Baumer
Passion for Sensors

Description of functions and interfaces

PLP70 H/S

Continuous level sensor

EN-US

V2 | 2/6/2024

Table of contents

1 About this document **4**
1.1 Purpose and scope of application 4
1.2 Applicable documents 4
1.3 Labels in this manual 4
1.4 Warnings in this manual 4

2 General functionality **5**

3 Block diagram **6**
3.1 Block diagram Hardware 6
3.2 Block diagram Software 7

4 Interfaces **8**
4.1 IO-Link 8
4.2 DFON 10
4.3 FlexProgram 11
4.4 qTeach 12

5 Operating functions **13**
5.1 Basic functions 13
5.1.1 Factory settings 13
5.1.2 Damping 14
5.1.3 Unit fill level 16
5.1.4 Mounting position 17
5.1.5 Immersion sensitivity 18
5.1.6 qTeach 19
5.1.7 Level correction 19
5.2 Switching Signal Channel (SSC) 22
5.2.1 Switching points 22
5.2.2 Hysteresis 23
5.2.3 Switching logic 24
5.2.4 Switching function 25
5.2.5 Alarm behavior 27
5.3 Analog output 28
5.3.1 Analog output enable 28
5.3.2 Scale analog output with 4 and 20 mA 29
5.3.3 Minimum and maximum output current 31
5.3.4 Output current at system error 32
5.3.5 Output current sensor not covered 32

6 Diagnostic functions **33**
6.1 Simulation 33
6.1.1 Analog output 33
6.1.2 Digital output 35
6.2 Identification 36

7 Annex 37
7.1 IO-Link 37
7.1.1 PDI 37
7.1.2 Identification 38
7.1.3 Parameter 39
7.1.3.1 Factory Reset Menu 39
7.1.3.2 Sensor Setup Menu 39
7.1.3.3 Switch Menu 41
7.1.3.4 Analog Output Menu 42
7.1.3.5 Simulation menu 43
7.1.3.6 Calibration menu 44
7.2 DFON 45
7.3 FlexProgram 48
7.4 qTeach 49

1 About this document

1.1 Purpose and scope of application

This document enables safe and efficient sensor parameterization using various interfaces. The manual describes the available functions to support installation and software use via the interfaces.

The illustrations are examples only. Deviations are at the discretion of Baumer at all times. The manual is a supplementary document to the existing product documentation.

1.2 Applicable documents

- Available for download at www.baumer.com:
  - Data sheet
  - EU Declaration of Conformity
- Attached to product:
  - Quickstart
  - General information sheet (11042373)

1.3 Labels in this manual

Identifier	Usage	Example
Dialog element	Indicates dialog elements.	Click the ***OK*** button.
Unique name	Indicates the names of products, files, etc.	*Internet Explorer* is not supported in any version.
`Code`	Indicates entries.	Enter the following IP address: `192.168.0.250`

1.4 Warnings in this manual

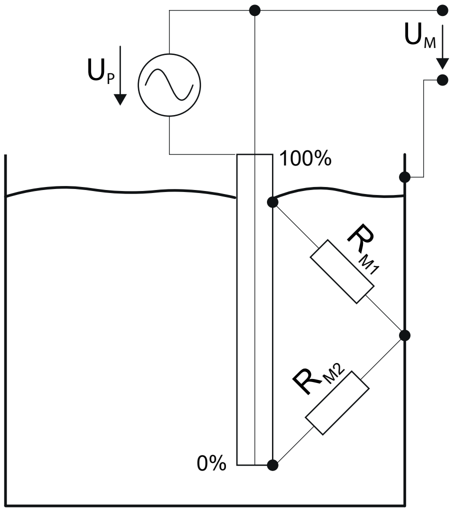
Warnings draw attention to potential personal injury or material damage. The warnings in this manual indicate different hazard levels:

Symbol	Warning term	Explanation
	DANGER	Indicates an imminent potential danger with high risk of death or serious personal injury if not being avoided.
	WARNING	Indicates potential danger with medium risk of death or (serious) personal injury if not being avoided.
	CAUTION	Indicates a danger with low risk, which could lead to light or medium injury if not avoided.
	NOTE	Indicates a warning of material damage.
	INFO	Indicates practical information and tips that enable optimal use of the devices.

2 General functionality

The potentiometric level sensor allows for both process monitoring and control, as level monitoring in feed containers and storage tanks or for rapid level changes in filling installations and processes.

Measurement principle



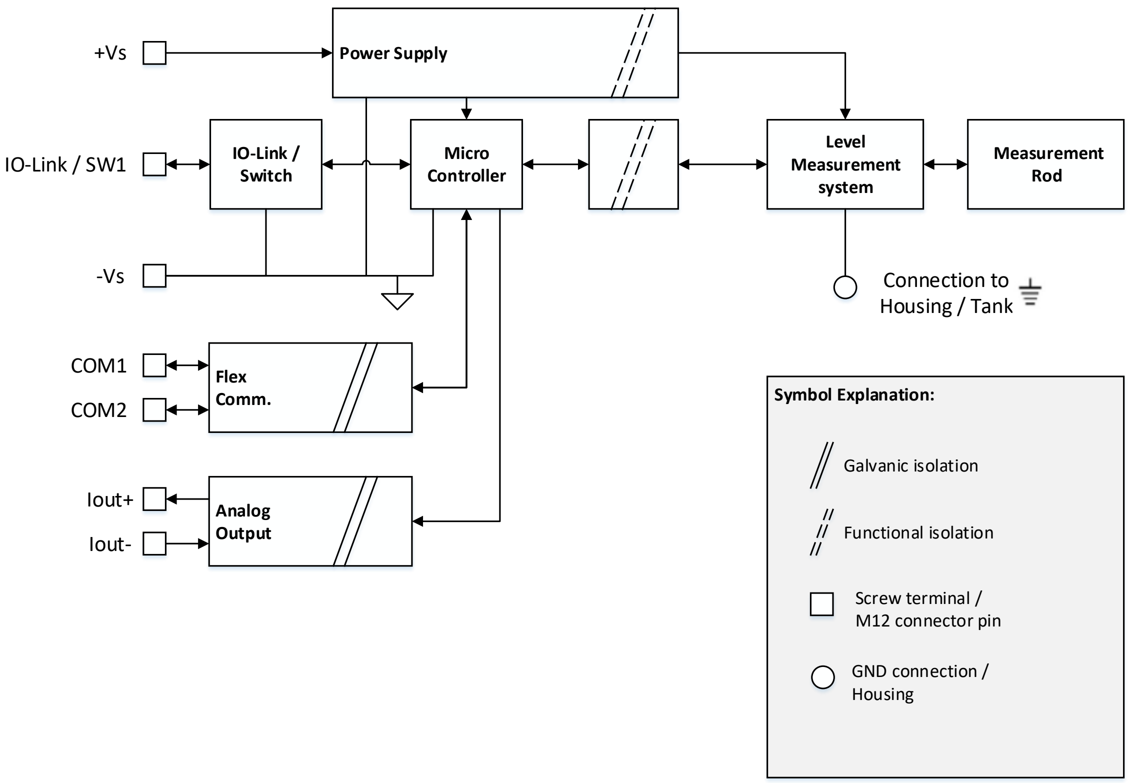
Ill. 1: Principle of potentiometric level measurement

The sensor operates on the alternation of the voltage ratio between sensing probe and metal tank wall. The fluid's electrical conductivity and capacity generate an electrical flux field. Here, the sensing probe acts as voltage divider at which the conductivity/capacity ratio is subject to alteration according to filling level. The voltage ratio is proportional to the filling level.

Simply, the system of probe and fluid can be considered a potentiometer where alterations in the filling level can be compared to turning a standard potentiometer.

