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TURCK

LS-5
Level Sensor

Instructions for Use

Described product

Level Sensors Series LS-5

Manufacturer

Hans Turck GmbH & Co. KG
Witzlebenstraße 7
45472 Mülheim an der Ruhr
Germany
Tel. +49 208 4952-0
Fax +49 208 4952-264
more@turck.com
www.turck.com

Legal notices

Original document

This document is an original document of Turck.

Contents

1 About this document

1.1 Information on the operating instructions

These operating instructions provide important notes on how to use sensors from Turck.

Prerequisites for safe work are:

- Compliance with all safety notes and handling instructions supplied.
- Compliance with local work safety regulations and general safety regulations for sensor applications.

The operating instructions are intended to be used by qualified personnel and electrical specialists.

Note:

Read these operating instructions carefully before starting any work on the device, in order to familiarize yourself with the device and its functions.

The instructions constitute an integral part of the product and are to be stored in the immediate vicinity of the device so they remain accessible to staff at all times. Should the device be passed on to a third party, these operating instructions should be handed over with it.

These operating instructions do not provide information on operating the machine in which the sensor is integrated. For information about this, refer to the operating instructions of the particular machine.

1.2 Scope

These operating instructions serve to incorporate a sensor into a customer system. Instructions are given by stages for all actions required.

These instructions apply to all available device variants of the sensor. For more detailed information for the identification of the available device types, see “3.1.2 Type code”.

Available device variants are listed on the online product page:

▶ www.turck.com

Various device variants are used as examples for commissioning, based on the default parameter settings for the relevant device.

Simplified device name in the document: In the following, the sensor is referred to in simplified form as LS-5. Exceptions occur where a distinction between device variants is required due to different technical features or functions. In this case, the complete type designation (e.g. LS-5) is used.

1.3 Explanation of symbols

Warnings and important information in this document are labeled with symbols. The warnings are introduced by signal words that indicate the extent of the danger. These warnings must be observed at all times and care must be taken to avoid accidents, personal injury, and material damage.

DANGER

... indicates a situation of imminent danger, which will lead to a fatality or serious injuries if not prevented.

WARNING

... indicates a potentially dangerous situation, which may lead to a fatality or serious injuries if not prevented.

CAUTION

... indicates a potentially dangerous situation, which may lead to minor/slight injuries if not prevented.

IMPORTANT

... indicates a potentially harmful situation, which may lead to material damage if not prevented.

NOTE

... highlights useful tips and recommendations as well as information for efficient and trouble-free operation.

1.4 Further information

NOTE

All the documentation available for the sensor can be found on the online product page at:

www.turck.com

The following information is available for download there:

- Model-specific online data sheets for device variants, containing technical data, dimensional drawings and diagrams
- EU declaration of conformity for the product family
- Dimensional drawings and 3D CAD dimension models in various electronic formats
- These instructions for use are available in English and German, and in other languages if necessary
- Other publications related to the sensors described here (e.g. IO-Link)
- Publications dealing with accessories

2 Safety information

2.1 Intended use

The LS-5 is designed for both continuous level measurement and point level measurement in nearly all liquids (a list of the possible media can be found in the appendix).

The sensor is not affected by changes in the properties of the liquids to be measured.

The LS-5 can be used in metal containers or bypass/immersion pipes. A coaxial tube is required for use in plastic containers.

2.2 Incorrect use

Any use outside of the stated areas, in particular use outside of the technical specifications and the requirements for intended use, will be deemed incorrect use.

If the operator wishes to use the sensor in other conditions or in different environments, then the manufacturing service may issue an operating license in consultation with the customer and in exceptional cases.

2.3 Limitation of liability

Applicable standards and regulations, the latest state of technological development, and our many years of knowledge and experience have all been taken into account when assembling the data and information contained in these operating instructions. The manufacturer accepts no liability for damage caused by:

- Failing to observe the operating instructions
- Incorrect use
- Use by untrained personnel
- Unauthorized conversions
- Technical modifications
- Use of unauthorized spare parts, consumables, and accessories

With special variants, where optional extras have been ordered, or owing to the latest technical changes, the actual scope of delivery may vary from the features and illustrations shown here.

2.4 Modifications and conversions

IMPORTANT

Modifications and conversions to the sensor and/or the installation may result in unforeseeable dangers.

Interrupting or modifying the sensor or Turck software will invalidate any warranty claims against Turck. This applies in particular to opening the housing, even as part of mounting and electrical installation.

Before technical modifications to and expansions of the sensor, the prior written approval of the manufacturer must be obtained.

2.5 Requirements for skilled persons and operating personnel

WARNING

Risk of injury due to insufficient training.

Improper handling of the sensor may result in considerable personal injury and material damage.

- All work must only ever be carried out by the stipulated persons.

The operating instructions state the following qualification requirements for the various areas of work:

- **Instructed personnel** have been briefed by the operator about the tasks assigned to them and about potential dangers arising from improper action.
- **Skilled personnel** have the specialist training, skills, and experience, as well as knowledge of the relevant regulations, to be able to perform tasks delegated to them and to detect and avoid any potential dangers independently.
- **Electricians** have the specialist training, skills, and experience, as well as knowledge of the relevant standards and provisions to be able to carry out work on electrical systems and to detect and avoid any potential dangers independently. In Germany, electrical specialists must meet the specifications of the BGV A3 Work Safety Regulations (e.g., Master Electrician). Other relevant regulations applicable in other countries must be observed.

The following qualifications are required for various activities:

Activities	Qualification
Mounting, maintenance	• Basic practical technical training • Knowledge of the current safety regulations in the workplace
Electrical installation, device replacement	• Practical electrical training • Knowledge of current electrical safety regulations • Knowledge of device control and operation in the particular application concerned (e.g.conveying line)
Commissioning, configuration	• Basic knowledge of the control system in use • Basic knowledge of the design and setup of the described connections and interfaces • Basic knowledge of data transmission
Operation of the device for the particular application	• Knowledge of device control and operation in the particular area of application concerned (e.g. bottling plant) • Knowledge of the software and hardware environment for the particular application concerned (e.g. bottling plant)

2.6 Operational safety and particular hazards

Please observe the safety notes and the warnings listed here and in other chapters of these operating instructions to reduce the possibility of risks to health and avoid dangerous situations.

2.7 General safety notes

- Read the operating instructions prior to commissioning.
- These operating instructions are valid for devices with a firmware version higher than V1.0.
- The LS-5 is not a safety component under the EU Machinery Directive.
- Observe national safety and work safety regulations.
- Wiring work and the opening and closing of electrical connections may only be carried out when the power is switched off.
- The radiated power is far lower than that from telecommunication equipment. According to current scientific research, the operation of this device can be classified as safe and nonhazardous.

2.8 Repairs

Repair work on the sensor may be performed only by qualified and authorized personnel from Turck. Interruptions or modifications to the sensor on the part of the customer will invalidate any warranty claims against Turck.

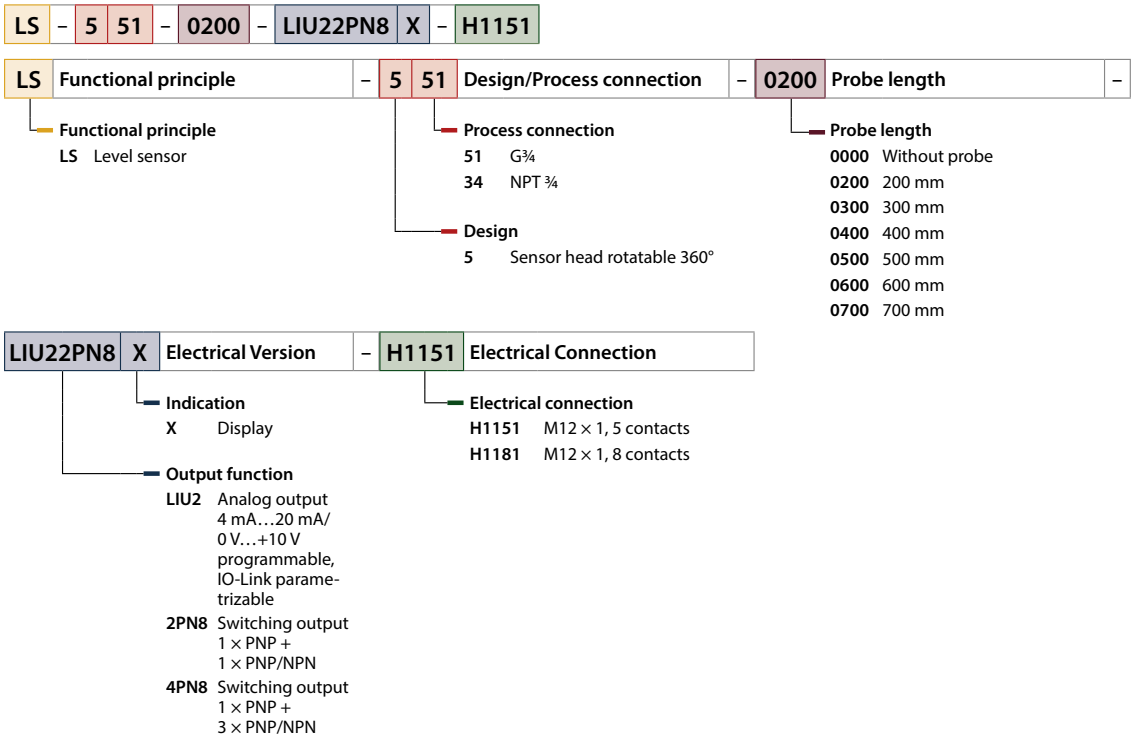
3 Product description

3.1 Product ID

3.1.1 Information on the housing

There is information printed on the housing identifying the sensor and its electrical connection.

3.1.2 Type code



Not all variants of the type code can be combined with each other!

3.2 Product characteristics

3.2.1 Device view

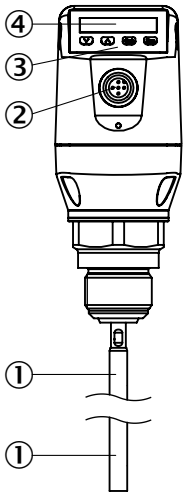


Fig. 1: LS-5

① Sample probe

② Electrical connection

③ Operating buttons

④ Display

3.2.2 Operating buttons

The sensor is operated using the display and operating buttons.

For a detailed description of the pushbuttons and their functions, see “8.1 Display and pushbuttons”.

3.3 Product features and functions

3.3.1 Principle of operation

The LS-5 uses TDR (Time Domain Reflectometry) technology.

This is a process to determine transit times of electromagnetic waves. The sensor electronics generate a low-energy electromagnetic pulse, which is linked to and runs along the probe.

If this pulse strikes the surface of the liquid to be measured, a portion of the pulse is reflected there and is conducted back up along the probe path to the electronics, which then calculate the level based on the time difference between the sent and the received pulse.

The sensor can output this level as a continuous measured value (analog output) and can also derive two and/or four freely positionable switching points from it (switching outputs).

IO-Link communication is also available for the switching output (Q1), see “8.1.3 IO-Link”.

3.3.2 Fields of application

The innovative TDR technology enables reliable level measurement which is largely application-independent. The LS-5 is suitable for both continuous level measurement and point level measurement in nearly all liquids.

The sensor is not affected by changes in the properties of the liquids to be measured.

The LS-5 can be used in metal containers or bypass/immersion pipes. A coaxial tube is required for use in plastic containers.

4 Transport and storage

4.1 Transport

For your own safety, please read and observe the following notes:

IMPORTANT

Damage to the sensor due to improper transport.

- The device must be packaged for transport with protection against shock and damp.
- Recommendation: Use the original packaging as it provides the best protection.
- Transport should be performed by specialist staff only.
- The utmost care and attention is required at all times during unloading and transportation on company premises.
- Note the symbols on the packaging.
- Do not remove packaging until immediately before you start mounting.

4.2 Transport inspection

Immediately upon receipt at the receiving work station, check the delivery for completeness and for any damage that may have occurred in transit. In the case of transit damage that is visible externally, proceed as follows:

- Do not accept the delivery or only do so conditionally.
- Note the scope of damage on the transport documents or on the transport company's delivery note.
- File a complaint.

Note:

Complaints regarding defects should be filed as soon as these are detected. Damage claims are only valid before the applicable complaint deadlines.

4.3 Storage

Store the device under the following conditions:

- Recommendation: Use the original packaging.
- Do not store outdoors.
- Store in a dry area that is protected from dust.
- To ensure that any residual moisture present can escape, do not store in airtight containers.
- Do not expose to any aggressive substances.
- Protect from sunlight.
- Avoid mechanical shocks.
- Storage temperature: see “12 Repair work”.
- Relative humidity: see “12 Repair work”.
- For storage periods of longer than 3 months, check the general condition of all components and packaging on a regular basis.

