are sent as decimal numbers.

Note

For commands requiring binary data transmission, e.g. ADB, RDB, RTB, the data display in the terminal program can generally not be evaluated

By default the sensor will accept instructions irrespective of case.

The sensor may respond with an error message rather than the requested sensor parameter or measured value.

The following **error messages** are possible:

80h (ç) no error
81h (ü) invalid parameter
82h (é) invalid instruction
83h (â) overflow

Possible error messages from earlier versions of the software:

30h	no error
31h	invalid parameter
80h	overflow
84h	hardware error
FFh	invalid instruction

The parameters sent to the sensor are stored there in the EEPROM and remain available even after an interruption to the supply voltage. The condition for this is that communication with the sensor must run without any problems for the duration of the transmission + approx. 100 ms
The response of the sensor must be received with a delay of no longer than 1 measurement cycle (approx. 10 ms). The sensor ensures data consistency while parameters are being defined by finishing a measurement before interpreting and executing a new instruction.

Important features of UC sensors

The following are some of the features of the new sensors

- a **synchronisation input:**
The sensors can be synchronised externally, or they may be synchronised with one another.

- a **temperature probe:**
The propagation rate of ultrasound varies with, amongst other factors, the temperature of the carrier medium. By measuring the ambient temperature, this influence is taken into account when measuring the distance from the echo propagation time.

- independent **modes of operation** of the switching outputs:
The response of the individual sensor outputs can be modified to suit the application: switching point mode, window mode, reflex photoelectric barrier mode, double switching point mode or range monitoring.

- **additional switching points:**
Additional switching points can be configured for window mode, double switching point mode or range monitoring.

- an **independent switching hysteresis:**
The hysteresis of switching outputs is in limits that can be specified independently of one another.

- a definable **blind range:**
An extended blind range can be defined, in which any echoes that may be received will be ignored.

- the facility to **store** a whole set of user settings **for security**, and retrieve them as and when required.

- certain **changes to the evaluation methods** in relation to earlier versions of the software.

- Default setting
The factory settings stored in the sensor can be fetched at any time.

The instructions AD, RD and RT are supplemented by new versions **ADB, RDB** and **RTB**, which return the required data in binary form.

Description of Sensors

1 Propagation time measurement

Ultrasonic sensors ascertain the distance to an object by measuring the time distance between the sending out of an ultrasonic package and the arrival of the echo reflected by the object. After sending the ultrasonic packet (burst), the sonic transformer needs a certain period of time for the vibration to die down. An echo cannot be received during this period. Once the transformer has come to rest it can then be stimulated again by the echo, and can send out an echo signal. The time taken for the vibration to die down causes a blind range immediately in front of the sensor.

The (detection) range of the sensor is directly dependent on the sound reflection properties of the object. Good reflectors can be detected from up to double the nominal detection range. On the other hand, an object situated close to the sensor can produce several echo signals (as the ultrasonic package passes backwards and forwards several times between the target and the sensor housing). This can lead to incorrect evaluation, for example if the first echo falls in the blind range and only the second echo is recognised as an echo signal.
Blind range and range are functions of the energy contained in the burst: the longer the burst is, the greater the range, but by the same token the time for the vibration to die down and thus the blind range of the ultrasonic transformer are also increased.

1.1 Variable burst and pulse times, parameter setting options (CBT, CCT)

The sensors are set up in the factory to use variable burst lengths (CBT, 0). The evaluation adapts the burst length to match the measured echo propagation time. If the propagation time measured is short, then the sensor will shorten the burst down to its minimum length. Conversely the burst will be set to the maximum length if the sensor receives a distant echo. If the sensor is unable to detect any echo, it toggles the burst length between maximum and minimum.

The **CBT** command (CBT,xxx [µs]) sets the burst length to a constant value. The same burst is then transmitted irrespective of the measured echo propagation time.

The **CCT** command influences the measurement cycle time. After CCT,0, the evaluation adapts the measurement cycle to the echo propagation time determined: the measurement is terminated if no further echo occurs within 2.5 times the time following the last echo.
The sensor determines the result and starts the next measurement cycle. Shorter response times thus occur, but also the danger of incorrect measurements in the case of very distant objects. If echoes are picked up from them after the new burst, these may be mistaken for echoes from very close objects.
The CCT,xxx [ms] command sets a constant cycle length. However, pauses of variable length (1 ms to 100 ms) are inserted between the cycles. This means that echoes from distances greater than 6.5 m can be reliably evaluated as well, although the response time of the sensor increases.

2 Blind range, parameter setting options (BR)

In normal circumstances, the sensor uses the first echo that arrives to determine the echo propagation time. An object close to the sensor is thus always detected. If this object is to be disregarded, however, because the region to be monitored begins behind it, the sensor can be allocated an extended blind range using the **BR** command. The sensor ignores any echoes it detects in this region. An object may however generate a second or third echo which lies beyond the blind range, and thus produces an incorrect measurement. The evaluation can no longer recognise and suppress duplicate echoes.
The decay behaviour of the ultrasonic converters changes depending on the temperature. For this reason, the default setting of the ultrasonic sensors will ignore all echo signals for up to 75 % of the blind range quoted in the data sheet. If a larger blind range is required (for example, to eliminate an unwanted nearby object in the detection range), this range can be selected via the **BR** command. All echo signals up to the specified distance are then suppressed.

3 Temperature effect and compensation, parameter setting options (TO, VS0, TEM, REF)

The propagation rate of sound depends on the physical properties of the carrier medium. In the case of a gas-air mixture, temperature changes greatly affect the velocity of sound. Air pressure and humidity are lesser factors. Incorrect temperature induced measurements of the sensor are compensated by determining the temperature.

The temperature measurement is generally carried out inside the sensor and thus does not directly include the temperatures in the measurement range. The offset value **TO** takes into account the difference between the temperatures in the sensor and in the sound measurement range.

If the sensor is to operate in a gas other than air, the corresponding sound velocity in this gas at 0 °C must be set using **VS0**.
The temperature (in Kelvin) measured at the temperature probe can be interrogated by the **TEM** command. The TEM command with a parameter (TEM,xxx), on the other hand, provides a temperature from which the resulting temperature offset TO can be calculated using the measured temperature.

Another possibility is to allocate a reference distance to the sensor via the **REF** command. A target must then be located at the specified distance in the detection range. Using this distance and the measured echo propagation time, the sensor calculates the VSO value, taking into consideration the previously defined offset TO. The sound velocity VSO of a gas mixture can thereby be determined.

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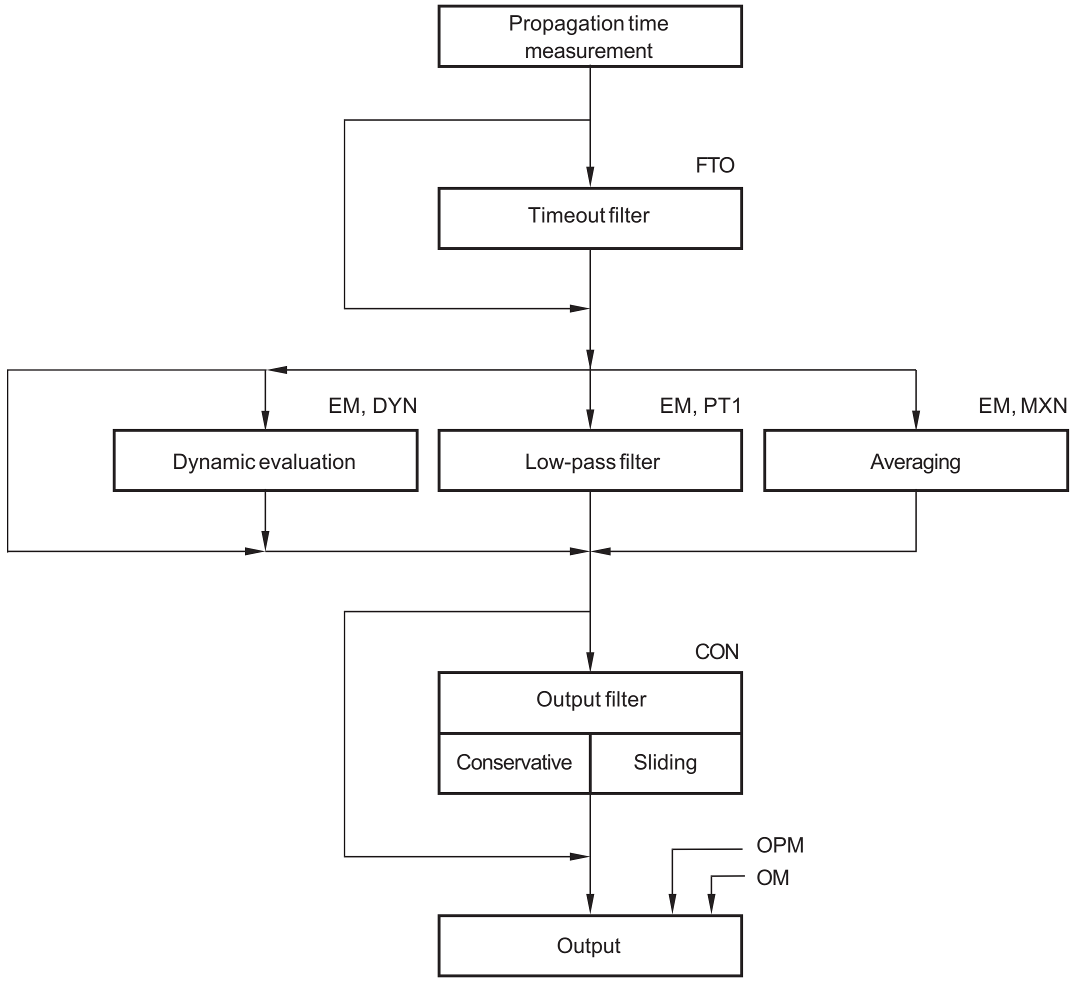
4 Evaluating the measured echo propagation times, parameter setting options (EM, ...)

Propagation time measurement produces an echo propagation time corresponding to the distance of the object. Disturbances can occur, caused for example by electromagnetic influences, interference noise, multiple echoes or echoes from other (unsynchronised) ultrasonic sensors. Different evaluation methods provide greater protection from interference. Of these, **only one** can ever be activated :

- No evaluation
- Dynamic evaluation
- Low-pass filter (PT1-)
- Averaging (with extreme value suppression)

For special applications, an additional **FTO** filter ensures that measurements without a recognised echo are ignored.



4.1 Masking out measurements without echo, timeout filter (FTO)

This additional filter checks before the evaluation whether or not an echo has been received. If not, the measured value is rejected and the evaluation is aborted. The filter is active when the **FTO** instruction has been issued with a parameter. The parameter determines the number of measurements without echo that are to be discarded.

4.2 Dynamic evaluation (EM,DYN[,N])

The evaluation algorithm compares the echo propagation time already measured against an expected value, which is calculated from the last measured value and the difference from the last measured value but one. If the present measurement value does not correspond to the expected value, it is replaced once by the expected value. The measurement must deviate for a second time before it will be accepted.

The parameter **N** specifies the permitted deviation of the final measured propagation time from the expected value as a percentage (1 % … 15 %). If no parameter or zero is passed, then the default value N = 1 [%] is used.

4.3 Low-pass filter (PT1-) (EM,PT1[,N[,P[,C]]])

Sudden, wild fluctuations in the measured echo propagation times act on the measurement result as though filtered through a low-pass filter.
The PT1 evaluation adds the actual measured value to the weighted final measurement result and from this calculates the nearest measurement result.
The parameter **N** (0 ... 999) determines the weighting factor.
If no parameter N is specified, N takes the default value of 30.

Weighting algorithm : see instruction EM,PT1... in the instruction set.

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Acceptance window (PT1)
An extra level of immunity to interference is provided when an acceptance window is activated (P not equal to 0). Up to a certain threshold (C), any measured values that exhibit more than a permitted percentage deviation (P in %) from the previous result will be discarded. Any spontaneous disturbances are therefore not even included in the PT1 evaluation.
Only if a specific number of measured values in succession fall outside the acceptance window will the subsequent values again be included in the PT1 evaluation.

4.4 Calculation of average with suppression of extreme values (EM,MXN,M,N)

This algorithm uses the parameters M (1 ... 8) and N (0 ... 3) to determine how many echo propagation times are included (M) and how many are excluded (N) from the evaluation. The algorithm removes the N worst measured values from the M most recent ones. The average is calculated from the remaining (M minus N) values.
Requirement: N < M/2.

4.5 Conservative or sliding output filter (CON)

To switch an output, the calculated result must remain above or below the switching point for a certain number of measuring cycles. Depending on the value of CON, this filter operates either conservatively (CON < 10) or sliding (CON ≥ 10).
The value of the parameter in the CON command acts at the same time as a counter for the depth of the filter.

Conservative (CON < 10): The output will be switched if CON is (always) nearer the test result than the switching point. The counter will be reset to zero even if just one measured value exceeds the switching point. The filter will then expect a succession of CON measurements nearer the switching point.

Sliding (CON ≥ 10): An up-down counter increments when the measured values are nearer than the switching point and decrements in cases where the results are greater than the specified switching point. The output switches when the counter reaches the value of CON and switches back when the counter has a value of zero.

5 Modes of operation of the switching outputs, configuring options (OPM)

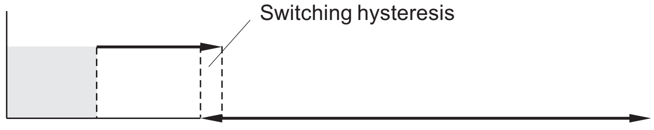
The switching outputs of the ultrasonic sensors can switch according to the mode of operation:

- Switching mode (default),
- Window mode,
- Reflex photoelectric barrier mode,
- Double switching point mode and
- Range monitoring

The switching outputs can also be configured as N/C contacts or N/O contracts, irrespective of the mode of operation.
E6/E7 sensors: both switching outputs can be set independently of each other.
IUE0/E2 sensors: the IU output only works in switching mode or range monitoring.

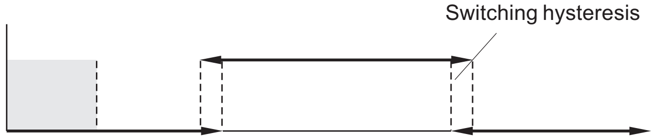
5.1 Switching value mode (S)

The switching output switches when an object is detected that is nearer than the selected switching point. If the object disappears, the output switches back again using the delay inherent in the hysteresis value. Sensors with differing acquisition ranges have blind ranges that are also of different sizes. Details can be found in the data sheets.



