USER GUIDE

LWT300 Series

Guided Wave Radar
Level Transmitter (Modbus)



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CHAPTER 1

Safety

This instrument has been manufactured in accordance with state-of-the-art procedures; it is operationally safe. It has been tested and left the factory in perfect working condition. The information in this guide, as well as all applicable documentation and certificates, must be observed and followed to maintain this condition throughout the period of operation.

This chapter provides an overview of the safety conditions that must be observed when installing and operating the instrument. Full compliance with all general safety requirements must be observed during instrument operation. For personnel and system safety, and to ensure optimum performance, make sure that you thoroughly understand the content of this guide before installing, using and maintaining the instrument, and carefully plan any installation, modification, or repair before actually proceeding.

Additionally, each chapter in this guide contains descriptions of processes or procedural instructions with their own specific safety information. Only by observing all safety information can you minimize the risks of hazards to personnel and/or the environment. Additional safety information is provided in the LWT300 series Hazardous Location Safety Guide (part no. 3KXL001271U0141).

Definitions

This document uses the following safety notices to bring attention to key technical and safety-related information.



DANGER—SERIOUS DAMAGE TO HEALTH/RISK TO LIFE

Indicates a hazardous situation that, if not avoided **will** result in death or serious injury.



WARNING—DAMAGE TO HEALTH/RISK TO LIFE

Indicates a hazardous situation that, if not avoided **could** result in death or serious injury.



CAUTION—DAMAGE TO HEALTH

Indicates a hazardous situation that, if not avoided, could result in **minor or moderate injury.**



NOTICE

Indicates information considered important, but not hazard related, that could impact things **other than personal injury,** like property damage.



WARNING—HIGH VOLTAGE

Indicates the presence of electrical energy at voltages high enough **to inflict harm on living organisms.**



WARNING—SHARP EDGES

Indicates the presence of sharp edges that could cause personal injury if touched.



WARNING—HOT SURFACES

Indicates the presence of heat sufficient enough to cause burns.



ELECTROSTATIC DISCHARGES

Indicates a device or part of a device that is susceptible to electrostatic discharges.



Identifies any terminal intended for connection to an external conductor for protection against electrical shock in case of a fault, or the terminal of a protective earth (ground) electrode.



Identifies protective earth conductor terminals.

Indicates the presence of direct current.

Personnel



WARNING

Only qualified and authorized personnel should be put in charge of the installation, electrical connection, commissioning, operation, and maintenance of the instrument.

This personnel must hold the necessary qualifications and authorizations, such as training or instruction, to operate and maintain devices or systems in accordance with safety engineering standards regarding electrical circuits, high pressures, aggressive media, and adequate safety systems, based on local and national safety standards, e.g., building codes, electrical codes, etc.



WARNING

The instrument can be operated at high levels of pressure and with aggressive media. As a result, serious injury or significant property damage may occur if this device is operated incorrectly.

Depressurize the vessel before opening the connection to the instrument. Any process media released may cause severe injuries.

Provide adequate protection and training against all chemicals involved in the work environment.

Electrical

Connection information in this guide must be observed; otherwise, the applicable protection type may be affected.



WARNING

Connections may **only** be performed by authorized personnel in accordance with the provided electrical circuit diagrams.

In addition, involved personnel must observe the relevant safety regulations regarding the installation and operation of electrical systems, and the relevant standards, regulations and guidelines about explosion protection.

If required by the relevant national electrical code, a circuit breaker or switch in the building installation, marked as the disconnect switch, shall be in close proximity to the equipment and within easy reach of the operator.

Do not make electrical connections unless the approval markings and protection methods printed on the instrument data plate (refer to part no. 3KXL001177U1209) matches the classification of the area in which you want to install the instrument.

When installing the instrument in hazardous areas, only use non sparking tools.

Use **only** tools compliant with national insulation standards, e.g., DIN EN 60900.



ELECTROSTATIC DISCHARGES

Before performing any connection, operators shall make sure that they have discharged all static electricity from their body before touching electronic components.

- All connections must be established in a de-energized state.
- Before installing the instrument, make sure that the appropriate supply voltage is available.
- The power supply shall be equipped with short circuit protection and auto restart functions.
- For continuous installation protection, a double insulation power supply (5 kV or higher) shall be used for the supply and communication lines.
- In an industrial environment where EMIs (electromagnetic interferences) are extremely present (e.g., rock quarries, mines, large chemical plants, etc.), ABB recommends the use of noise filters on the DC power supply to the instrument.
- Instruments will not work if exposed to common mode voltages in excess of the maximum allowed supply voltage.

Grounding

- Ground the instrument according to requirements (see “Grounding the Instrument” on page 29).



WARNING

Ensure that the equipment or any device or power cord connected to the instrument is properly grounded.

If an interruption of the protective earthing connection is suspected, make sure that the equipment is not used. All protective earthing connections (grounding) must be active at all times. The absence of grounding can lead to a potential shock hazard that could result in serious personal injury.

Use the instrument **only** if a properly grounded power source is available in accordance with the local electrical code.

- To avoid injury or property damage in external installations exposed to lightning, a transient voltage suppression module or galvanic isolator shall be installed, with proper grounding, before entering a building with a cable. Refer to local building and electrical codes for proper practices.

Environmental (WEEE)

The LWT series of instruments has required the extraction and use of natural resources for its production. Therefore, the instrument may contain hazardous substances that could impact health and environment. To avoid dissemination of these hazardous products into the environment, and also to reduce extraction, and protect our natural resources, ABB strongly recommends using the appropriate recycling systems to make sure that materials used to produce your equipment are reused or recycled in a sound way.

The crossed-out wheeled bin reproduced on the product label (and illustrated below) is a clear reminder that the product must not be disposed of with household waste.



For European countries, at the end of life of the instrument, contact your distributor before disposing of the instrument.

Cybersecurity

This product is designed to be connected to and to communicate information and data via a network interface. It is the operator's sole responsibility to provide and continuously ensure a secure connection between the product and your network or any other network (as the case may be).

Operators shall establish and maintain any appropriate measures (such as, but not limited to, the installation of firewalls, the application of authentication measures, the encryption of data, the installation of anti-virus programs, etc.) to protect the product, the network, its system and the interface against any kind of security breaches, unauthorized accesses, interferences, intrusions, leakages and/or thefts of data or information.

ABB Measurement and Analytics and its affiliates are not liable for damages and/or losses related to such security breaches, any unauthorized access, interference, intrusion, leakage and/or theft of data or information.

ABB strives to maintain cybersecurity for its products and services. By visiting the web page indicated below, you will find notifications about newly found software vulnerabilities and options to download the latest software.

It is recommended that you visit this web page regularly:

http://new.abb.com/about/technology/cyber-security

Modbus Protocol Disclaimer

The Modbus® protocol is an unsecured protocol and as such, the intended application of this instrument should be assessed to ensure that these protocols are suitable before implementation.

To prevent any unauthorized accesses, always ensure that physical access to the instrument and network is properly secured.

For cybersecurity reasons, ABB decided **not to password protect the Modbus communication protocol** in LWT series instruments.

HART Protocol Disclaimer

The HART® protocol is an unsecured protocol and as such, the intended application of this instrument should be assessed to ensure that these protocols are suitable before implementation.

To prevent any unauthorized accesses, always ensure that physical access to the instrument and network is properly secured.

For cybersecurity reasons, ABB decided **not to password protect the HART communication protocol** in LWT series instruments.

Totalflow Protocol Disclaimer

The Totalflow® protocol is an unsecured protocol and as such, the intended application of this instrument should be assessed to ensure that these protocols are suitable before implementation.

To prevent any unauthorized accesses, always ensure that physical access to the instrument and network is properly secured.

For cybersecurity reasons, ABB decided **not to password protect the Totalflow communication protocol** in LWT series instruments.

General Deployment Guidelines

- Limit and control physical access to the device and the network on which it is connected.
- Limit and control access to all Modbus communication tools.
- Use role-based access according to needs.
- Change all default passwords and strictly control their dissemination.
- Lock and/or write-protect the instrument whenever possible and/or practical.
- Disable Service access (from the Advanced access level; see “Disabling Access to the Service Account” on page 45).

CHAPTER 2

Introduction

The LWT series of instruments are microprocessor-based level transmitters that use very low power microwave energy to determine the level of the product being measured. A rod, cable or coaxial “probe” is hung into the vessel to act as a waveguide, i.e., microwave energy stays concentrated around the length of the probe instead of being dispersed, as it would be if there was no probe.

About This Guide

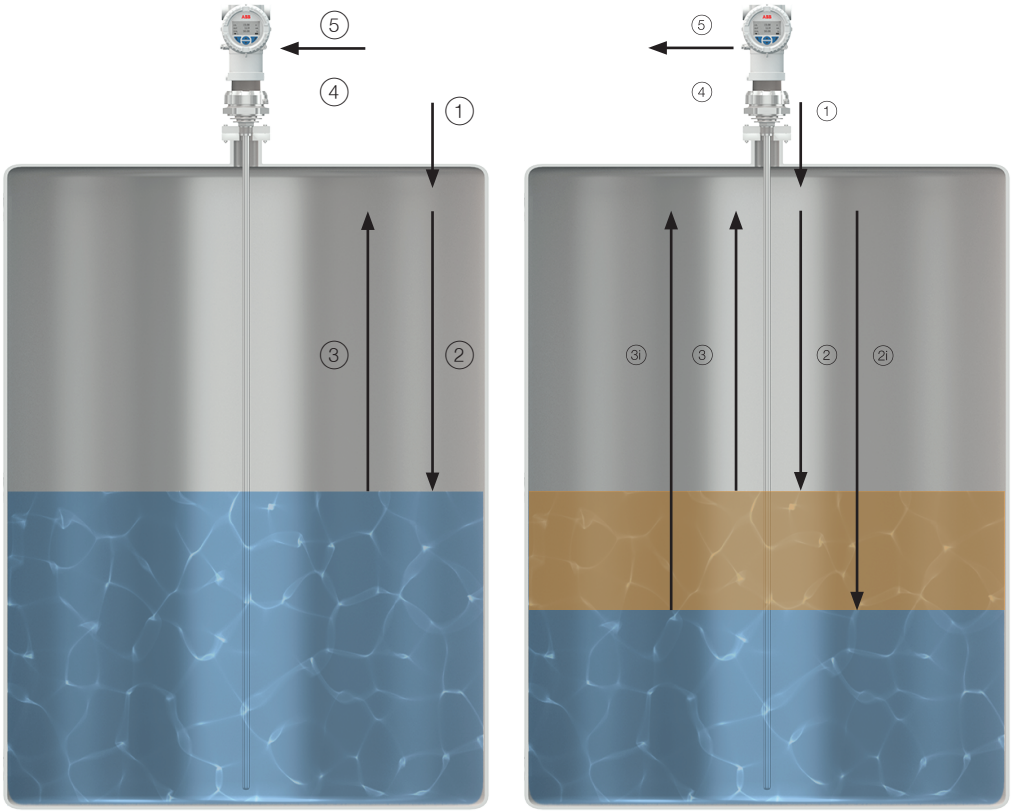
This user guide is intended for personnel using LWT series instruments for routine monitoring. It contains installation, usage, maintenance, and troubleshooting instructions.

Read this guide carefully before working with the instrument. For personnel and system safety, and for optimum performance, make sure that you thoroughly understand the contents of this document before installing, using or maintaining the instrument. This guide does not contain detailed information on all available models or every conceivable event that may occur during setup, operation, and maintenance work.

Basics of LWT Level Measurement

The instrument electronics housing (a.k.a. “the head”) is fitted with a special adapter (a.k.a. “the coupler”) that serves as a connection between the head and the process in which measurements will be taken. A rod—single or coaxial—or cable (a.k.a. “the probe”) hangs from the coupler into the product being measured (see Figure 1 on page 8).