5 Mounting

5.1 Installation conditions

The LS-5 is mounted vertically from above into the container or bypass, using its process connection. The LS-5 level sensor has a G ¾ or ¾" NPT threaded connection. A minimum connecting piece diameter in accordance with the diagrams below must be observed.

The LS-5 must be installed so that after mounting there is sufficient distance to other tank components (e.g. supply tubes, other measurement devices), the container wall or the container bottom. These minimum distances are also specified in the diagrams.

The LS-5 can also be used in a metal immersion pipe or bypass. The installation conditions are shown in the Figure on page 15.

Ensure that there is a good metallic connection between the LS-5 measuring device and the tank/bypass. When operating the sensor, ensure that the ambient temperature is not above or below the limits.

Insulating the sensor housing is not permitted for tanks with hot media.

When positioning the device, ensure that the sensor is not directly exposed to the filling flow.

The sensor housing can be rotated 360°, allowing for the cable outlet to be positioned freely.

5.1.1 Installation in a container

Note:

The distances are identical for the sensor with remote amplifier.

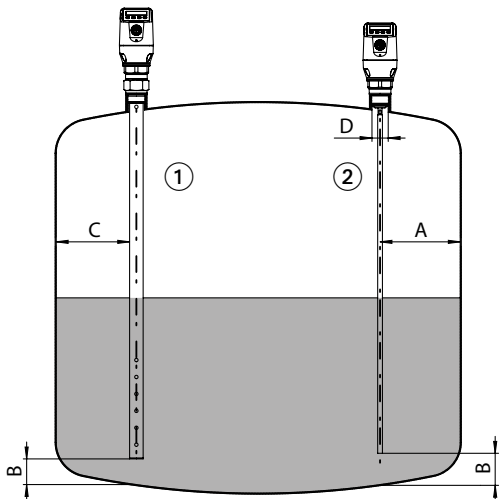


Fig. 2: LS-5

① **Coaxial tube in metallic and non-metallic containers**

C = In the case of a coaxial probe there are no minimum distances from the container wall and built-in components to be observed.

② **Mono-probe with metallic containers**

Installation in the nozzle

D ≥ DN 25

Distance to container wall/container bottom:

A ≥ 50 mm

B ≥ 10 mm

Distance to components built into the container

≥ 100 mm

5.1.2 Installation in a metal immersion tube or metal bypass

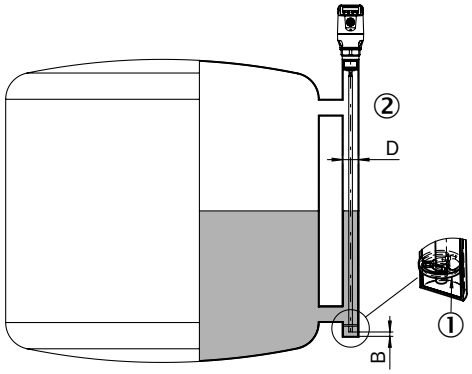


Fig. 3: LS-5

① *Centering*

② *D ≥ DN 40*

Distance to bypass/container bottom

B ≥ 10 mm

Centering: To prevent contact between the probe and the bypass pipe during oscillations, the probe should be centered according to its length and depending on the diameter of the bypass pipe. To do this, it is necessary to insert one or two centering pieces.

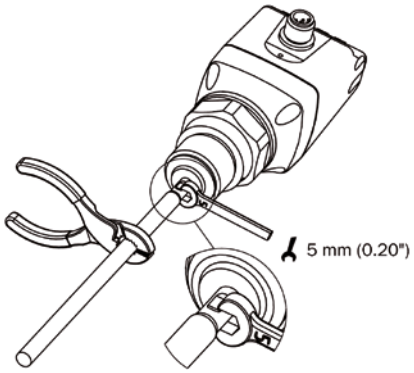
5.2 Shortening or replacing the probe rod

If the probe rod is too long for the application, it can be shortened to the container height. In this case, you should not shorten the probe beyond its minimum length of 100 mm. If the LS-5 is to be used in a hygienic application, then be sure that the roughness of Ra≤0.8 µm is reestablished on the shortened machined surfaces of the mono-probe.

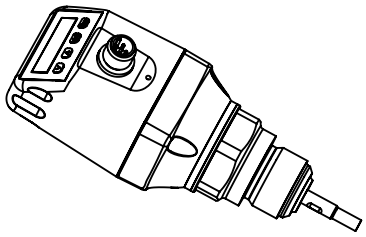
5.2.1 Procedure

Shorten the probe rod as desired. Adjust the new probe length in the LS-5, see “8.4.7 Configuring the probe length”. Ensure that this correction corresponds to the probe length, because an incorrect value in the Length menu has a direct effect on measurement accuracy and can lead to faults. The probe length L is set out in Chapter “15 Dimensional drawings”.

The probe rod can be swapped. Use a suitable tool. If the system experiences strong vibrations, secure the probe with thread-locking lacquer.

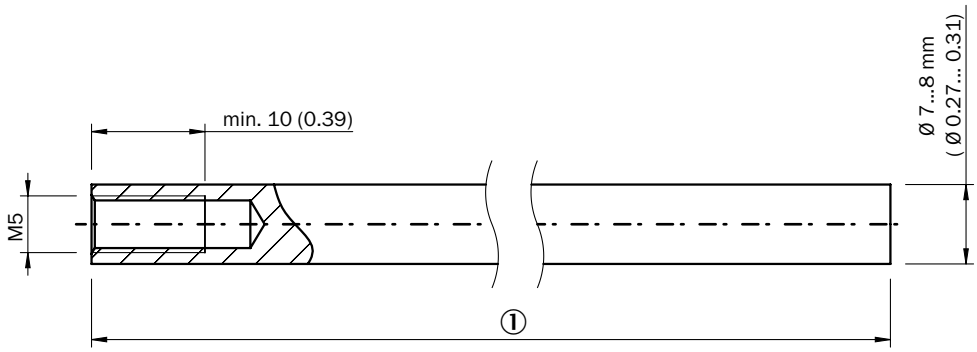


5.3 Mounting the probe rod



With the LS-5, the probe rod can be modified by the customer. The specifications for the probe rod must be as follows:

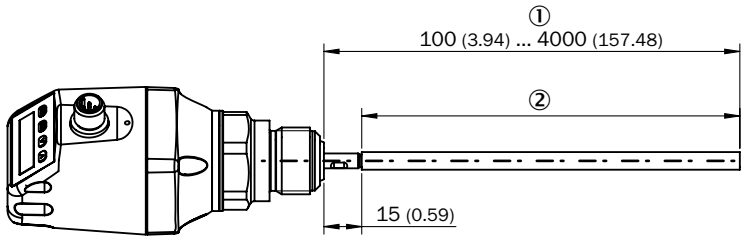
Probe rod diameter:	7 mm ... 8 mm
Female thread on the probe rod:	M5
Female thread length:	min. 10 mm
Material:	Stainless steel



① *Probe rod length*

Total probe length: 100 mm ... 1000 mm
Total probe length = 15 mm + probe rod length

Set the total probe length as described in Chapter “8.4.7 Configuring the probe length”. The EXPRT-Config-Length menu is password protected. If the system experiences strong vibrations, secure the probe with thread-locking lacquer.



① *Total probe length*

② *Probe rod length*

6 Electrical installation

6.1 Safety

6.1.1 Notes on the electrical installation

IMPORTANT

Equipment damage due to incorrect supply voltage!

An incorrect supply voltage may result in damage to the equipment.

- Only operate the device using a protected low voltage and safe electrical insulation as per protection class III.

IMPORTANT

Equipment damage or unpredictable operation due to working with live parts.

Working with live parts may result in unpredictable operation.

- Only carry out wiring work when the power is off.
- Only connect and disconnect electrical connections when the power is off.

- **The electrical installation must only be performed by electrically qualified personnel.**
- **Standard safety requirements must be met when working in electrical systems.**
- Only switch on the supply voltage for the device when the connection tasks have been completed and the wiring has been thoroughly checked.
- When using extension cables with open ends, ensure that bare wire ends do not come into contact with each other (risk of short-circuit when supply voltage is switched on!). Wires must be appropriately insulated from each other.
- Wire cross-sections in the supply cable from the customer's power system must be designed in accordance with the applicable standards. In Germany, observe the following standards: DIN VDE 0100 (Part 430) and DIN VDE 0298 (Part 4) and/or DIN VDE 0891 (Part 1).
- Circuits connected to the device must be designed as SELV circuits (SELV = Safety Extra Low Voltage).
- Protect the device with a separate fuse at the start of the supply circuit.

Instructions for laying data cables:

- Use screened data cables with twisted-pair wires.
- Implement the screening design correctly and completely.
- To avoid interference, e.g. from switching power supplies, motors, clocked drives, and contactors, always use cables and layouts that are suitable for EMC.
- Do not lay cables over long distances in parallel with voltage supply cables and motor cables in cable channels.

The IP67 protection class for the device is only achieved under the following conditions:

- The cable connected at the M12 connection is screwed on.

If this is not done, the device does not fulfill any specified IP enclosure rating!

6.2 Electrical connection

6.2.1 Overview of the electrical connections

The sensor is connected using a pre-assembled female cable connector with M12 x 1 plug connector (5/8-pin). With the power switched off, plug the female cable connector into the sensor and screw it tight.

Connect the cable according to its function. After the supply voltage is set up, the sensor performs a self-test. Once installed, the sensor is ready for operation upon completion of the self-test (< 5 s). The display shows the current measured value.

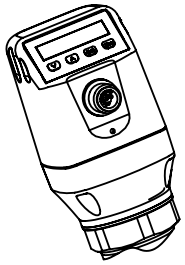


Fig. 4: LS-5

6.2.2 Pin assignment, M12 plug connector, 5-pin

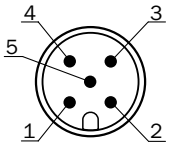


Fig. 5: M12 x 1 plug connector, 5-pin

Contact	Marking	Wire color	Description
1	L+	Brown	Supply voltage
2	Q_A	White	Analog current/voltage output
3	M	Blue	Ground, reference potential for current/voltage output
4	C/Q_1	Black	Switching output 1, PNP/ IO-Link communication
5	Q_2	Gray	Switching output 2, PNP/ NPN

6.2.3 Pin assignment, M12 plug connector, 8-pin

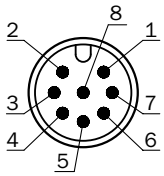


Fig. 6: M12 x 1 plug connector, 8-pin

Contact	Marking	Description
1	L+	Supply voltage
2	Q_2	Switching output 2, PNP/ NPN
3	M	Ground, reference potential for current/voltage output
4	C/Q_1	Switching output 1, PNP/IO-Link communication
5	Q_3	Switching output 3, PNP/NPN
6	Q_4	Switching output 4, PNP/NPN
7	Q_A	Analog current/voltage output
8		No function

The wire colors for 8-pin cables are not standardized. Always note the pin assignment of the sensor.

7 Commissioning

7.1 Quick commissioning (with factory settings)

Quick commissioning is used in applications under reference conditions see “5 Mounting”.

The following rules apply:

- Use in metallic containers or immersion/bypass pipes
- The liquid to be measured has a Dielectric constant of > 5, see “18 Media list”

Commissioning

1. Mount the sensor in accordance with the installation conditions, see “5 Mounting”.
2. The container must be empty and/or the level must be at least 200 mm below the end of the probe.
3. Log in to expert mode, see “8.4.1 Expert mode”.
4. After mounting, launch the AutCal menu item.
   - Press and hold the Set pushbutton for at least 3 seconds.
   - Use the Set pushbutton to confirm the AutCal menu item and then use it again to confirm the “OK?” confirmation prompt.
   - The AutCal function is confirmed with !CalOK.
5. Configure outputs, see “8.2 Configuring the switching outputs”.

Note:

If the AutCal function has been confirmed with !NoSig, relaunch AutCal.

If problems occur during commissioning, see “11 Troubleshooting”.

7.2 Advanced commissioning

Advanced commissioning is required when quick commissioning is not sufficient or if one of the following situations applies:

- The liquid to be measured has a Dielectric constant of < 5, see “18 Media list”.
- There are tank components which can interfere with the measurement signal (in the case of the LS-5).
- In the event of significant ripples in the surface of the liquid.
- If there are variations in the installation conditions, see “5 Mounting”.