5.2 Window mode (W)

The switching output only switches if the sensor detects the first echo within the evaluation window. The window sizes are configurable (DIP switches or parameter inputs).
If a number of echos arrive at the sensor at different times, one of which is **before** SDx1, the output will not switch even if there is an echo in the measuring window. The sensor only evaluates the first echo. It is therefore not possible to detect multiple echos in this way.

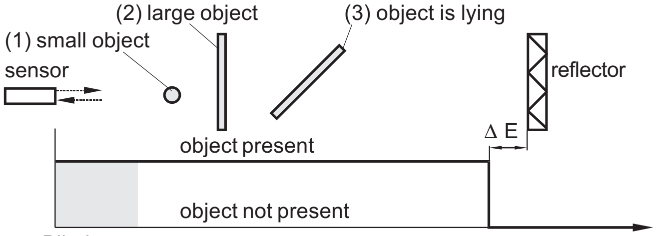


5.3 Reflex photoelectric barrier mode (R)

The switching output switches in the following circumstances:
(1) the sensor picks up echos from a small object in the sound cone **and** from the reference reflector,
(2) the sensor detects a large object but does **not** receive an echo from the reference reflector,
(3) the sensor is not picking up any echos because, for example, an object is lying at an angle and deflecting the sound.

The position of the reference reflector must not be changed. The distance taught, for example through SD1, must be smaller than the distance to the reflector by the amount Δ E:

UC 3000	Δ E > 2 % 3000 (60 mm)
UC 6000	Δ E > 2 % 6000 (120 mm).



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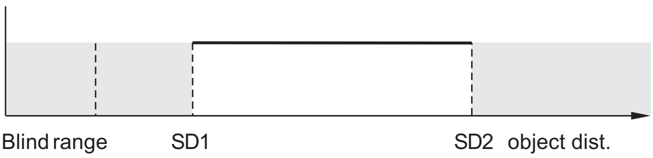
5.4 Double switching point mode (H) switching output

The sensor retains the previous switching status in an area of the evaluation window selected using DIP switches or parameter inputs. The switching output switches when an object approaches the sensor switching point and only switches back when the object moves away beyond the switching point at a distance from the sensor. Both switching points generate a large hysteresis.

5.5 Range monitoring (L) switching output

The sensor monitors the evaluation window. The output only switches when an object is detected within the window. Echos from ranges in front of or behind the evaluation window are ignored. Multiple echos from the zone that is greyed out, including echos in front of SDx1, do not affect the evaluation.



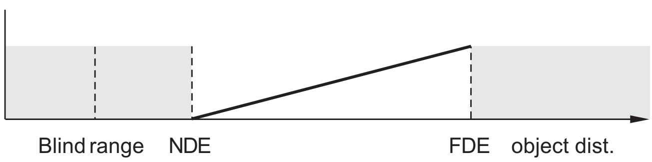
5.6 Standard mode (S) IU output

The current/voltage output provides a signal that is proportional to distance. The range limits NDE, FDE can be selected by a command or by setting DIP switches. As far as the evaluation is concerned, the status of the UDS flag is important. In the case of UDS, the switch setting is 1.

If the area limits are selected such that NDE > FDE, the current/voltage value will have a falling output ramp.

5.7 Range monitoring (L) IU output

The sensor only monitors the evaluation window that is delimited on both sides by a blind range. The IU output provides a signal that is proportional to distance. The range limits (NDE, FDE) are specified with commands or DIP switches.
Echo from areas that are greyed out are ignored, but do not result in an interruption of the measurement.



6 Switching functions, configuring options (OM)

6.1 N/O and N/C switching functions

Switching outputs cam work as N/C or N/O contacts. The **OM** command is used to configure both switching outputs as N/C or N/O independently of each other. Which potential is switched - PNP or NPN - has no effect as both variants use the same software.

6.2 Noise-free switching function, configuring options (FSF)

The sensor can be assigned a noise-free switching function for fault situations. The default is the type 0 noise-free switching function, where the switching outputs or the analog outputs retain their existing status.
In the case of type 1, the sensor responds as if an object had been detected.
In the case of type 2, on the other hand, as if the sensor had not detected an object.
If a fault current of 0 mA to 4 mA (or a voltage of 0 V to 2 V) had also been specified for the analog output, this current (or voltage) value will be on the analog output in the event of a fault.

7 Synchronisation of ultrasonic sensors

The sensors are not synchronised during normal operation. An interaction can therefore occur if a minimum distance is not observed during installation.
The necessary minimum distance can be relatively large, depending on the nominal acquisition area, the distance to the object and the site conditions. There will therefore be an area between two sensors that will remain undetected.
If an area of shadow like this is unacceptable, in other words the ultrasonic sensors must operate within a confined area, interaction can be prevented by synchronising the sensors. The synchronisation input and output Sync is provided for this purpose on selected ultrasonic sensors.
Synchronisation pulses sent to the output initiate the measuring cycle in the sensor.

Sensors equipped with a sychronisation input/output operate as follows:

- individual sensors asynchronised (Sync is not wired)
- adjacent sensors synchronised (Sync lines connected)
- synchronisation via an external control
- High level deactivates the sensor (standby)

In the case of a constant low level (or Sync remains unwired) the sensor operates in asynchronised mode.
The sensor reports an active measuring cycle by outputting a High signal on Sync. If the sychronisation lines of adjacent sensors are connected, the sensors sychronise themselves (without an external control). Only one sensor performs a measuring cycle at any one time. The response time of the sensor increases as the number of sensors increases.

In the case of external sychronisation, an external control issues an sychronisation pulse to each sensor in turn. The sensors operate in a multiplexed manner, i.e. one after the other. The response time also increases in this case as the number of sensors increases.

If the sychronisation pulse is issued to all the sensors simultaneously, they will all switch to synchronous operation.

If the signal is always High, the sensor will switch to stand by mode (after 1 second).

Creating the synchronous signal

The sychronisation pulses on Sync can be positive or negative; in both cases, the measuring cycle in the sensor is initiated by the falling edge. The maximum repetition rate, the time to the start of the next measuring cycle, depends on the type of sensor and the number of sychronised sensors.

All sensor instructions at a glance

Instruct.	Meaning	Type	Parameter Response / Ack.	Page
VS	**V**elocity of **S**ound	read	Current velocity of sound in [cm/s]	33
VS0	**V**elocity of **S**ound at **0**°C	read/set	Velocity of sound at 0 °C in [cm/s]	33
TO	**T**emperature **O**ffset	read/set	Temperature offset in [0.1 K]	33
TEM	**Tem**perature	read/adapt TO	Temperature at sensor in [0.1 K]	33
REF	**Ref**erence Distance	adapt by VS0	Reference distance in [mm]	33
SD1[1]	**S**witching **D**istance **1 / 1**	read/set	Near switching point/ output 1 in [mm]	32
SD12	**S**witching **D**istance **1 / 2**	read/set	Far switching point / output 1 in [mm]	32
SD2[1]	**S**witching **D**istance **2 / 1**	read/set	Near switching point / output 2 in [mm]	32
SD22	**S**witching **D**istance **2 / 2**	read/set	Far switching point / output 2 in [mm]	32
SH1	**S**witching **H**ysteresis 1	read/set	Switching hysteresis for output 1 in [%]	32
SH2	**S**witching **H**ysteresis 2	read/set	Switching hysteresis for output 2 in [%]	32
NDE	**N**ear **D**istance of **E**valuation	read/set	Near limit of measuring window in [mm]	28
FDE	**F**ar **D**istance of **E**valuation	read/set	Far limit of measuring window in [mm]	28
UDS	**U**se **D**ip **S**witches	read/set	0/1 for inactive / active DIP switches	32
SSY	**S**tartup **Sy**chronised	read/set	0/1 for normal / synchronous operation following Reset	31
BR	**B**lind **R**ange	read/set	Extended blind range in [mm]	28
CCT	**C**onstant **C**ycle **T**ime	read/set	Pause time in [ms]	29
CBT	**C**onstant **B**urst **T**ime	read/set	Burst length in [µs]	29
FTO	**F**ilter **T**ime**O**ut	read/set	Filter depth, number of measurements to be filtered. No echo	29
EM	**E**valuation **M**ethod	read/set	Evaluation method, encoded (NONE/PT1,../MXN,.../DYN,...)	29
CON	**CON**servative Filter	read/set	Type of filter, encoded, threshold value	31
OPM	**Op**eration **M**ethod	read/set	Mode of operation of outputs: S,R,W,L,H	34
OM	**O**utput **M**ode	read/set	Output mode (1) N/C, (0) N/O	34
FSF	**F**ail **S**afe **F**unction	read/set	Fault response, fault current on output	34
MD	**M**aster **D**evice	read/set	Master or Slave mode for sensor	35
DIP	Read **DIP** Switches	read	DIP switch settings, encoded	33
AD	**A**bsolute **D**istance	read	Distance in [mm]	27
RD	**R**elative **D**istance	read	Relative distance, digit (0...4095)	27
RT	**R**andom **T**ime	read	Echo propagation time in machine cycles	28
SS1	**S**witching **S**tate **1**	read	Switching output 1 active / not active	32
SS2	**S**witching **S**tate **2**	read	Switching output 2 active / not active	32
ADB	**A**bsolute **D**istance **B**inary	read	Distance in [mm], binary	27
RDB	**R**elative **D**istance **B**inary	read	Relative distance, binary	28
RTB	**R**un **T**ime **B**inary	read	Echo propagation time in machine cycles	28
ER	**E**cho **R**eceived	read	Echo detected yes / no	35
VER	Sensor **VER**sion	read	Version code	31
ID	Sensor **ID**entification	read	Typ, EPROM, Version	31
DAT	Software **DAT**e and Version	read	Date, time	31
RST	Sensor Software **R**e**S**e**T**	instruction	Reset ack. 0	35
DEF	**DEF**ault Settings	instruction		35
SUC	**S**tore **U**ser **C**onfiguration	instruction		35
RUC	**R**ecall **U**ser **C**onfiguration	instruction		35
ST	**St**atus Information	read	Status and error bytes	36

This table provides a quick overview of the sensor instructions, the tasks they perform and the reaction / response that can be expected from the sensor.

The page numbers shown should make the instructions easier to find under the sensor instruction set.

The default values of the parameters are shown in the table overleaf.

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Default values of sensors

Instruction	Meaning	Default Value		
		UC500	UC3000	UC6000
VS0	**V**elocity of **S**ound at **0** °C	33160		
TO	**T**emperature **O**ffset	0		
SH1	**S**witching **H**ysteresis 1	1		
SH2	**S**witching **H**ysteresis 2	1		
SD1[1]	**S**witching **D**istance **1 / 1**	60	300	800
SD12	**S**witching **D**istance **1 / 2**	280	1650	3400
SD2[1]	**S**witching **D**istance **2 / 1**	500	3000	6000
SD22	**S**witching **D**istance **2 / 2**	280	1650	3400
NDE	**N**ear **D**istance of **E**valuation	60	300	800
FDE	**F**ar **D**istance of **E**valuation	500	3000	6000
UDS	**U**se **D**ip **S**witches	1		
BR	**B**lind **R**ange	0		
CCT	**C**onstant **C**ycle **T**ime	1		
CBT	**C**onstant **B**urst **T**ime	0		
FTO	**F**ilter **T**ime **O**ut	0		
EM	**E**valuation **M**ethod	MXN,5,2		
CON	**CON**servative Filter	2		
OPM	**Op**eration **M**ethod	SS		
OM	**O**utput **M**ode	00		
FSF	**F**ail **S**afe **F**unction	0 [,-1]		
MD	**M**aster **D**evice	OFF		
SSY	**S**tartup **Sy**chronised	0		

Instruction set

Attention

Some instructions work with parameter values that are set in the DIP switches (switching points, evaluation window limits, etc.).
*Using the UDS query it is possible to check in advance of such instructions whether or not the DIP switch setting is evaluated. If the UDS flag is set to zero, then the applicable values are **not** those from the DIP switches, but (other) parameter values defined and stored previously. The reaction of the sensor varies accordingly.*
Following UDS,1 the DIP switch setting applies!

AD [**A**bsolute **D**istance]

Instruction: AD	Example: -
Parameters: -	Unit: -
Response: Distance [mm]	Range: -
Reference: Master mode	

This instruction requests the absolute distance measured. The sensor returns the measured values in [mm], sometimes even if they lie outside the detection range. However, operation in the blind range is not permitted. Reliable functioning in the range above the detection range cannot be guaranteed.
Response when no echo received: Maximum value
(2 x detection range + 1).
Fault response: Error code E.

ADB [**A**bsolute **D**istance **B**inary]

Instruction: ADB	Example: -
Parameters: -	Unit: -
Response: Binary, dist.	Range: -
Reference: AD	

The same result is returned as with AD, but in binary format. The bytes corresponding to the binary value are, as a rule, non-printable ASCII characters, which are not displayed by the terminal program.
Example for a distance of 1445 mm: Response = <05h><A5h><CR>.
Fault response: Error code FFFEh.

RD [**R**elative **D**istance]

Instruction: RD	Example: -
Parameters: -	Unit: -
Response: 4 digits	Range: 0...4095
Reference: RDB, NDE, FDE, UDS	

For sensors of type IU with an analog output.
Requests the relative distance [digit].
In other words, the position of an object is determined in a measurement range of the analog output defined with NDE and FDE (or via DIP switches). The 12-bit D/A converter enables a resolution of 4095 digits. The sensor responds accordingly with zero at the window limit nearer to the sensor, and with 4095 at the window limit further from the sensor. Each intermediate position corresponds to a numeric value from 0 … 4095.

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Important!
The UDS instruction decides whether the evaluation limits are defined by the DIP switch setting or through parameters.
Fault response: Error code E.

RDB [Relative Distance Binary]

Instruction: ADB	Example: -
Parameters: -	Unit: -
Response: Binary code	Range: 0 ... 4095
Reference: RD, NDE, FDE, UDS	

For sensors of type IU with an analog output.
Requests the relative distance [digit] as in RD, but in binary format.
In other words, the position of an object is determined in a measurement range of the analog output defined with NDE and FDE (or via DIP switches). The 12-bit D/A converter enables a resolution of 4095 digits. The sensor responds accordingly with zero at the window limit nearer to the sensor, and with 4095 at the window limit further from the sensor. Each intermediate position corresponds to a numeric value from 0 … 4095, which is output in binary format.
The bytes corresponding to the binary value are, as a rule, non-printable ASCII characters, which are not displayed by the terminal program.
Fault response: Error code FFFEh.

RT [Random Time]

Instruction: RT	Example: -
Parameters: -	Unit: Mz = 1.085 µs
Response: Machine cycles	Range: -
Reference: -	

The RT instruction requests the echo propagation time. The response is in machine cycles (1 mc = 1.085 µs).
In the event that the sensor does not detect any echo, then the timeout is similarly shown in machine cycles
Fault response, e.g. echo from the blind range: Error code E.