Figure 1 The measurement cycle



When two liquids are in the tank and are separated, if the dielectric constant difference between the two is more than 10, it is possible to detect the total level and the interface level at the same time. The radar wave will go through the first layer (having a low dielectric constant) and reach the top of the second layer (having a higher dielectric constant).

The head sends a very short pulse of microwave energy through the coupler and down the probe (1). That pulse travels along the length of the probe (2) and, when it encounters the product surface, some of the energy is reflected and travels back towards the coupler (3). When the reflected energy reaches the coupler, it is sensed by the electronics (4). By measuring the time elapsed between the initial pulse and the reflected one, the electronics can calculate the product level (5).

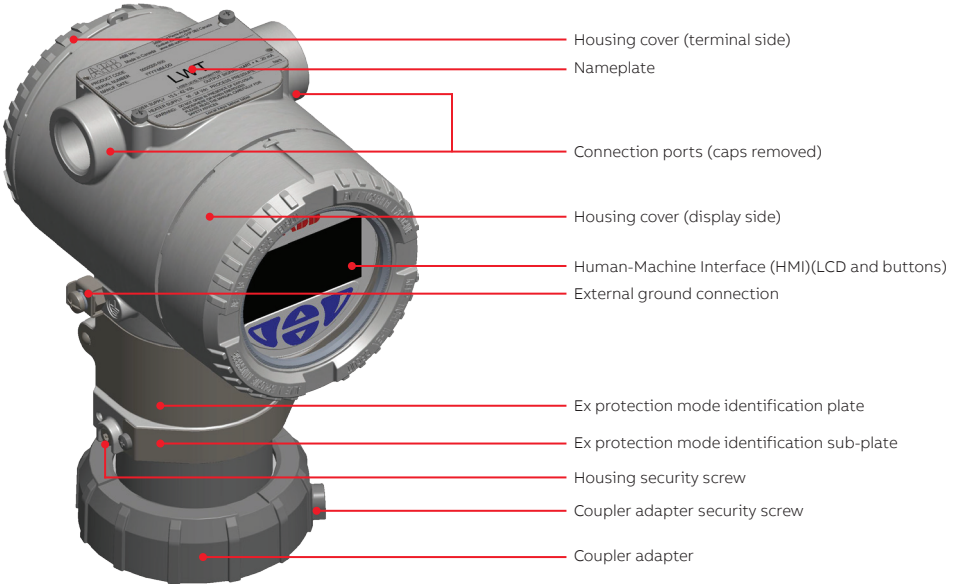
Since microwave energy travels at the speed of light, one complete measurement cycle is made up of several thousand pulses. The electronics use the time domain reflectometry (TDR) sampling technique to reconstruct, from these numerous pulses, a waveform that can be processed by the microprocessor (see “Diagnosing From a Waveform” on page 82). Measurement cycles are made up to five times every second (depending on configuration and probe length) and results are processed before generating a current output proportional to the level of the product.

First Look

Below is a first look at the main components of the LWT series instruments:

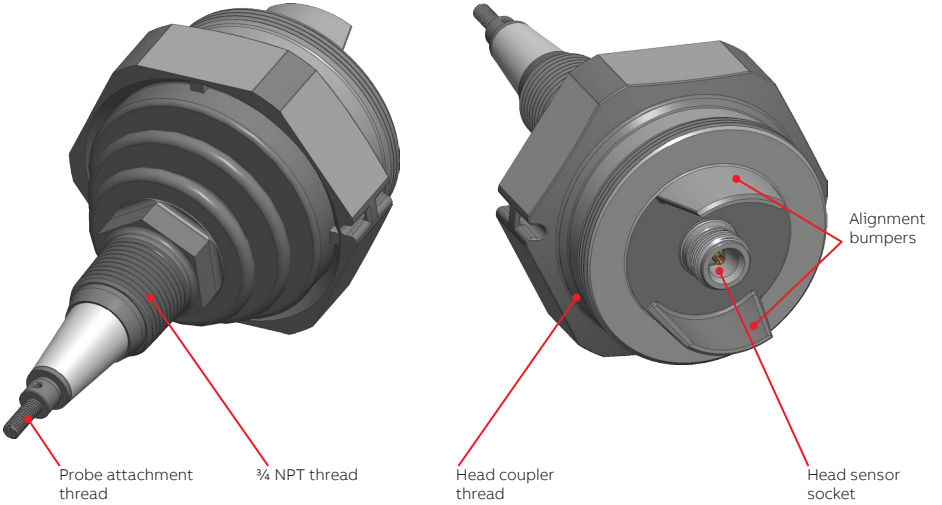
The Head

Figure 2 LWT Instrument Head



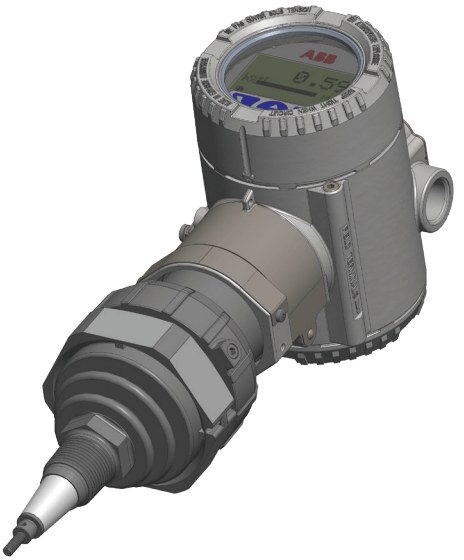
The Coupler

Figure 3 Typical ¾ NPT LWT310 Instrument Coupler



As Shipped

Figure 4 Head-Coupler Assembly



Basic Installation Procedure

Here are the basic installation steps described in this guide. The following chapters provide more details.

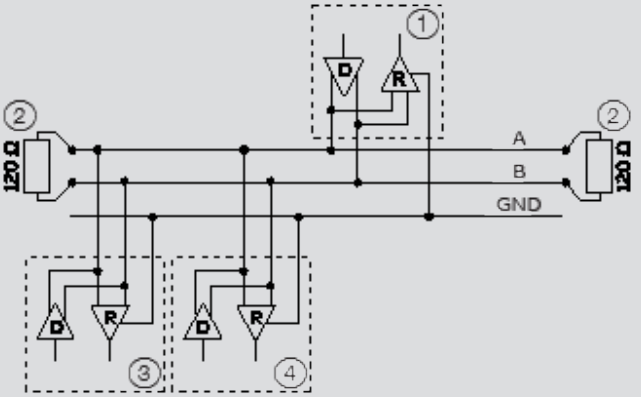
1. Access and properly secure the installation site (vessel depressurization and cool down, mains power down, etc.) (see page 17).
2. Attach the probe to the head-coupler assembly (see page 20).
3. Slide the probe in the vessel and attach the assembled LWT system on the external flange (see page 22).
4. Ground the head unit and connect it to the mains (see page 29).
5. Power up (see page 30) and configure the instrument (see page 41).

Modbus-Specific Considerations

Using the Modbus® protocol allows devices made by different manufacturers to exchange information via the same communication bus without the need for any special interface devices. Up to 32 devices can be connected on one Modbus line (RS-485 serial interface). The Modbus network can be expanded using repeaters. The LWT Modbus can be configured to communicate with a Flow computer/RTU using Modbus RTU protocol or LevelMaster protocol (also known as ROS protocol or Tank protocol).

NOTICE

All Modbus networks must be **terminated.** In this case, each end of the network needs a 120 Ω terminal resistor, as illustrated below:



(1) Modbus master
(2) Terminating resistor
(3) Modbus slave 1
(4) Modbus slave 32

Star or daisy chain configurations are not allowed under any circumstances.

See also “Modbus Protocol Disclaimer” on page 6.

Disclaimers

ABB declares that the content of this guide is not part of any prior or existing agreements, commitments, or legal relationships, nor are they intended to amend these. ABB obligations arise from the conditions of the relevant sales agreement, which also contains the solely binding warranty regulations in full. These contractual warranty provisions are neither extended nor limited by the information provided in this guide.

Improper Use

It is prohibited to use the instrument for any of the following, including but not limited to:

- A climbing aid, e.g., for mounting purposes.
- A support for external loads, e.g., as a support for pipes.
- By adding material, e.g., by painting over the name plate, or welding/soldering on parts.
- By removing material, e.g., by drilling the housing.

Repairs, alterations, and enhancements, or the installation of replacement parts, are only permissible as far as these are described in this guide. Approval by ABB must be requested in writing for any activities beyond this scope. Repairs performed by ABB-authorized centers are excluded from this article.

Technical Limit Values

The instrument is designed for use exclusively within the values stated on the name plates and within the technical limit values specified on the data sheets.

Technical limit values that must be observed at all times are

- The maximum working pressure, ambient working temperature, and maximum process temperature may not be exceeded.
- The housing protection type must be observed.
- The electrical specifications must be observed.

Operator Liability

Prior to measuring levels of corrosive and abrasive materials, the operator must check the level of resistance of all instrument parts coming into contact with these materials.



CAUTION

Prior to using the instrument, safety data sheets (SDS) of all products being monitored must be available at all times for users' security.

ABB will gladly support you in selecting the materials, but cannot accept any liability in doing so.

Operators must strictly observe the locally applicable national regulations with regard to installation, function tests, repairs, and maintenance of electrical devices.

CHAPTER 3

Installing the LWT

The following pages explain how to proceed with a typical physical installation of your LWT instrument. Keep in mind that there are numerous possible installation scenarios; this documentation cannot cover them all. However, all efforts have been made to properly indicate the main challenges associated with such an installation.

Safety First!

WARNING

For personnel and system safety, and to ensure optimum performance, make sure that you thoroughly understand the content of this guide, and especially the Safety chapter (see page 1), before installing, using and maintaining the instrument.

Carefully plan any installation, modification or repair before actually proceeding.

Before You Start

In preparation for the installation of your LWT instrument, and taking into account that you cannot always decide the location of this installation, you should try and follow the recommendations below:

- Install the assembled LWT system (probe/coupler/head assembly) (see page 29) as far as possible from the fill/drain stream.
- When inserting probes, avoid internal obstructions (tubing, ladders, agitators, etc.)
- Avoid mounting the instrument too close to the vessel inlet or to internal objects (15 cm [6 in.]).
- To prevent excessive probe movement in an agitated process, or where installation close to the vessel wall is required, secure the bottom end of a probe to the vessel. Probes installed from the top of the vessel may require the use of a stilling well.
- Weighted cable probes should be allowed to hang inside the vessel under the tension of the weights.

NOTICE

You may need to shorten the probe. Your instrument was delivered with a probe length set at the time of purchase. This probe length is programmed into the instrument. Should you have to shorten the probe, do not forget to change the probe length programmed in the instrument (see “Changing Probe Length” on page 54).

- Flanged connections should be made using materials (bolts, studs, nuts and gaskets) and procedures (torque specifications) approved for use by the customer, and compatible with the medium of monitored process.

Environmental Considerations

The LWT should be installed in an area that is within its specified temperature range, taking into consideration the enclosure ratings and the construction materials.

NOTICE

If the site where the LWT will be installed is subject to severe vibration conditions, harsh environment errors might be flagged (see “Setting Process Conditions” on page 55). Contact ABB for information on using a remote coupler installed on a bracket to dampen oscillations (see “Installing a Remote Head LWT Instrument” on page 26).

Hazardous Area Considerations

- LWT housings are certified as conforming to protection type IP 66/68 (according to IEC 60529) or Type 4X/6P (according to NEMA).
- The external housing is not made to resist high pressures. Only the probe and coupler can come in contact with the process.
- LWT instruments must only be installed in hazardous areas for which they are properly certified. The certification plate is permanently fixed on the neck of the instrument head.