Commissioning

1. Mount the sensor in accordance with the installation conditions, see “5 Mounting”.
2. Log in to expert mode, see “8.4.1 Expert mode”.
3. Select the measuring mode.
   - Access the EXPRT-CONFIG-MeasMd menu using the arrow and Set pushbuttons.
   - HiSpd: max. length = 2005 mm, response time < 400 ms.
   - HiAcc: max. length = 6,005 mm, response time < 2,800 ms, more stable measured values recommended for liquids with low DKs and where TrsHld is < 70.
4. Teach-in the static sources of interference in the tank.
   - Static sources of interference in the tank generated by tubes, beams, couplings, or a cleaning ball are taught into the system as standard.
   - Access the EXPRT-CONFIG-CalRng menu using the arrow and Set pushbuttons. The following rules apply:
     - Teach-in depth starts from the LS-5 process connection
     - Teach-in depth should cover all interference signals
     - Maximum teach-in depth (recommended) = probe length
     - Set the value range between 95 mm ... 6,005 mm
   - If the tank cannot be emptied completely, the CalRng teach-in depth must be adapted accordingly.
   - The level must be at least 200 mm below the CalLen and/or the end of the probe.
5. Launch the AutCal function.
   - Access the AutCal menu using the arrow and Set pushbuttons.
   - The following information applies: The probe must not be covered with liquid in the CalRng set in step 4 (teach-in depth + 200 mm).
   - Use the Set pushbutton to confirm the AutCal menu item and then use it again to confirm the “Ok?” confirmation prompt.
   - The AutCal function is confirmed with !CalOK.
6. Analyze the signal quality.
   - The signal quality can be analyzed when the device is installed, see “8.4.9 Evaluating signal quality”.
   - In the event of problems:
     - Reduce the value in the EXPRT-CONFIG-TrsHld menu.
     - Set the parameter to HiAcc in the EXPRT-CONFIG-MeasMd menu.
     - Switch on the filters in the Set filters menu.
     - Reduce the parameter in the EXPRT-CONFIG-MaxCol menu.
7. Configure the filter (see Chapter “8.4.2 Filtering measured values”).
8. Perform maximum change of level/plausibility check (see Chapter “8.4.2 Filtering measured values”).
9. Configure outputs (“8.2 Configuring the switching outputs”).

Note:

- Use the foam commissioning instructions for applications with foam.
- The sensor automatically quits expert mode after 5 minutes of inactivity on the display.
- Any of the following processes voids the configuration (AutCal):
  - Changing the probe length
  - Changing the measuring mode
  - Changing the teach-in depth

If problems occur during commissioning, see “11 Troubleshooting”.

7.3 Foam commissioning (with factory settings)

For use in applications with a significant buildup of foam.

Performing foam calibration

1. Mount the sensor in accordance with the installation conditions, see “5 Mounting”.
2. Log in to expert mode, see “8.4.1 Expert mode”.
3. Empty the tank completely.
   - The probe rod must be completely free from medium and foam.
   - Buildup must be removed from the probe.
   - The end of the probe must not be fixed to the bottom of the tank.
4. Select the measuring mode.
   - Access the EXPRT-Config-MeasMd menu using the arrow and Set pushbuttons, and configure to HiAcc.
5. Select mode
   Access the EXPRT-Config-Mode using the arrow and Set pushbuttons, and configure to Foam.
6. Perform the empty calibration.
   - Access the EXPRT-Foam-CalEmp menu using the arrow and Set pushbuttons.
   - !CalOk: Proceed to step 7.
   - !faild: Ensure that the tank is empty and repeat step 6.
7. Fill with medium (without foam) until the probe is covered by at least 200 mm. The maximum level must remain 200 mm from the process connection.
8. Perform EXPRT-Foam-CalMed.
   - !CalOk: Everything in working order, proceed to step 9.
   - !faild: Carry out step 8 again.
     The LS-5 must now display a valid measured value.
9. Check the foam calibration in EXPRT-INFO-CalSta.
   - FomCal: Foam commissioning was completed successfully.
   - CalMis: Commissioning unsuccessful. Please repeat the process.

Note:

- Measurement deviation can be higher.
- Signal quality 1 and 2 are not counted.
- The sensor automatically quits expert mode after 5 minutes of inactivity on the display.
- Configuration (foam teach) does not take place in the following processes:
  - Changing the probe length
  - Changing the measuring mode
  - Changing the teach-in depth
  - Performing AutCal

If problems occur during commissioning, see “11 Troubleshooting”.

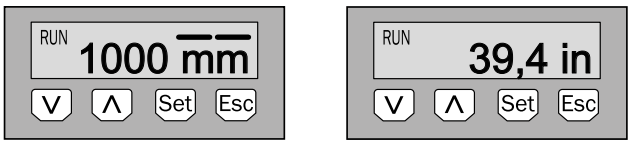
8 Operation

8.1 Display and pushbuttons

All lengths specified in the menu refer to the end of the probe and/or, for a configured offset (for LS-5 see “8.4.7 Configuring the probe length”), to the tank bottom. You can access the menu by pressing the Set pushbutton for at least three seconds.

8.1.1 Variants with two switching outputs

Q1 Q2



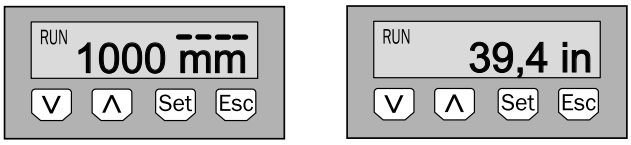
Arrow pushbuttons: *Navigating in the menu and changing values*
Set pushbutton: *Saving and confirming*
Esc pushbutton: *Exiting the operating menu step-by-step*

Note:

A bar graph above the unit symbol indicates the statuses of the switching outputs when using millimeters as the unit. This display is not available when inches are selected as the unit.

8.1.2 Variants with four switching outputs

Q1/2/3/4



Arrow pushbuttons: *Navigating in the menu and changing values*
Set pushbutton: *Saving and confirming*
Esc pushbutton: *Exiting the operating menu step-by-step*

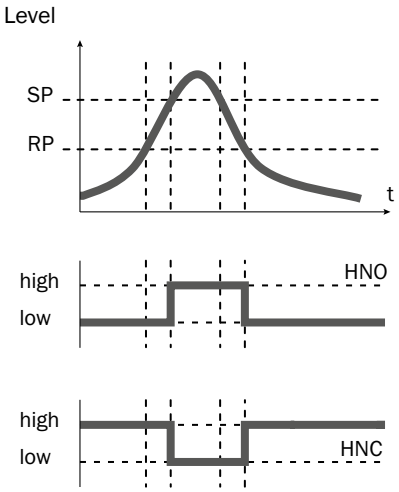
8.1.3 IO-Link

For operation over IO-Link, an IODD file and a description of the available telegram parameters are available for download at www.turck.com.

8.2 Configuring the switching outputs

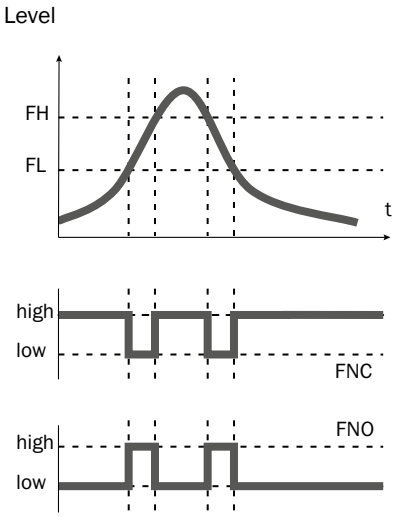
8.2.1 Switching hysteresis and window function

Depending on 2 or 4 output variants



If the level is fluctuating around the target value (e.g. ripple movement during filling), the hysteresis keeps the switching status of the outputs stable. When the level is increasing, the output switches when the respective switching point (SP) is reached; if the level sinks again, the output switches back only after the reset switching point (RP) has been reached.

Depending on 2 or 4 output variants



The window function enables monitoring of a defined range. If the level is between window high (FH) and window low (FL), the output will be active (normally open) and/or inactive (normally closed).

The error status of the measuring device reflects the cable break monitoring. During an error status, the measuring device switches to a safe state; i.e. the switching outputs become inactive.
As far as the downstream signal evaluation is concerned, this corresponds to a cable break.

8.2.2 Normally open with adjustable hysteresis

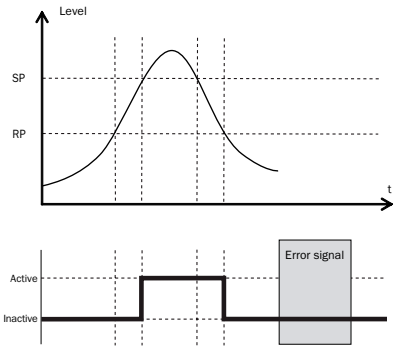
Applications

- Dry run protection
- Empty signal

Configuration

1. Configure the Qx switching output as normally open.
   - Set the parameter in the QxMENU-OUx menu to Qx_Hno.
2. Set the switching point.
   - Set the value in the QxMENU-SPx menu to the level in mm (e.g. 500 mm).
3. Set the reset point.
   - Set the value in the QxMENU-RPx menu to the level in mm (e.g. 450 mm).
4. Select the electrical property (NPN/PNP/DRV (push/pull)).
   Select the parameter in the QxMENU-TYPx menu.
   The following rules apply:
   - Qx-PNP = Switching output in PNP circuit
   - Qx-NPN = Switching output in NPN circuit
   - Qx-Drv = Switching output in push/pull function

Switching output behavior



Switching output		PNP	NPN	DRV	Error status
Normally open/HNO	active	U_v	0 V	U_v (PNP switched)	inactive
	inactive	0 V [1]	U_v [2]	0 V (NPN switched)	

[1] Pulldown only.

[2] Pullup only.

8.2.3 N/C output with configurable hysteresis

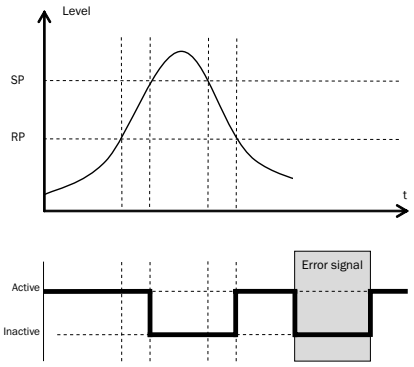
Applications

- Overfill protection
- Full signal

Configuration

1. Configure the Qx switching output as normally closed.
   - Set the parameter in the QxMENU-OUx menu to Qx_Hnc.
2. Set the switching point.
   - Set the value in the QxMENU-SPx menu to the level in mm (e.g. 500 mm).
3. Set the reset point.
   - Set the value in the *QxMENU-RPx* menu to the level in mm (e.g. 450 mm).
4. Select the electrical property (NPN/PNP/DRV (push/pull))
   Select the parameter in the *QxMENU-TYPx* menu.
   The following rules apply:
   - Qx-PNP = Switching output in PNP circuit
   - Qx-NPN = Switching output in NPN circuit
   - Qx-Drv = Switching output in push/pull function

Switching output behavior



Switching output		PNP	NPN	DRV	Error status
Normally closed/ HNC	active	U_v	0 V	U_v (PNP switched)	inactive
	inactive	0 V[1)]	U_v[2)]	0 V (NPN switched)	

[1)] Pulldown only.

[2)] Pullup only.

8.2.4 N/O output with window function

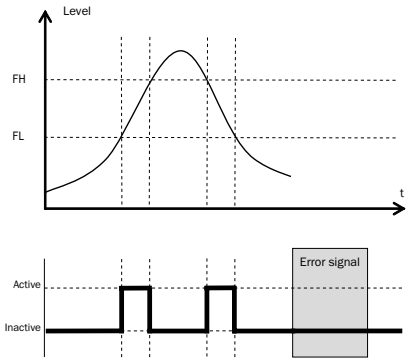
Application

The critical filling level for the application is within the FHx and FLx window thresholds.

Configuration

1. Configure the Qx switching output as normally open.
   - Set the parameter in the QxMENU-OUx menu to Qx_Fno.
2. Set the switching point.
   - Set the value in the QxMENU-FHx menu to the level in mm (e.g. 500 mm).
3. Set the reset point.
   - Set the value in the QxMENU-FLx menu to the level in mm (e.g. 400 mm).
4. Select the electrical property (NPN/PNP/DRV (push/pull)).
   Select the parameter in the QxMENU-TYPx menu.
   The following rules apply:
   - Qx-PNP = Switching output in PNP circuit
   - Qx-NPN = Switching output in NPN circuit
   - Qx-Drv = Switching output in push/pull function

Switching output behavior



Switching output		PNP	NPN	DRV	Error status
Normally open/FNO	active	U_v	0 V	U_v (PNP switched)	inactive
	inactive	0 V [1]	U_v [2]	0 V (NPN switched)	

[1] Pulldown only.

[2] Pullup only.

8.2.5 N/C output with window function

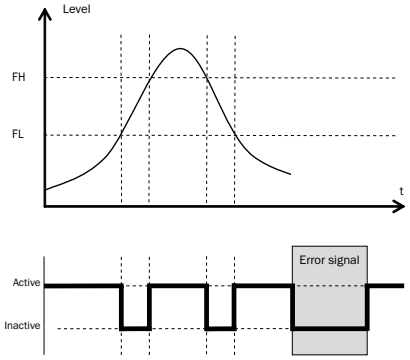
Application

The critical filling level for the application is outside the FHx and FLx window thresholds.