RTB [RunTime Binary]

Instruction: RT	Example: -
Parameters: -	Unit: Mz = 1.085 µs
Response: M/c cycles	Range: -
Reference: -	

The RTB instruction, like the RT instruction, requests the echo propagation time. The response (number of machine cycles [1.085 µs]) is in binary form. The response bytes are, as a rule, non-printable ASCII characters, which are not displayed by the program.
Since the propagation time for sensors with a measurement range of 6000 mm can accept values of above 10,000 h, UC 6000 sensors send a 3-byte response, while the other sensors use 2 bytes.

NDE [Near Distance of Evaluation]
FDE [Far Distance of Evaluation]

Instruction: NDE / FDE,xxxxx	Example: NDE / NDE,500
Parameters: Distance	Unit: mm
Response: Size of meas. window	Range: Blind range to 2 x detection range
Reference: BDE, UDS, RD, RDB	

NDE / FDE **(no parameters)** are used to request the limits of the measurement window nearer to / further from the sensor.
The instruction **NDE**,xxxxx defines the evaluation limit of the analog output that is **closest to the sensor**,
the instruction **FDE**,xxxxx defines that **furthest from the sensor**.
The valid values lie between the blind range and 2 x detection range.
NDE < FDE: analog output with rising ramp,
NDE > FDE: analog output with falling ramp,
NDE = FDE: the analog output forms a switching point.
Note:
Under favourable conditions, the sensor can even receive echoes from distances greater than the detection range; the sensor therefore accepts parameter values up to double the nominal detection range.

Important!
The UDS instruction determines whether the evaluation limits are defined by the DIP switch setting or through parameter values. UDS, 1 means that the switch setting is applicable, i.e. the parameter values are not effective at the moment and are put in non-volatile storage in the sensor. UDS,0 activates this "default".

BR [Blind Range]

Instruction: BR / BR,xxxxx	Example: BR,400
Parameters: "Ext. blind r.".	Unit: mm
Response: Current, extended" blind range	Range: ½ blind range to 2 x nominal detection range
Reference: Propagation time, blind range, NDE, OPM, L	

The BR instruction requests the current value of the extended blind range.

A response of 0 means that the sensor is **not** operating with an extended blind range, and the value from the data sheet is applicable.
The response xxxxx specifies the width of the "extended" blind range.

BR,xxxxx is used to assign to the sensor a range similar to the blind range.
Up to this distance the sensor ignores any echoes received. This has the effect of excluding any objects in the immediate vicinity of the sensor that are responsible for interference. As a rule a larger, "extended" blind range is created.

Note:
Under ideal conditions the blind range can be reduced to almost 75 % of the range specified in the data sheet (the BR instruction accepts parameter values from 1). When working with a reduced blind range, it is essential that control measurements should be used for checking purposes (see "Logging series of measurements" in the Ultra 3.0 service program.

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CBT [Constant Burst Time]

Instruction: CBT / CBT,xxx	Example: CBT,0
Parameters: Burst length	Unit: Burst length in [µs]
Response: current burst length	Range: 0 = variable (see below) 30 ≤ constant
Reference: propagation time meas., cycle time, CCT	

The CBT instruction asks whether the evaluation is working with a constant or a variable burst time.
Response 0: The sensor adjusts the burst time automatically according to the echo propagation time.
Response xxx: The constant burst time currently defaults to xxx [µs] .
The instruction CBT,xxx defines a new constant burst time and deactivates dynamic adjustment. The following values are possible:

30 µs .... 300 µs for UC 3000 sensors
55 µs .... 500 µs for UC 6000 sensors.

Note:
With CBT,0, objects that are close to the sensor and do not reflect ultrasound well result in a shortening of burst time because of the short echo propagation time; under certain circumstances this may result in the object being measured unreliably. Remedial action enables a constant burst time to be established.

CCT [Constant Cycle Time]

Instruction: CCT / CCT,xxxx	Example: CCT,10
Parameters: 0 / 1, Pause	Unit: 0 / 1 encoded, ms
Response: See below	Range: 0...1000
Reference: Propagation time measurement, CBT	

The CCT instruction asks whether or not the sensor is operating with constant measurement cycle times.
A response of 0 means that it is not operating with fixed cycles. In other words, the evaluation aborts the measurement cycle if no further echo is recorded within 2.5 times the time since the last echo. The sensor adjusts the repetition rate according to the echo propagation times currently being measured.
A response of 1 to 1000 means that the evaluation is performed with a constant measurement cycle. Pauses are inserted between the measurement cycles (length 1 ms … 1000 ms).
The CCT,0 instruction specifies evaluation with dynamic measurement cycles.
The CCT,xxxx instruction specifies evaluation with pauses between constant measurement cycles. The pause length can be set in the range 1 … 1000 [ms]. Default value: 1
The pauses increase the response times of the sensor.
Note:
The CCT,xxxx instruction is only effective if the sensor is not synchronised. If the sensor receives pulses via the synchronous input, then these will be treated as a higher priority.

FTO [Filter Time Out]

Instruction: FTO / FTO,xxx	Example: FTO,3
Parameters: Filter depth	Unit: Counter
Response: Current filter	Range: 0 ... 255
Reference: Evaluation EM, CON, OM	

Filter between echo propagation time measurement and evaluation.
The FTO instruction requests the filter depth set for the timeout filter (measurement cycles with no echo).

Response 0: Evaluation operates without an input filter.
Response xxx: The counter of the filter is set to xxx (filter depth).

The FTO,xxx instruction instructs the sensor software how many measurement cycles that have detected **no** echo are to be ignored. These measurements (with no echo) are not evaluated until an internal counter exceeds the value transferred with FTO. Not until the number of measurements (with no echo) exceeds the value of xxx is the resulting maximum value for the propagation time calculated.

Note:
This parameter is useful, for example, with objects that do not reflect ultrasound well (if an echo is not always received) or with liquids in a state of motion (when the ultrasonic pulse passing through the liquid is occasionally reflected to the side by surface movement).

EM [Evaluation Method]

Instruction: EM / EM, NONE/DYN/PT1/MXN	Example: EM,NONE
Parameters: See below	Unit: Encoded or counter
Response: See below	Range: See below
Reference: Propagation time measurement, FTO,CON	

This instruction determines the evaluation method to be used for the sensor. There can never be more than one (or none) activated at the same time. The corresponding coding is appended to the instruction with a comma:
EM **requests** which evaluation method is currently set with which parameters.

EM,NONE	No evaluation
EM,DYN	Dynamic evaluation
EM,PT1	Low-pass filter (PT1-)
EM,MXN	Averaging (with suppression of extreme values)

After the instruction **EM, NONE** no specific evaluation is carried out, and each measured value is output directly. The filters FTO and CON can be activated irrespective of EM.

Dynamic Evaluation:

The instruction **EM,DYN[,N]** compares the current measured value with an expected value, which is calculated from the last measured value and a differential change from the last measured value but one. If the measured value differs from the expected value, it is replaced once by the expected value. Only if a second measured value is also different will the measured value be accepted.
The parameter **N** allows the optional addition of the allowable percentage deviation (1 % to 15 %) of the measured value from the expected value. If no parameter or a zero is passed, then the deviation is set to 1 %. The value of this parameter cannot exceed 15 %.

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Note:
This evaluation is particularly well suited to situations in which the objects are constantly within the detection range, but are in motion.
Examples: EM,DYN or with a parameter EM,DYN,5
Range: Deviation N 0 ... 15 %

Low-pass filter (PT1-):

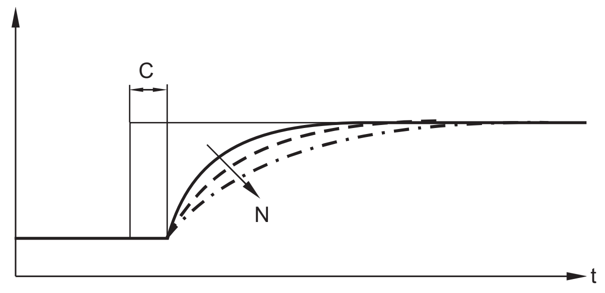
The instruction **EM, PT1 [,N [,P [,C]]]** calculates the new measurement result from the measured value and the weighted last measurement result. In this way, after spontaneous jumps in measured values, the values are retrospectively brought into line with the current value.
Up to three parameters separated by commas can be appended to the instruction code EM, PT1, ... :
The first parameter **N** (0 … 1000) determines the weighting with which the last measurement result is put into the new measurement result,
the second parameter **P** (0 % … 15 %) defines the allowable percentage deviation from the measured value for the acceptance window and
the third parameter **C** (0 … 15) is a count threshold for rejecting deviant measured values
Default values: 30 for N / 0 for P (inactive acceptance window) / 5 for C.

Range:	Weighting N	0 ... 1000
	Deviation P	0 ... 15 %
	Reject counter C	0 ... 15

Weighting:
The PT1 evaluation adds the current measured value to the weighted last measurement result and calculates from that the new measured value using the following formula:

$$E_{(new)} = \frac{10 \bullet MW_{(neu)} + E \bullet N}{10 + N}$$

$E_{(new)}$ = new, weighted result of the evaluation
$MW_{(new)}$ = current measured value
E = last, weighted result of the evaluation



N = weighting factor

The weighting exhibits typical low-pass response. After the measured values (distances / propagation times) have been changed in the form of a jump, the evaluation results are retrospectively brought into line with the current values on the typical curve. The larger the weighting factor N chosen, the shallower will the curve be, and in turn the longer the tracking will take.

Acceptance window (for PT1):
If P is not equal to 0 and the acceptance window is activated, then the measured value is compared with the previous measurement result. If the difference is greater than specified (in %) by P, the measured value is rejected - if the counter threshold has not yet been reached.
Counter threshold: Once the counter threshold has been exceeded, even deviant measured values are accepted. This means that the current measured values lay C-times in succession (!) outside the window defined by P.

Note: The counter associated with the acceptance window is reset to 0 if a measured value falls within the window again.
Example: EM,PT1,40,5,5

Averaging (with extreme value suppression):
With instruction **EM, MXN, M, N** the two parameters M and N specify how many measured values are included in the evaluation (M) and how many of them are suppressed as illegal values (N).
The algorithm produces the average of the last M measurements. Of these, the N measured values that deviate furthest from the interim mean value are suppressed. In this way, the measurement result is only calculated as the average of the remaining M minus N measured values.
M can take a value from 2 to 8 in this instance, and N must be less than M/2.

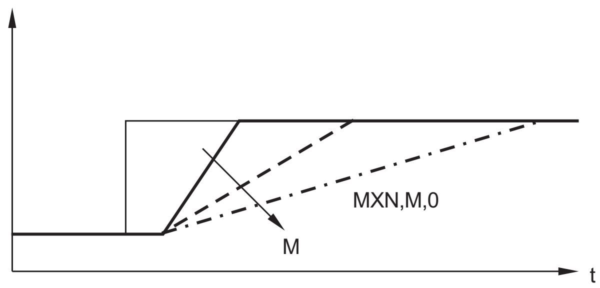
M	8	7	6	5	4	3	2
N_{max}	3	3	2	2	1	1	0

If only the first parameter is supplied, the evaluation N uses the largest permissible value. If the parameters are not specified, then the default values M = 5, N = 2 are used:

Example:	EM,MXN	(sets M = 5, N = 2)
	EM,MXN,7	(sets M = 7, N = 3)
	EM,MXN,6,1	(sets M = 6, N = 1)

Range:	Measured values M 2 ... 8
	Invalid values N < M/2

Effect:
When the measured values change in jumps, averaging responds by bringing the evaluation towards the new measured values in a linear manner. The parameter M determines the rise (steepness), and thus the approach time. The larger the value of M, the longer it takes to reach the current value.



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CON [CONservative Filter]

Instruction: CON / CON,xxx	Example: CON,5
Param.: Filter type, counter	Unit: -
Response: Current filter	Range: 0 ... 255
Reference: Evaluation EM, ..., FTO	

Filter between evaluation and output of measured value.

The instruction CON requests the filter type and filter depth set (xxx).

Response 0: The output filter is not active.

Response 1 ... 9: the filter is set to conservative, response 10 ... 255: sliding filter.
The values 1 .. 9 / 10 ... 255 are counter values (filter depth).

The instruction CON, xxx provides the sensor with the threshold value for the output filter.

xxx < 10: conservative output filter,
xxx ≥ 10: sliding output filter.

CON,0 deactivates the output filter.

Conservative output filter: The measurement result must lie closer than the switching point in an unbroken sequence before the switching output is switched over as frequently as specified by the instruction CON,xxx. If a single measurement lies beyond the switching point, the corresponding counter will be reset and xxx measurements in sequence must again lie below the switching point in order for the switchover to be performed. In order to switch the output back, the corresponding conditions apply, whereby the measurement results must then lie beyond the switching point.
Sliding output filter: A forward/backward counter is incremented when the measurement result lies closer than the switching point, and it is decremented for values equal to or beyond the switching point. If the counter reaches the value xxx, the output is switched. If the counter reaches the value zero, the switching output is switched back.

Note:
In details provided elsewhere on the conservative filter, different terms are sometimes used, but they still describe the same algorithm:
Conservative: also "strictly conservative", sliding: also "integrating".

DAT [Software DATe]

Instruction: DAT	Example: -
Parameters: -	Unit: -
Response: See below	Range: -
Reference: ID, VER	

This instruction requests the date of the sensor software:
Sample sensor response to DAT: Date: 08/30/96 Time: 08:27:10

ID [Sensor IDentification and Version]

Instruction: ID	Example: -
Parameters: -	Unit: -
Response: See below	Range: -
Reference: VER, DAT	

The sensor is interrogated for its identification. Sample response:
Sensor: P&F UC3000+U9+E6-R2 Eprom: 1801U079 Version: 100

VER [Sensor VERsion]

Instruction: VER	Example: -
Parameters: -	Unit: -
Response: See below	Range: -
Reference: DAT, ID	

The sensor is interrogated for its version code.
It returns four coded characters indicating the sensor type:
- the **first two** characters indicate the **detection range**:
  - 05 : 500 mm
  - 02 : 2000 mm
  - 03 : 3000 mm
  - 04 : 4000 mm
  - 06 : 6000 mm
- the **third** character indicates the **sensor type**:
  - 0 : undefined+
  - 1 : UJ3000+U1+8B-RS / UJ6000-FP-8B-RS
  - 2 : UJ3000+U1+E22+RS / UJ6000-FP-E22+RS
  - 3 : UJ3000+U1+IU+RS / UJ6000-FP-IU+RS
  - 4 : UJ3000+U1+RS / UJ6000-FP+RS
  - 5 : UC3000+U1+E6/E7+R2 / UC6000-FP-E6/E7+R2
  - 6 : UC3000+U1+IUE0/E2+R2 / UC6000-FP-IUE0/E2+R2
  - 7 : UC....-30GM-E6/E7-V15-R2
  - 8 ... F undefined
- the **fourth** character indicates the **software version.**

SSY [Startup Sychronised]

Instruction: SSY,0/1	Example: SSY,1
Parameters: 0 / 1	Unit: -
Response: 0 / 1	Range: 0 = Not synchr. 1 = Synchr.
Reference: Sychronous operation	

This instruction determines whether the sensor goes immediately into normal mode (SSY,0) after a reset (power on), or whether it starts with synchronised mode (SSY,1).
Following SSY,1 the operational standby time is extended. When the synchronisation input / output is open the sensor waits for approx. 1 second before changing over into normal mode.
Note:
If the sensor is to work in synchronised mode, the instruction SSY,1 must be issued in advance.