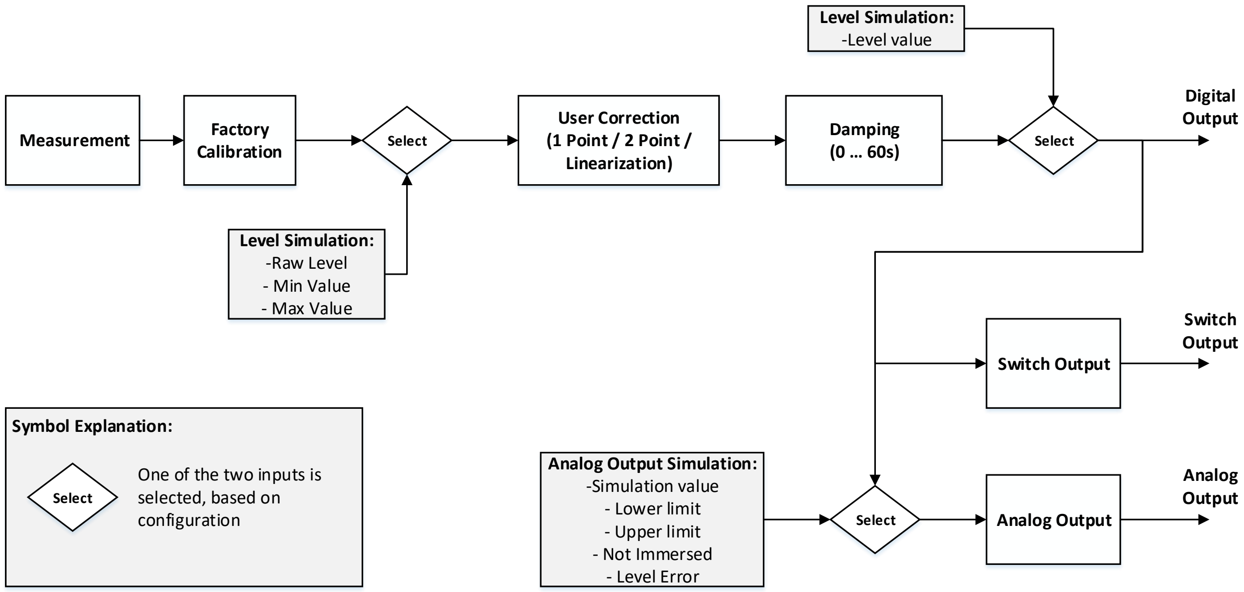
3 Block diagram

3.1 Block diagram Hardware



Ill. 2: Block diagram Hardware

3.2 Block diagram Software



Ill. 3: Block diagram Software

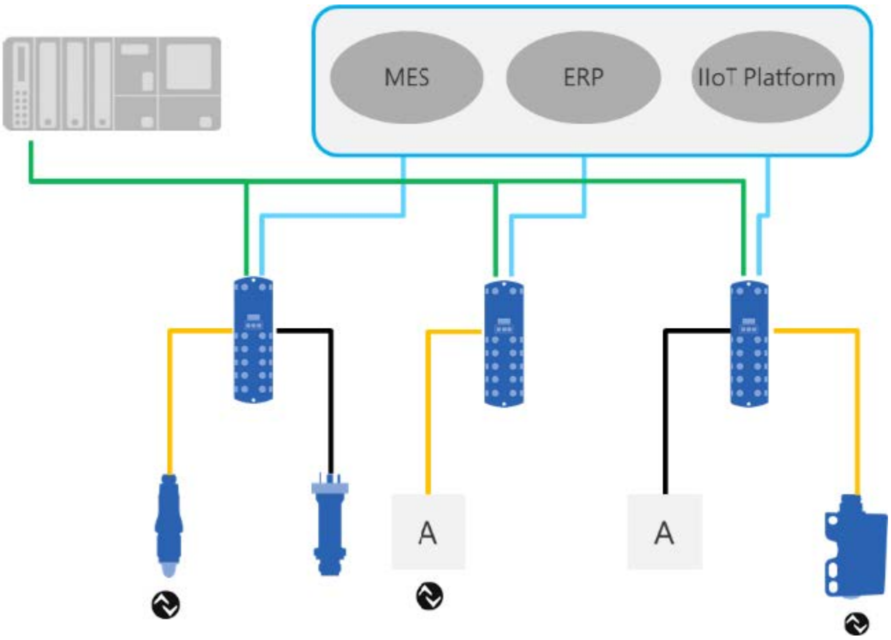
4 Interfaces

This section describes the available interfaces for operator to sensor communication.

4.1 IO-Link

IO-Link enables manufacturer-independent digital, bidirectional point-to-point communication. For this purpose, actuators or sensors are connected to an IO-Link master by standardized 3-wire connecting cables.

The IO-Link interface serves for parameterization of the sensor functions. In addition, measurement data and the function-generated sensor and status information are digitally transmitted in the form of process data to the machine controller (PLC). Secondary data informing on the machine condition allow for continuous process monitoring and process optimization.



Ill. 4: IO-Link architecture

The IO-Link master clustering several sensors connects the controller via the respective fieldbus system, which is the so-called operational technology communication (OT communication). In addition, another Ethernet-based connection to the IO-Link master(e.g., via OPC UA or MQTT) enables direct communication between sensor and IT systems (IT communication).

There are two types of communication between IO-Link master and device.

- **Cyclic communication:**
  transmission in real time - This data and information (process data) is used for process control in automation systems.
- **Acyclic communication:**
  Time-uncritical communication for secondary data transmission or sensor parameterization.

To address both sensor functions and secondary data correctly, IO-Link interface description utilizes the so-called IODD (IO Device Description). IODD is available for download on the sensor website (download section). Digital sensor communication, secondary data and the option of direct sensor communication with the IT world makes IO-Link a cornerstone in Smart Factory.

INFO

For evaluation, parameterization and use of IO-Link sensors, Baumer provides both IO-Link USB-C master and Baumer Sensor Suite. The IO-Link USB-C Master enables IO-Link devices to communicate with the computer without external power supply. Baumer Sensor Suite is a computer-based tool to understand and use IO-Link devices and to visualize sensor functions of different sensor brands. This allows for engineering both at the workplace and straight at the machine. Further information at baumer.com/bss.

4.2 DFON

The display of the *CombiSeries* allows uniform operation and process monitoring throughout the entire *CombiSeries* product family. The CombiView display provides all required information at a glance. e.g.:

- Temperature measurement
- Pressure measurement
- Conductivity measurement
- Level measurement
- Flow measurement

Ease of operation

The display allows intuitive and uniform operation by touch screen and two relay outputs for direct process control. Display power and digital signal supply of *CombiSeries* devices is via integrated UnitCom ribbon cable. This way you can configure transmitter and display in parallel via the display touchscreen. Alternatively, for configuration use the *FlexProgrammer 9701* and the additionally required software *FlexProgram*. In addition, parameterization of each sensor can be individually defined.

Parameterization

Instruction:

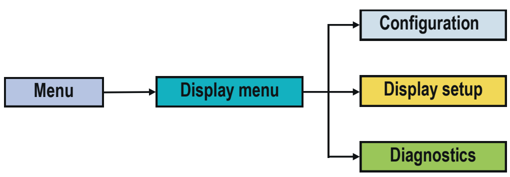
a) Touch the screen.
  ✓ Button ***Menu*** is shown at the bottom of the screen.

b) Click button ***Menu***.
  ✓ The display provides two options for selection.

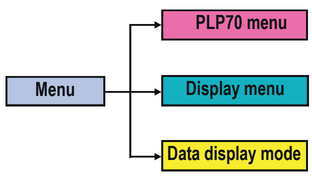
c) Make a choice:
  ✓ With 4 ... 20 mA loop configuration (connected to pin 1 and 2 on the display).
  ✓ Using a transmitter which communicates with *DFON* via UnitCom ribbon cable.

Result:

✓ Proceed with sensor parameterization.



Menu Display



DFON menu

Product menu

Here, proceed with parameterization of the connected transmitter.

Display menu

Here, proceed with configuration of the *DFON* display.

Data display menu

Here, proceed with parameterization of the connected measuring device. The parameterized values also apply for the *DFON* display. Any settings made via display are overwritten.

Select background colors and relays under:

Menu* | *Display menu* | *Configuration

The data display mode communicates digitally with the transmitter.

4.3 FlexProgram

The *FlexProgrammer 9701* is a configuration tool based on the *FDT-Container Technology* and particularly designed to match a large variety of *Baumer* products. *FDT* is a software interface specification. This software interface defines the data exchange between application and field device software components. *FlexProgram* is to access the different field devices for configuration of the related Baumer sensors using the respective *DTMs (Device Type Manager)*.

In standard operation, *FlexProgrammer 9701* is operated and powered via the computer's USB port. In an analog way, Baumer products can be monitored and parameterized independently of the computer (i.e. stand-alone). For doing so, configuration profiles of numerous Baumer products supporting the PC software *FlexProgram* can be directly saved to the *FlexProgrammer 9701* and are immediately available for parameterization. In this case, *FlexProgrammer 9701* is powered by the internal battery to enable remote configuration. The integrated LC display allows users to crosscheck the parameterization of the current product.

***FlexProgram* online download:**

Instruction:

a) Download both the PC software *FlexProgram* and the firmware for your sensor at the Baumer homepage www.baumer.com.

b) Unzip and save the file in any directory, e.g. on your desktop.

   ✓ If a firmware update the file is available.

- Open the PC software *FlexProgram* and follow the user menu navigation.

INFO

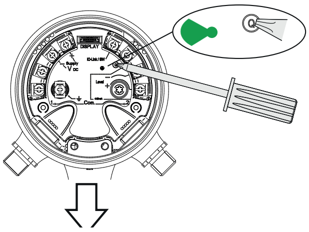
More information or support is available at *FlexProgramm* itself:

FlexProgram | Level | CombiLevel PLP70 | Help

4.4 qTeach

Some sensor functions enable parameterization via the Baumer *qTeach* feature. For parameterization via *qTeach*, hold a ferromagnetic tool against the sensor-integrated teach button.

During the parameterization operation, the sensor-integrated LED provides you with visual feedback.



Ill. 5: Parameterization via *qTeach*

Parameterization via *qTeach* is enabled in the factory settings. These can be disabled.

INFO

Parameterization via teach is accessible for the first 5 minutes after sensor power on. After this time having expired,*qTeach* is disabled. If enabled within these initial 5 minutes,*qTeach* is remains enabled for another 24 hours.

5 Operating functions

5.1 Basic functions

5.1.1 Factory settings

The *Reset* function will restore the factory settings. Default will be restored in the entire user settings.

For detailed information on the access data listed see chapter *Annex [▸ 37]*.

IO-Link access: factory settings

Name	Index	Subindex	Description
System Command	2	0	▪ 130: Reset factory settings

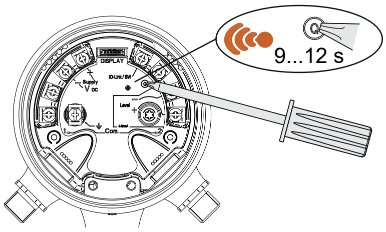
DFON access: Factory settings

- ***Menu* | *PLP70 menu* | *Diagnostic* | *Factory reset***

FlexProgram access: Factory settings

- ***FlexProgram* | *Level* | *CombiLevel PLP70x* | *Measuring (Online)* | *Factory reset***

qTeach access: Factory settings



Instruction:

- Place a ferromagnetic tool for 9 to12 seconds against the sensor's teach button.

Result:

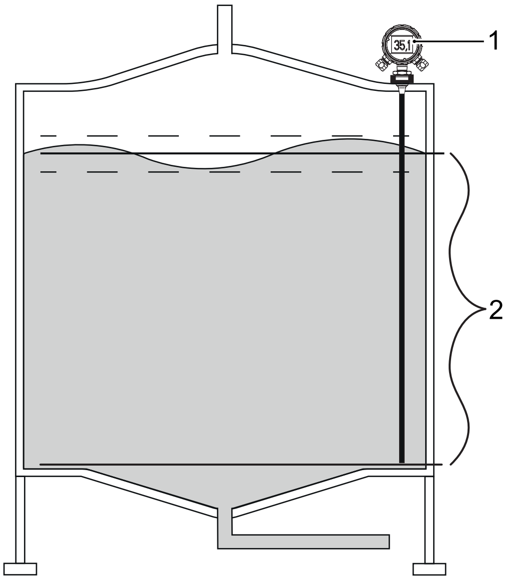
✓ The sensor LED is flashing amber.

✓ The sensor is now reset to the factory settings.

5.1.2 Damping

The *Damping* function outputs... a moving average of the levels measured within time intervals of 0 ... 60 seconds. This is to compensate any fluctuations, for example, by stirred, sloshed or splashing fluid.