Power Considerations

- For maximum power supply voltage, refer to the instrument identification plate.
- For signal and power loop connections up to 1,200 meters (4,000 feet) in length, use Ø 0.8 to 0.35 mm² (18 to AWG 22) twisted, stranded pair wiring. Longer loops will require larger wires.
- Supply voltage at the instrument terminals must be between 10.5 and 28.5 V DC.
- Typical power consumption is below 30 mW.

Cable and Cable-Gland Considerations

WARNING

Cables, cable glands and unused port plugs must comply with the intended type of protection (e.g., dust proof, flameproof, etc.) and degree of protection (e.g., IP68 or Type 6P).

It is the costumers’ responsibility to use appropriate cable glands, screw plugs, lubes and/or sealants for the cable entry ports. ABB does not assume any responsibility for cable glands or adapters that do not meet the above requirements.

The installer assumes responsibility for any other type of sealing medium used.

In the particular case of explosion proof installations, remove the temporary plastic caps and close the unused opening with a plug certified for explosion containment with appropriate rating.

Wires and cable glands shall be rated to at least 100 °C.

NOTICE

The LWT instrument has a ½-inch NPT/M20 cable gland entry.

- Avoid routing cables with other electrical cables (with inductive load, motors, etc.) or near large electrical equipment.
- Where cable glands are used, they shall be certified/listed for the explosive atmosphere/hazardous location, local temperatures, and required enclosure environmental (ingress protection [IP] or Type) rating.
- These cable glands **must only be used with braided shielded cables**. When installing them, make sure to fold the cable shield over the O-ring which presses the braiding against the inside wall of the body, thus ensuring good contact.

NOTICE

If you plan on using cable glands that are not supplied by ABB, refer to your supplier's data sheet for proper installation.

Vessel-Specific Considerations

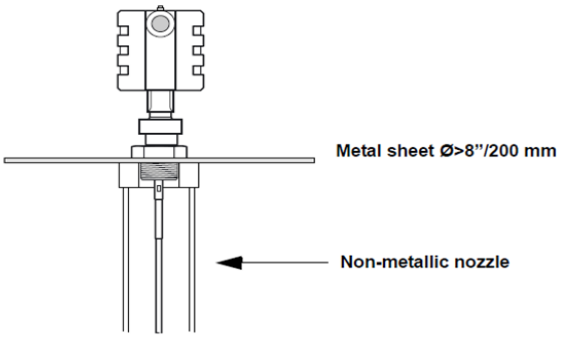
- For best performance, install the LWT flush with the top of a metallic vessel with a good ground connection between the coupler and the tank.
- Avoid installing the LWT while the probe is close to the filling stream.
- If using a cable probe in the presence of heavy turbulence, use an anchor at the bottom of the tank.
- Avoid installations too close to inlet pipes or other internal metallic objects.

Plastic and Fiberglass Tanks, and Open-Air Installations

LWT instruments installed in a non-metallic vessel or in open-air environments will be subject to interference from other electromagnetic devices, e.g., radios. You may need to use stilling wells to eliminate such interferences.

Also, with non-metallic vessels you can use an instrument equipped with a flange, or replace the flange with a metal sheet insert (>150 mm/6 in) to make contact with the coupler.

Figure 5 Metal Sheet on non-metallic vessels



Concrete Tanks

Concrete tanks require mounting the probe:

- 30 cm (1 ft) from the wall (for measuring lengths **up to** 6.1 m [20 ft]);
- 61 cm (2 ft) from the wall (for measuring lengths **over** 6.1 m [20 ft]).

The face of the LWT mounting/launch plate should be even with the inner surface of the concrete roof.

Bushings

- If the installation requires the use of a bushing, you may need to increase the blocking distance to avoid false echoes (see "Diagnosing From a Waveform" on page 82).
- Avoid stacking multiple bushings of different sizes as this creates false echoes.
- Typically, oil and gas applications have 3 inch or 4 inch threaded connections on the top of the tank. Use metal bushing with a good electrical contact with the LWT threaded coupler (avoid rust and Teflon tape to be able to keep a good ground connection between the coupler and the tank).

Nozzle-Specific Considerations

- Nozzle length is configured for system operation and not for calibration purposes. It is automatically taken into account (subtracted) when measurements are made.
- Probes installed in side-vessel connections require additional support within the nozzle connection.
- Probes installed in very agitated processes need a spacer at the top connection to prevent the probe from touching any part of the nozzle.

Gathering the Necessary Tools

To proceed with the installation of an LWT instrument, you need some basic tools:

- 3 mm hexagonal key
- ¼", 5⁄16", ⅜" and 7⁄16" wrenches, or adjustable wrench
- Flat head screwdriver (¼")
- Safety footwear and goggles
- Protective gloves
- ESD protection equipment

Accessing the Location



DANGER

The installation area must be secured. If necessary, tape off all limits of approach to the installation area and ensure that all personnel understands the risks associated with the installation procedure.



DANGER

The instrument can be operated at high levels of pressure and with aggressive media. As a result, serious injury or significant property damage may occur if this device is operated incorrectly.

Depressurize the vessel before opening the connection to the instrument. Any process media released may cause severe injuries.

Provide adequate protection and training against all chemicals involved in the work environment.



WARNING

Only qualified and authorized personnel should be put in charge of the installation, electrical connection, commissioning, operation, and maintenance of the instrument.

This personnel must hold the necessary qualifications and authorizations, such as training or instruction, to operate and maintain devices or systems in accordance with safety engineering standards regarding electrical circuits, high pressures, aggressive media, and adequate safety systems, based on local and national safety standards, i.e., building codes, electrical codes, etc.

When installing the instrument in hazardous areas, only use non-sparking tools.



CAUTION

Prior to using the instrument, safety data sheets (SDS) of all products being monitored must be available at all times for users' safety.

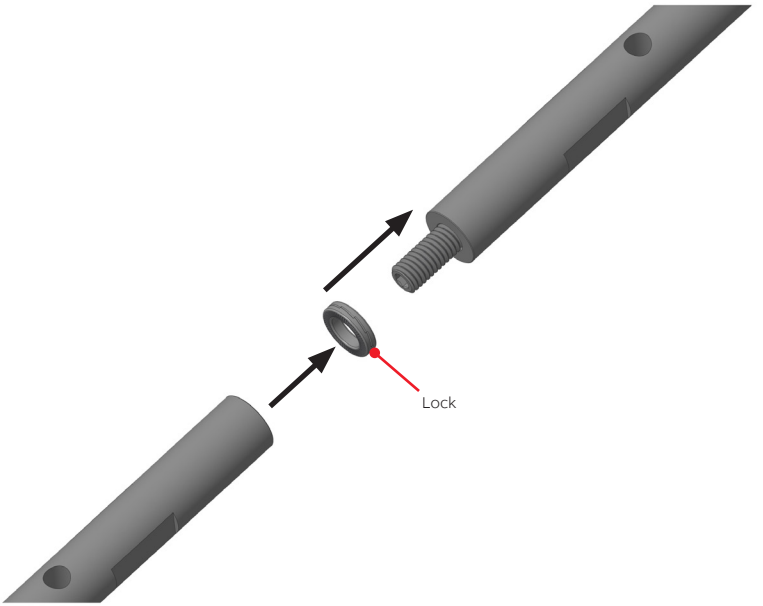
Assembling a Segmented Probe

Segmented probes are rod probes divided in 1-meter (3.3 feet) segments that must be assembled on site. Each segment is inserted into the vessel at the moment of assembly, starting with the end-of-probe segment. The following explains the assembly procedure.

To assemble a segmented probe on site:

1. Slide in the head lock on the set screw fixed on one of the probe segments.
2. Screw the female end of the end-of-probe segment on the male end of the first segment and tighten by hand.

Figure 6 Assembling two segments of a segmented probe



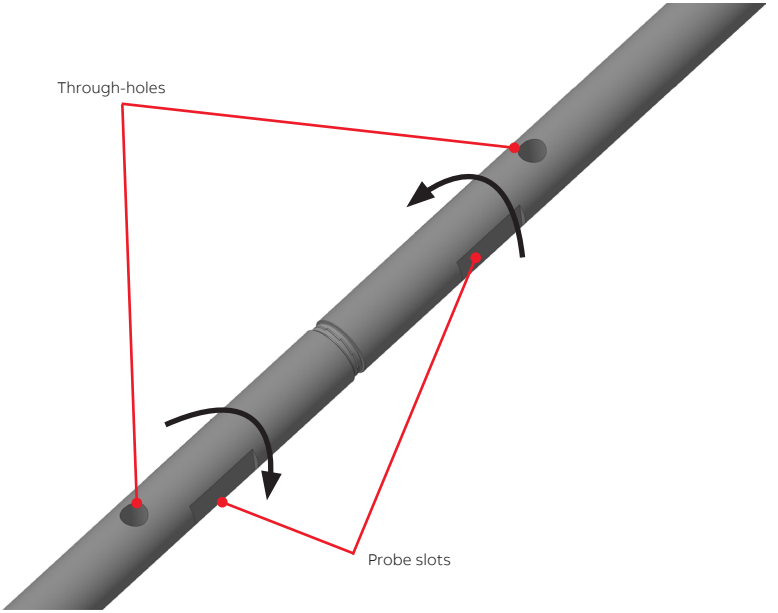
3. Use two wrenches (each one holding the probe slot of the segment) to apply the recommended torque (see below) in opposite directions at the same time (see Figure 6 on page 18).

NOTICE

There are two sizes of head locks: 8.9 mm (0.35 in) and 13.5 mm (0.53 in). The recommended torque, as specified by the manufacturer, is as follows:

- For the 8.9 mm lock: 2.8 N·m (2.1 lbf.ft).
- For the 13.5 mm lock: 13.5 N·m (10.0 lbf.ft).

Figure 7 Tightening probe segments together



4 Insert the probe assembly in the vessel, making sure that the assembly does not fall in the vessel by inserting a metal pin (not provided) in the through-hole in such a way that the pin rests across the vessel port.

5 Repeat steps 1 to 4 for all the remaining segments until you reach the probe segment that connects to the coupler. For more information on attaching the probe to the coupler, see “Attaching a Probe to the Coupler” on page 20.

Attaching a Probe to the Coupler

Depending on your specific application, you might have to install a cable or rigid probe.

ELECTROSTATIC DISCHARGES

Electronic components are sensitive to electrostatic discharges.

Before performing any connection, operators shall make sure that they have discharged all static electricity from their body before touching electronic components.

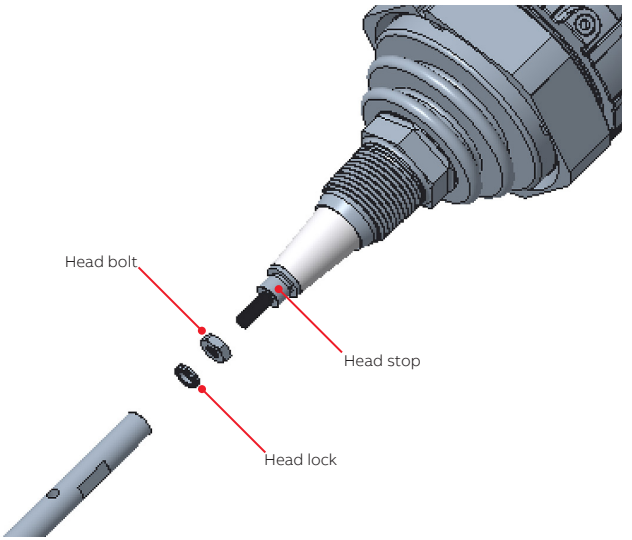
NOTICE

LWT instruments come in a wide variety of configurations. They can come with probes already attached and/or external flanges already soldered on, or neither. The following pages explain the most common procedure although it might have already been performed at the factory.