Configuration

1. Configure the Qx switching output as normally closed.
   - Set the parameter in the QxMENU-OUx menu to Qx_Fnc.
2. Set the switching point.
   - Set the value in the QxMENU-FHx menu to the level in mm (e.g. 500 mm).
3. Set the reset point.
   - Set the value in the QxMENU-FLx menu to the level in mm (e.g. 400 mm).
4. Select the electrical property (NPN/PNP/DRV (push/pull)).
   Select the parameter in the QxMENU-TYPx menu.
   The following rules apply:
   - Qx-PNP = Switching output in PNP circuit
   - Qx-NPN = Switching output in NPN circuit
   - Qx-Drv = Switching output in push/pull function

Switching output behavior



Switching output		PNP	NPN	DRV	Error status
Normally closed/FNC	active	U_v	0 V	U_v (PNP switched)	inactive
	inactive	0 V [1]	U_v [2]	0 V (NPN switched)	

[1] Pulldown only.

[2] Pullup only.

8.2.6 N/O output with error signal

Application

If there is an error message at the LS-5, this can be transferred using a switching contact.

Configuration

1. Configure the Qx switching output as normally open.
   - Set the parameter in the QxMENU-OUx menu to Qx_Eno.
2. Select the electrical property (NPN/PNP/DRV (push/pull)).
   Select the parameter in the QxMENU-TYPx menu.
   The following rules apply:
   - Qx-PNP = Switching output in PNP circuit
   - Qx-NPN = Switching output in NPN circuit
   - Qx-Drv = Switching output in push/pull function

8.2.7 N/C output with error signal

Application

If there is an error message at the LS-5, this can be transferred using a switching contact.

Configuration

1. Configure the Qx switching output as normally closed.
   - Set the parameter in the QxMENU-OUx menu to Qx_Enc.
2. Select the electrical property (NPN/PNP/DRV (push/pull)).
   Select the parameter in the QxMENU-TYPx menu.
   The following rules apply:
   - Qx-PNP = Switching output in PNP circuit
   - Qx-NPN = Switching output in NPN circuit
   - Qx-Drv = Switching output in push/pull function

8.3 Configure the analog output

8.3.1 Automated signal detection

The LS-5 can automatically detect which signal is required based on the connected output load.

The following rules apply:

- 4 mA ... 20 mA < 500 ohms at Uv > 15 V
- 4 mA ... 20 mA < 350 ohms at Uv > 12 V
- 0 V ... +10 V > 750 ohms at Uv ≥ 14 V

Configuration

1. Access the QAMENU-TYP menu using the arrow and Set pushbuttons.
2. Set the QAMENU-TYP menu to Auto?.

Note:

Automated signal detection is only active when the device is switched on for the first time. After this the function can be activated again in the QAMENU-TYP menu with Auto?.

8.3.2 Current output 4 mA ... 20 mA

Configuration

1. Set the upper limit value (20 mA).
   - Set the value in the QAMENU-QAHIGH menu to the level in mm (e.g. 500 mm).
2. Set the lower limit value (4 mA).
   - Set the value in the QAMENU-QALOW menu to the level in mm (e.g. 10 mm).
3. Invert the signal.
   The analog signal can be inverted in the QAPOL menu.
   Set the parameter in the QxMENU-QAPOL menu to QA-INV.
   - QA-NRM = Analog output signal as configured
   - QA-INV = Analog output signal is inverted; QAHIGH 4 mA and QALOW 20 mA
4. Select the electrical signal.
5. Set the parameter in the QxMENU-QATYP menu to 4 mA ... 20 mA.

8.3.3 Voltage output 0 V ... +10 V

Configuration

1. Set the upper limit value (10 V).
   - Set the value in the QAMENU-QAHIGH menu to the level in mm (e.g. 500 mm).

2. Set the lower limit value (0 V).
   - Set the value in the QAMENU-QALOW menu to the level in mm (e.g. 10 mm).
3. Invert the signal.
   The analog signal can be inverted in the QAPOL menu.
   Set the parameter in the QxMENU-QAPOL menu to QA-INV.
   - QA-NRM = Analog output signal as configured
   - QA-Inv = Analog output signal is inverted: QAHIGH 0 V and QALOW 10 V
4. Select the electrical signal.
   Set the parameter in the QxMENU-QATYP menu to 0 V ... +10 V.

8.4 Advanced functions

8.4.1 Expert mode

Expert mode must first be set in order to activate special functions.

Logging into expert mode

1. Access the PASSW menu using the arrow pushbuttons.
2. Enter the password 000537.

Expert mode may be locked again if the password is entered incorrectly or if the voltage supply is disconnected.

8.4.2 Filtering measured values

Activating filtering

Smoothing of the measured value; e.g. in the case of ripples on level surfaces. For fast level changes, the average of the measured values over X seconds is indicated.

▶ Parameters in the Set filters menu.
The possible values are Off, 400 ms, 600 ms, 1000 ms, 1400 ms, 2 s, 5 s, 10 s.

Maximum change of level (plausibility check)

For applications which cause level jumps as a result of significant interference on the LS-5. Entry for the maximum level dynamic in the application and/or the maximum permissible change rate of the level.

1. Log in to expert mode; see “8.4.1 Expert mode”.
2. Reduce the parameter in the EXPRT-CONFIG-MaxCol menu.
   AnySpd (50 cm/s) (default), 10 cm/s, 5 cm/s, 2 cm/s

Note:

- For MeasMd = HiSpd, any max. change rate is possible
- For MeasMd = HiAcc, max. is 10 cm/s

8.4.3 Automated adjustment of the interference signal limit

The adjustment of the interference signal limit (TrsHld) can be carried out automatically in many applications.

Configuration

1. Set a fill level of 30 %.
2. Log in to expert mode; see “8.4.1 Expert mode”.
3. Perform in the EXPRT-Pulse-AutoTn menu.

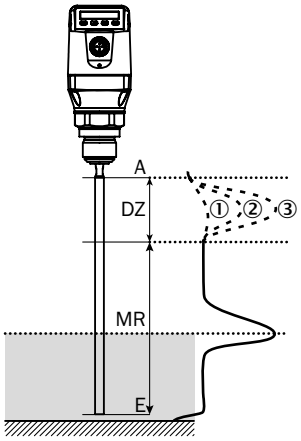
The sensor calculates a suitable value for TrsHld.

Note:

This setting can be used only in pulse mode.

8.4.4 Blanking the interference signals in the masked zone

To blank interference signals from the range above the maximum expected fill level, a zone can be masked (dead zone). This zone begins at the process connection and continues up to the configured point. If signal values above the defined limit value (TrsHld) occur within this range, the sensor enters a safe state and signals the error !MaskZ.



MaskTr	①		②		③	
	DZ	MR	DZ	MR	DZ	MR
20%	x	✓	✓	x	✓	x
100%	x	✓	x	✓	✓	x
200%	x	✓	x	✓	x	✓

① No reflection/very weak reflection

② Weak reflection (e.g. spray water)

③ Strong reflection (e.g. thick layer of ketchup)

DZ Dead zone

MR Active measuring range

x No detection/measurement

✓ Detection/measurement

Configuration

1. Log in to expert mode; see “8.4.1 Expert mode”.
2. Define the parameter in the EXPRT-Pulse-MaskZn menu.

Note:

This setting can be used only in pulse mode.

8.4.5 Selection of evaluation method

You can switch between pulse mode and foam mode as an evaluation method. Depending on the selected mode, other evaluation algorithms are used.

Configuration

1. Log in to expert mode; see “8.4.1 Expert mode”.
2. In the EXPRT-Config-Mode menu, select between Pulse and Foam.

The following rules apply:

- Mode = Pulse: The sensor measures either with or without AutCal.
- Mode = Foam: The sensor measures only with valid CalEmp+CalMed. If no valid calibration is available, the CalPls message is displayed and the sensor enters a safe state.

Note:

If AutCal is called up while the sensor is in foam mode, then AutCal is denied and the error message !Denid is shown.

8.4.6 Testing the configuration

Testing outputs

Switching/analog outputs can be simulated. This makes it possible to check the wiring and signal values on the connected systems, such as the PLC control, relay and lamps.

Configuration

Activate the Qx switching output

▶ Set the parameter in the QxMENU-SimQx menu to QxOn.

Additional options:

- QxOff = switching output off
- QxNorm = switching output in measuring operation
- QxOn = switching output is active

Note:

The simulation is automatically deactivated if the supply voltage is interrupted.

Activate the QA analog output

▶ Set the parameter in the QAMENU-SimCur or SimVol menu to the desired signal value.

- SimCur for current output
- SimVol for voltage output

Note:

The simulation is automatically deactivated if the supply voltage is interrupted.

Simulating the level

Even if there is no liquid in the container yet, it is possible to select a filling level in the menu in order to test the sensor configuration. When simulating a level value, all outputs on the LS-5 are set according to the defined configuration. The function should not be selected until a configuration is complete.

Configuration

▶ Set the parameter to the desired filling level as a % in the SimLev menu.

Note:

- The level simulation refers to the probe length and/or container level (probe length + offset) if an offset is configured.
- The simulation is only active when there are no error messages. The simulation is automatically deactivated if the supply voltage is interrupted.

Parameter selection

- SimOff: Off
- Filling level 0 %
- Filling level 25 %
- Filling level 50 %
- Filling level 75 %
- Filling level 100 %

8.4.7 Configuring the probe length

1. Log in to expert mode; see “8.4.1 Expert mode”.
2. Access the EXPRT-Config-Length menu using the arrow and Set pushbuttons.
3. Enter the probe length in the Length menu. Please note the defined probe length in Chapter “15 Dimensional drawings”.

Note:

- HiSpd: max. length = 2005 mm, response time < 400 ms
- HiAcc: max. length = 6,005 mm, response time < 2,800 ms

8.4.8 Teaching-in static interference signals

Static interference signals in the tank generated by tubes, beams, couplings, or a cleaning ball can be taught-in. The probe length provides the value for the teach-in depth.

1. Log in to expert mode; see “8.4.1 Expert mode”.
2. Access the EXPRT-Pulse-CalRng menu using the arrow and Set pushbuttons.
3. Set the value range between 95 and 6005 mm.

Note:

- The value starts from the LS-5 process connection.
- The value should cover all interference signals.
- Maximum value = probe length – 100 mm.
- The AutCal must then be carried out, see “7 Commissioning”.
- The CalRng parameter should always correspond to the probe length for LS-5s with remote amplifier.

8.4.9 Evaluating signal quality

Parameters describe the quality of the measuring signal.

▶ Log in to expert mode, see “8.4.1 Expert mode”.

SigQa1

Characteristic for the robustness of the EXPRT-Pulse-TrsHld setting.

Not active in foam mode. The displayed value is only valid if the sensor displays the correct level value.

- Value range: 0 % ... 100 %
- Good signal: > 40 % (a high pulse reserve is provided with the current TrsHld setting.)

▶ Measures: Reduce EXPRT-Pulse-TrsHld to increase SigQa1.

Note:

- Changing TrsHld will have an impact on SigQa2 and SigQa3.
- If a satisfactory SigQa1 value cannot be achieved by adjusting TrsHld in conjunction with the SigQa values, the installation condition must be checked. Using a coaxial tube improves signal detection, particularly in media with low DK values (e.g. oil).

SigQa2

Characteristic for the robustness of echo pulse detection in relation to interference pulses.

Not active in foam mode. The displayed value is only valid if the sensor displays the correct level value.

- Value range: 0 % ... 100 %
- Good signal: > 50 %

▶ Measures: Run AutCal; check installation conditions; remove deposits from probe and process connection.

SigQa3

Characteristic for signal noise and electromagnetic interference.

- Value range: 0 % ... 100 %
- Good signal: > 75 %
- Poor signal: < 50 %

Not active in foam mode. The displayed value is only valid if the sensor displays the correct level value.

- Value range: 0 % ... 100 %

▶ Measures:

- Increase EXPRT-Config-TrsHld
- EXPRT-Config-MeasMd = HiAcc
- Improve filtering
- Switch on filter
- Reduce EXPRT-Config-MaxCol

8.4.10 Activating the display lock

To prevent the sensor from being tampered with, password protection can be activated for the display.

When the protection is active, the expert password (000537) must be entered before the menu can be accessed.

The menu is only unlocked once the correct password is entered.

Configuration

1. Log in to expert mode; see “8.4.1 Expert mode”.
2. The protection can be (de)activated via the EXPRT-Config-Lock menu.

Note:

- The user is logged out again after 5 minutes of inactivity.
- When the display is locked, only the configured measured value display (DspVal) can be seen.

8.4.11 Selecting the display unit (millimeter/inch)

This setting makes it possible to display and configure all length measurements in either millimeters or inches.