In the following illustration, the level sensor is subject to continuous fluctuations. Though the overall level does not change, there are short and slight fluctuations. Damping will compensate such fluctuations, so ensure the true actual level of the fluid is being measured.



Ill. 6: Tank with inside swell (fluctuation) and level sensor

1	Level sensor	2	Average level depending on time

INFO

Damping inertia

Mandatory to observe the damping inertia. The larger the selected time interval, the more sluggish will react level measurement. Consequently, sudden fluctuations may escape notice.

The *Damping* function provides the following parameters:

Measuring signal damping

Function *Damping of the measuring signal*: provides the following parameter:

- *Measuring signal damping*: `[0 ... 60]s`

Damping of the immersion signal

Function *Damping of the immersion signal* provides the following parameters:

- *Disable*: Damping of the immersion signal disabled.
- *Enable*: Damping of the immersion signal enabled. Damping of the measurement signal is also present when the sensor is immersed in the medium.

For detailed information on the following access data please see chapter *Annex [▸ 37]*.

IO-Link access: Damping

Name	Index	Subindex	Description
Measurement Damping	121	2	Enter time interval for measurement damping: ▪ min.: `0 s` ▪ max.: `60 s`
Immersion Damping	121	1	Enable/disable damping of the immersion signal: ▪ `0`: Disabled ▪ `1`: Enabled

DFON access: Damping

- ***Menu | PLP70 menu | Output Config | Damping | Level damping***
- ***Menu | PLP70 menu | Output Config | Damping | Immersion damping***

FlexProgram access: Damping

- ***FlexProgram | Level | CombiLevel PLP70x | Input | Level and immersion damping***

5.1.3 Unit fill level

NOTICE

The **unit defined here applies to all functions and parameters of the level sensor**. Default values are defined as a percentage. Therefore, ensure all parameters are aligned with the selected measuring unit to prevent damage, like by overflow or empty tank.

The function *Level unit* defines the measuring unit in the level sensor. According to the probe length, the measured level can be specified either as a percentage or as a unit of length.

The following parameters are available for function *Level unit*:

- Percentage [%] according to the length of measuring probe
- Millimeter [mm]
- Centimeter [cm]
- Meter [m]
- Inch [inch]
- Foot [Foot]

For detailed information on the access data listed see chapter *Annex [▸ 37]*.

IO-Link access: Level measuring unit

Name	Index	Subindex	Description
Unit Filling Level	74	3	Choose physical unit for the measured value: ▪ `20`: Percent ▪ `41`: Meter ▪ `46`: Millimeter ▪ `54`: Centimeter ▪ `55`: Feet ▪ `56`: Inch

DFON Access: Level measuring unit

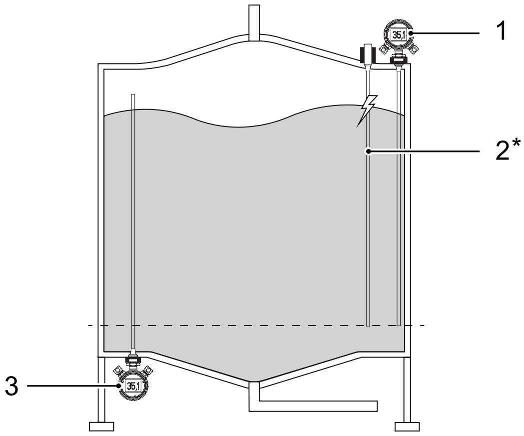
- ***Menu* | *PLP70 menu* | *Output Config* | *Level Unit***

FlexProgram access: Level measuring unit

- ***FlexProgram* | *Level* | *CombiLevel PLP70x* | *DTM-Setup* | *Level unit***

5.1.4 Mounting position

Use function *mounting position* to parameterize the sensor's mounting position. You can mount the sensor either on top or at bottom:



Ill. 7: Sensor mounting positions

1	Top mount	2	Electrode (optional)
3	Bottom mount		

* The electrode is only required if the tank material is not conductive.

Function *mounting position* provides the following parameters:

- *Top mount:* The sensor is installed on the top.
- *Bottom mount*: The sensor is installed at the bottom.

For detailed information on the following access data please see chapter *Annex [▸ 37]*.

IO-Link access: Mounting position

Name	Index	Subindex	Description
Mounting Position	77	6	Choose mounting position of the sensor: ▪ `0`: Sensor is mounted on top of the tank. ▪ `1`: Sensor is mounted at the bottom of the tank

DFON access: mounting position

- ***Menu | PLP70 menu | Input Config | Mounting position***

FlexProgram access: Mounting position

- ***FlexProgram | Level | CombiLevel PLP70x | Input | Mounting position***

5.1.5 Immersion sensitivity

Function *Immersion sensitivity* is to adjust the sensor's medium sensitivity when being immersed. Conductivity is medium-specific. Immersion sensitivity is in intervals of [0 ... 100]. The higher the immersion sensitivity, the higher the detection sensitivity when the sensor is immersed in the medium.

Example: No level detected by the sensor when being immersed in the medium implies increasing the immersion sensitivity. In an analog way, immersion sensitivity must be decreased if an empty tank is detected as filled.

The function *Immersion sensitivity* provides the following parameters:

- *Immersion sensitivity*: `[0 ... 100]`

For detailed information on the following access data please see chapter *Annex [▸ 37]*.

IO-Link access: Immersion sensitivity

Name	Index	Subindex	Description
Immersion Sensitivity	106	1	Enter the sensitivity of immersion detection: ▪ min.: `0` ▪ max.: `100`

DFON Access: Immersion sensitivity

- ***Menu | PLP70 menu | Input Config | Immersed sensitivity***

FlexProgram access: Immersion sensitivity

- ***FlexProgram Level| CombiLevel PLP70x |Input Immersion sensitivity| |***

5.1.6 qTeach

Use this function to disable or enable user interface *qTeach*.

The *qTeach* function provides the following parameters:

- *Disabled*: *qTeach* interface disabled.
- *Enabled*: *qTeach* interface enabled.

For detailed information on the following access data please see chapter *Annex [▸ 37]*.

IO-Link access: qTeach

Name	Index	Subindex	Description
qTeach enabled	58	1	Enable/disable the qTeach user interface: ▪ `0`: Disabled ▪ `1`: Enabled

DFON Access: qTeach

- ***Menu | PLP70 menu | Diagnostic | qTeach***

FlexProgram Access: qTeach

- ***FlexProgram | Level | CombiLevel PLP70x | Output | qTeach***

5.1.7 Level correction

The function *Level correction* defines the correction applicable to the measured value.

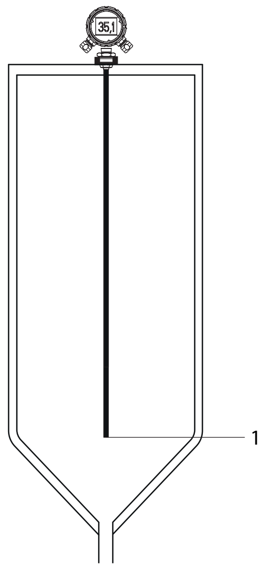
Level correction significantly depends on the tank shape in which sensor is going to detect the medium. Level calculation assumes linear level increase. This means 50% of the fill level is half the maximum fill level. Funnel-shaped or cylindrical tanks however may be different.

The function *Level correction* provides the following parameters:

- *Disabled*: No correction of the measured fill level.
- *1-point*: All measured values will be corrected by the offset value. The offset value is added to the measured fill level. Correction of fill level by offset provides the following parameters:
  - *Offset value*: `[-200 000 ... 200 000]`
- *2-point*: A linear correction by the offset value is applied to the measured value. The correction is calculated out of two points described by the following parameters:
  - *2-point measured values*: `[-200 000 ... 200 000]` for both parameters 0 and 1
  - *2-point corrected value* s: `[-200 000 ... 200 000]` for both parameters 0 and 1.
- *Linear*: The measured value is applied a linearization with up to 30 points. The number of points can be defined between 3 and 30. Linearization is always defined by two consecutive *Linear-corrected values* and will be applied instead of the *Linear-measured values*. The following parameters are to be configured:
  - *Linear table length*: `[3 ... 30]`
  - *Linear-measured values*: `[-200 000 ... 200 000]` for parameters 0 ... 29.
  - *Linear-corrected values*: `[-200 000 ... 200 000]` for parameters 0 ... 29.

Application examples for different types of level correction

1-point correction



Tank level indication (right illustration) is linear throughout the entire measuring range.

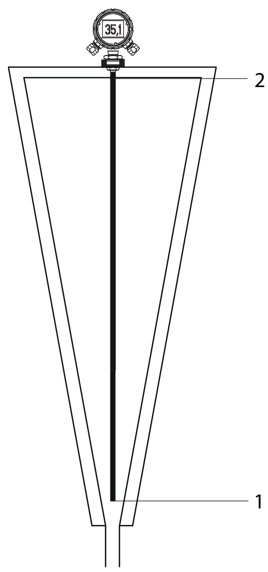
Example : The sensor is not long enough to reach the tank bottom. Hence, the sensor is not capable of point level detection at 0 % but level detection will only be successful at at least 10%.

Consequently, parameter *1-point*-offset correction is:

Offset = 10

The level reaching the 10 % mark does not mean the tank is empty, but the level is below the measuring range and for this reason no further measurement results will be delivered. The display stagnates at 10%.

2-point correction



Point level detection in the tank (right) is not linear for the measuring range from 1 to 2 due to the increasing tank diameter. Consequently, the resistor ratios in the voltage divider are no longer proportional to each other

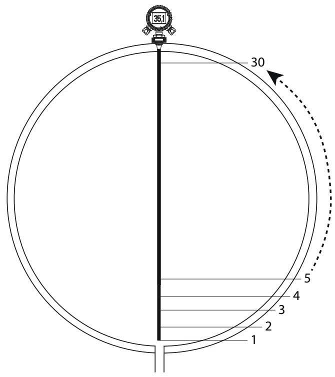
Example: In point level detection without offset, the sensor will indicate 0% (tank empty) at measuring point 1. At measuring point 2 (tank full), the sensor indicates a value greater than 100% due to the non-proportional ratio of the voltage divider. For a corrective measure, the true measured values at 0 % and 100 % must be identified. In the next step, these values must undergo linearization using the *2-point* correction. Example:

Consequently, the parameters for *2-point* correction are as follows:

- *measured value [0]* = 0%
- *measured value [1]* = 130%
- *corrected value [0]* = 0%
- *corrected value [1]* = 100%

Linear correction is now applied to the measured values from point 1 to point 2.