To attach a probe on a standard coupler:

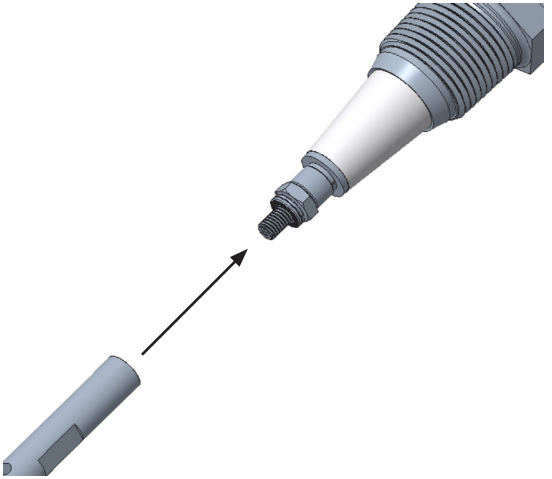
1. Screw the provided head bolt on the screw-in end and tighten by hand until it reaches the head stop.
2. Insert the head lock behind the head bolt.

Figure 8 Installing the probe



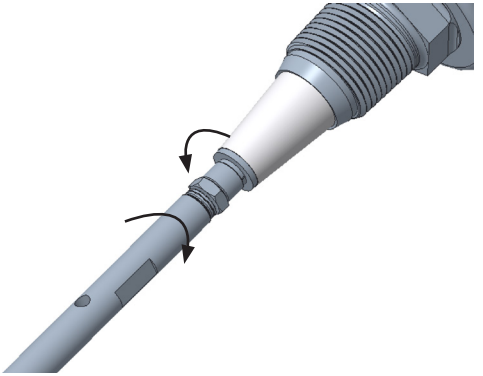
3. Screw in the probe end and tighten by hand.

Figure 9 Screwing in the probe



4 Once all the parts are in place, use two wrenches (one holding the head bolt and the other, the probe slot) to apply the recommended torque (see below) in opposite directions at the same time.

Figure 10 Tightening the probe



NOTICE

Once the probe is attached, handle it carefully to avoid bending the coupler/probe assembly.

NOTICE

There are two sizes of head locks: 8.9 mm (0.35 in) and 13.5 mm (0.53 in). The recommended torque, **as specified by the manufacturer,** is as follows:

- For the 8.9 mm lock: 2.8 N·m (2.1 lbf.ft).
- For the 13.5 mm lock: 13.5 N·m (10.0 lbf.ft).

Installing the LWT Instrument

NOTICE

Installing the LWT system directly on the top of the vessel **provides the best return signal.**

Once the probe and coupler/head assembly have been attached, you need to:

1. Insert the probe end into the flange, down the nozzle and to the bottom of the vessel.
2. Secure the coupler as necessary:
   - If you have an NPT-style coupler, apply a proper sealant on the NPT threads and screw the coupler in the NPT flange.

     NOTICE

     As much as possible, avoid using PTFE tape on the threaded connection as this type of tape can affect the ground connection between the coupler and the tank. If PTFE tape is used, it shall be used in a very thin layer to avoid electrically isolating the coupler from the tank.
   - If your coupler came in a flanged configuration, make sure that the appropriate gasket is installed before inserting the coupler assembly, and secure the flange with the appropriate nuts and bolts to the torque required by the flange class.

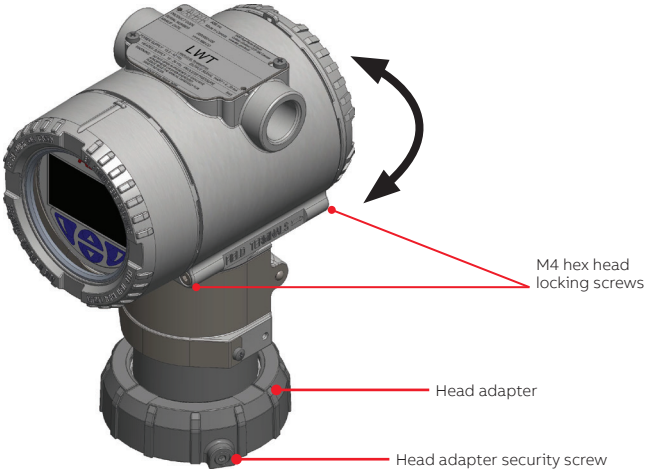
Rotating the Housing

To improve HMI visibility or field access to the wiring, you may rotate the LWT housing 360° from its initial position, and secure it in any of these positions.

To rotate the housing:

1. With a hexagonal key, slightly loosen the head adapter security screw (less than one full turn) (see Figure 11).

Figure 11 Rotating the housing



2 Loosen the head adapter by a quarter turn. This should allow the housing to rotate freely.
3 Position the housing in a way that is optimal to your location.
4 Once the housing is in the proper position, re-tighten the head adapter.
5 Re-tighten the head adapter security screw to secure the head adapter.

Rotating the HMI

ELECTROSTATIC DISCHARGES

Electronic components are sensitive to electrostatic discharges.

Before performing any connection, operators shall make sure that they have discharged all static electricity from their body before touching electronic components.

When the head unit is installed, it is possible to rotate its HMI in one of four different positions at 90° intervals.

To rotate the HMI:

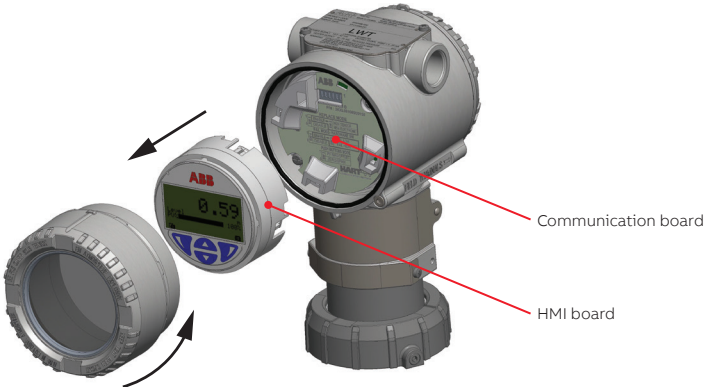
1 Make sure that the instrument is powered off and that the M4 hex head locking screws are screwed in (see Figure 11).
2 Unscrew the housing cover on the HMI side (hazardous area warnings must be heeded; see “Safety” on page 1).

CAUTION

Do not grab the instrument by its threaded interface. Thread edges are sharp and constitute a risk of personal injury (see Figure 21 on page 31).

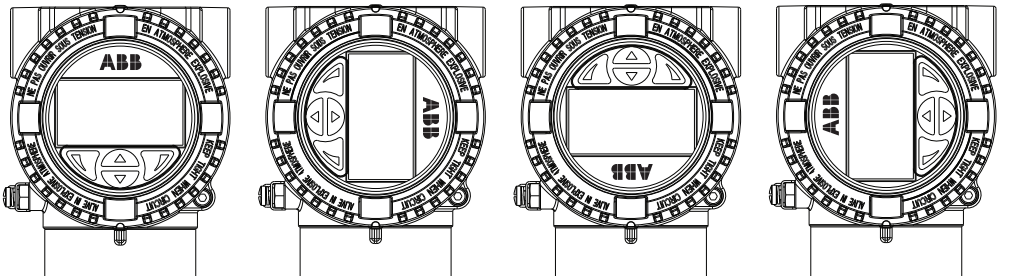
3 Pull the HMI board away from the communication board.

Figure 12 Pulling out the HMI board



4 Rotate the HMI board according to the new desired position.

Figure 13 Four positions for the instrument HMI

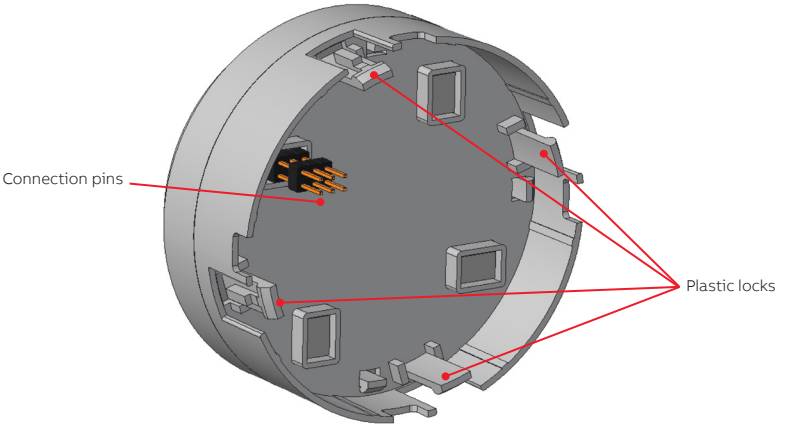


5 Properly align the connection pins and gently push back the HMI board on the communication board, making sure that the four plastic locks are properly fixed.

NOTICE

Be careful not to bend the connection pins (see Figure 14) when pushing the board back in.

Figure 14 Connection pins on back of HMI board



6 Hand tighten the housing cover back in place.

NOTICE

For Ex d and/or flameproof installations, see note “Securing housing cover in flameproof/ explosion proof areas” on page 33.

Installing a Remote Head LWT Instrument

Certain process conditions (especially high temperatures) warrant the use of a remote head on the LWT300 instrument. Remote head instruments are also very useful for any reason where you might prefer or need to distance the head from the coupler (ease of access, floating roofs, etc.)

There are three main steps to installing a remote head instrument:

1. Installing the probe-coupler assembly in the vessel (see “Assembling a Segmented Probe” on page 18 and/or “Attaching a Probe to the Coupler” on page 20).
2. Installing the head on a support bracket in a remote location.
3. Connecting the probe-coupler assembly to the instrument head with the proper coaxial communication cable.

The following pages explain the last two steps.

The support bracket provided with your instrument is designed to be fixed on a pipe. It comes with an adapter that links the instrument head and coupler.

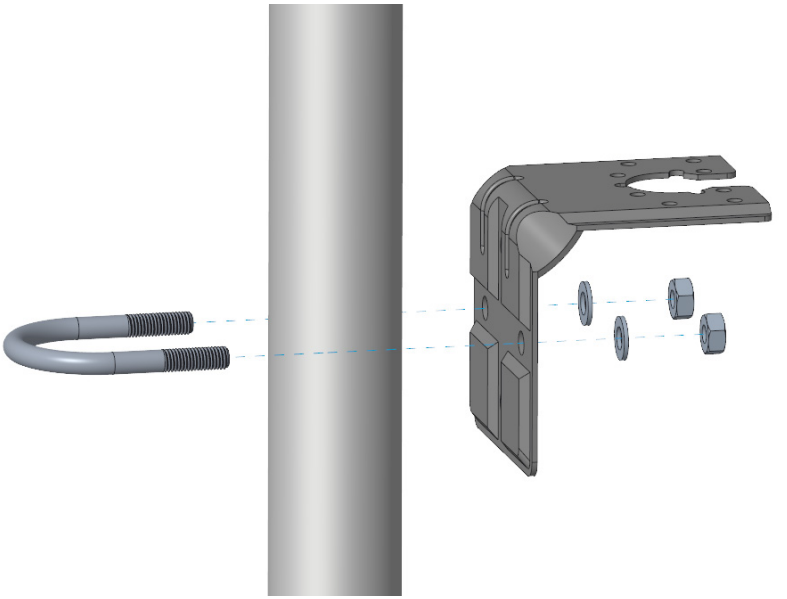
NOTICE

The sensor head must not be installed up side down. The instrument “neck” should always be lower than the HMI.