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UDS [Use Dip Switches]

Instruction: UDS / UDS,x	Example: UDS,1 / UDS,0
Parameters: 0, 1	Unit: -
Response: 0 / 1	Range: 0 = DIP switches off 1=DIP switches active
Reference: Evaluation, SD11/12/21/22, SH1/2, OPM, OM	

The UDS instruction requests whether the sensor software is currently operating using the DIP switch settings or the corresponding (stored) parameter values.

Instruction UDS,0: The DIP switch settings are ignored.
Instruction UDS,1: The DIP switch settings are being used.

The following are affected:

Parameter	UDS,0	UDS,1
Switching point 1	Instruction SD1	DIP switches 1-4
Switching point 2	Instruction SD2	DIP switches 5-8
Switching function	Instruction OM	DIP switches 9

Attention

Note that the instruction UDS,x has an effect on the action of other sensor instructions, e.g. instructions RD, RDB, NDE, FDE, SD11 ... SD22, SS1/2, OM.

SD1[1] [Switching Distance 1.1]
SD12 [Switching Distance 1.2]
SD2[1] [Switching Distance 2.1]
SD22 [Switching Distance 2.2]

Instruction: SD1/SD11,xxxxx	Example: SD12,1200
Parameters: Switching point	Unit: mm
Resp.: Current switching pt.	Range: Blind range to 2 x nominal switching distance
Reference: UDS, OPM (H/W/L), SH1, SH2	

The instructions SD1 / SD11.../ SD22 **(no parameters)** query the current switching points.

The instructions **with parameters** define the switching points of the sensor. The permissible values lie between the blind range and double the detection range. Parameters are defined using a maximum of 5 characters in [mm] and are appended to the instruction code with a comma.

The instructions SD**1**1 and SD**1**2 relate to switching output **1**,

The instructions SD**2**1 and SD**2**2 to switching output **2**.

The instructions SD1**1** and SD2**1** determine the **first** (closest to the sensor) switching point for all operation modes, while instruction SD1**2** and SD2**2** determine the **second** (furthest from the sensor) switching point for operation modes window mode W, double switching point mode H and range monitoring L.
Examples:
SD11 requests the switching point closest to the sensor for switching output 1.
SD22 requests the switching point furthest from the sensor for switching output 2.
SD12,05000 sets the switching point of output 1 furthest from the sensor to 5 m.
SD21,00400 sets the switching point of output 2 closest to the sensor to 400 mm.
Note:
Under favourable conditions the sensor can even pick up echoes from distances greater than the detection range; the sensor therefore accepts switching points up to double the nominal switching distance / detection range.

Important!
Following UDS,1 the **DIP switches are activated**. The switching points set using these switches now take priority. When queried, the sensor responds with the values corresponding to the switch positions. The specified value is stored, and is available when the DIP switches are deactivated.

SH1 [Switching Hysteresis 1]
SH2 [Switching Hysteresis 2]

Instruction: SH1,xx / SH2,xx	Example: SH1,12
Param.: Switching hyster.	Unit: %
Response: 0 ... 15	Range: 0 ... 15
Reference: UDS, SD1 ... SD22	

The instructions SH1 / SH2 request the size of the current switching hysteresis on the corresponding switching outputs.

The instruction SH1,xx determines the switching hysteresis around the switching point for switching output 1: the value, which can be set from 0 % … 15 % is related to the switching distance.
The instruction SH2,xx determines the switching hysteresis for switching output 2 (in type E6/E7 sensors).

SS1 [Switching State 1]
SS2 [Switching State 2]

Instruction: SS1 / SS2	Example: SS1
Parameters: -	Unit: -
Response:	0 / 1 Range: -
Reference: UDS	

The sensor outputs are interrogated for their logical switching status:

SS1 requests switching output 1, SS2 requests switching output 2.

Response 0: output is not active, not switched.

Response 1: output is active, has switched.

The N/O / N/C functions are not taken into account.

Important !
Following UDS,1 the DIP switches are activated. The switching points set using these switches now take priority. When queried, the sensor responds with the values corresponding to the switch positions. The values defined for the switching points are stored, and are available when the DIP switches are deactivated (UDS,0).

DIP [Read **DIP** switches]

Instruction: DIP	Example: DIP
Parameters: -	Unit: -
Response: 3 hex.chars.	Range: 0 ... 9, A ... F
Reference: UDS	

Interrogates DIP switch settings.
In response the sensor sends three hexadecimal characters representing the switch positions in coded form:
Bit value 0 = SWITCH OFF, bit value 1 = SWITCH ON.
Response:
First character: hexadecimal value of DIP switches 1 - 4,
Second character: hexadecimal value of DIP switches 5 - 8,
Third character: setting of DIP switch 9.

Example 1: The sensor response B91 h corresponds to switch position 1011 1001 1.
Example 2: With a response 111 h, only DIP switches 4, 8 and 9 are set.

VS0 [**V**elocity of **S**ound at **0** °C]

Instruction: VS0,xxxxx	Example: VS0,33160
Parameters: Sound velocity	Unit: 0.01 m/s = cm/s
Response: Sound velocity	Range: 10000 ... 60000
Reference: TEM, REF, TO, VS	

The VS0 instruction requests the value which the sensor software is currently using in calculations for the velocity of sound at 0 °C. This value has a strong influence on the distance calculated from the propagation time.
The instruction VS0,xxxxx sets the default velocity of sound at 0 °C in [cm/s]. This value needs to be modified if, for example, the sensor is to operate in a gas mixture other than air.
The effect of varying VS0 on the calculated distance with a fixed reference distance of 356 mm:

Input	Sound vel. [m/s]	Distance [mm]
Default value	331.6	356
VS0, 10 000	100	270
VS0, 60 000	600	647

VS [**V**elocity of **S**ound]

Instruction: VS	Example: -
Parameters: -.	Unit: 0.01 m/s = cm/s
Response: Sound vel.	Range: -
Reference: VS0, TO, evaluation, temperature measurement	

The instruction VS reads the velocity of sound currently being used.

The 5-digit value represents the unit [0.01 m/s = cm/s]. Thus, the response 35057 means that the evaluation is operating with a velocity of sound of 350.57 m/s.
The result is a function of **VS0**, the measured temperature and the temperature offset **TO**.
Note:
The velocity of sound cannot be set!

TO [**T**emperature **O**ffset]

Instruction: TO / TO,xxxx	Example: TO,80
Parameters: Temperature	Unit: 0.1 Kelvin
Response: Temperature	Range: **-200** ... +200
Reference: Temperature measurement, TEM, VS, VS0	

The instruction TO reads the current temperature offset.
The instruction TO,xxxx sets a constant temperature offset in the sensor for the measured temperature.

The offset takes into account the difference between the temperature in the measurement section and at the temperature probe (generally in the sensor case). From this the sensor calculates the echo propagation times corresponding to the switching distances in conjunction with the temperature.

The parameter is also accepted **with a minus sign**.
Example: TO,-183 denotes an offset of -18.3 °C

TEM [**TEM**perature]

Instruction: TEM / TEM,xxxxx	Example: TEM,80
Parameters: Temperature	Unit: 0.1 Kelvin
Response: Temperature	Range: see below
Reference: Temperature measurement, TO, VS0	

The TEM instruction requests the temperature measured by the temperature probe at the sensor. The sensor responds with 0.1 [Kelvin].

If the instruction TEM,xxxxx is used to specify a default temperature value for the sensor, it will then calculate the resulting temperature offset **TO** from this and the measured value.

The value passed must be set such that the restriction of ±200 [0.1K] for TO is adhered to.
The sensor will reject incorrect values with 81h <invalid parameter>.

REF [**REF**erence Distance]

Instruction: REF,xxxxx	Example: REF,5000
Parameters: Distance	Unit: mm
Response: -	Range: See below
Reference: Evaluation, temperature comp., VS0, TEM, TO	

It is not possible to query the reference distance.

This instruction requires that a target should be located in the detection range at an appropriate, measured distance.
The instruction REF,xxxxx passes to the sensor a reference distance in mm. From this, along with the measured echo propagation time and the temperature offset, the sensor calculates a new velocity of sound at 0 °C (**VS0**).
Limitation: VS0 can only accept values as follows: 60000 > VS0 > 10000 [0.01 m/s = cm/s].

If a sensor needs to operate in a gas mixture other than air, then the instruction REF determines the VS0 for the gas.

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OPM [Operation Mode]

Instruction: OPM / OPM,xy	Example: OPM,SS
Param.: Coded op.mode	Unit: -
Response: Current op.mode	Range: Letters
Reference: Evaluation, SD1 ... SD22, UDS	

The instruction OPM requests which operation mode is currently set for the switching output and/or IU output.
The response consists of one or two letters (xy): the first for output 1, the second for output 2 (if present). See below for the meaning of xy.

The instruction OPM, xy defines the operation mode of the switching outputs and/or the IU analog output:
The first letter (**x** = S … L) determines the operation mode of **output 1**,
the second letter (**y** = S ... L) that of **switching output 2** and/or the **IU output**.

The following operation modes are possible for the **switching outputs**:
S Switching point
W Window mode
R Reflex photoelectric sensor
H Double switching point mode
L Range monitoring
The **IU output** can only work in two operation modes:
S Standard mode
L Range monitoring

The sensor acknowledges the passing of parameters with 80 h, or, in the event of incorrect parameters, with 81 h <invalid parameter>.

Note:
The functionality of the operation modes is explained under “Description of the sensors”, paragraph 5 “Operation modes of the switching outputs“.

Important!
Switching points and detection range limits that have been set using DIP switches are only effective if DIP switch evaluation is activated with UDS,1. Following UDS,0 the corresponding stored parameter values are applied.

OM [Output Mode]

Instruction: OM / OM,xx	Example: OM,00
Parameters: -	Unit: -
Response: 0 / 1 / 00 / 10 / 01 / 11	Range: 0 = N/O contact, 1 = N/C contact
Reference: UDS	

The instruction OM enquires about the current configuration of the outputs (N/C / N/O).
Response 2: functions as N/O contact,
Response 3: functions as N/C contact.

The instruction OM,xx determines how the outputs are to be configured:

Sensors of type E6/E7:
The **first** of the two characters following the instruction code refers to **switching output 1**,
the **second** to **switching output 2**.
A **0** defines the output as **N/O contact**, while a **1** defines it as **N/C contact.**

The number of existing switching outputs determines whether one or two parameters are appended to the instruction.
Note:
The switching function is coded in the same way for both PNP sensors (types E6 / E0) and NPN sensors (types E7 / E2).
Important!
Following **UDS,1** the settings of the DIP switches have a higher priority, i.e. if DIP 9 = ON then both switching outputs will operate as N/O contacts irrespective of the flag OM; if DIP 9 = OFF, on the other hand, then the switching outputs will operate as N/C contacts.
The setting defined by OM is stored and comes into effect following UDS,0.

FSF [Fail Safe Function]

Instruction: FSF / FSF,x[,yy]	Example: FSF,1,3 5
Parameters: -	Unit: Encoded / [0.1 mA]
Response: See below Fault current inactive = -1	Range: 0, 1, 2 / 0 ... 40
Reference: Switching response, OM, OPM, NDE, FDE	

The FSF instruction enquires which disturbance response / fault current is currently set.

The instruction FSF, x, yy determines the response of the sensor in the event of a disturbance.

The parameter **x** defines the reaction of the evaluation circuit with a number 0, 1 or 2.

For **sensors with an analog output** the parameter **yy** (0 to 40) can be used to append an additional constant **fault current** to this error code. It is defined in units of 0.1 mA: values 1 to 40 represent fault currents of 0.1 mA to 4.0 mA.

Deactivate fault current circuit: yy = **-1**

x = 0 / Type 0: (Default value) The switching output and/or the analog output retain the current switching state/ output current in the event of an error.

x = 1 / Type 1: The sensor responds as if a **target** had been **detected**:
The switching output switches (corresponds to the N/C / N/O function following instruction OM)
Fault current yy specified: the analog output accepts the specified parameter
No fault current specified:
Analog output → 4 mA (when NDE ≤ FDE: rising ramp)
Analog output → 20 mA (when NDE > FDE: falling ramp)

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x = 2 / Type 2 : The sensor responds as if a **no target** had been **detected**:
The switching output does not switch, it remains inactive (depending on OM instruction)
Fault current yy specified: the analog output accepts the defined parameter (0.1 mA to 4 mA)
No fault current specified:
Analog output → 20 mA (when NDE ≤ FDE: rising ramp)
Analog output → 4 mA (when NDE > FDE: falling ramp)

Example:
FSF,1,35 means fail-safe switching function type 1, current of 3.5 mA in the event of a fault on the analog output.

MD [Master Device]

Instruction: MD / MD,AD...OFF	Example: MD,DAD
Parameters: Data	Unit: Encoded
Response: See below	Range: See below
Reference: AD, RD, RT, SSx, ADB, RDB, RTB, OFF	

The instruction MD, ... is used to set the mode of operation of the sensor: master or slave mode.
A sensor normally operates in slave mode.
Slave mode: the sensor generally only responds to instructions. If a periodic distance enquiry is required, the sensor must be sent an AD instruction from time to time.

Master mode: when each measurement is complete, the sensor automatically forwards the result to the serial interface.

The instructions MD,AD ... MD, OR put the sensor into master mode; the associated parameter (after the comma) determines how the data will be transmitted.

The conditions associated with data transmission are identical to those for the instructions AD, RD, RT, ADB, RDB, RTB and SS.