Linear correction



Due to the tank shape, the tank level indicator in the right illustration is never linear. Using linear correction, the actual fill level is approximated. The more measuring points, the more accurate is level indication. For doing so, divide the sensor virtually into max. 30 segments of the same size.

Example: The sensor is long enough to nearly reach the tank bottom. Hence, level detection at point 1 will be successful even at nearly 0 %. Each other segment will deliver a value of 100%/29 ≈ 3.5%. At measuring point 2, the sensing probe is immersed at 3.5 %, but the indicated level is only 2 %. At measuring point 3, the sensing probe is immersed by 7%, the indicated level is 7%. Continue at will.

This results in the following parameters for *linear* correction:

- *measured value [0]* = 0
- *measured value [1]* = 3.5
- *measured value [2]* = 7
- ...
- *measured value [29]* = 100

- *corrected value [0]* = 0
- *corrected value [1]* = 2
- *corrected value [2]* = 7
- ...
- *corrected value [29]* = 100

For detailed information on the access data listed see chapter *Annex [▸ 37]*.

IO-Link access: Level correction

Name	Index	Subindex	Description
Level Correction	400	1	Choose level correction applied to the measured value: ■ `0`: Correction disabled ■ `1`: 1 point correction enabled ■ `2`: 2 point correction enabled ■ `3`: Linearization correction enabled

DFON access: level correction

- ***Menu* | *PLP70 menu* | *Input Config* | *Level Correction* | *Level Correction model***
- ***Menu* | *PLP70 menu* | *Input Config* | *Level Correction* | *1 point (offset)***

FlexProgram access: Level correction

- ***FlexProgram* | *Level* | *CombiLevel PLP70x* | *Input* | *Level correction***

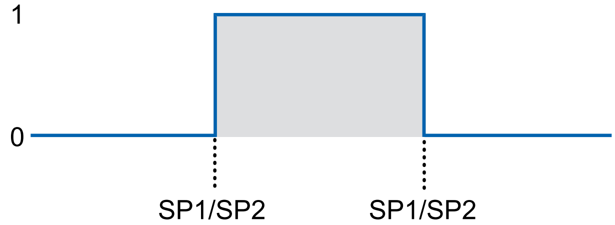
5.2 Switching Signal Channel (SSC)

5.2.1 Switching points

Via the *Switching points* function, distances (switching points) are defined at which the switching output is to be activated. This function may be used for quality control, for example to check whether the fill level is within a tolerance window.

Function *Switching points* provides the following parameters:

- *Minimum switching point*: SP1 = 10 % (factory setting)
- *Maximum switching point*: SP2 = 90 % (factory setting)



Ill. 8: Sensor switching operations within the range SP1 to SP2

For detailed information on the following access data please see chapter *Annex [▶ 37]*.

IO-Link access: switching points

Name	Index	Subindex	Description
Switch Window Min.	16128	1	Enter switching window min. value.
Switch Window Max.	16128	2	Enter switching window max. value.

DFON Access: switching points

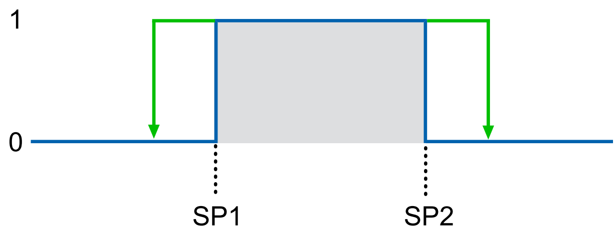
- ***Menu | PLP70 menu | Switch Config | Switching window***

FlexProgram access: switching points

- ***FlexProgram | Level | CombiLevel PLP70x | Switch setup | Switching points***

5.2.2 Hysteresis

The *Hysteresis* prevents unwanted switching of the switching output. The parameterized value of the hysteresis is the difference in distance between the points at which the switching output is activated and deactivated. Baumer recommends always setting the hysteresis not equal to 0.



Ill. 9: Hysteresis in window mode

Function *Hysteresis* provides the following parameters:

- *Hysteresis*: `[-33 333 ... 33 000]` A positive hysteresis value corresponds to a hysteresis outside the window.

Example

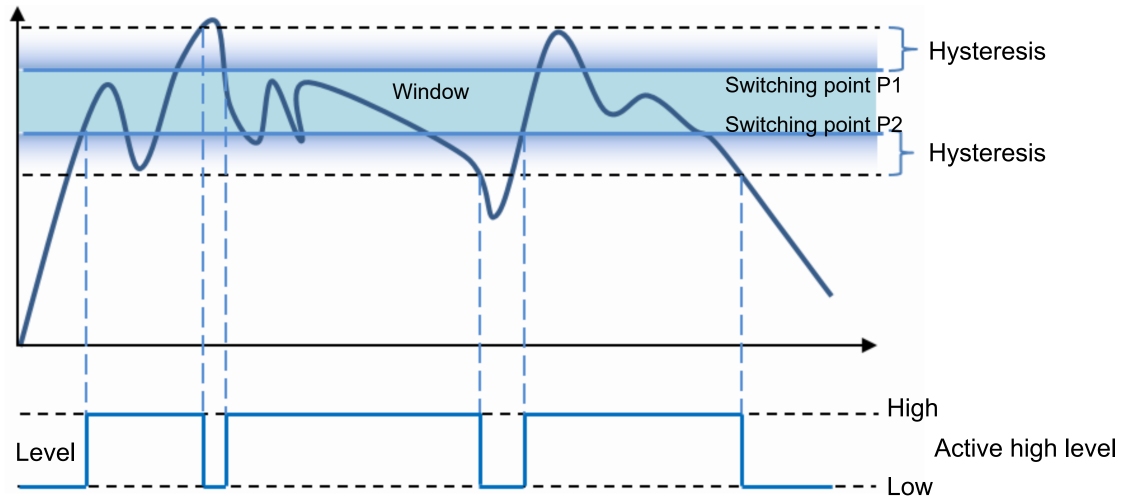
- *Minimum switching point* (SP1): 30 %
- *Maximum switching point* (SP2): 60 %
- *Hysteresis*: 2%

The switching output is active at measured levels between 30 % and 60 %. As soon as the level is dropping from 30% down to 29%, the switching output remains active by hysteresis. However, as soon as the measured level is dropping 28 % or exceeding 62 %, the switching output will not be active.

For further level change, the output will not be active again until level is between 30 % and 60 % (parameterized switching point).

Switching output behavior

Hysteresis:



Ill. 10: Behaviour of the switching output in window mode

For detailed information on the following access data please see chapter *Annex [▸ 37]*.

IO-Link access: hysteresis

Name	Index	Subindex	Description
Hysteresis	69	1	Define the hysteresis value of the switch window limits.

DFON Access: hysteresis

- ***Menu | PLP70 menu | Switch Config | Switching window***

FlexProgram access: hysteresis

- ***FlexProgram | Level | CombiLevel PLP70x | Switch setup | Hysteresis***

5.2.3 Switching logic

Function *switching logic* is for setting the switching signal to *high active* or *low active*. This results into inverted switching signal behavior.

Function *Switching logic* provides the following parameters:

- *High active*: (default) the measured value being within the switching window will output a high signal.
- *Low active*: the measured value being within the switching window will output a low signal.

For detailed information on the following access data please see chapter *Annex [▸ 37]*.

IO-Link access: switching logic

Name	Index	Subindex	Description
Switching Logic	16129	1	Define the polarity of the switch. ▪ `0`: high active ▪ `1`: low active

DFON access: switching logic

- ***Menu | PLP70 menu | Switch Config | Switch logic***

FlexProgram access: switching logic

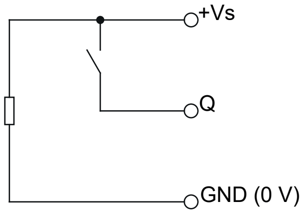
- ***FlexProgram | Level | CombiLevel PLP70x | Switch setup | Switch logic***

5.2.4 Switching function

Function *Switching function* defines its on/off behavior.

With **PNP sensors** the load is connected to both switching output and GND; with GND being the new reference point. In the event of signal change at the sensor, the transistor will switch through. Current flow is from Vp+ to GND via transistor load which will close the circuit.

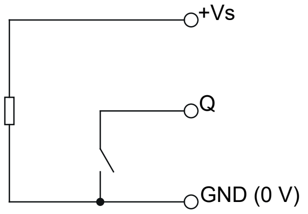
The output being inactive will have the control voltage virtually applied to +Vp, blocking the transistor and this way eliminating current flow.



Ill. 11: Circuit diagram of PNP switching output

With **NPN sensors** the load is connected to switching output and Vp+; with Vp+ being the reference point. Changing signals at the sensor will make the transistor switch through, current flow is from Vp+ via transistor load to GND which will close the circuit.

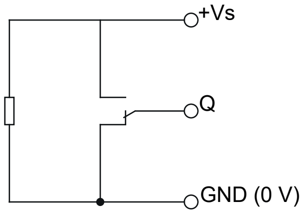
The output being inactive will have the control voltage virtually applied to GND (0 V) blocking the transistor and this way eliminating current flow.



Ill. 12: Circuit diagram of NPN switching output

Push-pull switching outputs are basically a mixture of PNP and NPN switching outputs. The control is done in such a way that always only one transistor becomes conductive and thus the output is connected either with reference potential GND (0 V) or in active state with operating voltage potential +Vs. The connected control device may integrate any number of load RL resistors, the switching potentials adjust independently of size or wiring.

Interfaces for fast data transmission generally integrate push-pull switching outputs, as IO-Link in communication mode.



Ill. 13: Circuit diagram of push-pull switching output

Function *Switching function* provides the following parameters:

- *Off*
- *Push-Pull*
- *PNP*
- *NPN*

For detailed information on the following access data please see chapter *Annex [▸ 37]*.