To install the remote head instrument:

1. Locate an NPS 2-sized pipe strong enough to support the weight of the instrument head.
2. Position the support bracket on the pipe and use the provided U-bolt, nuts and washers to fix it (see Figure 15).

Figure 15 Positioning the Support Bracket

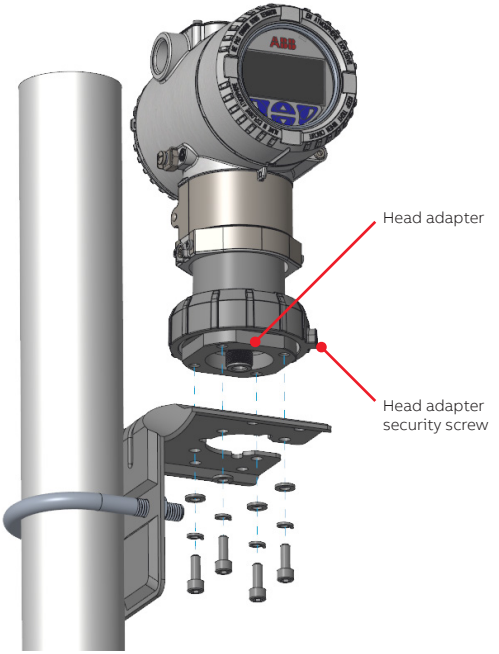


3 Place the instrument equipped with the coupler-head adapter on top of the support bracket and install the four screws to secure the instrument (see Figure 16).

NOTICE

As much as possible, avoid using PTFE tape on the threaded connection as this type of tape can affect the ground connection between the coupler and the adapter. If PTFE tape is used, it shall be used in a very thin layer to avoid electrically isolating the coupler from the adapter.

Figure 16 Positioning the Instrument Head on the Support Bracket



4 Tighten by hand the head adapter on the head-coupler adapter.

5 Re-tighten the head adapter security screw to secure the head adapter.

6 Completely unwind the coaxial cable

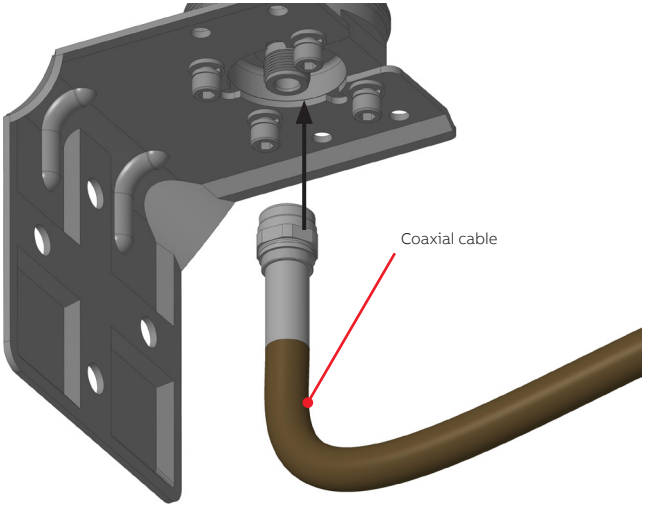
7 Connect one end of the coaxial cable to the bottom of the head-coupler adapter (see Figure 17).

NOTICE

When connecting either end of the coaxial cable, we strongly suggest the use of a wrench or pliers. More specifically, a torque wrench dedicated to type-N RF connectors preset at a torque value between 2.0 and 2.5 N·m (17 and 22 in.lb).

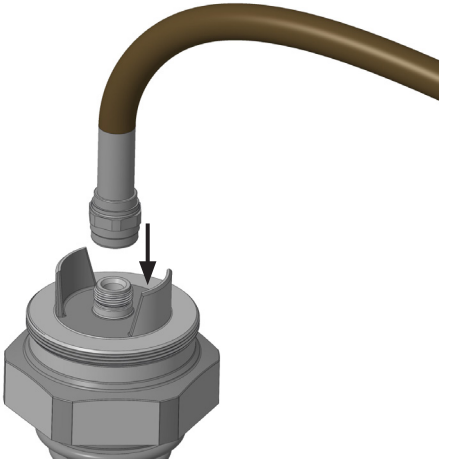
The coaxial cable bend radius shall not be less than 150 mm (6 in).

Figure 17 Connecting the coaxial cable to the head-coupler adapter



8 Connect the other end of the coaxial cable to the top of the coupler (see Figure 18).

Figure 18 Connecting the coaxial cable to the top of the coupler

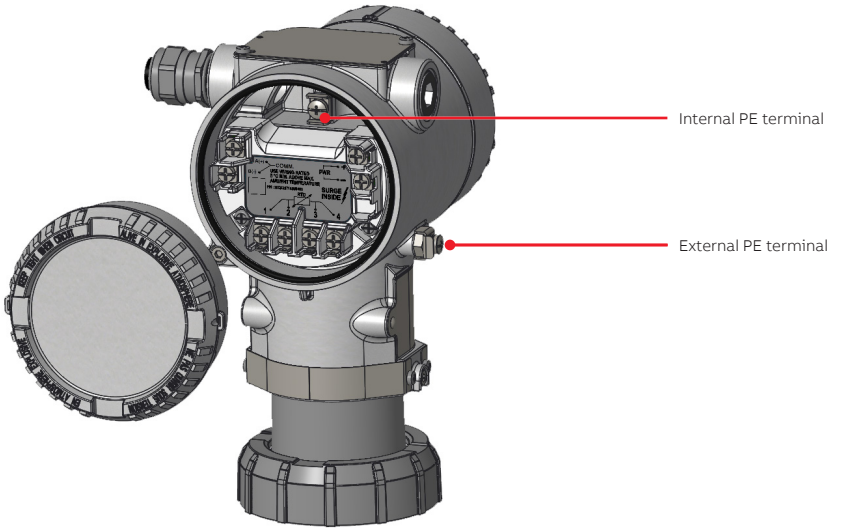


Grounding the Instrument

The LWT must be grounded in accordance with national electrical codes, using a protective earth (PE) terminal by means of a short connection to an equipotential bonding. The equipotential bonding conductor must have a maximum cross-section of 4 mm² (AWG 12).

PE terminals are available inside and outside the instrument housing (see Figure 19). Both terminals are electrically interconnected.

Figure 19 Position of the two PE terminals



If using the external PE terminal, you must connect the grounding wire to the monitored vessel.

When grounding the LWT with a shielded wire, connect the wire to the PE terminal located inside the housing. **That shielded wire should only be grounded at one end, not both.**

NOTICE

The LWT instrument has a ½-inch NPT/M20 cable gland entry

The most effective way to ground the LWT housing is a direct connection to a ground with a maximum impedance of 5 mΩ.

Outside installations or installations exposed directly or indirectly to lightning discharges shall have a secondary lightning protection module. Use of a protected terminal block in combination with a lightning arrestor module is mandatory for the continuous protection of users and installations.

WARNING

The terminal block needs to be replaced if the installation shows any sign of damage resulting from direct or indirect lightning discharges.

Connecting the Instrument

WARNING

All connections must be established in a de-energized state. Before working on the circuit, secure the breaker to prevent any accidental power-up.

In an explosion proof/flameproof installation, do not remove the covers while the instrument is energized.

ELECTROSTATIC DISCHARGES

Electronic components are sensitive to electrostatic discharges.

Before performing any connection, operators shall make sure that they have discharged all static electricity from their body before touching electronic components.

NOTICE

Ensure that a drip loop (1) (water trap) is used when installing the connecting cables for the sensor. If necessary, rotate the transmitter housing as necessary.

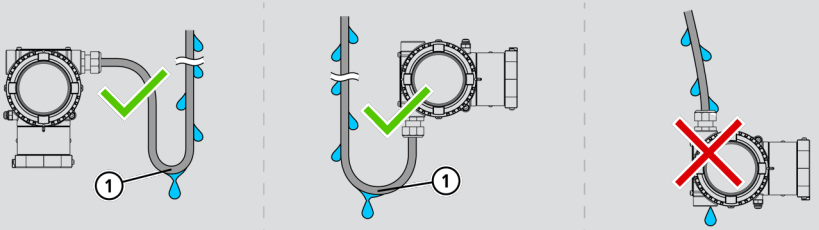
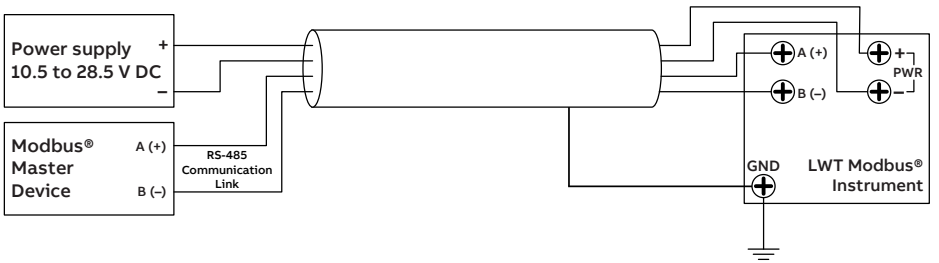


Figure 20 Typical LWT Modbus connection



To connect the LWT instrument:

1 Remove the temporary plastic caps (see Figure 21 on page 31).

WARNING

Remove the temporary plastic caps and cover the unused opening with a hermetic cap rated for the environment (in the particular case of explosion-proof installations, the cap must be certified and appropriately rated for explosion containment).

2 Make sure that the M4 hex head locking screws are screwed in (see Figure 11).

3 Remove the housing cover on the “terminals” side (see Figure 21 on page 31).

WARNING

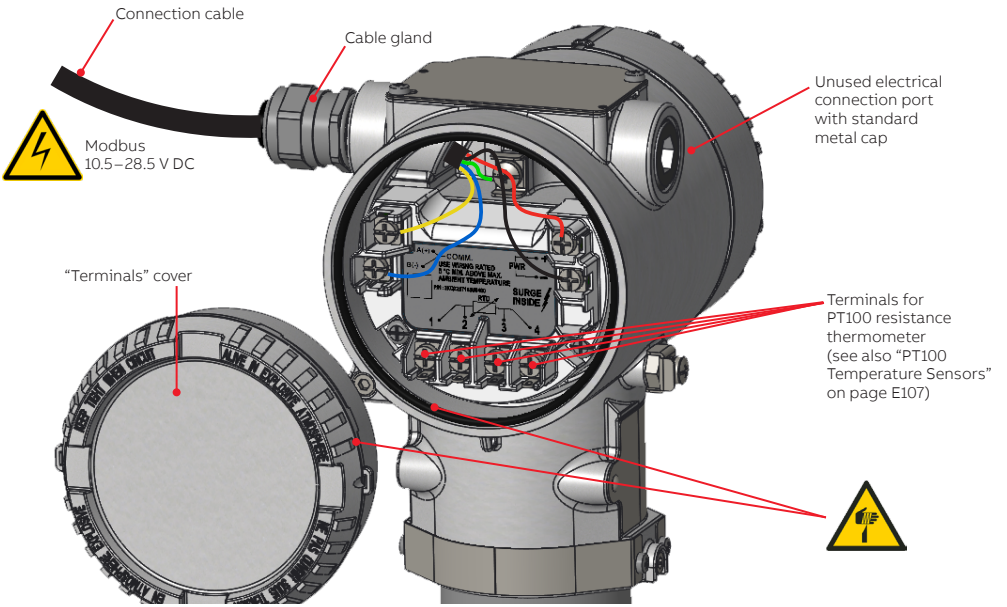
Do not handle the instrument by the threaded interface. Threaded edges are sharp and could cause personal injuries.