Configuration

1. Log in to expert mode; see “8.4.1 Expert mode”.
2. Set the unit in the EXPRT-Config-Unit menu (mm/inch).

8.4.12 Setting the offset

This setting makes it possible to indicate the level value on the display in relation to the tank bottom instead of the end of the probe. The actual container level is then indicated on the display.

Configuration

1. Log in to expert mode; see “8.4.1 Expert mode”.
2. Set the offset in the EXPRT-Config-Offset menu (0 mm ... +3,000 mm).

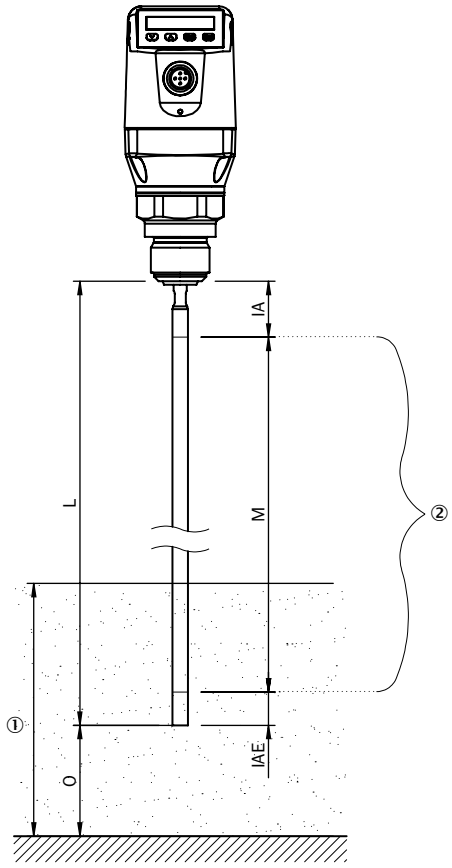


Fig. 7: LS-5

① *Level*
② *QALOW/QAHIGH*
SPx/RPx
FHx/Fl x
Can be set only in this zone
O: Offset
L: Probe length
M: Measurement length
IA: Inactive area at process connection
IAE: Inactive area at probe end

Note:

If the offset parameter is changed, the SPx/RPx/FLx/FHx/QALOW/QAHIGH parameters are automatically adjusted.

8.4.13 Resetting the calibration

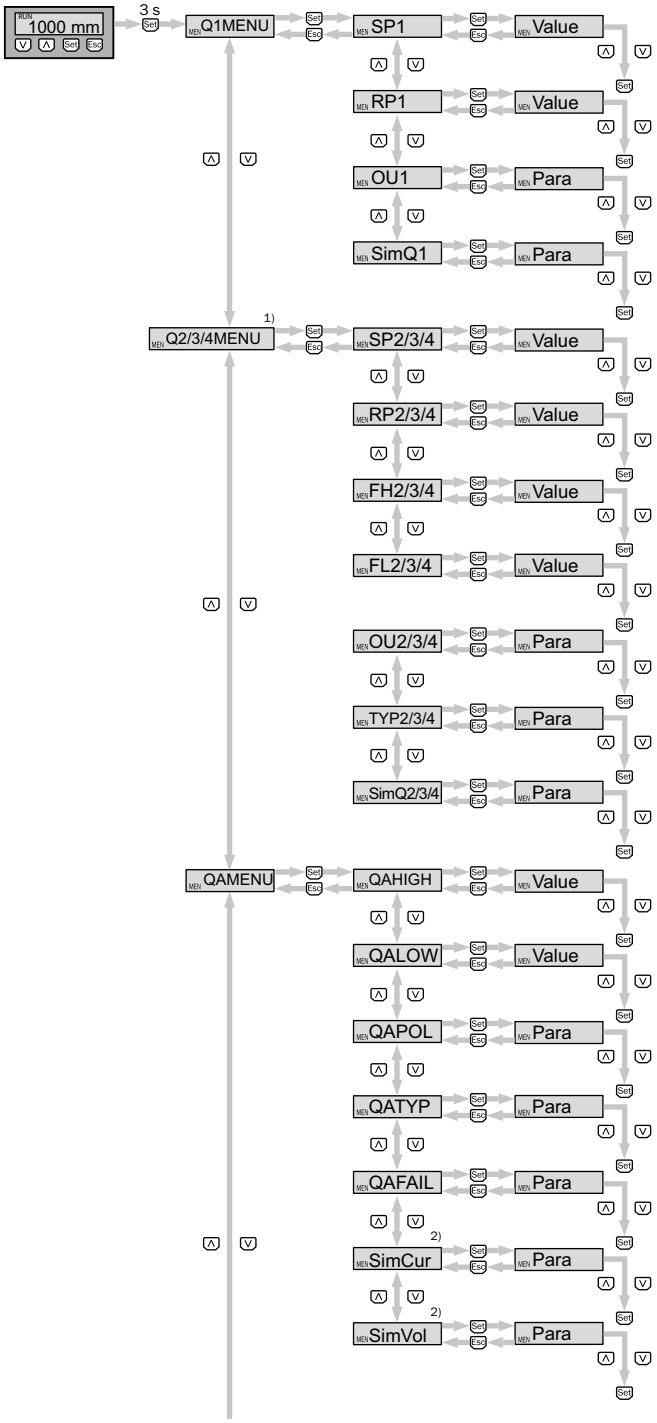
Resetting AutCal

1. Log in to expert mode; see “8.4.1 Expert mode”.
2. Reset AutCal in the EXPRT-Pulse-Reset menu.

Resetting CalEmp+CalMed

1. Log in to expert mode; see “8.4.1 Expert mode”.
2. Reset CalEmp+CalMed in the EXPRT-Foam-Reset menu.

9 Menu overview

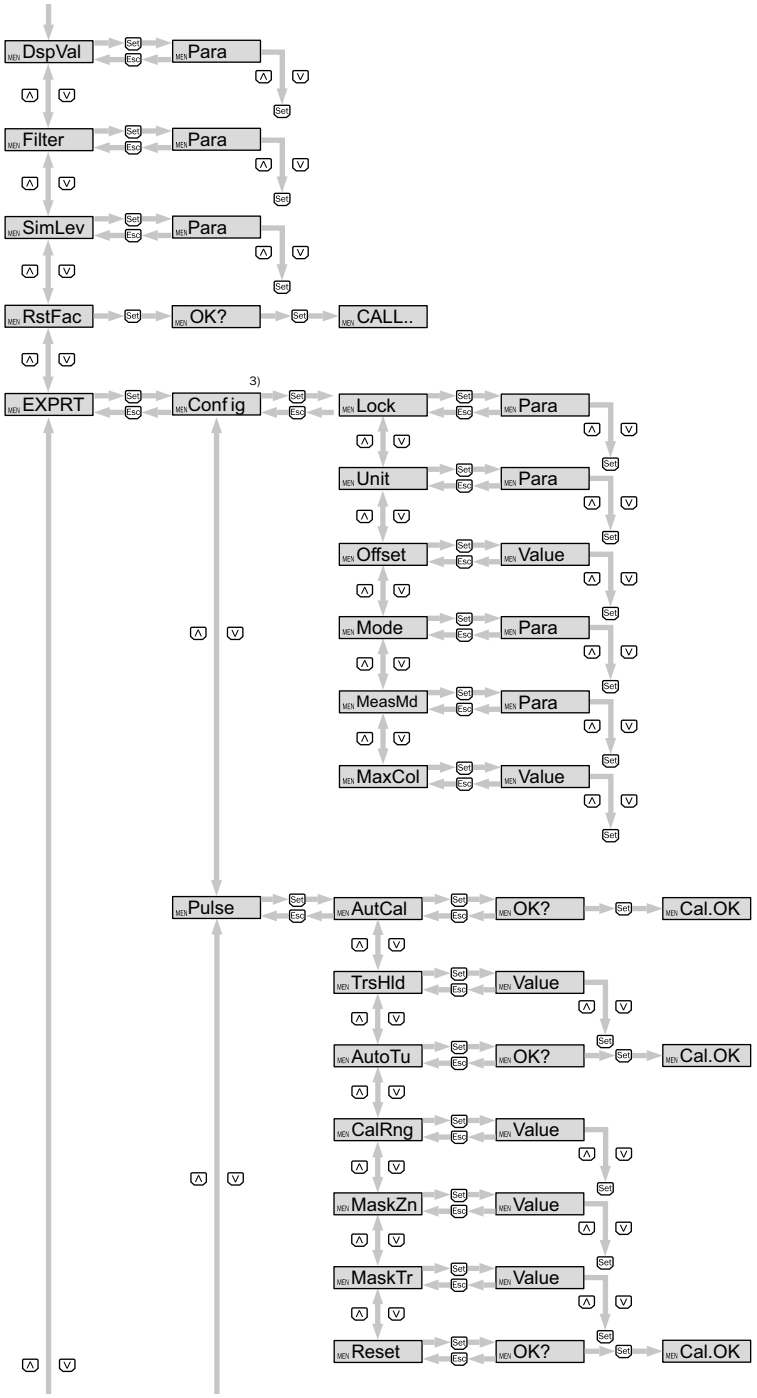


1) Visible elements depend on the OUx parameter selection

2) Visible elements depend on the QATYP parameter selection.

3) Password-protected measuring range.

Q3 and Q4 are only available for an LS-5 with four switching outputs.

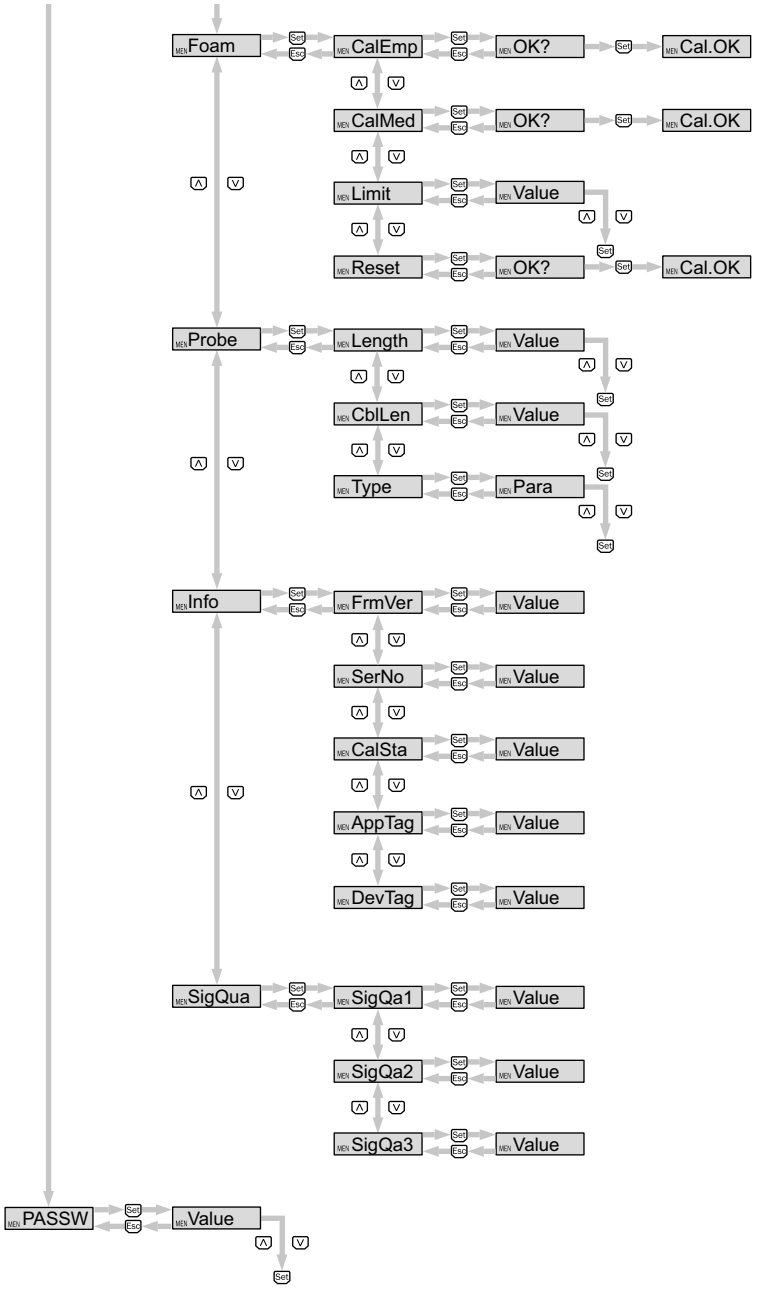


1) Visible elements depend on the OUx parameter selection

2) Visible elements depend on the QATYP parameter selection.

3) Password-protected measuring range.

Q3 and Q4 are only available for an LS-5 with four switching outputs.



1) Visible elements depend on the OUx parameter selection

2) Visible elements depend on the QATYP parameter selection.

3) Password-protected measuring range.

Q3 and Q4 are only available for an LS-5 with four switching outputs.