IO-Link access: switching function

Name	Index	Subindex	Description
Switch Function	78	1	Choose the function of the switch output: ▪ `0`: OFF ▪ `1`: Push-Pull ▪ `2`: PNP ▪ `3`: NPN

DFON access: switching function

- ***Menu* | *PLP70 menu* | *Switch Config* | *Switching function***

FlexProgram access: switching function

- ***FlexProgram* | *Level* | *CombiLevel PLP70x* | *Switch setup* | *Switch function***

5.2.5 Alarm behavior

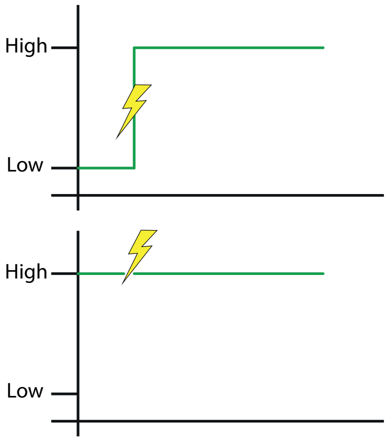
Function *Alarm behavior* is to override the switching output in the event of error. Triggered *alarm behavior* will override the switching output function.

Function *Alarm behavior* provides the following parameters:

- *No alarm behavior*
- *high active*: Output of a high signal in the event of error
- *low active*: Output of a low signal in the event of error
- *Off* (High Impedance)
- *Frozen*: In the event of error, the output retains its current state until the error has been corrected.

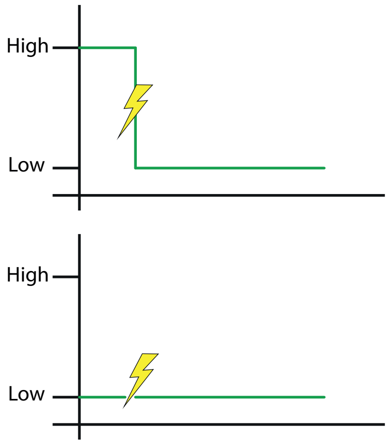
Examples of high and low active:

high active



Switching signal is set to *High*.

low active



Switching signal is set to *Low*. .

For detailed information on the following access data please see chapter *Annex [▸ 37]*.

IO-Link access: alarm behavior

Name	Index	Subindex	Description
Switch 1 Alarm mode	78	5	Set the behavior of the switch output on wire break or system error alarm: ▪ `1`: Output High ▪ `2`: Output Low ▪ `3`: Output Floating ▪ `4`: Output Frozen

DFON access: alarm behavior

- ***Menu | PLP70 menu | Switch Config | Alarm behaviour***

FlexProgram Access: Alarm Behavior

- ***FlexProgram | Level | CombiLevel PLP70x | Switch setup | Alarm behaviour***

5.3 Analog output

5.3.1 Analog output enable

This function is used for analog output switch on/off. The analog output is enabled by default.

Function *Activate analog output* provides the following parameters:

- *Enabled* (factory default)
- *Disabled*

For detailed information on the following access data please see chapter *Annex [▸ 37]*.

IO-Link access: enable analog output

Name	Index	Subindex	Description
Analog Output	202	1	Enable/disable analog current output: ▪ `0`: Disabled ▪ `1`: Enabled

DFON access: analog output enable

- ***Menu | PLP70 menu | Output Config | Current output***

FlexProgram access: analog output enable

- ***FlexProgram | Level | CombiLevel PLP70x | Output | Current output***

5.3.2 Scale analog output with 4 and 20 mA

This function is to define analog output scaling to the measured value range. Default is 0 ... 100 %.

Function *Scale analog output* provides the following parameters:

- *Measured values of 4 mA*: `[-33 000 ... 33 000]` Here, enter the level value corresponding to 4 mA output current.
- *Measured values of 20 mA*: `[-33 000 ... 33 000]` Here, enter the level value corresponding to 20 mA output current.

Example: Default 4 mA represents 0 % and 20 mA represents 100 %. Therefore, a measured current of 12 mA will deliver a level of 50%.

For detailed information on the following access data please see chapter *Annex [▸ 37]*.

IO-Link access: Analog output scaling

Name	Index	Subindex	Description
Measurement at 4mA	202	3	Enter the level value corresponding to 4 mA output current.
Measurement at 20mA	202	5	Enter the level value corresponding to 20 mA output current.

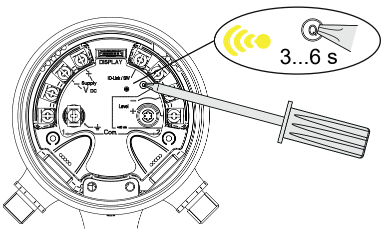
DFON access: analog output scaling with 4 and 20 mA

- ***Menu | PLP70 menu | Output Config | Current Level configuration | Input at 4mA***
- ***Menu | PLP70 menu | Output Config | Current Level configuration | Input at 20mA***

FlexProgram access: analog output scaling with 4 and 20 mA

- ***FlexProgram | Level | CombiLevel PLP70x | Output | Current output scale with 4 mA and 20 mA***

qTeach access: analog output scaling with 4 and 20 mA

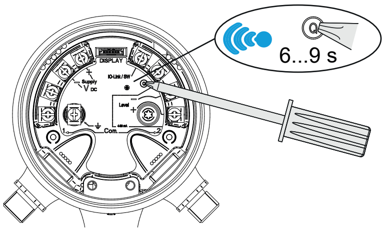


Instruction:

- Hold a ferromagnetic tool for 3 ... to 6 s against the sensor's teach button.

Result:

- ✓ The yellow LED is flashing.
- ✓ The current level corresponds to an output current of 4 mA.



- Hold a ferromagnetic tool for 6 ... to 9 s against the sensor's teach button.

Result:

✓ The blue LED is flashing.

✓ The current level corresponds to an output current of 20 mA.

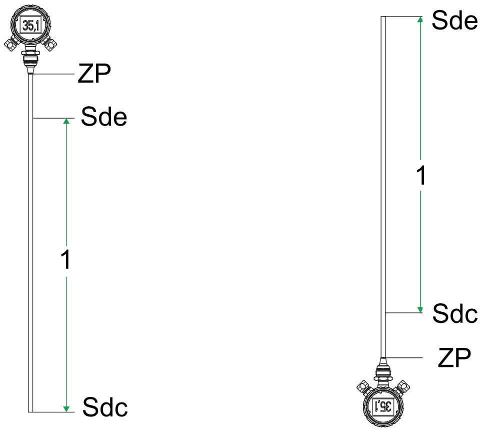
5.3.3 Minimum and maximum output current

This function is for defining the minimum and maximum limit of the output current. Thus, the resolution can be increased for a certain output current range to obtain more accurate level measurement results.

Function *minimum and maximum output current* provides the following parameters:

- *Minimum output current*: `[2,4 ... 23] mA` at 3.8 mA (default: `Sdc`) minimum limit of linear current range
- *Maximum output current*: `[2,4 ... 23] mA` at 20.5 mA (default: `Sde`) maximum limit of linear current range

The function automatically defined the minimum and maximum output current in relation to the sensor mounting position.



Ill. 14: Analog measuring field for sensor top mount (left) and bottom mount (right)

1	Analog measurement field

For detailed information on the following access data please see chapter *Annex [▸ 37]*.

IO-Link access: minimum and maximum output current

Name	Index	Subindex	Description
Low Current Limit	202	7	Enter lower limit for linear current range.
Upper Current Limit	202	9	Enter upper limit for linear current range.

DFON access: minimum and maximum output current

- ***Menu* | *PLP70 menu* | *Output Config* | *Output current limits***

FlexProgram access: minimum and maximum output current

- ***FlexProgram* | *Level* | *CombiLevel PLP70x* | *Output* | *Minimum and maximum output current***

5.3.4 Output current at system error

Here, the related analog output value in the event of system error can be defined. This parameter will be output in the event of a system error.

Function *Output current at system error* provides the following parameters:

- *Output current at system error*: `[2.4 ... 23] mA` at 23 mA (default)

For detailed information on the following access data please see chapter *Annex [▸ 37]*.

IO-Link access: output current at system error

Name	Index	Subindex	Description
System Error Current	11028	2	Enter output current value in case of system error.

DFON access: output current at system error

- ***Menu | PLP70 menu | Output Config | Error output***

FlexProgram access: output current at system error

- ***FlexProgram | Level | CombiLevel PLP70x | Output | Output current system error***

5.3.5 Output current sensor not covered

This function defines the output current parameter at *sensor not covered*. If the dipstick is not immersed in any medium, the output current can output a specific value.

For doing so, specify parameter:

- *Output current sensor not covered*: `[2.4 ... 23] mA` at 3.5 mA (default)

For detailed information on the following access data please see chapter *Annex [▸ 37]*.

IO-Link access: output current sensor not covered

Name	Index	Subindex	Description
Not Immersed Current	116	3	Enter output current value when measuring rod is not touching any medium (empty tank).

DFON access: output current sensor not covered

- ***Menu | PLP70 menu | Output Config | Error output***

FlexProgram access: output current sensor not covered

- ***FlexProgram | Level | CombiLevel PLP70x | Output | Output current sensor not immersed***

6 Diagnostic functions

6.1 Simulation

Function *Simulation* is to test whether measuring system or controller react as expected to individual analog output values. This is particularly helpful during system installation, since the parameterization made can be tested for crosscheck.

Either the analog or the digital output can be simulated.

6.1.1 Analog output

This function is to select the values to be simulated at the analog output.

- **Simulation value:** Parameter *Simulation value analog output* is provided directly at the analog output.
  This function is helpful for parameterization to ensure the scaling between measured level and analog output is as required. Straight during installation, you can make sure the sensor output values are correctly interpreted by the controller.
- **Lower limit:** Simulate the minimum output current (e.g. 3.8 mA). The analog output value of the device is the result of *Lower limit* processing with applied user-specific correction (offset).
  This function supports parameterization/installation. With applied user correction or at device exchange, the resulting minimum output level can be evaluated.
- **Maximum limit:** Simulate the maximum output current (e.g. 20.5 mA). The analog output value of the device is the result of processing the *Maximum limit* with applied user correction.
  This function supports parameterization/installation. With applied user correction or at device exchange the resulting maximum output level value can be evaluated.
- **Output current in the event of system error:** Simulate the parameter in the event of system error (e.g. 23 mA). The analog output value of the device is the result of *output current in the event of system error* processing with applied specific correction (offset).
- **Output current if sensor not covered:** Simulate the defined value for the sensor being uncovered (e.g. 3.5 mA). The analog output value of the device is the result of *output current if sensor not covered* with applied user correction.