MD,AD: [Absolute Distance] absolute distance in mm, in ASCII format
MD,RD: [Relative Distance] relative distance in digits (12 bit) in ASCII format (for sensors of type IU with analog output)
MD,RT: [RunTime] measured echo propagation time in machine cycles (1 Mz = 1.085 µs)
MD,SS: [Switching States] logical status of the switching outputs
sensors of type E6/E7: two figures (first for output 1 / second for output 2)
sensors of type IU: one figure for the switching output
sensors of type 8B: no parameter.
Figure = 0: output not switched, Figure = 1: output switched
MD,ADB: Absolute distance in binary format
MD,RDB: Relative distance in binary format (for sensors of type IU with analog output)
MD,RTB: Echo propagation time in binary format
MD,OFF: Terminates master mode

Note 1:
In the case of binary transmissions the response bytes are, as a rule, non-printable ASCII characters, which are not output by the terminal program.
Note 2:
The relative distances enquire about the position of the object in a measuring window defined with the configuring instructions NDE and FDE or through the DIP switches. The resolution is 4095 digits.

Important!

The switching points and range limits defined using the DIP switches only take effect when DIP switch evaluation has been activated with UDS,1. The corresponding stored parameter values take effect following a UDS,0 instruction.

Results filter D for master mode:

If only **changing** measured values are to be transferred in master mode, then a results filter **D** can be added in to the instruction. As long as the measured value remains stable, no transfer of measured values is carried out.

Examples:

MD,DAD: The distance is shown in mm if the distance to the object changes.
MD,DRT: The measure for echo propagation time is the number of machine cycles. The numbers are output only if the distance changes.

ER [Echo Received]

Instruction: ER	Example: -
Parameters: -	Unit: -
Response: 0 = No echo 1 = Echo	Range: 0 / 1
Reference: OER, ODR	

The instruction BR enquires whether or not the sensor has picked up an echo. The echo propagation time, i.e. the calculated distance, is of no interest.
Response 0: No echo received, Response 1: Echo detected.

RST [sensor software ReSeT]

Instruction: RST	Example: -
Parameters: -	Unit: -
Response: (Ack.)	Range: -
Reference: -	

The sensor performs a Reset as a result of this instruction. The instruction is acknowledged (80h)

SUC [Store User Configuration]
RUC [Recall User Configuration]
DEF [DEFault Settings]

Instruction: SUC
Instruction: RUC
Instruction: DEF

The **SUC** instruction causes the sensor to **save** all the specified parameter values in the sensor.

The **RUC** instruction reads these saved values and restores them in the sensor.

The saved parameter values are not lost through the DEF instruction, nor through a reset or failure of the operating voltage. The values stored using the SUC instruction remain available until such time as they are overwritten by a new SUC instruction.

The instruction **DEF** causes the sensor to restore the factory settings for the parameters (which are stored in the sensor itself). In this process any current parameters are lost if they were not previously saved using SUC (see table of default values).

ST [**ST**atus information]

Instruction: ST	Example: -
Parameters: -	Unit: -
Response: See below	Range: -
Reference: See below	

The ST instruction requests the three “status” bytes of the sensor. The response consists of 6 tetrads, whose bits contain fault and status details. Thus, for example, when the response from the sensor is 00 08 16, bits 1, 2, 4 and 11 are set: bits FR, ER, RV, UDS.

The meanings of the individual bits are as follows:

NE	LTE	ECO	ECE	DEO	DE	SDO	SD	TSE	EEE	SB	SSY	UDS				CTI	TI	SBY	FR	SY	ER	RV	
1				2				3				4				5				6			

Explanations of the individual bits:

Error bits:

NE: [no echo] The sensor has not detected an echo signal immediately after the pulse.

LTE : [long term echo] The sensor receives an echo signal that is longer than one measurement cycle.

ECO : [echo count error occurred] This bit is set by ECE, but only reset with ST.

ECE : [echo count error] The sensor detects an error through too many multiple echoes. The bit is only valid during the current measuring cycle so the error is also flagged up by the ECO bit.

DEO : [deaden error occurred] This bit is set by DE, but only reset with ST.

DE : [deaden error] The sensor has detected a near range that is too long. The bit is only valid during the current measuring cycle so the error is also flagged up by the DEO bit.

SDO : [sensor disturbance occurred] This bit is set by DIS, but only reset with ST.

SD : [sensor disturbed]] This bit is set when the sensor is disturbed. In this case the sensor does not change the statuses of the switching outputs, or those statuses change to the fail-safe status set

TSE : [temperature sensor error] An error occurred during measurement of the ambient temperature, or the learn plug of the sensor is still in the learn position.

EEE : [EEPROM error occurred]] An error occurred when describing the EEPROM; ST is used to delete the bit.

Miscellaneous bits:

SB : [short blind range] This bit is set until a blind range selected using the BR,xxxx instruction is less than 75 % of the blind range specified in the data sheet.

SSY : [startup sychronised] The instruction SSY,1 sets the bit, which is reset by the instruction SSY,0.

UDS : [use DIP switches] This bit is set with the instruction UDS,1 and reset with UDS,0.

Program status bits:

CTI : [capable of teach] CTI indicates that the sensor is capable of teaching, i.e. the sensor detects after a reset that the temperature probe / teach plug is detached. After about 5 minutes the bit is deleted. After each teach process the 5 minutes are started anew.

TI : [sensor in teach-in mode] This bit is set during teach-in mode.

SBY : [sensor is in standby mode] As long as the sensor is in standby mode, this bit is set.

FR : [sensor free running] This bit is set when the sensor is operating in free-running mode. It is reset, on the other hand, if the sensor is operating synchronously or is in standby mode.

SY : [sensor is sychronised] This bit is set when the sensor is operating synchronously, and is reset when the sensor is operating in free-running mode or is on standby.

ER : [echo received] This bit is set when the sensor detects an echo. This is valid only for the current measurement cycle. The instruction ER interrogates the status of this bit.

RV : [result valid] This bit is set when the sensor was able to correctly determine its output data. This is valid only for the current measurement cycle. If errors occur the bit remains set to 0.

Date of issue 23.03.98

Description and Instruction Set of Sensors

UJ3000	+U1+8B	+RS
UJ3000	+U1+E22	+RS
UJ3000	+U1+IU	+RS
UJ3000	-FP-8B	+RS
UJ6000	-FP-E22	+RS
UJ6000	-FP-IU	+RS

Date of issue 23.03.98

Description and Instruction Set of UJ Sensors

1 General information on type E22 / 8B / IU sensors

All ultrasound sensors have a blind range between the sound decoupling layer and the measurement range. If an object is located within the blind range a false echo can result which corresponds to two or three times the distance to the object, i.e. the evaluation results are false.

The geometry of the decoupling layer determines the form of the sound beam, and thus the size of the measurement range. With good reflectors and in favourable conditions, ultrasonic sensors can even pick up echoes from distances greater than the measurement range. For this reason switching points can sometimes be set for the sensors up to double the distance of the nominal detection range. However, there can be no guarantee that the object will always be detected reliably.

When ultrasound sensors are provided with DIP switches, their assignment is typically as follows:
DIP switches 1 … 8 define the switching points, DIP switch 9 the switching behaviour (N/O / N/C contact) and switch 10 defines whether the sensor outputs transfer measurement values or whether they are used for communication via the serial interface.

Attention

If the sensor is connected to a serial port with DIP switch 10 set incorrectly, this may result in irreparable damage to the port. DIP 10 must be set to OFF!

As a rule, DIP switches 1 … 4 are used to set the switching points / measurement window limits closer to the sensor, and DIP switches 5 … 8 are used for those further from the sensor (see data sheet or the appendix to this document.

2 Propagation time measurement

Ultrasonic sensors ascertain the distance to an object by measuring the time delay that elapses between the sending out of an ultrasonic package and the arrival of the echo reflected by the object.
After sending the ultrasonic package (burst), the sonic transformer needs a certain length of time for the vibration to die down. An echo cannot be received during this period. Once the transformer has come to rest it can then be stimulated again by the echo, and can send out an echo signal. The time taken for the vibration to die down causes a blind range immediately in front of the sensor.

The (measurement) range of the sensor is directly dependent on the sound reflection properties of the object. Good reflectors can be detected from up to double the nominal detection range. On the other hand, an object situated close to the sensor can produce several echo signals (as the ultrasonic package passes backwards and forwards several times between the target and the sensor housing). This can lead to incorrect evaluation, for example, if the first echo falls in the blind range and only the second echo is recognised as an echo signal.
Blind range and range are functions of the energy contained in the burst: the longer the burst, the greater the range, but by the same token the time for the vibration to die down and thus the blind range of the ultrasonic transformer also increase.

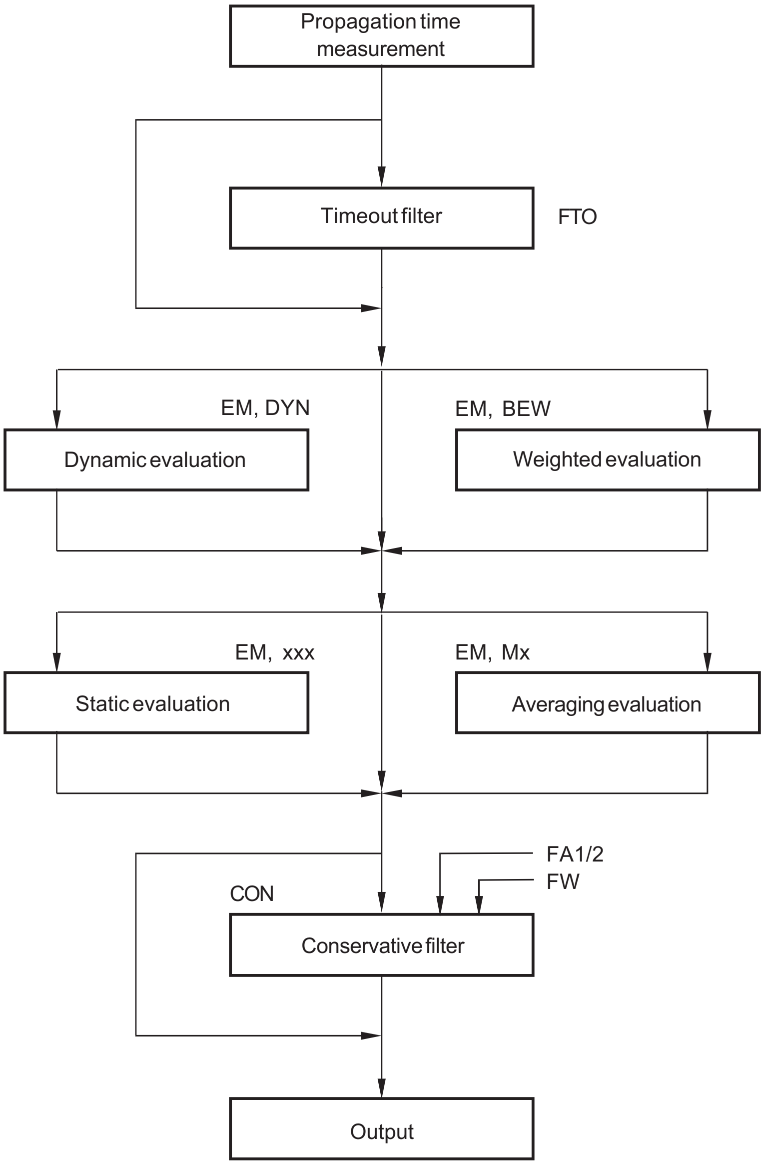
Variable burst and cycle times, parameter assignment options (CCT,CBT)
By default the sensor adapts the burst length to match the measured echo propagation time. If the propagation time measured is short, then the sensor will shorten the burst down to its minimum length, and the burst will be set to the maximum length if the sensor receives a distant echo. If the sensor is unable to detect any echo, it toggles the burst length between maximum and minimum.
Sensors with ports offer the opportunity to determine the response of the sensor externally. Thus, for example, the command **CBT** can be used to assign a fixed value to the burst length. Following this command, the burst sent out always has the same length irrespective of the echo propagation time measured.
The instruction **CCT**, on the other hand, defines the measurement cycle time / repetition rate of the sensor. It is possible here to choose between a constant and a variable measurement cycle time. With the constant option, the sensor does not adjust the length of the measurement cycle according to the current echo propagation time. An additional, random wait time can be added to the constant measurement cycle in order to reduce any reciprocal effect that adjacent sensors may have on one another.
The evaluation is performed between measurement of the echo propagation time and the output corresponding to the sensor type (switching output / analog output).

3 Evaluation of the measured echo propagation times, parameter assignment options (EM,...)

Propagation time measurement produces an echo propagation time corresponding to the distance of the object. Disturbances can occur, caused for example by electromagnetic influences, interference noise, multiple echoes or echoes from other ultrasonic sensors.
Various filtering and evaluation methods are employed to improve the degree of disturbance immunity:

- Timeout filter **(FTO)**
- Dynamic evaluation / weighting evaluation **(EM,DYN / EM,BEW)**
- Static evaluation / averaging evaluation **(EM,xxx / EM,Mx)**
- Conservatives filter **(CON)**

(see page 43)



How the evaluation is performed can be regulated via the serial interface: each stage can be activated or deactivated using a parameter. When one of the alternative methods is selected, the others are deactivated.

3.1 Timeout-Filter, Masking out measurements without echo (FTO)

If an echo is received, the sensor stores the measured propagation time. If a measurement occurs **without** an echo, the stored value can be inserted as the echo propagation time. The number of substitutions is specified in the FTO instruction.
In the case of a parameter of 3, for example, in the event of three consecutive incorrect measurements, the propagation time is replaced by the last propagation time measured. If a fourth incorrect measurement follows, the value for the maximum distance is inserted.
This filter stage is deactivated by FTO,0.

3.2 Dynamic or weighted evaluation

3.2.1 Dynamic evaluation (EM, DYN)

The current echo propagation time is compared against the last measurement. If both times are the same within certain limits, the new time replaces the old one. The difference in the two times is stored as a trend indicator.
If, however, both times vary greatly, then the time is replaced once by an interpolated value calculated from the last measured value and the stored difference. If there is a second strong deviation the new measured value is then accepted. Faulty individual measurements can be suppressed in this way.
Dynamic evaluation can only be activated or deactivated.

3.2.2 Weighted evaluation (EM,BEW)

The current measured echo propagation delay is compared to see if it is the same as the three previous times (within a tolerance). If the newly-measured time agrees approximately with one of the previous times, then this time is accepted (two out of the four measured values are identical!).

If this is not the case, the three previous propagation times are compared: if they approximately agree, the propagation time is replaced by its average value.

If only two of these three times agree, then the time is replaced by the average value of these two times.

However, if all four times differ completely, the newly-measured time is accepted (as no better decision is possible).

The weighting evaluation can only be activated or deactivated.