10 Overview of parameters

Parameter	Description
Q1MENU, Q2MENU, Q3MENU, Q4MENU	See "8.2 Configuring the switching outputs".
SPx	Switching point, switching output 1 or 2 or 3 or 4 (SPx > RPx). Note: Not displayed if the switching output in the OUx menu is set to Error or Window.
RPx	Reset switching point, switching output 1 or 2 or 3 or 4. Note: Not displayed if the switching output in the OU2/3/4 menu is set to error or window.
FHx FLx	• Upper threshold (high) window function, switching output 2/3/4 (FHx > FLx) • Lower threshold (low) window function, switching output 2/3/4 Note: Not displayed if the switching output in the OU2/3/4 menu is set to error or hysteresis.
OUx	Switching output switching function. • Qx-Hno = Hysteresis function, normally open • Qx-Hnc = Hysteresis function, normally closed • Qx-Fno = Window function, normally open (function only available for Q2/3/4) • Qx-Fnc = Window function, normally closed (function only available for Q2/3/4) • Qx-Eno = Error signal, normally open (function only available for Q2/3/4) • Qx-Enc = Error signal, normally closed (function only available for Q2/3/4) If Qx is used as an error signal, SPx/FHx and RPx/FLx are hidden in the menu.
SimQx	See "8.4.6 Testing the configuration".
TYP2/3/4	• Qx-PNP = Switching output in PNP circuit • Qx-NPN = Switching output in NPN circuit • Qx-Drv = Switching output executed in push/pull function
QAMENU	See "8.3 Configure the analog output".
QAHIGH	Input of the filling level in mm for 20 mA/10 V signal (QAHIGH > QALOW).
QALOW	Input of the filling level in mm for 4 mA/0 V signal.
QAPOL	The analog output signal can be inverted. • QA-Nrm = Analog output signal as configured • QA-Inv = Analog output signal is inverted: QAHigh 4 mA/0 V and QALow 20 mA/10 V

Parameter	Description
QATYP	Setting for the output signal. • 4 mA ... 20 mA • 0 V ... +10 V • Auto V = Qa operated with voltage output of 0 V ... +10 V • Auto A = Qa operated with current output of 4 mA ... 20 mA • Auto? = Automated signal detection based on the existing load resistance During a menu query, either 4 mA ... 20 mA or 0 V ... +10 V is displayed.
QAFAIL	Output behavior as per NE43 in the event of a fault (function only available when current output has been selected under QATYP). • 3.5 mA = Analog current output is set to 3.5 mA in the event of a fault. • 21.5 mA = Analog current output is set to 21.5 mA in the event of a fault.
SimCur	See “8.4.6 Testing the configuration”.
SimVol	See “8.4.6 Testing the configuration”.
DspVal	Setting the display. • Distan = The display shows the distance in mm in relation to the end of the probe. • QaPerc = The display shows the fill level in % in relation to the QA analog output with the corresponding QAHIGH and QALOW thresholds. • QaBarG = The display shows a bar graph in relation to the QA analog output with the corresponding QAHIGH and QALOW thresholds. • QaSign = The display shows the current QA output value in mA or V. • QxSign = The display shows the output states.
Filter	See “8.4.2 Filtering measured values”.
SimLev	See “8.4.6 Testing the configuration”.
RstFac	Resetting the set parameters to the factory settings.
EXPRT	See “8.4.1 Expert mode”.
Lock	See “8.4.11 Activating the display lock”.
Unit	See “8.4.12 Selecting the display unit (millimeter/inch)”.
Offset	See “8.4.13 Setting the offset”.
Mode	See “8.4.5 Selection of evaluation method”.
MaxCol	See “8.4.2 Filtering measured values”.
MeasMd	Measuring mode. • HiSpd: max. length = 2,005 mm, response time < 400 ms • HiAcc: max. length = 6,005 mm, response time < 2,800 ms, (more stable measured values, recommended for liquids with low DKs and where TrsHld is < 70) • mode-1: not supported; deactivates current AutCal/ foam calibration

Parameter	Description
Pulse	See “8.4.5 Selection of evaluation method”.
AutCal	See “7 Commissioning”.
TrsHld	This value describes a factor which determines how strong an echo has to be in order to be recognized by the device. The value range lies between 20 % and 500 %. The default is 100 % in this case. Only shown if password entered. • 20 % = high sensitivity • 100 % = standard • 500 % = low sensitivity
AutoTn	See “8.4.3 Automated adjustment of the interference signal limit”.
CalRng	Calibration range. • Value range: 95 mm ... 6005 mm Range starting from the process connection in which static interference signals (coupling sections, welds, spray balls, etc.) are hidden during the AutCal process. During the AutCal process, there must not be any medium in the defined area of +200 mm. See “8.4.8 Teaching in static interference signals”.
MaskZn	See “8.4.4 Blanking the interference signals in the masked zone”.
MaskTr	See “8.4.4 Blanking the interference signals in the masked zone”.
Reset	Resets the value for AutCal.
Foam	See “7.3 Foam commissioning (with factory settings)”.
CalEmp	See “7.3 Foam commissioning (with factory settings)”.
CalMed	See “7.3 Foam commissioning (with factory settings)”.
Limit	Limit between foam and fluid. • Range: 20 to 100 % • Factory setting: 90 % • Medium surface: 90 % • Foam surface: < 90 % When measuring the foam surface, it may be necessary to reduce the limit. If the sensor displays a limit value that is too low, it is necessary to reduce the limit.
Reset	Resets the values for CalEmp and CalMed.
Probe	Special settings.
Length	• See “7.3 Foam commissioning (with factory settings)” (LS-5).
CblLen	See “8.4.10 Changing the coaxial cable length”.
Type	Choosing between rod and rope.
Info	Sensor information.
FrmVer	Shows the firmware version.
SerNo	Shows the serial number.
CalSta	Displays the status of the tank calibration. • Pulse = AutCal (calibrated), NoCal (not calibrated) • Foam = FomCal (calibrated), CalMis (not calibrated)
AppTag	Measuring point name, can only be described via IO-Link.

Parameter	Description
DevTag	Device name, can only be written over IO-Link.
SigQua	Parameter describes the quality of the measurement signal.
SigQa1	See “8.4.9 Evaluating signal quality”.
SigQa2	See “8.4.9 Evaluating signal quality”.
SigQa3	See “8.4.9 Evaluating signal quality”.
PASSW	See “8.4.1 Expert mode”.

11 Troubleshooting

11.1 Error message on the display

Error	Cause	Possible solution
!InvEc & level present	AutCal not executed; interference superimposes medium reflection.	Perform commissioning (See "7.1 Quick commissioning (with factory settings)").
	TrsHld setting is not suitable for the medium.	Perform advanced commissioning (See "7.2 Advanced commissioning").
!InvEc & empty tank	Probe length configured incorrectly.	Check probe length and compare against configuration in EXPRT-Config-LENGTH.
	Probe not available.	Check the probe.
!ATTNT	A parameter was written outside of the valid value range and therefore adjusted	Rewrite the value in the valid range.
	Another parameter was automatically adjusted due to a dependency (SPx, RPx).	Check the parameter again.
!WRONG	Incorrect password entered.	Enter the correct password.
!NoCal	Information: The AutCal process and/or foam calibration was rejected because the probe length, teach-in depth or measuring mode was changed.	Perform commissioning again if necessary.
!Denid	AutCal was called up in Foam sensor mode.	AutCal is available only in Pulse mode. Perform foam calibration in Foam mode.
CalPls	No valid calibrations for CalEmp and CalMed.	Perform foam calibration.
!CalOk	The teach-in process was successful.	
!NoSig	AutCal failed.	Repeat commissioning.
!faiId	Foam-CalEmp or FoamCalMed menu item failed.	Follow the foam commissioning instructions.
!SC-Q1 !SC-Q2 !SC-Q3 !SC-Q4 !SC-Qa	Short-circuit at the output.	Remove short-circuit.
	Load resistance at the output is too low.	Increase the load resistance.
!IOLOf	Supply voltage too low for IO-Link communication.	Increase the supply voltage to achieve the desired functionality.
!QaOff	Supply voltage too low for analog output.	Increase the supply voltage to achieve the desired functionality.
!QxOff	Supply voltage too low for switching outputs.	Increase the supply voltage to achieve the desired functionality.
!QaOvf	The ohmic load at the analog current output Qa is too high.	Reduce the load at Qa.
	The analog current output Qa is not wired.	Connect the load to Qa.
!MaskZ	Interference/pulse exceeds value for MaskTr.	Increase MaskTr or identify and eliminate interference.
!Range	The maximum allowable measuring range was exceeded. Measurement in this configuration is not possible.	Reduce the probe length and/or coaxial cable length; see "8.4.10 Changing the coaxial cable length".
!Cable	The coaxial cable is damaged/defective.	Replace the coaxial cable.
	The coaxial cable length was configured incorrectly.	See "8.4.10 Changing the coaxial cable length".
The display only shows RUN. It is otherwise empty.	The DspVal menu parameter is at QaBarG and the level is below QALOW.	Change QALOW or DspVal.

Error	Cause	Possible solution
Display off	Temperature is too high.	Reduce the temperature.
	Temperature is too low.	Increase the temperature.
	No supply voltage.	Connect the sensor correctly.
!Err[xx] !ErM[xx] !ErI[xx] !ErO[xx]	System error.	The device is defective and must be replaced.
NVFail	Memory error.	The device is defective and must be replaced.

11.2 Operating the display

Error	Cause	Possible solution
The menu item SPx/ RPx is not displayed.	QxMENU/OUx is not configured to Qx-Hno and/or Qx-Hnc.	Configure Qx (see “8.2 Configuring the switching outputs”).
The menu item FHx/ FLx is not displayed.	QxMENU/OUx is not configured to Qx-Fno and/or Qx-Fnc.	Configure Qx (see “8.2 Configuring the switching outputs”).
QAFAIL Is not displayed.	The analog output Qa is in voltage mode (QATYP = 0 to 10 V).	Configure Qa (see “8.3 Configure the analog output”).
SimVol is not displayed.	The analog output Qa is in current mode (QATYP = 4 to 20 mA).	Configure Qa (see “8.3 Configure the analog output”).
SimCur is not displayed.	The analog output Qa is in voltage mode (QATYP = 0 to 10 V).	Configure Qa (see “8.3 Configure the analog output”).
EXPRT-Config-... is not displayed.	Correct password not entered.	See “8.4.1 Expert mode”.
EXPRT-Foam-... is not displayed.	Correct password not entered.	See “8.4.1 Expert mode”.
Lengths are expressed as decimal numbers.	Inch is activated as the display unit.	Configure the unit (see“8.4.12 Selecting the display unit (millimeter/inch)”).
The menu only shows PASSW.	The display lock is activated.	See “8.4.11 Activating the display lock”.

11.3 Outputs

Error	Cause	Possible solution
Switching output does not behave as expected	Configuration incorrect.	Perform configuration of the switching output (See “8.2 Configuring the switching outputs”).
	An error is pending; the sensor outputs are in a safe state.	Remove the cause of the error.
	Cable break.	Check the cable.
Analog output does not behave as expected	Configuration incorrect.	Configure the analog output (See “8.3 Configure the analog output”).
	An error is pending; the sensor outputs are in a safe state.	Remove the cause of the error.
	Cable break.	Check the cable.

11.4 Error behavior

Error	Cause	Possible solution
After installation, the sensor indicates a high level although the tank is empty.	AutCal not performed.	Perform commissioning (see “7 Commissioning”).
When used with a coaxial tube, the sensor indicates a high level although the tank is empty.	AutCal not performed.	Perform commissioning (see “7 Commissioning”).
Level value fluctuates on the display.	Medium surface unsettled.	Activate filtering (see “7.1 Quick commissioning (with factory settings)”).
The displayed level value/SPx/RPx/FHx/FLx/QALOW/QAHIGH is greater than the probe length.	An offset was configured for the level value.	Adjust the offset (see “8.4.13 Setting the offset”).
	Incorrect probe length configured.	Adjust the probe length (see “8.4.7 Configuring the probe length”).
Level occasionally jumps to a higher value.	Contamination in the vicinity of the process connection.	Cleaning.
	Spray ball or supply system wets the probe with medium above the medium surface.	Observe the installation conditions Configure the MaxCoL plausibility filter (see “8.4.2 Filtering measured values”).
	Change in the ambient conditions regarding the situation during the AutCal process.	Perform commissioning again (See “7 Commissioning”).
	Significant buildup of foam.	Perform foam commissioning (See “7.3 Foam commissioning (with factory settings)”).
	TrsHld set too low, the echo algorithm detects interference reflections.	Increase TrsHld.
Level occasionally jumps to 0 mm.	TrsHld set too high.	Perform advanced commissioning (See “7 Commissioning”).
	Significant buildup of foam.	Perform foam commissioning.
No measurement of low levels for media with low DKs.	Increased inactive range at the probe end for media with a low DK.	
Increased measurement inaccuracy.	Use of foam algorithm.	