Function *Simulation of the analog output* provides the following parameters:

- *Off*: No analog output simulation
- *Simulation value*: Display *Simulation value analog output*
- *Minimum limit*: 3.8 mA (default)
- *Maximum limit*: 20.5 mA (default)
- *Output current in the event of system error*: 23 mA (default)
- *Output current if sensor not covered*: 3.5 mA (default)

Selecting *simulation value* will simulate the following parameter:

- *Simulation value analog output*: 3.8 mA (default)

For detailed information on the following access data please see chapter *Annex [▸ 37]*.

IO-Link access: analog output

Name	Index	Subindex	Description
Current Output Simulation	248	2	Choose current output simulation type of the sensor: ▪ `0`: Off ▪ `1`: Simulation Value ▪ `2`: Lower Limit ▪ `3`: Upper Limit ▪ `5`: Not Immersed ▪ `6`: Device Error
Current Output Simulation Value	248	5	Enter current output simulation value.

DFON access: analog output

- ***Menu | PLP70 menu | Diagnostic | Current simulation | Simulation type***
- ***Menu | PLP70 menu | Diagnostic | Current simulation | Simulation value***

Also see about this

Analog output [▸ 28]

6.1.2 Digital output

This function is to select the values to be simulated at the digital output.

- **Simulation value:** parameter *Simulation value digital output* is provided directly at the digital output.
- **Raw value:** The defined level correction (*1-point*, *2-point* or *Linear*) will be applied to parameter *Simulation value digital output*. The digital output value of the device is the result of processing the entered value with applied user correction.
  This function is helpful for parameterization to ensure the scaling between measured level and analog output is as required. Straight during installation, you can make sure the sensor output values are correctly interpreted by the controller.
- **Minimum limit:** Simulates the minimum limit for the filling (e.g. 0 %). In the next step the defined level correction will be applied (*1-point*, *2-point* or *Linear*). The digital output value of the device is the result of processing the minimum limit value with applied user correction.
  This function supports parameterization/installation. With applied user correction or at device exchange, the resulting minimum output level can be evaluated.
- **Maximum limit:** Simulates the maximum limit for the filling level (e.g. 100 %). In the next step the defined level correction will be applied (*1-point*, *2-point* or *Linear*). The digital output value of the device is the result of processing the maximum value with applied user correction.
  This function supports parameterization/installation. With applied user correction or at device exchange the resulting maximum output level value can be evaluated.

Function *Simulation of the digital output* provides the following parameters:

- *Off*: No simulation at digital output
- *Simulation value*: Displaying the *Simulation value digital output*
- *Raw value*: Displaying the *Simulation value digital output* after level correction.
- *Minimum limit*: minimum limit 0 % at digital output(default). The value entered applies the same unit as defined as level measuring unit: percent, mm, cm, m, inch, feet.
- *Maximum limit*: Maximum limit 100 % at digital output (default). The value entered applies the same unit as defined as level measuring unit: percent, mm, cm, m, inch, feet.

Selecting *simulation value* or *raw value* will simulate the following parameter:

- *Simulation value digital output*: 0 % (default). The value entered applies the same unit as defined as level measuring unit: percent, mm, cm, m, inch, feet.

For detailed information on the following access data please see chapter *Annex [▸ 37]*.

IO-Link access: digital output

Name	Index	Subindex	Description
Level Simulation	248	12	Choose level simulation type of the sensor: ▪ `0`: Off ▪ `1`: Simulation Value ▪ `2`: Raw Value ▪ `3`: Min Value ▪ `4`: Max Value
Level Simulation Value	248	13	Enter level simulation value.

DFON access: digital output

- ***Menu* | *PLP70 menu* | *Diagnostic* | *Level simulation* | *Simulation type***
- ***Menu* | *PLP70 menu* | *Diagnostic* | *Level simulation* | *Simulation value***

Also see about this

Unit fill level [▷ 16]
Level correction [▷ 19]

6.2 Identification

The sensor can be added user or application-specific information. Identification settings as follows:

- Sensor properties:
  - *Application-specific tag*: max. 32 characters
  - *Function tag*: max. 32 characters
  - *Location tag*: max. 32 characters
- The sensor's installation date:
  - *Tag*: Values between `1 ... 31`
  - *Month*: Values between `1 ... 12`
  - *Year*: Values between `1900 ... 2100`
- Length of sensing probe: Provides the device-specific length of the sensing probe. Length reading is directly by sensor software and cannot be changed.

7 Annex

7.1 IO-Link

7.1.1 PDI

subindex	bit offset	data type	allowed values	default value	acc. restr.	mod. other var.	excl. from DS	name	description
1	64	Boolean						Switch 1 Output	
2	65	Boolean						Active Alarms	
3	66	Boolean						Configuration Error	
4	67	Boolean						Current Out Error	
5	68	Boolean						Immersed	
6	32	32-bit UInteger						Output current	
7	0	Float32						Measured Value	

Octet 0

bit offset	71	70	69	68	67	66	65	64
subindex	//////	//////	//////	5	4	3	2	1

Octet 1

bit offset	63	62	61	60	59	58	57	56
subindex	6							
element bit	31	30	29	28	27	26	25	24

Octet 2

bit offset	55	54	53	52	51	50	49	48
subindex	6							
element bit	23	22	21	20	19	18	17	16

Octet 3

bit offset	47	46	45	44	43	42	41	40
subindex	6							
element bit	15	14	13	12	11	10	9	8

Octet 4

bit offset	39	38	37	36	35	34	33	32
subindex	6							
element bit	7	6	5	4	3	2	1	0

Octet 5

bit offset	31	30	29	28	27	26	25	24
subindex	7							
element bit	31	30	29	28	27	26	25	24

Octet 6

bit offset	23	22	21	20	19	18	17	16
subindex	7							
element bit	23	22	21	20	19	18	17	16

Octet 7

bit offset	15	14	13	12	11	10	9	8
subindex	7							
element bit	15	14	13	12	11	10	9	8

Octet 8

bit offset	7	6	5	4	3	2	1	0
subindex	7							
element bit	7	6	5	4	3	2	1	0

7.1.2 Identification

Index	Subindex	Name	Data type	Access rights	Value range	Description
16	0	Vendor Name	String	R	ASCII	Vendor name that is assigned to a vendor ID, e. g. Baumer.
17	0	Vendor Text	String	R	ASCII	Additional information about the vendor, e. g. www.baumer.com
18	0	Product Name	String	R	ASCII	Complete product name, e. g. PLP70x.
19	0	Product ID	String	R	ASCII	Vendor-specific product or type identification, e. g. PLP70.
21	0	Serial number	String	R	ASCII	Unique, vendor-specific identifier of the individual device, e. g. K462.27.X-0401-4251.
22	0	Hardware revision	String	R	ASCII	Unique, vendor-specific identifier of the hardware revision of the individual device, e. g. 00.00.01
23	0	Firmware Revision	String	R	ASCII	Unique, vendor-specific identifier of the firmware revision of the individual device, e .g. 00.00.04
24	0	Application specific Tag	String	R/W	ASCII	Possibility to mark a device with user-or application-specific information.
25	0	Function Tag	String	R/W	ASCII	Possibility to mark a device with function-specific information.
26	0	Location Tag	String	R/W	ASCII	Possibility to mark a device with location-specific information.
104	4	Day	Uint8	R/W	1	User date, day
104	5	Month	Uint8	R/W	1	User date, month
104	6	Year	Uint16	R/W	2	User date, year
1003	2	Length	Uint32	R	4	Length of measurement rod [mm]

7.1.3 Parameter

7.1.3.1 Factory Reset Menu

Index	Subindex	Name	Data type	Access rights	Value range	Description
2	0	System Command	Uint8	W		The parameters of the device are reset to factory settings. Note: A download of the data storage may be executed on the next power circle. ▪ 130: Reset factory settings

7.1.3.2 Sensor Setup Menu

Index	Subindex	Name	Data type	Access rights	Value range	Description
121	2	Measurement Damp-ing	Int32	R/W	0 ... 60	Enter time interval for measurement damping: ▪ min.: `0 s` ▪ max.: `60 s`
121	1	Immersion Damping	Int8	R/W	0 ... 1	Enable/disable damping of the immersion signal: ▪ `0`: Disabled ▪ `1`: Enabled
74	3	Unit Filling Level	Int32	R/W	20 and 41 ... 56	Choose physical unit for the measured value: ▪ `20`: Percent ▪ `41`: Meter ▪ `46`: Millimeter ▪ `54`: Centimeter ▪ `55`: Feet ▪ `56`: Inch
77	6	Mounting Position	Uint32	R/W	0 ... 1	Choose mounting position of the sensor: ▪ `0`: Sensor is mounted on top of the tank. ▪ `1`: Sensor is mounted at the bottom of the tank
106	1	Immersion Sensitivity	Uint8	R/W	0 ... 100	Enter the sensitivity of immersion detection: ▪ min.: `0` ▪ max.: `100`

Index	Subindex	Name	Data type	Access rights	Value range	Description
58	1	qTeach enabled	Bool	R/W	0 ... 1	Enable/disable the qTeach user interface: ▪ `0`: Disabled ▪ `1`: Enabled
400	1	Level Correction	Int32	R/W	0 ... 3	Choose level correction applied to the measured value: ▪ `0`: Correction disabled ▪ `1`: 1 point correction enabled ▪ `2`: 2 point correction enabled ▪ `3`: Linearization correction enabled

7.1.3.3 Switch Menu

Index	Subindex	Name	Data type	Access rights	Value range	Description
16128	1	Switch Window Min.	Float32	R/W	-33000 ... 33000	Enter switching window min. value.
16128	2	Switch Window Max.	Float32	R/W	-33000 ... 33000	Enter switching window max. value.
69	1	Hysteresis	Float32	R/W	-33000 ... 33000	Define the hysteresis value of the switch window limits.
16129	1	Switching Logic	Int32	R/W	0 ... 1	Define the polarity of the switch. ▪ `0`: high active ▪ `1`: low active
78	1	Switch Function	Int32	R/W	0 ... 3	Choose the function of the switch output: ▪ `0`: OFF ▪ `1`: Push-Pull ▪ `2`: PNP ▪ `3`: NPN
78	5	Switch 1 Alarm mode	Int32	R/W	1 ... 4	Set the behavior of the switch output on wire break or system error alarm: ▪ `1`: Output High ▪ `2`: Output Low ▪ `3`: Output Floating ▪ `4`: Output Frozen

7.1.3.4 Analog Output Menu

Index	Subindex	Name	Data type	Access rights	Value range	Description
202	1	Analog Output	Bool	R/W	0 ... 1	Enable/disable analog current output: ▪ `0`: Disabled ▪ `1`: Enabled
202	3	Measurement at 4mA	Float32	R/W	-33000 ... 33000	Enter the level value corresponding to 4 mA output current.
202	5	Measurement at 20mA	Float32	R/W	-33000 ... 33000	Enter the level value corresponding to 20 mA output current.
202	7	Low Current Limit	Int16	R/W	-2400 ... 23000	Enter lower limit for linear current range.
202	9	Upper Current Limit	Int16	R/W	-2400 ... 23000	Enter upper limit for linear current range.
11028	2	System Error Current	Uint16	R/W	-2400 ... 23000	Enter output current value in case of system error.
116	3	Not Immersed Current	Int16	R/W	-2400 ... 23000	Enter output current value when measuring rod is not touching any medium (empty tank).