NOTICE

After an interval of several weeks, increased force will be required to remove the housing cover. This situation is normal; it is caused by the type of gasket used.

4 Route the connection cable through the cable gland and the open electrical connection port. For more details, see also Figure 20 on page 30.

Figure 21 Accessing the terminals inside the LWT



5 From the connection cable:
   a Connect the ground cable to the internal PE terminal (if necessary)
   b Connect the Modbus cables to the **COMM A (+)** and **COMM B (–)** terminals.
   c Connect the positive lead to the **PWR +** terminal, and the negative lead to the **PWR –** terminals.
6 Plug and seal the electrical connection ports.
7 Put back the housing cover. Turn it so as to seat the O-ring into the housing, then continue tightening by hand until the cover contacts the housing metal-to-metal.
8 Once installation is complete, make sure that electrical ports are properly sealed against all types of fluid ingress (rain and/or corrosive vapors or gases) and verify the following:
   – Cover installations;
   – Locking screw tightness;
   – Process connection;
   – Electrical connection.
9 Power up the instrument by switching on the circuit breaker.

At power-on, the through-the-glass (TTG) touch interface goes through a calibration process. For the TTG to work properly, it is mandatory that the housing cover be correctly tightened before power-on.

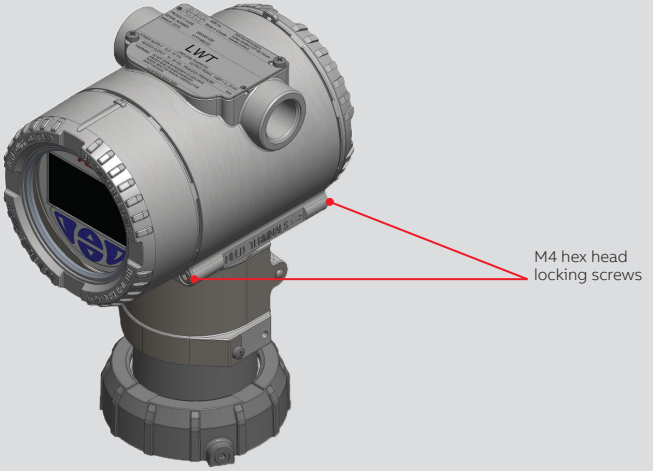
NOTICE

For instruments equipped with the through-the-glass (TTG) display option, wait for the HMI calibration process to complete (±30 seconds after power-on) before operating the HMI.

WARNING

Securing housing cover in flameproof/explosion proof areas

Both sides of the electronics housing feature a M4 hex head locking screw on the bottom side.



To secure a housing installed in a hazardous location:

1. Tighten the housing covers by hand.
2. Turn both locking screws counterclockwise until their head stops at the housing cover.

Upon Startup

Upon startup, the LCD turns on, the instrument establishes connection and the display starts showing values on Operator page 1 based on the factory-set configuration.

NOTICE

For instruments equipped with the through-the-glass (TTG) display option, wait for the HMI calibration process to complete (±30 seconds after power-on) before operating the HMI.

Figure 22 Instrument LCD on power-up

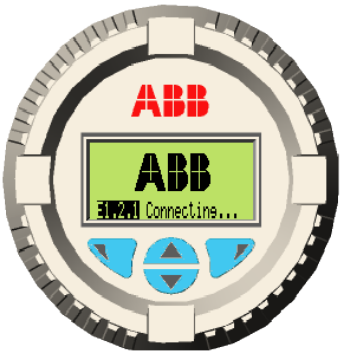


Figure 23 Initial Operator page with values based on default configuration



NOTICE

During the boot process, no level information is displayed.

For more information on Operator pages, see “Configuring Operator Pages” on page 42.

The next chapter introduces the standard instrument user interface: the human-machine interface (HMI).

CHAPTER 4

Introducing the User Interface

Chapter 5 and Chapter 6 discuss various configuration options, but first you need a basic understanding of the various ways to interact with the instrument.

Introducing LWT User Interfaces

To configure your LWT instrument, you need to understand the access methods to the parameters that you need to change and what to expect when you reach these parameters.

There are two methods to access the parameters, but only access using the instrument HMI is discussed in this user guide.

Once the LWT instrument is powered up, its display looks like this:

Figure 24 Typical Operator screen

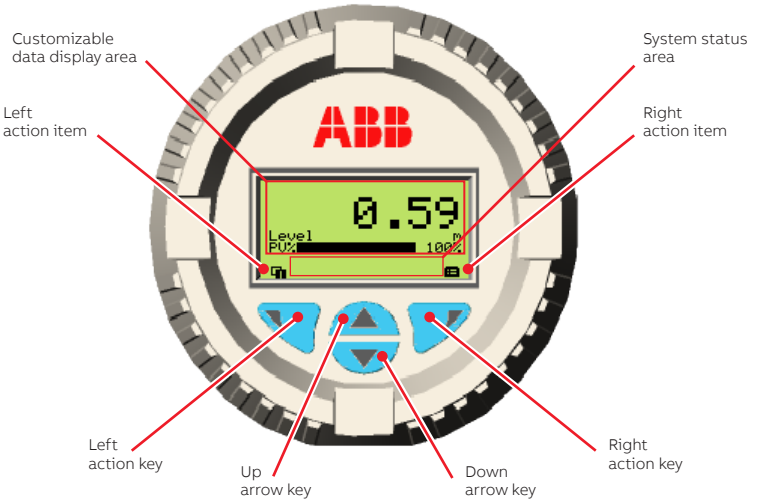


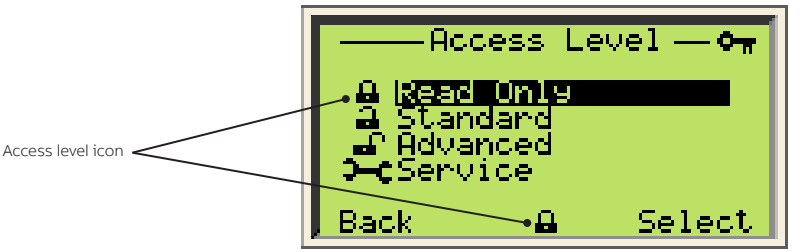
Table 1 Action items and explanation

Action item	Title	Action
Left		Gives access to the Diagnostics page (see “Diagnosing Problems” on page 77), the four Operator pages (see “Configuring Operator Pages” on page 42) and the Signals View (see “Selecting an Operator Page to Display” on page 43).
	Exit	Exits the current menu
	Back	Returns to the previous sub-menu
	Cancel	Exits without saving the current parameter value
	Next	Selects the next position when entering alphanumerical values
Right		Gives access to the Configuration menus (see “Configuring the Instrument” on page 41).
	Select	Selects the highlighted sub-menu or parameter
	Edit	Allows editing of the current parameter
	OK	Saves the current parameter value or displays the stored parameter value

Accessing Menus

Upon selecting the configuration menus icon ( ) on the main screen, the interface displays a selection of four access levels: **Read Only**, **Standard**, **Advanced**, and **Service**.

Figure 25 Access-Level menu



All but the **Read Only** access level require a password (if defined). When selecting an access level, you will be asked for your password. By entering the proper password, you will gain access to features and functions associated with this access level.

The **Service** access level can only be accessed by or under the supervision of, ABB service personnel.

The icon adjacent to the access level provided is displayed in the system status area.

For more information on setting passwords, see “Protecting Access to Instrument Data” on page 44.

Navigating the Instrument Display

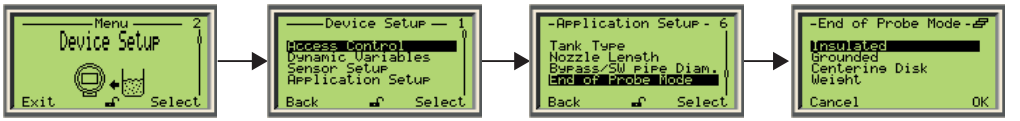
There are two operations that you can do when navigating the user interface. You can select an existing option, or edit a value.

Selecting an Option

Options can be selected but not modified. This is the easiest operation to perform:

1. Using the arrow and action keys, move up, down, left or right within a menu.
2. Once you find the option that you want to set, highlight it by using the arrow keys.
3. Press the right action key (**OK**). The highlighted option is selected and effective immediately.
4. Press the left action key (**Back**) repeatedly to exit the menu.

Figure 26 Selecting an existing option



Setting a Value

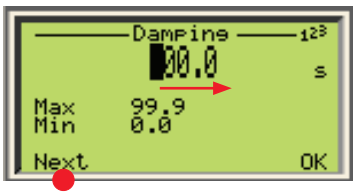
Contrary to options, you can modify values.

1. Using the arrow and action keys, move up, down, left or right within a menu.
2. Once you find the option that you want to set, highlight it by using the arrow keys.
3. Press the right action key (**Edit**) (see Figure 27 on page 37).
4. In the Edit screen, use the left action key (**Next**) to move from left to right over the editable values (see Figure 28 on page 37).
5. Once you are on the value that you want to modify, press the Up or Down arrow key to increase or decrease the highlighted value. Modify all necessary values as such.
6. Once you are done modifying values, press the right action key (**OK**). The modified value becomes effective immediately.
7. Press **Back** repeatedly to exit the menu.

Figure 27 Selecting a value to edit



Figure 28 Setting a value



The menus accessible at the first level (once the instrument is powered up and functional) are listed in “First-level Menu” on page A87.

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CHAPTER 5

Configuring the Instrument at Startup

Once the LWT instrument is physically installed and properly powered, you might need to configure the various parameters to better suit your needs if they go beyond the default configuration. The following pages explain the first-time **Easy Setup** configuration (in more detail than the Quick Start guide).

Your LWT instrument comes configured with certain default parameters, but you still need to select certain options and set specific values for your instrument to work as you expect. This configuration is performed via the **Easy Setup** menu. This menu makes you go through all the basic configuration items in succession until the basic configuration is complete. This menu was designed to cover most typical uses.

Figure 29 The Easy Setup menu



To quickly configure your instrument, you need to know the following:

- What you want to measure (level, ullage, interface, etc.)
- The unit in which these measurements must be made (meters, feet, etc.)
- The lowest and highest levels that you expect to measure in your vessel
- The dielectric constant of the vessel content
- The speed at which the vessel normally fills up or is drained (a.k.a. maximum level rate)
- The measurement that you want displayed on the first line of Operator page 1 (which appears upon powering on the instrument).

To configure with the **Easy Setup** menu:

1 From the **Easy Setup** menu, press **Select**. The **Application Category** screen appears. This sets the type of process (or interface between processes) in which level measurements will be made, based on the dielectric constant (DC) of the vessel content.
   - **a** Press **Edit**. The list of available values appears.
   - **b** Scroll up or down the list and highlight the required value.
   - **c** Press **OK**. The value is applied.

For more information, see “Selecting the Application Category” on page 48.

2 Press **Next**. The **Set PV** screen appears. This sets the type of measurement that you want to make.
   a Press **Edit**. The list of available measurements appears (default value: **Level**).
   b Scroll up or down the list and highlight the required measurement.
   c Press **OK**. The measurement is selected.

For more information, see “Setting Variables” on page 47.

3 Press **Next**. The **PV Unit** screen appears. This sets the measurement unit for the measurement type that you just previously selected.
   a Press **Edit**. The list of available measurement units appears.
   b Scroll up or down the list and highlight the required measurement unit.
   c Press **OK**. The measurement unit is selected.

For more information, see “Setting Variable Units” on page 47).

4 Press **Next**. The **↓Empty/Zero** screen appears. This sets the lowest level that you expect to measure in the vessel.
   a Press **Edit**.
   b Set the required value (see “Setting a Value” on page 37).
   c Press **OK**. The value is set.