3.3 Static or averaging evaluation

3.3.1 Static evaluation (EM,xxx)

A specified number of times is added up and the highest and lowest measured values are stripped out. The average value of the remaining measured values is then accepted as the valid propagation time. The number of the propagation times to be added is specified in the EM command as a parameter (EM,xxx / xxx = 3 ... 255).

Note : The measurement result is not output until the number of the propagation times to be added has been attained. Large values of xxx result in very long sensor response times.
With EM,3, the highest and lowest propagation times are suppressed. Thus only one more propagation time determines the measurement result.

3.3.2 Averaging evaluation (EM,Mx)

The last 2, 3 or 4 measured propagation times are averaged and become the new current time. No check is made for widely deviating measured values. The number of propagation times to be averaged is specified as a parameter (EM,Mx / x = 2 ... 4).

3.4 Conservatives filter (CON)

The fourth and final stage in the evaluation is performed with the conservative filter. The filter determines how many times a valid measurement result must be present before the corresponding output switches. The threshold for the conservative filter is specified by the instruction CON,xxx.
If xxx < 10, the filter is highly conservative, i.e. the propagation time must produce the corresponding measurement result in unbroken sequence, otherwise the corresponding counter is reset to zero.
If xxx $\geq$ 10, The filter has an integrally sliding function, i.e. the counter is incremented if the propagation time produces the measurement result, and decremented if not. If the counter reaches the threshold set by xxx, the output switches. If the counter reaches zero, it switches back.
With CON,0 the conservative filter is deactivated.

Note:
In details provided elsewhere on the conservative filter, different terms are sometimes used, but they still describe the same algorithm:
Conservative: also "strictly conservative", sliding: also "integrating.

4 Output of the results

4.1 Sensors of type E22

Sensors of type E22 have two independent switching outputs, which are also used as data lines for the RS 232 serial interface. With DIP switch 10 = ON, the lines operate as switching outputs, and with DIP 10 = OFF for the interface.
DIP switches 1 ... 8 are used to specify the switching points for both outputs (see appendix), DIP switch 9 determines their switching function as N/O contact (ON) or N/C contact (OFF). The function of the DIP switches can also be deactivated via the serial interface (instruction UDS,0): the values produced by the switches are not then used, but the parameters sent via the interface (or the default values).

4.2 Sensors of type 8B

Sensors of type 8B have an 8 bit data output, an fault output, a test input and a serial interface. The 8 bit outputs and the fault output are switching outputs.

UJ3000+U1+8B+RS:
Detection range: 300 mm ... 3000 mm.
The default value for the resolution in the axial direction is 11 mm (1 LSB). For distances $\leq$ 300 mm, 0000 0001 is transmitted; the bit string 1111 1110 then corresponds to a distance of 3083 mm (at a sound velocity of 344 m/s).

UJ6000-FP-8B+RS:
Detection range: 800 mm ... 6000 mm.
In the basic setting, the resolution in the axial direction is 21 mm (1 LSB). For distances $\leq$ 800 mm, 0000 0001 is transmitted; the bit string 1111 1110 then corresponds to a distance of 6113 mm (at a sound velocity of 344 m/s).

4.2.1 Data output format (ODF)

The measurement result can be output either as an 8 bit value or in binary coded decimal (BCD). The bits are then transmitted multiplexed.

4.2.1.1 8 bit output

The evaluation range defined by NDE and FDE is divided by the 8 bit resolution into 254 units.
NDE < FDE: this relative distance data produces binary coded (8 bit value) values of 1 ... 254 in the evaluation range corresponding to the distance measured. Measurement results outside the measurement window are characterised as follows:
Measurement result < NDE: output 0000 0001 (01h),

Measurement result > FDE: output 1111 1110 (FEh).
The bit combinations 00h and FFh are not used.

NDE > FDE: NDE and FDE are reversed before the calculation and the output value inverted before being output.

4.2.1.2 BCD coded:

With this output, the BCD coded digits are communicated on data lines 0 ... 3, and the weighting of the digits on data lines 4 ... 6.
The least significant position corresponds to a 1. The most significant bit is not used.
All data lines revert to zero following an output (see diagram).
Example: output of a value of 157.

	0001	0111	corresponds to 7
	0010	0101	corresponds to 5
	0100	0001	corresponds to 1
Bit	7....4	3....0	**Total 157**

4.2.2 Test port

Test port E1 (grey/pink) is used to check the function of the switching outputs. If the operating voltage $+U_B$ is applied to the test port for longer than 1 ms, all outputs (8 bit outputs and the fault output) are disconnected and reconnected for 200 ms. The switching of the outputs between 0000 0000 and 1111 1111 carries on for as long as the positive voltage is applied.

4.3 Sensors of type IU

Sensors of type IU each have an analog output and a switching output. Both outputs operate with DIP 10 = ON as data outputs and at DIP 10 = OFF (RS 232) for the serial interface.
DIP switches 1 ... 8 are used to set the evaluation limits (see appendix), DIP 9 defines the switch function as a N/O contact (ON) or N/C contact (OFF). The switching point lies at the centre of the evaluation range that was set using the DIP switches.
The operation of the DIP switches can also be deactivated via the serial interface using the UDS command: The parameters sent (or the default values) for the evaluation limits, switching point or switching function apply. When setting the parameters via the interface, the switching point can be set independently of the evaluation limits.

Current / voltage output

Depending on the load, the analog output switches between current output and voltage output. With a load resistance R_L < 500 Ohm, the analog output supplies output currents of 4 to 20 mA, depending on the distance determined. With a load resistance R_L > 1 kOhm, the analog output supplies output voltages of 2 V to 10 V, depending on the distance.

All sensor instructions at a glance

Instr.	Meaning	Type	Parameter Response/Ack.	Sensors	Page
VS	**V**elocity of **S**ound	read	Sound vel. in [cm/s]	all	52
SD1	**S**witching **D**istance **1**	read/set	near switching distance [mm]	E22, IU	51
SD2	**S**witching **D**istance **2**	read/set	far switching distance [mm]	E22	51
SH1	**S**witching **H**ysteresis **1**	read/set	switching hysteresis [%]	E22, IU	52
SH2	**S**witching **H**ysteresis **2**	read/set	switching hysteresis [%]	E22	52
NDE	**N**ear **D**istance of **E**valuation	read/set	near distance [mm]	8B, IU	48
FDE	**F**ar **D**istance of **E**valuation	read/set	far distance [mm]	8B, IU	48
BDE	**B**oth **D**istances of **E**valuation	set	Eval. limits in [mm]	8B, IU	48
REF	**REF**erence measurement	adjust	Reference distance in [mm]	all	52
UDS	**U**se **D**ip **S**witches	read/set	0/1 for inactive/active DIP	E22, IU	53
FTO	**F**ilter **T**ime **O**ut	read/set	Filter yes/no, filter depth	all	49
EM	**E**valuation **M**ethod	read/set	Eval. method. encoded	all	49
CON	**CON**servative filter	read/set	Filter type encoded, counter	all	50
FA1	**F**ilter **A**ctive for Output **1**	read/set	Output filter inactive/active	all	51
FA2	**F**ilter **A**ctive for Output **2**	read/set	Output filter inactive/active	all	51
FW	**F**ilter **W**indow	read/set	Filter width in [%]	8B	51
OM	**O**utput **M**ode	read/set	N/O / N/C response	all	53
ODF	**O**utput **D**ata **F**ormat	read/set	Data format	8B	54
MD	**M**aster **D**evice	read/set	Master/Slave mode	all	53
CCT	**C**onstant **C**ycle **T**ime	read/set	Repetition rate fix./dynam.	all	49
CBT	**C**onstant **B**urst **T**ime	read/set	Burst length in [µs]	all	49
RT	**R**andom **T**ime	read/set	With/without pause	all	52
DIP	Read **DIP** Switches	read	DIP switch setting	E22, IU	52
AD	**A**bsolute **D**istance	read	Distance in [mm]	all	48
RD	**R**elative **D**istance	read	Relative Distance	8B, IU	48
SS1	**S**witching **S**tate **1**	read	Switch.out. 0/1	E22, IU	49
SS2	**S**witching **S**tate **2**	read	Switch.out. 0/1	E22	49
OER	**O**bject in **E**valuation **R**ange	read	Object in eval.rng.	all	54
ODR	**O**bject in **D**etection **R**ange	read	Object in detect.	all	54
ER	**E**cho **R**eceived	read	Echo no/yes	all	54
VER	Sensor **VER**sion	read	Version code	all	51
ID	Sensor **ID**entification	read	Type, version	all	51
DAT	Software **DAT**e and Version	read	Date, time	all	51
RST	Sensor Software **R**e**S**e**T**	instruction	Reset ack.	all	54
DEF	**DEF**ault Settings	instruction		all	54

This table provides a quick overview of the sensor instructions, their inputs and the anticipated response/acknowledgement of the sensor.
The page numbers specified help locate the instruction in the sensor's instruction set.

The table overleaf shows the parameter default values.

Sensor default values

Parameter	UJ3000+E22	UJ3000+8B	UJ3000+IU	UJ6000-E22	UJ6000-8B	UJ6000-IU
VS	34400	34400	34400	34400	34400	34400
SD1	300		1650	800		3400
SD2	3000			6000		
NDE		300	300		800	800
FDE		3083	3000		6113	6000
SH1	10		10	10		10
SH2	10			10		
UDS	1		1	1		1
FTO	3	3	3	3	3	3
EM	OFF / 4	OFF / 4	OFF / 4	OFF / 4	OFF / 4	OFF / 4
CON	4	0	0	4	0	0
FA1	1	0	0	1	0	0
FA2	1	0	0	1	0	0
FW		10	10		10	10
OM	3	3	3	3	3	3
ODF		8B			8B	
MD	OFF	OFF	OFF	OFF	OFF	OFF
CCT	1	1	1	1	1	1
CBT	0	0	0	0	0	0
RT	0	0	0	0	0	0

Date of issue 23.03.98

Instruction set

Some instructions use parameter values that are set using the DIP switches (switching points, limits of evaluation window, etc.).
*Interrogating the UDS flag before issuing these instructions determines whether the DIP switch settings are to be used or not. If the UDS flag is set to zero, the DIP switch settings are **not** used. Instead, other parameter values that were specified and stored previously are used. The response of the sensor will differ accordingly.*
If UDS has a value of 1, the DIP switch settings are used.
Instructions: RD, NDE/FDE, BDE, SS1/SS2, SD1/SD2, SH1/SH2, OM, MD, OER.

Attention

AD [**A**bsolute **D**istance]

Instruction: AD	Example: -
Parameters: -	Unit: -
Response: Distance	Range: -
Reference: Master mode	

The AD instruction requests the calculated absolute distance.

The sensor returns the measured value as a 5-digit value in [mm], sometimes even when it lies outside the evaluation range. However, operation in the blind range is not permitted. No guarantee can be given that the system will function properly in the area outside the evaluation range.

The response returned if no echo was received: maximum value (2 x evaluation range + 1).
Response in the case of faults: Error code E.

RD [**R**elative **D**istance]

Instruction: RD	Example: -
Parameters: -	Unit: digits
Response: 3 figures	Range: 0 ... 254
Reference: AD, NDE, FDE, BDE	

Sensors of type 8B or IU are requested to return the relative distance [digit].
In other words, the position of an object within a range defined by NDE and FDE (or via DIP switches) for the output of the analog value is calculated. The 8 bit D/A converter provides a resolution of 254 digits. The sensor responds accordingly to the window limit nearest the sensor with 0 and to the one furthest away with 254. A value between 0 and 254 corresponds to each intermediate position.
Note:
Echoes from distances < NDE: response 001.
Echoes from distances > FDE: response 254.
Important!
The instruction UDS determines whether the limits are defined through the DIP switch settings or parameter values. If a UDS value of 1 is specified, the switch settings are used.

NDE [**N**ear **D**istance of **E**valuation]
FDE [**F**ar **D**istance of **E**valuation]

Instruction: NDE / FDE,xxxxx	Example: NDE / NDE,500
Parameters: Distance	Unit: mm
Response: Window limit	Range: Blind zone ... 2 x detection range
Reference: BDE, UDS	

NDE / FDE (no parameters) requests the measuring window limits nearest/furthest from the sensor of the analog value output of sensors of type 8B and IU.

The instruction **NDE**,xxxxx specifies the evaluation limit **nearest to the sensor**, the instruction **FDE**,xxxxx the one **furthest from the sensor**.

Note 1:
If the selected window limits are too close and therefore clip the 8 bit resolution, the sensor rejects this value with 81h <invalid parameter>.
Note 2:
NDE < FDE: positive output ramp.
NDE > FDE: negative output ramp.
Note 3:
Under ideal conditions, the sensor can also pick up echoes from distances greater than the evaluation range; the sensor therefore accepts parameters of up to double the nominal evaluation range.

Range:	UJ 3000	300 ... 6000 mm
	UJ 6000	800 ... 1200 mm

Important!
The instruction UDS determines whether the limits are defined through the DIP switch settings or parameter values. If a UDS value of 1 is specified, the switch settings are used, i.e. the parameters will be ignored for the time being and stored in the sensor. UDS,0 activates this "default setting".

BDE [**B**oth **D**istances of **E**valuation]

Instruction: BDE,xxxx,yyyy	Example: BDE,400,2000
Parameters: Distance	Unit: mm
Response: Window limits 2 x detection range	Range: Blind zone ...
Reference: EM, NDE, FDE	

Simultaneous setting of the evaluation limits nearest to (xxxx) and furthest from (yyyy) the sensor for sensors of type 8B and IU. The values are entered in millimetres, 4-digit and separated by commas. The valid values correspond to NDE and FDE.

Range:	UJ3000	300 ... 6000 mm
	UJ6000	800 ... 1200 mm

Evaluation limits not interrogated with BDE!

Note 1:
If the selected window limits are too close to each other and therefore clip the 8 bit resolution, the sensor rejects this value with 81h <invalid parameter>.
Note 2:
NDE < FDE: positive output ramp.
NDE > FDE: negative output ramp.

Note 3:
Under ideal conditions, the sensor can also pick up echoes from distances greater than the evaluation range; the sensor therefore accepts parameters of up to double the nominal evaluation range.

Important!
The instruction UDS determines whether the evaluation limits are defined through the DIP switch settings or parameter values. If a UDS value of 1 is specified, the switch settings are used, i.e. the parameters will be ignored for the time being and stored in the sensor. UDS,0 activates this "default setting".

SS1 [**S**witching **S**tate **1**]
SS2 [**S**witching **S**tate **2**]

Instruction: SS1 / SS2	Example: SS1
Parameters: -	Unit: -
Response: 0 = not active 1 = active output	Range: -
Reference: UDS, SD1, SD2, SH1, SH2, UDS	

The instructions SS1 / SS2 interrogate the logical status of the switching outputs.
SS1 interrogates switching output 1, SS2 switching output 2.