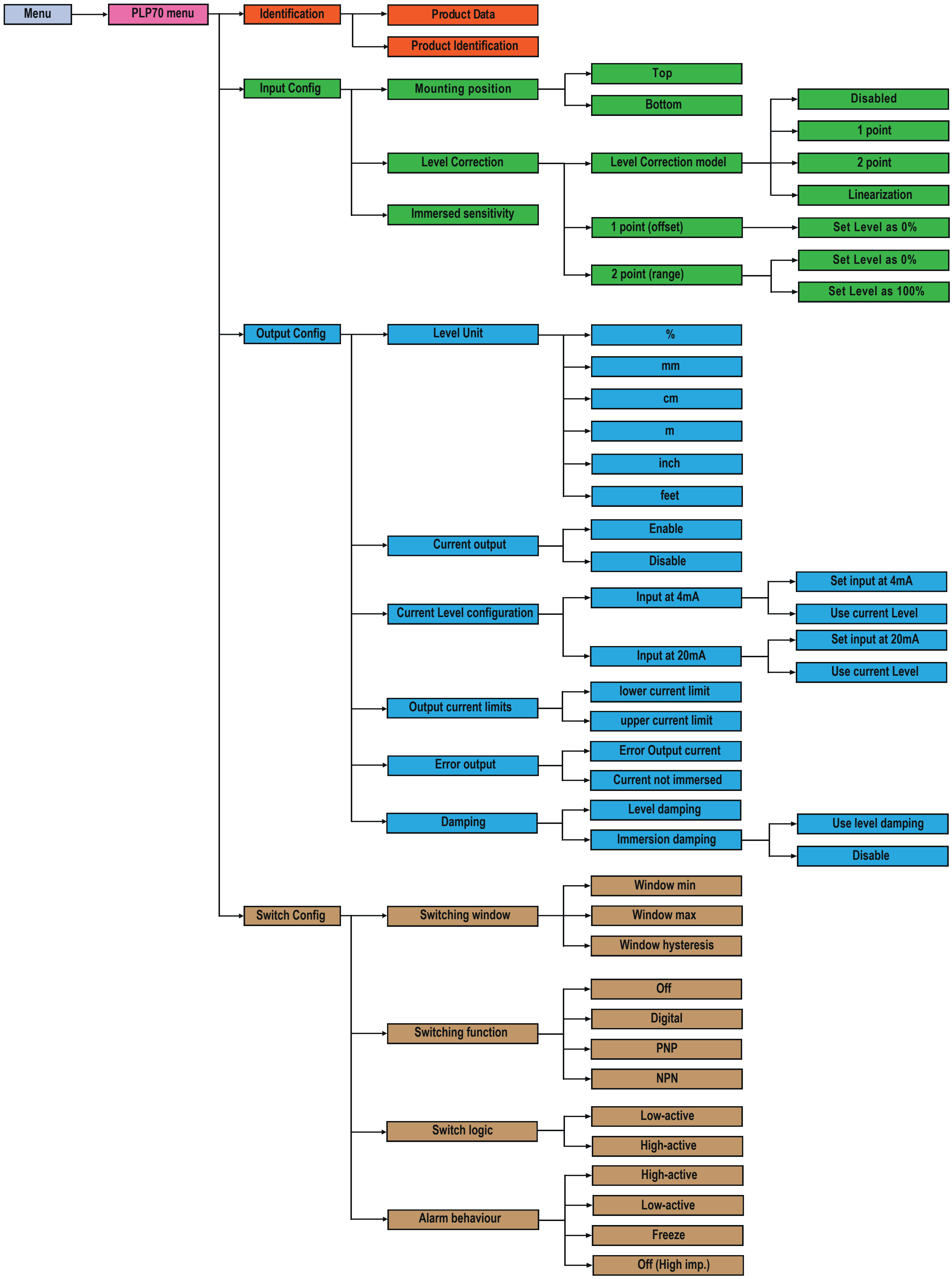
7.1.3.5 Simulation menu

Index	Subindex	Name	Data type	Access rights	Value range	Description
248	2	Current Output Simulation	Uint32	R/W	0 ... 3 and 5 ... 6	Choose current output simulation type of the sensor: ▪ 0: Off ▪ 1: Simulation Value ▪ 2: Lower Limit ▪ 3: Upper Limit ▪ 5: Not Immersed ▪ 6: Device Error
248	5	Current Output Simulation Value	Uint32	R/W	-2400 ... 23000	Enter current output simulation value.
248	12	Level Simulation	Uint32	R/W	0 ... 4	Choose level simulation type of the sensor: ▪ 0: Off ▪ 1: Simulation Value ▪ 2: Raw Value ▪ 3: Min Value ▪ 4: Max Value
248	13	Level Simulation Value	Float32	R/W	-33000 ... 33000	Enter level simulation value.

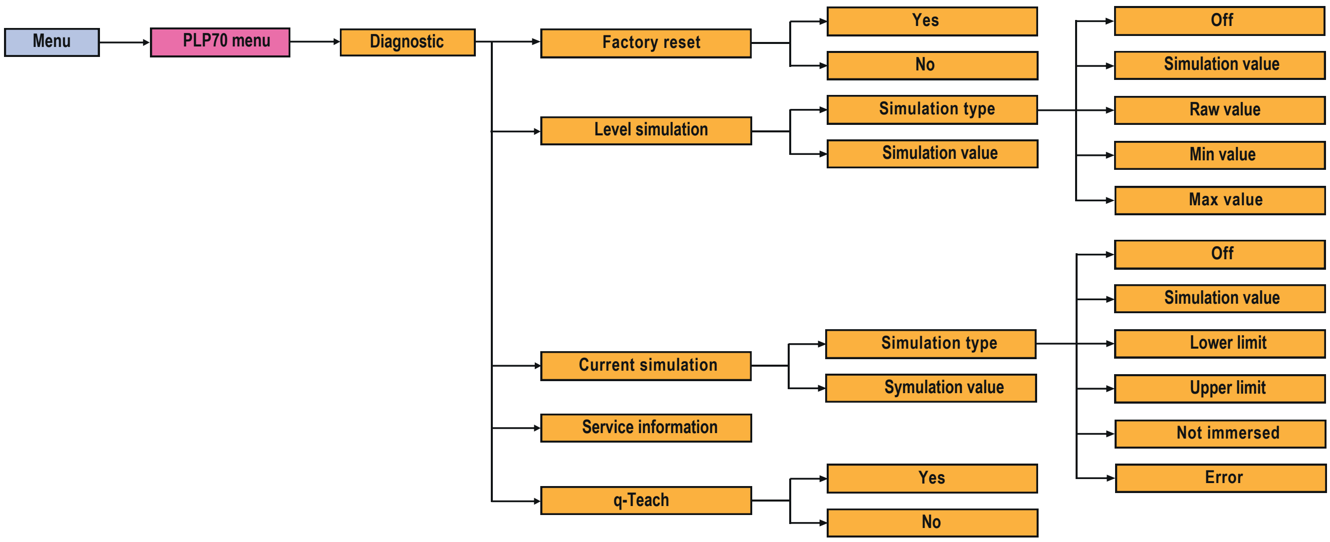
7.1.3.6 Calibration menu

Index	Subindex	Name	Data type	Access rights	Value range	Description
Calibration menu 1 – 1 point						
407	1	1 point – Offset	Float32	R/W	-33000 ... 33000	Enter the offset value used with 1 point Offset.
Calibration menu 2 – 2 point						
405	0	2 Point – Calibration Point	Float32	R/W	-33000 ... 33000	Enter the calibration points for 2 Point correction. Calibration value is an array of length 2.
404	0	2 Point – Calibration Value	Float32	R/W	-33000 ... 33000	Enter the calibration values for 2 Point correction. Calibration value is an array of length 2.
Calibration menu 3 – Linear						
400	2	Linear – Table Length	Uint8	R/W	3 ... 30	Enter the table length of linearization table.
402	0	Linear – Calibration Point	Float32	R/W	-33000 ... 33000	Enter the calibration points for linear correction. Calibration value is an array of length 30.
401	0	Linear – Calibration Value	Float32	R/W	-33000 ... 33000	Enter the calibration values for linear correction. Calibration value is an array of length 30.