12 Repair work

12.1 Maintenance

The LS-5 is maintenance-free. We recommend doing the following regularly:

- Checking the probe for contamination.
- Checking the screw connections and plug connections

12.2 Returns

If a device has to be returned, bear in mind that only devices with a decontamination declaration will be accepted. This is available for download at

http://www.turck.de/en/retoure-service-6079.php

and must be filled in completely and affixed to the outside of the packaging such that it is secure and cannot be impaired by adverse weather.

13 Disposal

Dispose of device components and packaging materials in compliance with applicable country-specific waste treatment and disposal regulations of the region of use.

14 Technical data

14.1 Features

Medium	Liquids
Detection type	Limit, continuous
Probe length **Mono-rod probe**	 200 mm ... 1,000 mm
Adjustable measuring range	95 mm ... 6,005 mm
Process pressure	–1 bar ... +10 bar
Process temperature	–20 °C ... +100 °C
GOST certificate	✓
RoHS certificate	✓
IO-Link	✓
UL certificate	✓

14.2 Performance

Accuracy[1)]	± 5 mm
Reproducibility[1)]	≤ 2 mm
Resolution	< 2 mm
Response time[2)]	< 400 ms
Dielectric constant	≥ 5 for mono-rod probe/rope probe ≥ 1.8 with coaxial tube
Conductivity	No limitation
Maximum level change[3)]	500 mm/s
Inactive area at end of probe[1)]	10 mm

[1)] With water under reference conditions, see "14.7 Measurement accuracy".
[2)] Depends on measuring mode (high-speed < 400 ms, high accuracy < 2,800 ms)
[3)] Depends on configuration (MaxCol - maximum change of level)

14.3 Mechanics/materials

Materials in contact with media:	1.4404, PTFE
Process connection	G 3/4 A, 3/4" NPT
Housing material	Plastic PBT
Max. probe load	≤ 6 Nm
Enclosure rating	IP67: EN 60529
Weight	Max. 1.3 kg

14.4 Reference conditions

Container with diameter	1 m
Minimum distance to built-in components	> 300 mm
Distance from end of probe to tank bottom	> 15 mm
Air humidity	65 % ± 20 %
Temperature	+20 °C ± 5 °C
Pressure	1,013 mbar abs. ± 20 mbar
Medium	Water, DK = 80
Centered installation of sensor	✓
Container parameterization carried out	✓

14.5 Ambient conditions

Ambient temperature, operation[1)]	–20 °C ... +60 °C
Ambient temperature, warehouse	–40 °C ... +80 °C

[1)] *According to UL listing: degree of contamination 3 (UL61010-1: 2012-05); air humidity: 80% at temperatures up to 31 °C; installation height: max. 3,000 m above sea level; only for indoor applications*

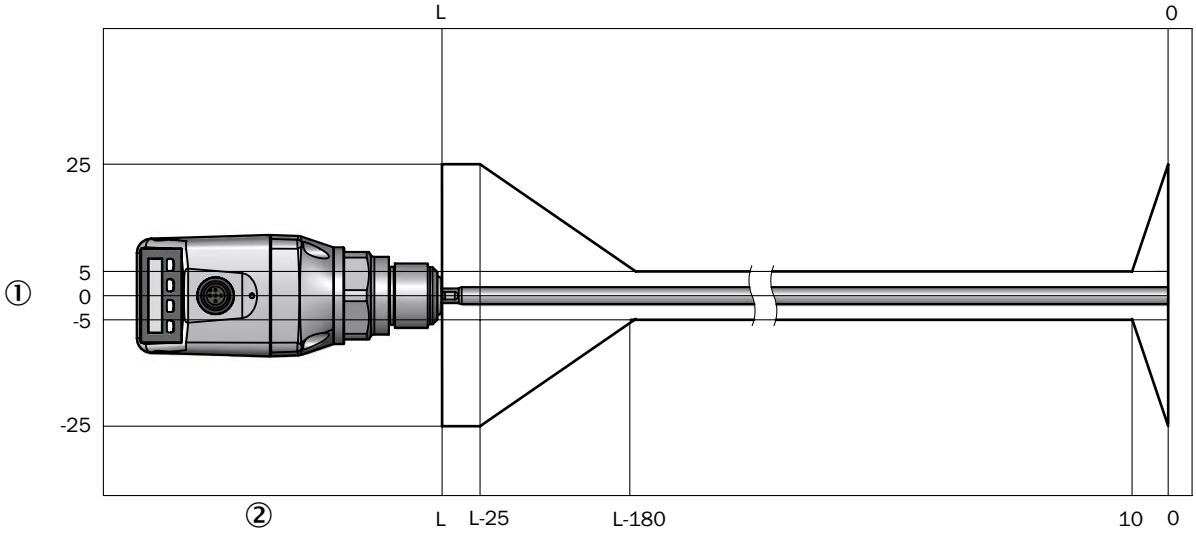
14.6 Electrical connection values

Supply voltage.	12 V DC ... 30 V DC
Current consumption	≤ 100 mA at 24 V without output load
Initialization time	≤ 5 s
Protection class	III
Connection type	M12 x 1, 5-pin M12 x 1, 8-pin
hysteresis	Min. 3 mm, freely configurable
Output signal[1)]	4 mA ... 20 mA / 0 V ... +10 V automatically switchable depending on output load[1)] 1 PNP transistor output (Q1) and 1 PNP/NPN transistor output (Q2) switchable, or 1 PNP transistor output (Q1) and 3 PNP/ NPN transistor outputs (Q2 to Q4) switchable (type-dependent)[1)]
Signal voltage HIGH	Uv –2 V
Signal voltage LOW	≤ 2 V
Output current	< 100 mA
Inductive load	< 1 H
Capacitive load	100 nF
Temperature drift	< 0.1 mm/K
Output load	4 mA ... 20 mA < 500 ohms at Uv > 15 V 4 mA ... 20 mA < 350 ohms at Uv > 2 V 0 V ... +10 V > 750 ohms at Uv ≥ 14 V
Lower signal level	3.8 mA ... 4 mA
Upper signal level	20 mA ... 20.5 mA
EMC	EN 61326-2-3, 2014/30/EU

[1)] All connections are reverse polarity protected. All outputs are overload and short-circuit protected.
[2)] Use an energy-limited circuit for the voltage supply as per UL61010-1 3rd Ed., Section 9.3

14.7 Measurement accuracy

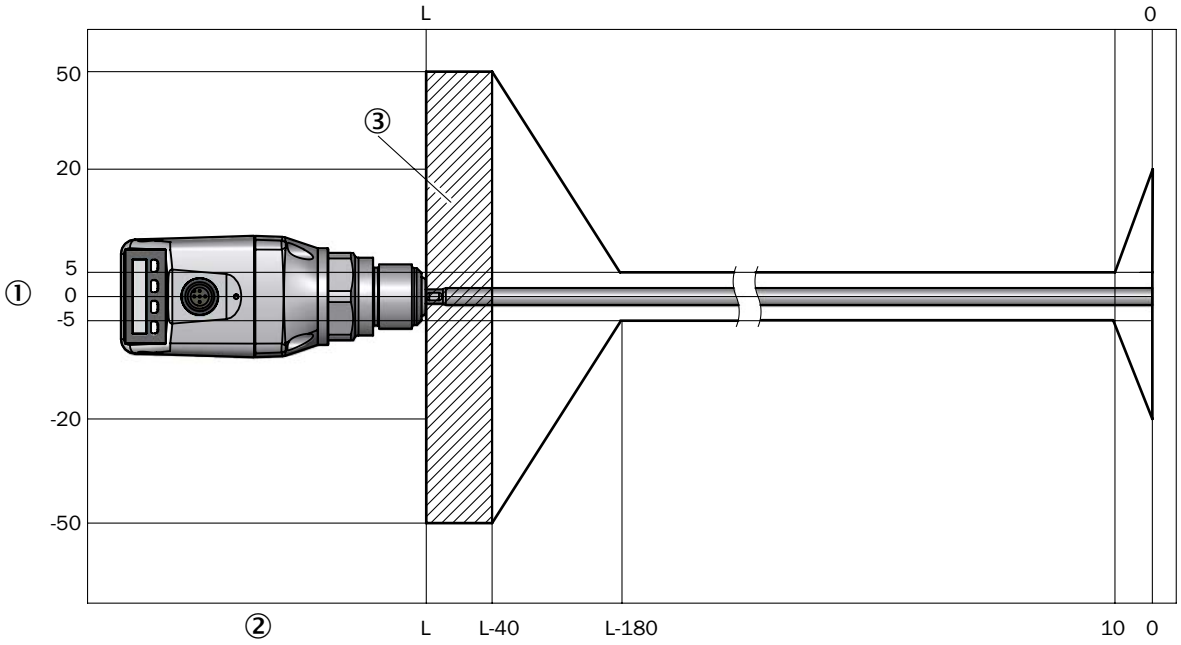
14.7.1 Measurement accuracy with parameterized container



① *Accuracy in mm*

② *Level in mm*

14.7.2 Measurement accuracy without parameterized container



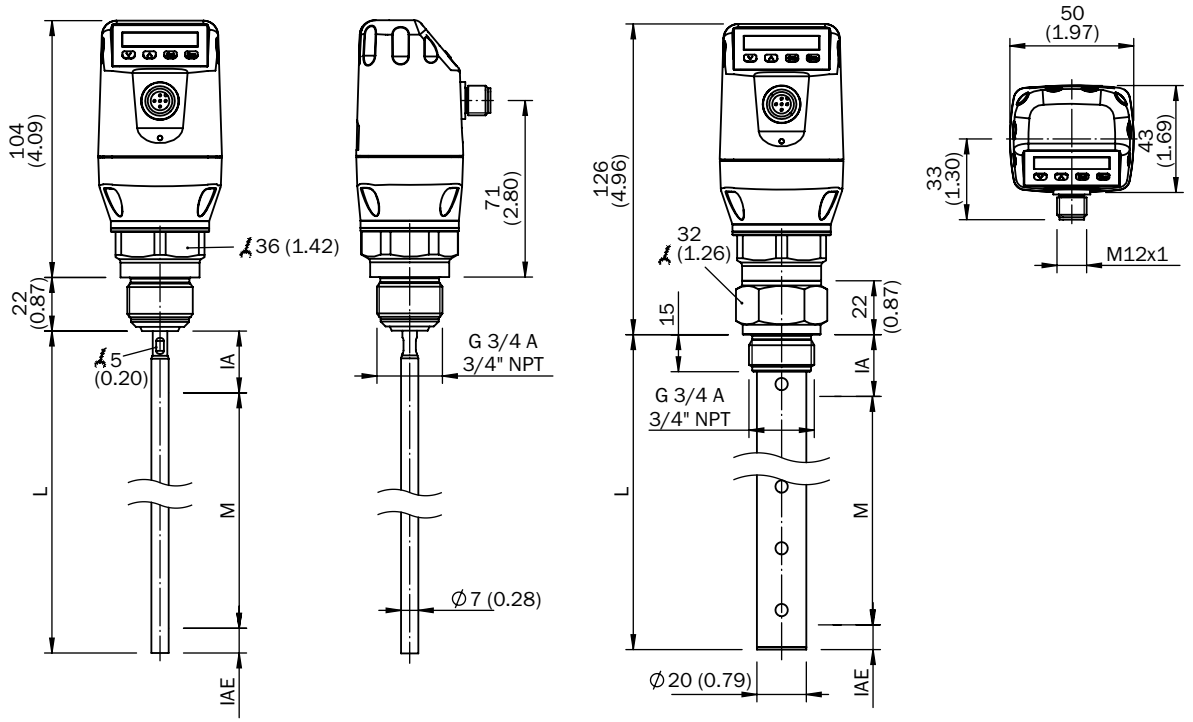
① *Accuracy in mm*

② *Level in mm*

③ *Inactive area*

15 Dimensional drawings

15.7.1 LS-5 with rod probe



Mono-probe *with coaxial tube*

M Measuring range
L Probe length
IA Inactive area at process connection 25 mm
IAE Inactive area at probe end 10 mm

16 Factory setting

Parameter	Factory setting
SP1	80% of the probe length measured from the end of the probe
RP1	5 mm below SP1
OU1	Q1_Hno
SP2	For 5-pin versions: 20% of the probe length measured from the end of the probe For 8-pin versions: 60% of the probe length measured from the end of the probe
RP2	5 mm below SP2
OU2	Q2_Hno
TYP2	Q2_PNP
SP3	40% of probe length measured from end of probe
RP3	5 mm below SP3
OU3	Q3_Hno
SP4	20% of the probe length measured from the end of the probe
RP4	5 mm below SP4
OU4	Q4_Hno
TYP3	Q3_PNP
TYP4	Q4_PNP
QAHigh	50 mm below start of probe
QALOW	10 mm above end of probe
QAPOL	QA_Nrm
QATYP	Auto
QAFAIL	3.5 mA
SimCur	SimOff
SimVol	SimOff
DspVal	Distan
Filter	Off
SimLev	SimOff
TrsHld	100
MaskZn	0 mm
MaskTr	50%
Mode	Pulse
CalSta	noCal
Probe/Type	Depending on probe type: Rod/Rope
MaxCol	Depending on measuring mode: HiSped = AnySped, HiAcc = 10 cm/s
MeasMd	HiSpd
CalRng	6,005 mm
FomSta	Inactive
Limit	90
Offset	0 mm
Unit	mm
Lock	Inactive

17 Media list

This list of media provides a guide to the **Dielectric constants (DK values)** of liquids. Water-based liquids always have a DK value > 5, which makes it easy to use the LS-5. For DK values < 5, a coaxial tube or a metallic immersion tube/bypass is always required.