For more information, see “Changing the Empty/Zero Value” on page 68.

5 Press **Next**. The **↑Full/Span** screen appears. This sets the highest level that you expect to measure in the vessel.
   a Press **Edit**.
   b Set the required value (see “Setting a Value” on page 37).
   c Press **OK**. The value is set.

For more information, see “Changing the Full/Span Value” on page 69.

6 Press **Next**. The **Max Level Rate** screen appears. This sets the expected rate at which the vessel fills up or is drained.
   a Press **Edit**. The list of available values appears.
   b Scroll up or down the list and highlight the required value.
   c Press **OK**. The value is applied.

For more information, see “Selecting Maximum Level Rate” on page 56.

7 Press **Next**. The **Display Line1 View1** screen appears. This sets the measurement displayed on the first line of text, as illustrated in Figure 31 on page 42.
   a Press **Edit**. The list of available values appears (default value: **Level**)
   b Scroll up or down the list and highlight the required value.
   c Press **OK**. The value is applied.

For more information, see “Configuring the Display” on page 41.

8 Press **Next**. The **Echo Lost Reaction** screen appears. This sets the behavior of the displayed measurement should the level echo be lost.
   a Press **Edit**. The list of available values appears (default value: **Hold Last Value**).
   b Scroll up or down the list and highlight the required value.
   c Press **OK**. The value is applied.
   d Press **Next** to return to the beginning of the **Easy Setup** menu.

CHAPTER 6

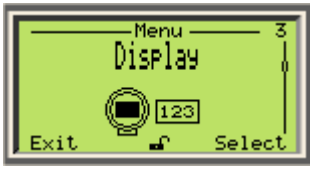
Configuring the Instrument

Once the LWT instrument is physically installed and properly powered, you might need to configure the various parameters to better suit your needs if they go beyond the default configuration. The following pages explain how to configure these various parameters from the built-in interface (a.k.a., the HMI). You can also configure the instrument via an external computer, as explained on page 65.

Configuring the Display

You set all LCD-specific parameters from the **Display** configuration menu.

Figure 30 Display menu



Contrast

To set the display contrast:

1. Select **Display** > **Contrast**.
2. Press the Up or Down arrow key to increase or decrease the contrast percentage.
   By default, the contrast is set to 50%.
3. Press **OK**.

Number of Decimals

The LWT allows you to set the number of decimals to display on screen for length, flow and volume units.

To set the number of decimals to display for these units throughout the interface:

1. Select **Display** > **Length Format**, **Flow Format** or **Volume Format**.
2. Press **Edit**.
3. From the list that appears, highlight the number of decimals to display (**X**, **X.X**, **X.XX**, **X.XXX**) and press **OK**.

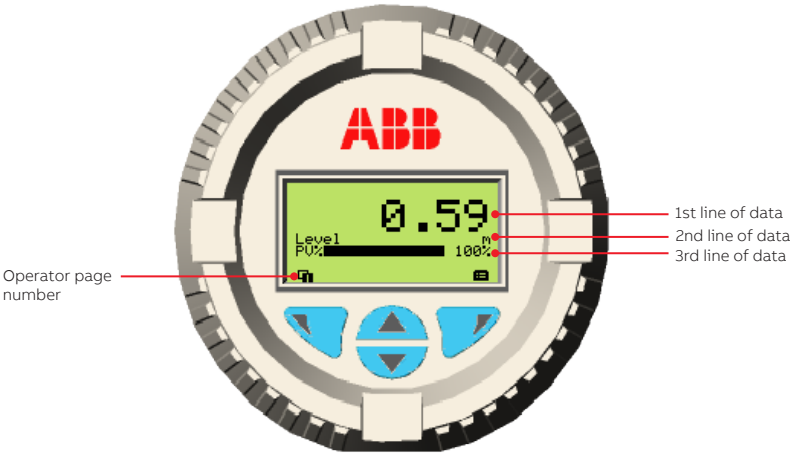
Volume and flow data can have their own decimal settings (for more information on volume and flow measurements, see also “Setting Up Linearization” on page 59).

Configuring Operator Pages

Operator pages display relevant information about ongoing process measurements. The LWT allows you to configure and display up to four different Operator pages. Each Operator page can display bargraphs and/or up to three lines of data. You can scroll automatically between the four Operator pages with the autoscroll feature (see “Enabling Operator Page Autoscroll” on page 43).

Operator page 1 appears by default once the LWT is powered on.

Figure 31 The default Operator page 1



To configure an operator page:

1. Select **Display** > **Operator Pages** > **Operator Page n** (*n* being the number of the operator page that you want to configure).
2. From the **Operator Page n** screen, select **Display Mode**.
3. Press **Edit**.
4. Highlight the display mode that you want and press **OK**.

   There are seven modes available:

   - **1Row 6Char S**
   - **1Row 6Char SBar**
   - **1Row 9Char**
   - **1Row 9Char Bar**
   - **2Row 9Char**
   - **2Row 9Char Bar**
   - **3Row 9Char**
5. Once the display mode is selected, press **Back** once to go back one screen to where you can select the value displayed on each line/graph of the selected Operator page.

   The values available for display depend on the display mode. For example, if you select the **2Row 9Char** display mode, the third line will not be available for configuration.
6. Select the **Line** or **Bargraph**.

7 Press **Edit**.

8 Highlight the value that you want to display and press **OK**.

9 (If necessary) Repeat steps 6 through 8 to configure all remaining values.

Once you have completed the configuration, exit the **Display** menu.

Selecting an Operator Page to Display

If necessary, you can choose which Operator page to display as the default display. When first connecting the instrument, Operator page 1 is selected by default.

To select another page:

1 From the startup display, press the left action key ( ). The **Operator Menu** appears.

2 Using the Up or Down arrow keys, highlight the **Operator Page** that you want to use by default.

> ***NOTICE***
>
> The **Signals View** and **Diagnostics** pages can be selected, but cannot be used as Operator pages. These pages are mostly used for troubleshooting purposes.

3 Press **Select**. The page is selected and you automatically return to the startup display where the newly selected page appears. For more information on configuring the content of Operator pages, see “Configuring Operator Pages” on page 42).

Enabling Operator Page Autoscroll

The autoscroll feature allows you to move automatically between Operator pages at a set time interval. This is useful when you simply want to record specific values manually without touching the instrument. This feature is disabled by default.

To enable autoscroll:

1 Select **Display** > **Autoscroll**.

2 Press **Edit**.

3 Select one of the time intervals (**3, 5, 7, 10 Seconds**) that you want to set as a time delay after which Operator pages scroll automatically.

4 Press **OK**.

When the autoscroll feature is enabled, a spinning icon appears next to the Operator page number.

Figure 32 Autoscroll icon next to the Operator page number (4)



> ***NOTICE***
>
> If the feature is activated and you want to deactivate it, highlight **Off** instead of the already selected time interval.

Protecting Access to Instrument Data

LWT instruments offer a few methods of protecting access to their data. You can set role-based passwords (standard and advanced users) and enable instrument write-protection from the **Access Control** menu under the **Device Setup** menu.

Figure 33 The Device Setup menu



For more information on securing your instrument from unwanted access, see “Cybersecurity” on page 5. **For security reasons, it is recommended to set passwords.**

Setting Up Role-Based Passwords

In LWT instruments, these passwords, comprised of six alphanumerical characters, give access to instrument functions and features based on the password entered.

To define passwords:

1. Select **Device Setup** > **Access Control** > **Standard Password** or **Advanced Password**.
2. Press **Edit**.
3. In the edit window, press the Up and Down arrow keys to move right or left on the alphanumerical ribbon and highlight the alphanumerical characters that you need to create the password.
4. Press **Next** to select the highlighted character and move on to the next character to highlight.
5. Repeat steps 3 and 4 until your password is complete.
6. Press **Next** one last time, then **OK** to save your password or **Cancel** to cancel the password that you just created.

Resetting Passwords

To reset all passwords:

1. Select **Device Setup** > **Access Control** > **Reset Password**.
2. Press **OK**.

   If no passwords have been set, **OK** is not displayed; you can only select **Back**.

   All passwords are reset, but the rest of the configuration remains unchanged (see also “Resetting to Factory Default” on page 64).

Disabling Access to the Service Account

In LWT instruments, the Service account allows access to service-specific functions usually reserved to administrators and ABB troubleshooting experts. It is good practice to disable access to this account and only allow a restricted number of users for this account as it could provide backdoor access and hamper the instrument cybersecurity protections. Only users with an Advanced account can perform this procedure.

To disable the Service account:

1 Select **Device Setup** > **Access Control** > **Service Account**.

2 Press **Edit**.

3 Select **Disabled** and press **OK**.

The Service account is now disabled. It will not be available from the **Access Level** menu. To re-enable the Service account, perform the same procedure, but select **Enabled** instead.

Preventing Unwanted Deletion of Data

To prevent inadvertent or malicious overwriting of an instrument's settings and data, you can enable software and/or hardware write protection; both are disabled by default.

NOTICE

With hardware or software write-protection enabled, it is impossible to modify instrument settings via Modbus or HART communication protocols.

Activating hardware write-protection prevents all forms of external access to the instrument.

Software Write-Protection

To enable software write-protection:

1 Select **Device Setup** > **Access Control** > **Write Protect** > **Software WP**.

2 Press **Edit**

3 Highlight **On** and press **OK**.

Data is now protected against erasing operations.

Hardware Write-Protection

NOTICE

Before performing this procedure, you can see if hardware write protection is already activated by navigating to **Device Setup** > **Access Control** > **Write Protect** > **Hardware WP.**

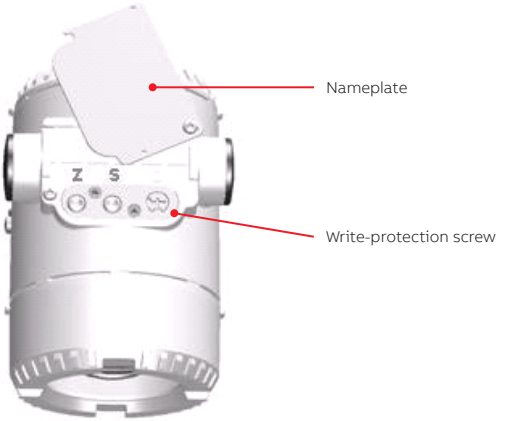
To enable hardware write-protection:

NOTICE

DO NOT use a magnetic screwdriver.

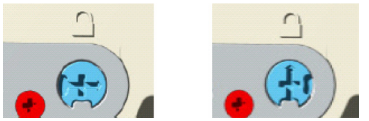
1 On the instrument head, unscrew and remove the nameplate. This exposes two buttons and the write-protection screw.

Figure 34 Accessing the write-protection screw



2 Using a suitable screwdriver, fully press down on the write-protection screw and turn 90° clockwise to activate hardware write protection or, if already activated, 90° counterclockwise to deactivate it.

Figure 35 Activating hardware write-protection



Deactivated write protection (default)

Activated write protection

3 Put the nameplate back in place.

Setting Dynamic Variables

The LWT instrument can monitor up to four variables. These variables are identified as primary (PV), secondary (SV), tertiary (TV), and quaternary (QV).

If you initially configured your LWT instrument with the help of the **Easy Setup** menu, you have already defined the primary variable (PV). The primary variable is often the most important value that you want to measure. You can also monitor three more variables.

Setting Variables

Variables are set in the **Device Setup** menu.