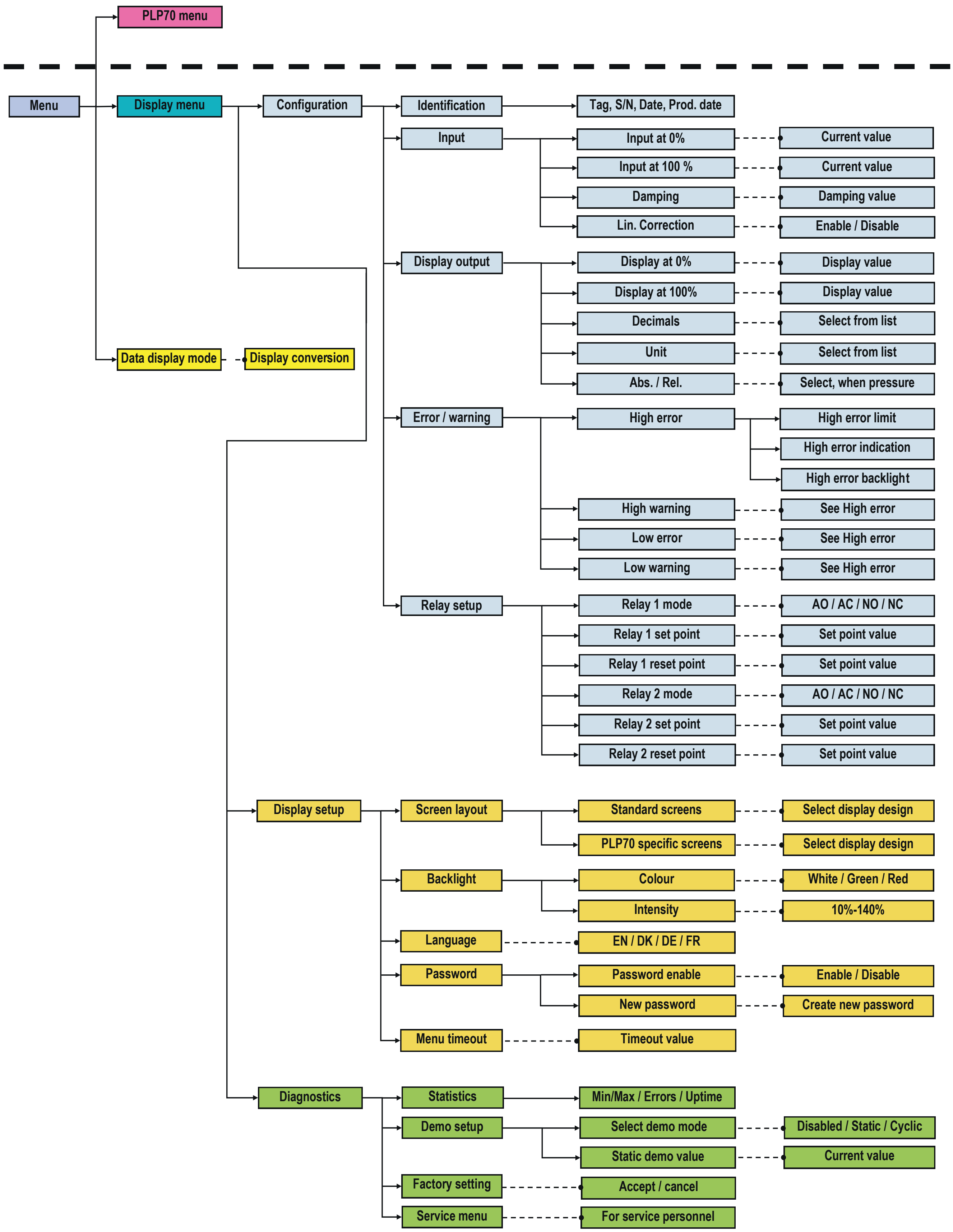
7.2 DFON



Ill. 15: DFON: menu structure plan (1)

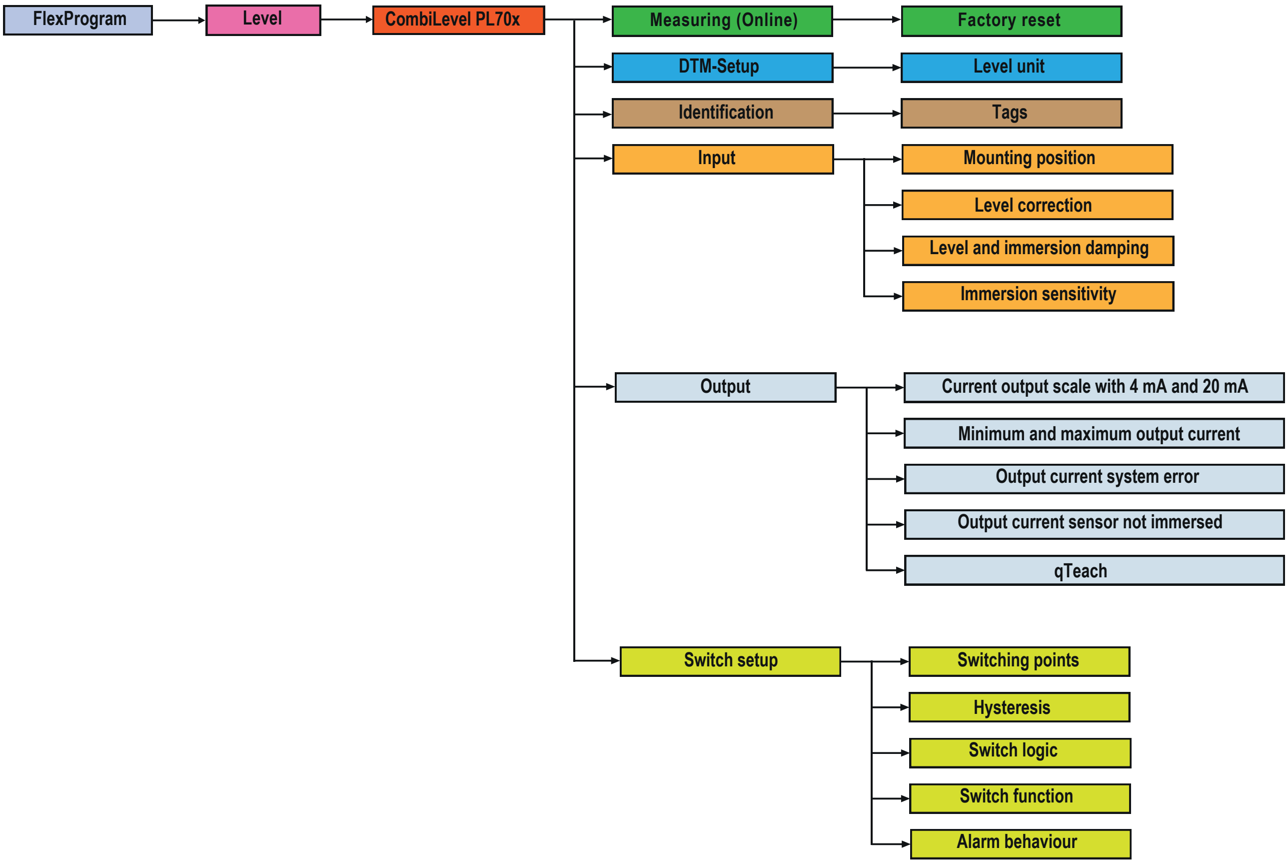


Ill. 16: DFON: menu structure plan (2)



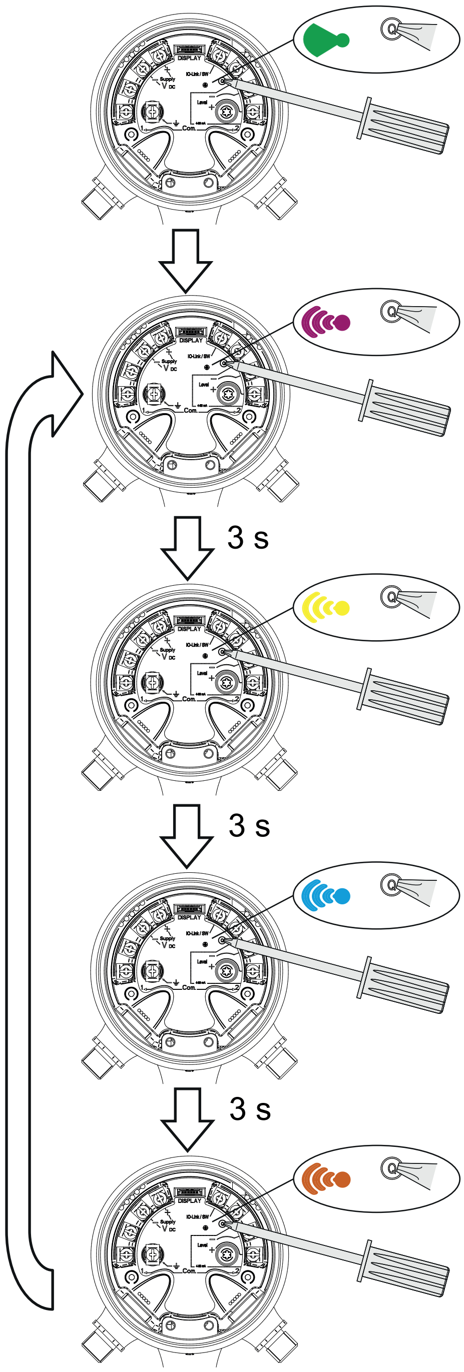
Ill. 17: DFON: menu structure plan (3)

7.3 FlexProgram



Ill. 18: FlexProgram: menu structure plan

7.4 qTeach



Removing the ferromagnetic tool will not produce any change.

Teach in level value corresponding to 4 mA output current.

Teach in level value corresponding to 20 mA output current.

Restore default.

Ill. 19: qTeach: Flowchart

List of illustrations

Ill. 1 Principle of potentiometric level measurement 5
Ill. 2 Block diagram Hardware 6
Ill. 3 Block diagram Software 7
Ill. 4 IO-Link architecture 8
Ill. 5 Parameterization via *qTeach* 12
Ill. 6 Tank with inside swell (fluctuation) and level sensor 14
Ill. 7 Sensor mounting positions 17
Ill. 8 Sensor switching operations within the range SP1 to SP2 22
Ill. 9 Hysteresis in window mode 23
Ill. 10 Behaviour of the switching output in window mode 23
Ill. 11 Circuit diagram of PNP switching output 25
Ill. 12 Circuit diagram of NPN switching output 25
Ill. 13 Circuit diagram of push-pull switching output 25
Ill. 14 Analog measuring field for sensor top mount (left) and bottom mount (right) 31
Ill. 15 *DFON*: menu structure plan (1) 45
Ill. 16 *DFON*: menu structure plan (2) 46
Ill. 17 *DFON*: menu structure plan (3) 47
Ill. 18 *FlexProgram*: menu structure plan 48
Ill. 19 *qTeach*: Flowchart 49

9007199624750091

Baumer A/S
Runetoften 19
DK - 8210 Aarhus V
www.baumer.com

Baumer
Passion for Sensors