Substance	DK value
Acetal (25 °C)	3.8
Acetaldehyde	15
Acetamide (77 °C)	59.2
Acetoacetic acid ethyl ester	15
Acetone	21.5
Acetophenone	18
Acetylacetone	23
Acetyl bromide	16.2
Acetyl chloride	15.9
Acetylene dibromide	7.2
Acetylene tetrabromide	5.6
Aconite acid ester	6.3
Adipic acid	1.8
Aerosile	1
Activated carbon	12
Alums (60 °C)	4.2
Allyl alcohol	20.6
Allyl chloride	8.2
Allyl iodide	6.1
Aluminum bromide (100 °C)	3.4
Aluminum foil	10.8
Aluminum hydroxide	2.5
Aluminum splinters	7.3
Aluminum sulfate	2.6
Formic acid	57.9
Ammonia	15
Ammonia solution (25%)	31.6
Ammonia salt	4.3
Pentanol	14.8

Substance	DK value
Amyl amine	4.5
Aniline	7
Anisaldehyde	22.3
Anisole	4.5
Anthracite	3.2
Antimony hydride	1.8
Malic acid diethylester	10
Argon	1.5
Arsine	2.1
Arsole	2.3
Asbestos	10
Ascorbic acid (vitamin C)	2.1
Azelaic acid diethylester	5
Azoxybenzene (36 °C)	5.2
Basalt	2.5
Cotton fiber flour	3.2
Bauxite	2.5
Bentonite	8.1
Benzal chloride	6.9
Benzaldehyde	17.6
Benzil (80 °C)	10
Benzine	2
Benzene	2.3
Benzene, heavy	3.2
Benzyl alcohol	13.5
Benzyl amine	4.6
Benzyl chloride	7
Beer brew	25
Bitumen	2.8

Substance	DK value
Hydrogen cyanide	158
Bore oil emulsion	25
Bornylacetate	4.6
Bromine	3.1
Butanoic acid	3
Camphene	2.3
Caproic acid (71 °C)	2.6
Caprylic acid	2.5
Carbazole	1.3
Carbonylcyanide	10.7
Cellite	1.6
Cetyl alcohol (60 °C)	3.6
Quinoline	8.8
Chlorine, liquid	2.1
Chloral	6.7
Chlorobenzine	5.7
Chloracetic acid	33.4
Chlorohydrin	31
Chlorinated lime	2.3
Chloroform (trichlormethane)	4.8
Cola essence	17.3
Cream (skin)	19
Cuminaldehyde	10.7
Cyanogen	2.5
Decalin	2.1
Degalan	3.1
Desmodur	10
Diacetone alcohol	18.2
Diamylether	3

Substance	DK value
Dibenzofuran (100 °C)	3
Dibenzyl (60 °C)	2.5
Diesel fuel	2.1
Diethylamine	3.8
Dimethylether (methyl ether)	5
Diofan	32
Dioxane	2
Diphenyl (75 °C)	2.5
Printing ink	4.6
Ice cream (–20 °C)	16.5
Iron (III) oxide red	1.9
Emulphor	4
Epichlorhydrin	23
Peanuts, dried	3.1
Peanut expeller	2.4
Vinegar	24
Acetic acid	6.2
Cement asbestos	3.2
Ethanol (ethyl alcohol)	16.2
Ether	4
Ethyl acetate	6
Ethylamine	6.9
Ethyl benzoate	6
Ethyl benzene	2.4
Ethylene chlorohydrin	25
Ethylene chloride	10.6
Ethylenediamine	15
Ethylene oxide (–1 °C)	13.9
Ethyl mercaptan	6.9
Fenchone	12.8
Ferrite pellets	21
Ferrosilicone	10

Substance	DK value
Ferrous sulfate (80 °C)	32.4
Ferrozell	18.3
Fat coal	3.4
Fatty acid (35 °C)	1.7
Fish oil	2.6
Flax pellets	1.4
Meat and bone meal	1.9
Tankage	1.9
Fly ash	3.3
Fluorine	1.5
Fluorbenzene	6.4
Hydrogen fluoride (0 °C)	83.6
Calcium fluoride	2.5
Formamide	109
Furan	3
Furfurol	41.7
Animal feed grist	2.4
Germanium tetrachloride	2.4
Grain grist	3
Gypsum	1.8
Fiber glass powder	1.1
Glass granulate	4
Cullet	2
Glucose (50 °C)	30
Glycerol	13.2
Glycerol water	37
Glycol	37
Glysantin	25
Granuform	4
Guaiacol	11
Guano (phosphate rock)	2.5
Oat	4.9

Substance	DK value
Urea	2.9
Resin	1.5
Hazelnuts	2
Hot glue (150 °C)	2.3
Heating oil	2.1
Helium	1.1
Heptane	1.9
Heptanal	9.1
Heptanoic acid (71 °C)	2.6
Heptene	2.1
Hexane	1.9
Hexene	2.1
Hexanol	12.5
Hibiscus	2.8
Wood chips	2.3
Charcoal	1.3
Wood swarf	1.5
Splints	1.1
Honey	24
Hydrazine	58
Imidazole, pure (100 °C)	23
Isoamyl acetate	4.8
Isoamyl alcohol	15.6
Isoamyl bromide	6
Isoamyl chloride	6.1
Isoamyl ether	2.8
Isoamyl iodide	5.6
Isobutanoic acid	2.6
Isobutyl alcohol	18.1
Isobutyl amine	4.4
Isobutyl benzene	2.3
Isobutyl bromide	7.2

Substance	DK value
Isobutyl chloride	6.5
Isobutyl cyanide	18
Isobutyl iodide	6.5
Isobutyl nitrate	11.7
Isobutyl silane	2.5
Isoquinoline	10.7
Isocyanate	6.1
Isoprene	2.1
Isopropanol	18
Isosafrol	3.3
Iodine	11.1
Iodobenzene	4.6
Methyl iodide	7.1
Hydrogen iodide	2.9
Coffee beans	1.5
Cocoa beans	1.8
Caustic potash	3.3
Potash salt	2
Lime	2
Potato starch	1.7
Ceramic compound	17
Ketchup	24
Gravel	2.6
Diatomaceous earth	1.4
Silicic acid	2
Bone fat	2.7
Bonemeal	1.7
Sodium chloride	23
Coal, 15% moisture	4
Diethyl carbonate	2.8
Coal dust	2.5
Coconut oil (refined)	2.9

Substance	DK value
Coke	3
Cork powder	1.7
Concentrated feed	3.2
Chalk	2.1
Cresol	11
Cresol resin	18.3
Crystal sugar	2
Fertilizer	4.3
Plastic pellets	1.2
Copper ore	5.6
Nitrous oxide	1.5
Lanolin	4.2
Latex	24
Lauric acid ethyl ester	3.4
Glue	2
Linoleic acid	2.7
Solvent	18
Skim milk powder	2.3
Corn	3.6
Corn grist	2.1
Corn starch syrup	18.4
Malt	2.7
Mandelic acid nitril	18
Small marble stones (grain size of 2-)	2.5
Mice feed	2.3
Flour	2.5
Molasses	31.3
Menthol (42 °C)	4
Mesityl oxide	15
Metal powder	6
Methanol (methyl alcohol)	33
Methyl acetate	8

Substance	DK value
Methylene bromide	7
Methylene chloride	9
Methylene chloride	9.1
Methylene iodide	5.3
Methyl nitrate	23.5
Methyl cellulose	3
Monochloremethane	9.8
Morpholine	7.3
Naphthenic acid	2.6
Naphthalene	2.5
Sodium carbonate	3
Sodium methylate	1.5
Sodium perborate	2.2
Sodium peroxide	2.7
Sodium sulfate	2.7
Nitrobenzene	35
Nitroethane	29
Nitroglycol	28.3
Nitroglycerin	19.3
Nitro varnish	5.2
Nitromethane	39
Nitrophoska	5,4
Nitrosyl bromide (13 °C)	15.2
Nitrosyl chloride	19
Pasta, milled durum	1.9
Octane	2
Octene	2.1
Octyl bromide	5
Oil	2
Oileic acid	2.5
Water-in-oil emulsion	24.2
Oxalo ethyl acetate	6

Substance	DK value
Palmitic acid	2.3
Palm tree nuts	2.2
Palm tree nuts	2.8
Palm seed oil	1.8
Paper scraps	1.2
Paraffin	1.6
Paraldehyde	15.1
Pelargon	2.8
Penta borane	21
Penta ethyl chloride	3.8
Penta chlorotoluene	4.8
Pentane	1.8
Pentanal (15 °C)	11.8
Pentene	2
Perchlorate	3.6
Hexachlorobutadiene	2.6
Perlite	1.7
PET powder	1.5
Phenetole	4.2
Phenol	8
Phenol resin	7.4
Phosgene	4.3
Phosphate	4
Phosphorus, liquid	3.9
Phosphorus salt	4
Pinane	2.1
Piperidine	5.8
Polyamide pellets	1.7
Polyethylene	1.2
Polypropylene	1.6
Polyrol	2.8
Polyvinyl acetals	2.8

Substance	DK value
Popcorn	1.1
Pril (liquid detergent)	1.2
Propanal (15 °C)	14.4
Propanol (propyl alcohol)	2.2
Propanoic acid	3.2
Propylamine	3
Propylene, liquid	1.9
Propylene chloride	9
Propylether	3.3
PVC powder, pure	1.3
Pyridine	13.2
Pyrrol	8
Silica sand	2
Quartz stone meal	2.7
Mercury diethyl	2.1
Rapeseed	3.3
Rapeseed grist	2.1
Rice	3
Rye	6
Rye bran	2.2
Beetroot seeds	3.5
Beetroot cuttings	7.3
Carbon black	18.8
Saccharose solution	20
Sawdust	1.3
Nitric acid (98%)	19
Hydrochloric acid	5
Salt water	32
Oxygen	1.5
Chamotte	1.8
Foam flakes	1.1
Lard (80 °C)	2.1

Substance	DK value
Soft soap	32
Chocolate powder	2
Black liquor	32
Sulfur	3.5
Sulfur dioxide (sulfurous acid)	14
Carbon disulfide, pure	2.6
Sulfuric acid	21.9
Sulfuric acid (15%)	31
Sulfuric acid (97%)	8.6
Sulfur trioxide	3.1
Hydrogen sulfide	6
Heavy fuel oil	2.2
Soap flakes	9.2
Soap pellets	3.5
Mustard	24
Mustard seeds	3.6
Silicone oil	2.7
Silicone rubber	2.9
Soy flour	4.5
Soy grains	2.9
Sunflower seeds	2
Chaff	1.5
Stearic acid	2.3
Rock salt (0–25 mm)	4.3
Styrene	2.4
Tobacco dust	1.8
Talcum	1.5
Tea powder	2
Tar, raw	4
Terephthalic acid	1.5
White spirit	2
Terpinene	2.7

Substance	DK value
Terpinolene	2.3
Tetrachloroethylene	2.5
Carbon tetrachloride	2.3
Thomaskali dust	3.4
Thujone (0 °C)	10.8
Meat and bone meal	2.2
Titan tetrachloride	2.8
Toluene	2.4
Clay	2.3
Transformer oil	2.1
Trichloroethylene	3.2
Triethyl aluminum	2.9
Triptan	1.9
Dry yeast	2
Ultrasil	1.4
Undecan	2
Valeric acid	2.7
Viscose	34.5
Wax	1.8
Benzine	2
Water	80.3
Water (360 °C)	10
Water, demineralized	29.3
Water, heavy	78.3
Sodium silicate	16
Hydrogen	1.2
Hydrogen peroxide, pure (0 °C)	84.2
Wine	25
Tartaric acid	35.9
Wheat	4
Wheat starch	2.5

Substance	DK value
Xylitol	40
Xylene	2.3
Toothpaste	18.3
Cellulose	1.2
Cement	2.2
Zinc oxide	1.5
Zinc powder	4.4
Sugar	1.8
Tinder	12

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