A response of 0 means that the object is further away than the switching point.
A response of 1 means that the object is closer than the switching point.
No account is taken of any N/C or N/O function.

Important!
The instruction UDS determines whether the limits are defined through the DIP switch settings or parameter values. If a UDS value of 1 is specified, the switch settings are used; UDS,0 means the parameters will be used.

CBT [**C**onstant **B**urst **T**ime]

Instruction: CBT / CBT,xxxx	Example: CBT,55
Parameter: Burst length	Unit: µs
Response: see below	Range: see below
Reference: Delay measurement, cycle time, CCT	

The instruction CBT enquires whether evaluation is to be performed using a constant or a variable burst length.

Response 0000: the sensor dynamically adjusts the burst length to the echo propagation time.
Response xxxx: the burst has a constant length of xxxx [µs].

The instruction CBT,xxxx defines a constant burst with a length of xxxx [µs] and simultaneously deactivates the dynamic adjustment.

Range: UJ 3000 20 .... 500 µs
UJ 6000 50 ... 1000 µs

CCT [**C**onstant **C**ycle **T**ime]

Instruction: CCT / CCT,xxx	Example: CCT,1
Parameters: measuring cycle	Unit: pause length in [ms]
Response: see below	Range: 0 (dynamic) / 1 to 100 (constant meas. cycle)
Reference: measurement of propagation time, RT, CBT	

The instruction CCT asks whether the sensor adjusts its measuring cycles to the echo it detects or uses constant cycles.
Response 000: the sensor adjusts the repetition rate according to the echo propagation times currently being measured. The evaluation interrupts the cycle if no further echo is received within 2.5 times the time since the last echo.
Response 1 ... 100: evaluation is carried out using constant measuring cycles irrespective of the propagation times. Pauses are inserted between the measuring cycles. The length of the pauses is specified as a value of between 1 and 100 [ms].

The instruction CCT,0 specifies that the evaluation will be carried out using dynamic measuring cycles.
The instruction CCT,xxx specifies that the evaluation will be carried out using constant measuring cycles, between which pauses of between 1 and 100 [ms] are inserted.
The pauses increase the response times of the sensor.
Range: Pause length 1 ... 100 [ms]

FTO [**F**ilter **T**ime **O**ut]

Instruction: FTO / FTO,xxx	Example: FTO,3
Parameters: Depth of filter	Unit: Counter
Response: Present filter	Range: 0 ... 255
Reference: Evaluation EM, CON, OM	

Filter between measurement of echo propagation time and evaluation:

The instruction FTO requests the present filter depth for measuring cycles **with no echo**.

The instruction FTO,xxx tells the sensor software how many measuring cycles **without** an echo to ignore. These measuring cycles will not be evaluated as long as an internal counter has a value less than that specified in FTO. The resulting maximum value for the propagation time is not evaluated until the number of measurements (without an echo) exceeds this value (1 ... 255).

The instruction FTO,0 deactivates the filter.

Note:
This filter ensures a stable output signal, for example, in the case of objects with weak reflections (when an echo is not always received) or in the case of fluid in motion (if the ultrasonic cone is deflected to one side by surface movement).

EM [**E**valuation **M**ethod]

Instruction: EM / EM, DYN/BEW/xxx/Mx	Example: EM,M3
Parameter: see below	Unit: encoded or counter
Response: see below	Range: see below
Reference: measurement of propagation time, FTO, CON	

The instruction determines the evaluation method for the sensor. The corresponding code is appended to the instruction, separated by a comma:

Queries:
EM Asks which evaluation method is currently set.

Example of responses:

OFF,000	no evaluation method activated
DYN,M3	dynamic and averaging evaluation, 3 measured values are averaged
BEW,016	weighted and static evaluation, 16 measured values are added together

Settings:

EM,DYN	**dynamic** evaluation	or
EM,BEW	**weighted** evaluation	
EM,xxx	**static** evaluation	or
EM,Mx	**averaging** evaluation	

The evaluation algorithm treats dynamic and weighted evaluation as mutually exclusive, similarly static and averaging evaluation. Each evaluation that is activated (e.g. dynamic) deactivates its alternative (e.g. weighted).

The instruction **EM,DYN1** activates **dynamic** evaluation, the instruction EM,DYN0 deactivates it.

Dynamic evaluation: the current echo propagation time is compared against the previous one. If they are identical within certain limits, the new propagation time replaces the old one. The difference between the two delays is saved as an trend indicator.
If both delays differ significantly, then the propagation time is replaced once by an interpolated value calculated from the last measured value and the stored difference. If there is a second strong deviation the new measured value is then accepted. Erroneous individual measurements can be suppressed in this way.

The instruction **EM,BEW1** activates **weighted** evaluation,

the instruction EM,BEW0 deactivates it.

Weighted evaluation: : The current echo propagation time is compared to see if it the same as the three previous ones (within a certain limit). If the newly-measured time agrees approximately with one of the previous ones, then this time is accepted (two out of the four values are identical!).

If this is not the case, the three previous delays are compared with one another: if they are approximately equal, the propagation time is replaced by the average of these three values.

If only two of these three times agree, then the time is replaced by the average value of these two values.

However, if all four values differ completely, the newly-measured time is accepted (as no better decision is possible).

The instruction **EM,xxx** activates **static** evaluation (xxx = 0/3 ... 255),
the instruction EM,0 deactivates it.

Static evaluation: A specified number of delays is added up and the highest and lowest measured value in these is stripped out. The average value of the remaining measured values then becomes the current time. The number of times to be added up is entered as a parameter in the EM instruction (EM, xxx / xxx = 3 ... 255).

Note:
The result of a measurement is not output until all the times have been added up. Large values of xxx result in very long sensor response times.
In the case of EM,3, the longest and shortest time is stripped out. In this case the result is determined from just one time.

The instruction **EM,Mx** activates **averaging** evaluation (x = 0/2, 3, 4)
The instruction EM,M0 deactivates averaging evaluation.

Averaging evaluation: The last 2, 3 or 4 measured propagation times are averaged and become the new current time. No check is made for widely deviating measured values. The number of times to be averaged is specified in the parameter (EM,Mx / x = 2 ... 4).

Parameters may be **combined**, for example:
EM, DYN1, M3.

CON [CONservative Filter]

Instruction: CON / CON,xxx	Example: CON,5
Param.: Type of filter, count.	Unit: -
Response: Current filter	Range: 0 ... 255
Reference: Evaluation EM, FA1/2, FW	

Filter between evaluation and output:

The instruction CON requests the currently selected type of filter or depth of filter (xxx).
Response xxx < 10: the filter is acting as a conservative filter,
Response xxx ≥ 10: the filter is acting as a sliding filter.

The instruction CON, xxx determines the type of filter and the threshold value for the output filter:
for values < 10 the filter is acting as a conservative filter,
for values ≥ 10 the filter is acting as a sliding filter.

The instruction CON,0 deactivates the filter.

Conservative output filter: At least x (1 to 9) consecutive measuring results need to be closer to the selected switching point before the output switches. If a single measured value is beyond the switching point, the counter is reset and x consecutive measurements need to be closer to the switching point again for the output to switch. The counting conditions apply for the switching back of the output.
Sliding output filter: An up-down counter increments when the measuring result is closer than the switching point and it decrements in the case of values that are equal to or beyond the switching point. If the counter equals the value xxx (10 to 255), the output is switched. The counter switches back if it reaches the value of zero.

Range:	1 ... 9	Conservative filter
	10 ... 255	Sliding filter

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Note:
In other parts of this documentation, other terms are used to describe the conservative filter, although they refer to the same algorithm:
Conservative: also "strictly conservative", sliding: also "integrating"

FA1 [**F**ilter **A**ctivate **1**]
FA2 [**F**ilter **A**ctivate **2**]

Instruction: FA1 / FA1,x	Example: FA1,0
Parameters: Filter active / inactive	Unit: -
Response: Current filter	Range: 0,1
Reference: Evaluation EM, CON, FW	

The instructions FA1/2,x can be used to activate or deactivate the filter for the individual outputs of the sensor identified by CON.

The instruction FA1 enquires whether or not the CON filter is active for output 1 (the 8B outputs in the case of type 8BB / analog output in the case of type IU).
The instruction FA2 enquires whether or not the CON filter is active for output 2 (switching output A1 in the case of Typ IU).

Response 0: CON filter not active, Response 1: CON filter active.

The instruction FA1, 1 or FA2, 1 activates the output filter, the instruction FA1, 0 or FA2, 0 deactivates the output filter for the **individual** output 1/2.

For sensors of different types, the instructions refer to:

	E22	8B	IU
FA1	A1	8B	IU
FA2	A2	-	A1

FW	-	8B	IU

FW [**F**ilter **W**indow]

Instruction: FW / FW,xx	Example: FW,1 0
Parameter: Window width	Unit: %
Response: Window width.	Range: 5 ... 25
Reference: Filter CON, FA1	

In the case of sensors of type 8B and IU, the instruction FW defines an evaluation window around the measured value for the conservative filter. The window width is set as a percentage of the measured value (5 to 25 %).

Sudden changes to the measured value that push the value beyond the window limits are processed by the CON filter. How many times such measured values have to lie outside the window before they affect the result, is specified using the CON instruction.

The instruction FW requests the size of the window.

The response xx provides the current width as a percentage of the measured value.

The instruction FW,xx sets the width of the window as a percentage of the measured value.

Range: 5 ... 25 % Default value: 10 %

DAT [Software **DAT**e]

Instruction: DAT	Example: -
Parameters: -	Unit: -
Response: See below	Range: -
Reference: ID, VER	

The instruction requests the date of the sensor software:
The response of the sensor to DAT is, for example:
Date: 10/14/94 Time: 08:27:10

ID [Sensor **ID**entification and version]

Instruction: ID	Example: -
Parameters: -	Unit: -
Response: See below	Range: -
Reference: VER, DAT	

The sensor is requested to return its identification and may respond, for example, with:
Sensor: P&F UJ6000+FP+E22+RS Eprom: 18-01U3

VER [Sensor **VER**sion]

Instruction: VER	Example: -
Parameters: -	Unit: -
Response: See below	Range: -
Reference: DAT, ID	

The sensor is requested to return a code providing information on the sensor type.
It returns four coded characters indicating the sensor type:
- the **first two** characters indicate the **detection range**:

  05 : 500 mm
  02 : 2000 mm
  03 : 3000 mm
  04 : 4000 mm
  06 : 6000 mm
- the **third** character indicates the **sensor type**:
  0 : undefined
  1 : UJ3000+U1+8B-RS / UJ6000-FP-8B-RS
  2 : UJ3000+U1+E22+RS / UJ6000-FP- E22+RS
  3 : UJ3000+U1+IU+RS / UJ6000-FP- IU+RS
  4 : UJ3000+U1+RS / UJ6000-FP+RS
  5 : UC3000+U1+E6/E7+R2 / UC6000-FP-E6/E7+R2
  6 : UC3000+U1+IU+E0/E2+R2 / UC6000-FP- IU-E0/E2+R2
  7 : UC....-30GM-E6/E7-V15-R2
  8..F undefined
- the **fourth** character indicates the **software version** (e.g. C).

SD1 [**S**witching **D**istance **1**]
SD2 [**S**witching **D**istance **2**]

Instruction: SD1 / SD2,xxxxx	Example: SD1,1200
Parameters: Switching value	Unit: mm
Response: See below	Range: see below
Reference: UDS, SH1, SH2	

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The instructions SD1 / SD2 (**no parameters)** request the current switching points.
The response is dependent on whether or not the DIP switches are active:
UDS,1 = DIP switches are active: Responds showing the current switching points.
UDS,0 = DIP switches are not active: Responds with values from previous SD1 / SD2,xxxxx instructions.

Instructions **with parameters** define the switching points of the sensor. Valid values lie between the blind range and double the evaluation range. The parameters are entered as 5-digits in [mm] and are separated from the instruction by a comma.

Range:	Sensors UJ3000	300 ... 6000
	Sensors UJ6000	800 ... 12000

The instruction SD**1**, xxxxx determines the **first** (close to sensor) switching point for all modes of operation,
the instruction SD**2**,xxxxx the **second** (distant from sensor) switching point (not in the case of IU type sensors).

Important!
If the **DIP switches** are **activated** (UDS,1), the switching points in the DIP switches have priority. The entered value is stored and becomes available once the DIP switches are deactivated (UDS,0).

SH1 [**S**witching **H**ysteresis **1**]
SH2 [**S**witching **H**ysteresis **2**]

Instruction: SH1,xx / SH2,xx	Example: SH1,12
Parameters: Range.	Unit: %
Response: 0....15	Range: 0....15
Reference: UDS, SD1, SD2	

The instructions SH1 / SH2 request information on how large the current switching hystereses for the switching points on outputs 1 / 2 are.

The instruction SH1,xx defines the switching hysteresis for switching output 1: the value is in the range 0 to 15 % of the switching distance.
The instruction SH2,xx defines the switching hysteresis for switching output 2 (in the case of sensors of type E22).

Important!
The hysteresis remains at 10 % as long as the DIP switches are active (UDS,1). The value specified using SH, xx only becomes effective following a UDS,0 instruction.

DIP [read **DIP** switches]

Instruction: DIP	Example: DIP
Parameters: -	Unit: -
Response: 3 hex. chars.	Range: 0....9, A.....F
Reference: -	

Interrogate DIP switch settings.
The sensor returns three hexadecimal characters indicating the switch settings:
Bit value 0 = switch OFF, Bit value 1= switch ON.

First character: hexadecimal value of the first four DIP switches,
Second character: hexadecimal value of the second group of four DIP switches,
Third character: setting of the ninth DIP switch.

Example 1: a response from the sensor of B91h indicates a switch setting of 1011 1001 1.
Example 2: a response of 111 h indicates that only DIP switches 4, 8 and 9 are on.

VS [**V**elocity of **S**ound]

Instruction: VS / VS,xxxxx	Example : VS,34000
Parameters: Sound velocity	Unit: 0.01 m/s = cm/s
Response: Sound velocity	Range: -
Reference: VS0, TO, Evaluation, Temperature measurement	

The instruction VS requests the current value for the sound velocity that will be used to calculate the distance from the echo propagation time. The response is a 5-digit number in units of [0.01 m/s = cm/s]. For example, a response of 34400 represents a velocity of 344.0 m/s.

VS,xxxxx passes a new sound velocity value to the sensor in [cm/s].
This new value is stored and **has a significant effect on the calculation of the distance**.

REF [**REF**erence Distance]

Instruction: REF,xxxxx	Example: REF,5000
Parameters: Ref. distance	Unit: mm
Response: None	Range: -
Reference: Evaluation, Temperature comp., VS0, TEM, TO	

A target must be located at a precisely measured distance within the evaluation range of the sensor. This reference value is passed to the sensor as a value in [mm] using the instruction REF,xxxxx. The sensor calculates a new sound velocity from this value and the calculated echo propagation time and saves it as a new reference value.

This parameter **cannot be interrogated**.
If the parameter is missing, the sensor responds with 82h.

RT [**R**andom**T**ime]

Instruction: RT / RT,x	Example: RT,0
Parameters: Pause 0 / 1	Unit: coded
Response: Current value (0 or 1)	Range: 0 = none 1 = with pause
Reference: CCT, CBT	

The instruction RT asks the sensor whether or not it is using random length pauses between two time measurements:
Response 0: no pauses, Response 1: with random length pauses.

The instruction RT,0 prevents the pause,
The instruction RT,1 specifies that pauses of random length are to be inserted between the time measurements.

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Important!
This instruction has a completely different impact in the case of UC sensors.

UDS [Use Dip Switches]

Instruction: UDS / UDS,x	Example: UDS,1 / UDS,0	
Parameters: 0, 1	Unit: -	
Response: See below	Range:	0 = not active 1 = active
Reference: Evaluation, SD1, SD2, SH1/2, OM		

The instruction UDS asks whether the software is currently using the DIP switch settings or the stored parameter values.

Instruction UDS,0: the DIP switches are not active,
Instruction UDS,1: DIP switch settings will be evaluated.

Attention

In the case of sensors that use the DIP switches to determine switching hysteresis, switching function (N/C / N/O) or evaluation limits in addition to the switching distance, UDS,0 does not apply to the DIP switch settings, but to the values or functions entered and saved via the interface.

OM [Output Mode]

Instruction: OM / OM,xx	Example: OM,23	
Parameter: -	Unit: -	
Response: See below	Range:	2 = N/O 3 = N/C
Reference: UDS, SS1, SS2		

The instruction OM asks how the outputs are currently configured (N/C / N/O).

Response 2: functions as N/O contact,
Response 3: functions as N/C contact.

The instruction OM,xx determines how the outputs are to be configured:
The **first** of the two characters following the instruction code refers to **switching output 1**,
the **second** to **switching output 2** (in the case of sensors of type E22).

Parameter value **2**: output functions as **N/O contact**.
Parameter value **3**: output functions as **N/C contract**.

The number of switching outputs present determines whether the instruction takes one or two parameters.

Sensors of type 8B and IU: The alarm output on type 8B and the switching output on type IU sensors are configured as N/O contacts with the instruction OM,2 and as N/C contacts (pnp) with OM,3.

Sensors of type E22: Following an OM,23 instruction, output 1, for example, will function as a N/O contact but output 2 as a N/C contact (pnp).

Important!
The switch settings will take precedence as long as the DIP switches are active. The parameters passed with the OM,xx instruction are saved and only take effect following a UDS,0 instruction.

MD [Master Device]

Instruction: MD / MD, AD...OFF	Example: MD,DAD
Parameter: Data	Unit: Coded
Response: See below	Range: See below
Reference: AD, RD, RT, SSx, ADB, RDB, RTB, UDS	

The instruction MD, ... is used to set the mode of operation of the sensor: master or slave mode.
A sensor normally operates in slave mode.

Slave mode: The sensor generally only responds to instructions. If a periodic distance enquiry is required, the sensor must be sent an AD instruction from time to time.
Master mode: When each measurement is complete, the sensor automatically forwards the result to the serial interface.

The instructions MD,AD ... MD, OR put the sensor into master mode; the associated parameter (after the comma) determines how the data will be transmitted.

The conditions associated with data transmission are identical to those for the instructions AD and RD.

MD,AD: [Absolute Distance] absolute distance in mm, 5-digit in ASCII format

MD,RD: [Relative Distance] relative distance in digits (8 bit) in ASCII format (for sensors of type IU and 8B with analog value output)

MD,SS: [Switching States] logical status of the switching outputs
sensors of type E22: two figures (first for output 1/ second for output 2)
sensors of type IU: one figure for the switching output
sensors of type 8B: no parameter.
Figure = 0: output not switched, Figure = 1: output switched

MD,OR: [Object in Range] a two-digit figure provides information about the detection of an object:
first figure: object in evaluation range (0 / 1 corresponds to no / yes)
second figure: object within evaluation range (0 / 1 corresponds to no / yes)
(Evaluation range: area between evaluation limits in the case of types 8B and IU or between switching points in the case of type E22)

MD,OFF terminates master mode

Note 1:
In the case of binary transmissions the response bytes are, as a rule, non-printable ASCII characters, which are not output by the terminal program.
Note 2:
The relative distances enquire about the position of the object in a measuring window defined with the configuring instructions NDE and FDE or through the DIP switches. The resolution is 254 digits.

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Important!
The switching points and range limits defined using the DIP switches only take effect when DIP switch evaluation has been activated with UDS,1. The corresponding stored parameter values take effect following a UDS,0 instruction.

ODF [**O**utput **D**ata **F**ormat]

Instruction: ODF, 8B/ BCD	Example: ODF,BCD
Parameters: 8B, BCD	Unit: Binary coded, cm
Response: Distance, coded	Range: -
Reference: NDE, FDE, evaluation	

This instruction and its parameter (8B or BCD) determines the data format of the transmission for sensors with an **8 bit output**:

ODF,8B: the relative object distance is output in parallel with a resolution of 8 bits.
NDE < FDE: Bit string 0000 0001 <01h>, if object distance ≤ NDE,
Bit string 1111 1110 <FEh>, if object distance ≥ FDE.
NDE > FDE: Bit string 0000 0001 <01h>, if object distance ≥ NDE,.
Bit string 1111 1110 <FEh>, if object distance ≤ FDE.
The bit strings 0000 0000 <00h> and 1111 1111 <FFh> are **not used**.
The bit string that is output remains on the output until it is next updated.

ODF,BCD: (binary coded decimal) the absolute distance to the object is multiplexed and output as a three figure decimal number to a resolution of 1 cm. The sensor forwards the figure in BCD format on data lines 0 to 3 followed by the weighting of the figures on data lines 4 to 6. The least significant position corresponds to a 1. The most significant bit is not used.
All data lines revert to zero following an output.
(refer to "Description of the Sensors" section 4.2.1 "Data Output Format" on page 44)

Important!
The instruction UDS has an effect on the present evaluation limits and hence the result.

OER [**O**bject in **E**valuation **R**ange]

Instruction: OER	Example: -
Parameters: -	Unit: -
Response: 0 = no target in eval. range, 1 = Target	Range: -
Reference: ODR, ER, MD,OR, UDS	

The instruction enquires whether or not an object was detected within the **evaluation range**.
Evaluation range for sensors of type 8B and IU:
the area between the limits of the evaluation range.
Evaluation range for sensors of type E22:
the area between the two switching points.

Response 0: no target within evaluation range,
Response 1: target detected within evaluation range.

Important!
The instruction UDS has an effect on the present switching points / evaluation limits and hence the result.

ODR [**O**bject in **D**etection **R**ange]

Instruction: ODR	Example: -
Parameters: -	Unit: -
Response: 0 = no target in detect. range, 1 = Target	Range: -
Reference: OER, ER, MD, OR	

The instruction enquires whether or not an object has been detected within the **detection range** (area between blind range and nominal evaluation range):

Response 0: no target within detection range,
Response 1: target detected within detection range.

ER [**E**cho **R**eceived]

Instruction: ER	Example: -
Parameters: -	Unit: -
Response: 0 = no echo, 1 = echo	Range: 0 / 1
Reference: OER, ODR	

The instruction BR enquires whether or not the sensor has picked up an echo. The echo propagation time, i.e. the calculated distance, is of no interest.

Response 1: echo picked up, Response 0: no echo picked up.

RST [sensor software **R**e**S**e**T**]

Instruction: RST	Example: -
Parameters: -	Unit: -
Response: Acknowl. with 0	Range: -
Reference: -	

The sensor performs a Reset as a result of this instruction. The instruction is acknowledged (80h).

DEF [**DEF**ault settings]

Instruction: DEF

The instruction **DEF** causes the sensor to restore the factory settings that it has stored internally. All existing parameters are overwritten in the process.

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1 Setting the switching points / evaluation limits of Type E22 / IU sensors via DIP switches

1.1 Sensors of type E22

1.1.1 Sensor UJ3000+U1+E22+RS:

Detection range 300 mm ... 3000 mm.

Switching value settings (table of values)

Switch 1 2 3 4	Switching distance [cm]	Switch 5 6 7 8	Switching distance [cm]
0 0 0 0	30	0 0 0 0	40
0 0 0 1	45	0 0 0 1	55
0 0 1 0	60	0 0 1 0	70
0 0 1 1	75	0 0 1 1	85
0 1 0 0	90	0 1 0 0	100
0 1 0 1	105	0 1 0 1	115
0 1 1 0	120	0 1 1 0	130
0 1 1 1	135	0 1 1 1	145
1 0 0 0	150	1 0 0 0	160
1 0 0 1	170	1 0 0 1	170
1 0 1 0	190	1 0 1 0	200
1 0 1 1	210	1 0 1 1	220
1 1 0 0	230	1 1 0 0	240
1 1 0 1	250	1 1 0 1	260
1 1 1 0	270	1 1 1 0	280
1 1 1 1	290	1 1 1 1	300

1 = ON; 0 = OFF

If ultrasonic sensors are equipped with DIP switches, these have a typical layout:

DIP switches 1 ... 8 specify the switching points, DIP switch 9 specifies the switching mode (N/C / N/O) and switch 10 specifies whether the sensor outputs transmit the measured value or are used for communication via the serial interface

Normally, DIP switches 1 ... 4 are used to set the near switching point / measurement window limit and DIP switches 5 ... 8 are used to set the far switching point / measurement window limit (see the appropriate data sheet).

1.1.2 UJ6000-FP-E22-RS:

Detection range 800 mm ... 6000 mm.

Switching value settings (table of values)

Switch 1 2 3 4	Switching distance [cm]	Switch 5 6 7 8	Switching distance [cm]
0 0 0 0	80	0 0 0 0	95
0 0 0 1	110	0 0 0 1	125
0 0 1 0	140	0 0 1 0	155
0 0 1 1	170	0 0 1 1	185
0 1 0 0	200	0 1 0 0	215
0 1 0 1	230	0 1 0 1	245
0 1 1 0	260	0 1 1 0	275
0 1 1 1	290	0 1 1 1	305
1 0 0 0	320	1 0 0 0	335
1 0 0 1	350	1 0 0 1	365
1 0 1 0	380	1 0 1 0	400
1 0 1 1	420	1 0 1 1	440
1 1 0 0	460	1 1 0 0	480
1 1 0 1	500	1 1 0 1	520
1 1 1 0	540	1 1 1 0	560
1 1 1 1	580	1 1 1 1	600

1 = ON; 0 = OFF

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1.2.1 UJ3000+U1+IU+RS:

Detection range 300 mm ... 3000 mm.

Setting the evaluation limits (table of values)

Switch 1 2 3 4	Switching distance [cm]	Switch 5 6 7 8	Switching distance [cm]
0 0 0 0	30	0 0 0 0	30
0 0 0 1	45	0 0 0 1	45
0 0 1 0	60	0 0 1 0	60
0 0 1 1	75	0 0 1 1	75
0 1 0 0	90	0 1 0 0	90
0 1 0 1	105	0 1 0 1	105
0 1 1 0	120	0 1 1 0	120
0 1 1 1	140	0 1 1 1	140
1 0 0 0	160	1 0 0 0	160
1 0 0 1	180	1 0 0 1	180
1 0 1 0	200	1 0 1 0	200
1 0 1 1	220	1 0 1 1	220
1 1 0 0	240	1 1 0 0	240
1 1 0 1	260	1 1 0 1	260
1 1 1 0	280	1 1 1 0	280
1 1 1 1	300	1 1 1 1	300

1 = ON; 0 = OFF

1.2.2 UJ6000-FP-IU+RS:

Detection range 800 mm ... 6000 mm.

Setting the evaluation limits (table of values)

Switch 1 2 3 4	Switching distance [cm]	Switch 5 6 7 8	Switching distance [cm]
0 0 0 0	80	0 0 0 0	80
0 0 0 1	110	0 0 0 1	110
0 0 1 0	140	0 0 1 0	140
0 0 1 1	170	0 0 1 1	170
0 1 0 0	200	0 1 0 0	200
0 1 0 1	230	0 1 0 1	230
0 1 1 0	265	0 1 1 0	265
0 1 1 1	300	0 1 1 1	300
1 0 0 0	335	1 0 0 0	335
1 0 0 1	370	1 0 0 1	370
1 0 1 0	405	1 0 1 0	405
1 0 1 1	440	1 0 1 1	440
1 1 0 0	480	1 1 0 0	480
1 1 0 1	520	1 1 0 1	520
1 1 1 0	560	1 1 1 0	560
1 1 1 1	600	1 1 1 1	600

1 = ON; 0 = OFF

1.2 Sensors of type IU

If the near evaluation limit is set to a lower value than the far evaluation limit, the analog output outputs a rising ramp. Conversely, the analog output outputs a falling ramp if the first evaluation limit is set larger than the second evaluation limit.

It is not permitted to set the same value for both evaluation limits: the sensor flashes red for a setting error.

The switching point of the sensor is in the middle of the two set evaluation limits.

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One Company, Two Divisions.

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- Binary and analog sensors
- in different technologies
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  - Magnetic sensors
  - Ultrasonic sensors
  - Photoelectric sensors
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Areas of Application

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- Conveyor or transport
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Product Range

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- Intrinsically safe field bus solutions
- Level control sensors
- Process measuring and control systems engineering at the interface level
- Intrinsic safety training

Areas of Application

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The Pepperl+Fuchs Group

USA Headquarter
Pepperl+Fuchs Inc. · 1600 Enterprise Parkway
Twinsburg, Ohio 44087 · Cleveland-USA
Tel. (330) 4 25 35 55 · Fax (330) 4 25 93 85
e-mail: sales@us.pepperl-fuchs.com

Asia Pacific Headquarter
Pepperl+Fuchs Pte Ltd. · P+F Building
18 Ayer Rajah Crescent · Singapore 139942
Tel. (65) 7 79 90 91 · Fax (65) 8 73 16 37
e-mail: sales@sg.pepperl-fuchs.com

Worldwide Headquarter
Pepperl+Fuchs GmbH · Königsberger Allee 87
68307 Mannheim · Germany
Tel. +49 621 7 76-0 · Fax +49 621 7 76-10 00
http://www.pepperl-fuchs.com
e-mail: info@de.pepperl-fuchs.com

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