To set one of the variables:

1 From the **Device Setup** menu, select **Dynamic Variables > Set** (**PV**, **SV**, **TV** or **QV**)

2 Press **Edit** and, from the list of variables that appear, highlight the variable that you want to monitor.

NOTICE

As is commonly accepted practice, the first two variables (**PV** and **SV**) relate to variations on distance measurements (**Level**, **Distance**, **Ullage**, **Interface**, **Thickness**, **Interface Distance**) whereas the last two variables (**TV** and **QV**) allow for monitoring of additional variables (**Amplitude**, **Electronics Temperature**, **Interface Amplitude**, **GPC Dynamic Factor**, **External Temperature** [linked to pt100 external temperature sensors; see “PT100 Temperature Sensors” on page E107]). Available variables depend on configuration choices made elsewhere (application category, linearization status or output type, etc.

NOTICE

To use an interface-related variable (**Interface**, **Thickness**, **Interface Distance**, **Interface Amplitude**), you must first set the application category to **Interface**.

3 Press **OK**. The variable is set and will be monitored and measured from now on.

Setting Variable Units

Variable measurement units are set in the **Device Setup** menu. They relate to four different types of measurement: level, flow, volume and temperature.

To set variable units

1 From the **Device Setup** menu, select **Dynamic Variables >** the unit that you want to set (**Length Unit**, **Flow Unit**, **Volume Unit**, **Temperature Unit**).

2 Press **Edit** and, from the list of units that appear, highlight the unit that you want to assign to a specific variable.

NOTICE

Variable units are specific to the type of variable (e.g., you will not find flow units in the **Volume Unit** menu).

3 Press **OK**. The unit is set and you return to the previous menu.

Configuring the Sensor

Certain sensor parameters can be configured to improve measurement accuracy and reliability. This configuration can be performed from the **Sensor Setup** menu found under the **Device Setup** menu.

Selecting the Application Category

The application category is the type of media in which the sensor will be used. Applications are based on the dielectric constant (DC) value of the medium measured. The default application category depends on the instrument ordered.

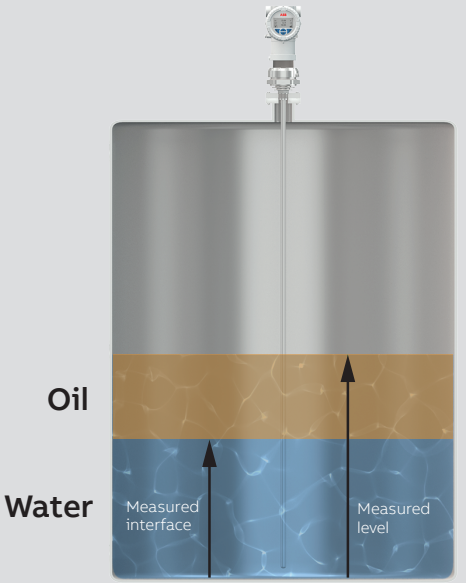
To set the application category:

1 Select **Device Setup** > **Sensor Setup** > **Application Category**.

2 Press **Edit**.

3 Highlight the appropriate application (based on medium measured [DC or liquid vs. solid] or the need to measure the interface between two liquids) and press **OK**.

The **interface application** is used to measure the height in a vessel where substances with differing dielectric constants separate naturally, as illustrated below. All measures are performed from the empty/zero value.



Selecting the Measurement Mode

Two measurement modes are available:

- **Threshold:** The level algorithm detection is based on a first echo signal after the blocking distance which crosses the threshold value.

- **Movement:** The level algorithm detection is based on the movement and displacement of a valid echo after the blocking distance. This mode is particularly useful when large false echoes are present.

To set the measurement mode:

1 Select **Device Setup > Sensor setup > Measurement mode**.

2 Press **Edit**.

3 Highlight the appropriate measurement mode and press **OK**.

NOTICE

In *movement measurement mode,* until the displacement of a valid echo is detected, the reported level corresponds to the first echo after the blocking distance which crosses the threshold value. Also in this mode, in presence of multiple false echoes, it is possible to select the echo corresponding to the actual level so that it is properly reported even if the level is static. For more information, see “Selecting a Level Echo” on page 83. See also “Defining a False Echo Zone” on page 51 for more information on managing the presence of false echoes.

Setting Algorithm Parameters

The following algorithm parameters can be adjusted to optimize the performance of the LWT:

- Level Amp. Threshold (for both measurement modes):
  - Value which determines the minimal amplitude for a level echo (see “Appendix G” on page G111 for more details).
- Int. Amp. Threshold (for both measurement modes):
  - Value which determines the minimal amplitude for an interface echo (see “Appendix G” on page G111 for more details).
- Interface lost period (for both measurement modes):
  - Period of time after the interface has been lost (the instrument uses the last valid value and raises the “No interface detected” flag) and waits before indicating the interface is now equal to the level. During emulsion phase, the interface echo may disappear for a long period of time. This value can be increased to prevent the instrument to reset the interface position too early after the interface is lost.
- Minimum echo displacement (for movement measurement mode only):
  - Minimum cumulative echo displacement required for identifying a movement-level track.
- Maximum displacement jump (for movement measurement mode only):
  - Maximum instantaneous echo displacement considered between two frames (for spurious jumps or track changes).

To set any of the algorithm parameters mode:

1 Select **Device Setup** > **Sensor setup** > **Algo parameters**.

2 Select the specific parameter you want to adjust.

3 Press **Edit**.

4 Set the parameter value and press **OK**.

Setting the Static Overflow

Some level applications use overflow tanks. In that situation, when movement measurement mode has been selected, we suggest enable the Static Overflow mode and set an overflow distance representing the distance between the sensor reference point and the position of the overflow.

To activate the static overflow mode:

1. Select **Device Setup > Sensor setup > Static Overflow > Static Overflow Mode**.
2. Press **Edit**.
3. Select **Enable** and press **OK**.
4. Select **Device Setup > Sensor setup > Static Overflow > Overflow Distance**.
5. Press **Edit**.
6. Set the overflow distance and press **OK**.

Setting the Dielectric Constant of Upper Media

When your application involves measurement of the interface between liquids (e.g., oil on top of water), you must indicate the dielectric constant (DC) of the first liquid that the pulse will encounter (in this case, oil).

To do so:

1. Select **Device Setup** > **Sensor Setup** > **Upper Media DC**.
2. Press **Edit**.
3. Set the proper dielectric constant (between 1.4 and 10) and press **OK**.

You can find the dielectric constant of most common liquids in “Appendix D” on page D103.

Configuring Gas Phase Compensation

Different substances have different dielectric constants (DC), and even a single substance has different DCs depending of its state (phase): solid vs. liquid vs. gaseous. When measuring the level of a substance in a vessel, inaccuracies can appear if that substance is present in two phases at the same time (e.g., liquid and vapor [gas]) The gas phase compensation (GPC) feature takes into account the variation of DC brought about by the presence of a substance in gas phase inside a vessel, thus considerably improving level measurement accuracy.

GPC generally applies to high-pressure, high-temperature (HPHT) applications (e.g., boilers), but it can be used in any application where a substance in gas phase is present.

GPC is configured from the **Device Setup** menu.

Figure 36 The Device Setup menu



Activating GPC

LWT instruments offer two modes for dealing with GPC: static, if you know exactly the percentage variation between the two phases present in the vessel, and dynamic, if you prefer to let the instrument calculate a proper compensation.

To activate the gas-phase compensation function:

1 Select **Device Setup** > **Sensor Setup** > **Gas Phase comp.** > **GPC Mode**.

2 Press **Edit**.

3 Highlight **Static** and press **OK**.



NOTICE

The menu also contains a **Dynamic** option. Dynamic-related options (**GPC Marker Distance**, **GPC Dynamic Factor**) are used specifically with high-pressure, high-temperature options not offered at the time of writing.

Setting the GPC Percentage (static mode)

In static GPC mode, the LWT instrument uses a precise percentage (slope correction) that you input as the baseline for gas-phase compensation (for more information, see “Appendix C” on page C101).

To set the GPC percentage:

1 Select **Device Setup** > **Sensor Setup** > **Gas Phase comp.** > **GPC Static Factor**.

2 Press **Edit**.

3 Set the necessary percentage of GPC and press **OK**.

Defining a False Echo Zone

In certain installations, the presence of false echoes along the probe may interfere with level measurements. *In movement measurement mode,* it is possible to define zones above the known level or interface where all found echoes will be ignored (false echoes).

To define the false echo zone above the known level:

1 Select **Waveform** > **False Echo Zones** > **Above Level Dist**.

2 Press **Edit**.

3 Set the distance between the top of the vessel and slightly above the known level.

4 Press **OK**.

To define the false echo zone between level and interface:

1 Select **Waveform** > **False Echo Zones** > **Above Interf. Dist.**

2 Press **Edit**.

3 Set the distance between the top of the vessel and slightly above the known interface.

4 Press **OK**.

Activating the False Echo Zones

Once the zones are defined, they need to be confirmed so that false echoes can be ignored:

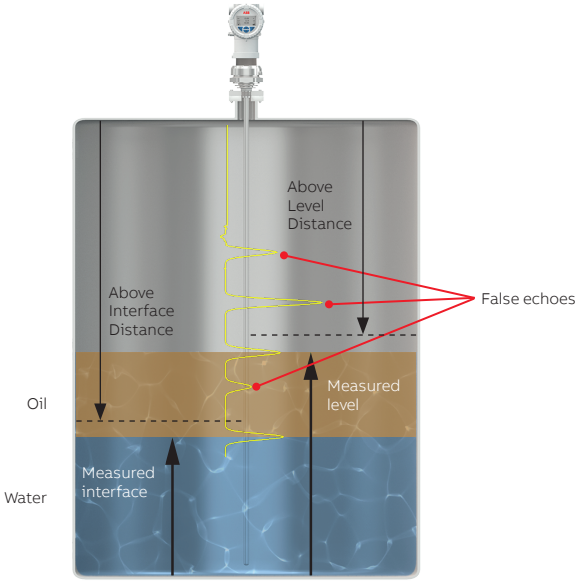
1 Select **Waveform > False Echo Zones > Confirm Zones**.

2 Press **Select**.

3 Press **OK**.

All echoes detected within the defined **Above Level Distance** will be ignored. The first echo located after the **Above Level Distance** will be the Level. All echoes between the Level echo and the **Above Interface Distance** will be ignored. The first echo located after the **Above Interface Distance** will be the Interface.

Figure 37 False Echo Zones



NOTICE

If false echoes appear in the defined zones later on, they will *not* be ignored.

Resetting Echo Tracking

There are situations, such as modifications made to the vessel, where echo tracking might need to be reset, effectively erasing the history of false echoes and starting anew.

To reset the tracking of echoes:

1 Select **Device Setup** > **Sensor Setup** > **Reset Tracking**.

2 Press **OK**.

Echo tracking is reset and you return to the previous menu.

NOTICE

The **Reset Tracking** function is also available directly under the **Waveform** menu.

Setting Up the Application

Before starting level measurements, you need to set certain hardware parameters regarding the probe, the vessel and the instrument nozzle. These parameters are set in the **Application Setup** menu under the **Device Setup** menu.

Figure 38 The Device Setup menu



Changing Probe Type

Your instrument, as delivered, was configured with the type of probe ordered. In the future, should you need to change the type of probe attached to your instrument, you also need to change the type of probe configured in the LWT instrument.

NOTICE

If you change the probe type, **remember** to change for a compatible end of probe (if necessary). **Isolated end of probes are only compatible with rod probes** (see “Changing End of Probe Mode” on page 55).

To do so:

1 Select **Device Setup** > **Application Setup** > **Probe Type**.

2 Press **Edit**.

3 Highlight the appropriate probe type and press **OK**.

Changing Probe Length

The probe length is already programmed into the instrument. Should you have to physically shorten the probe for any reason, do not forget to change the probe length programmed in the instrument.

To do so:

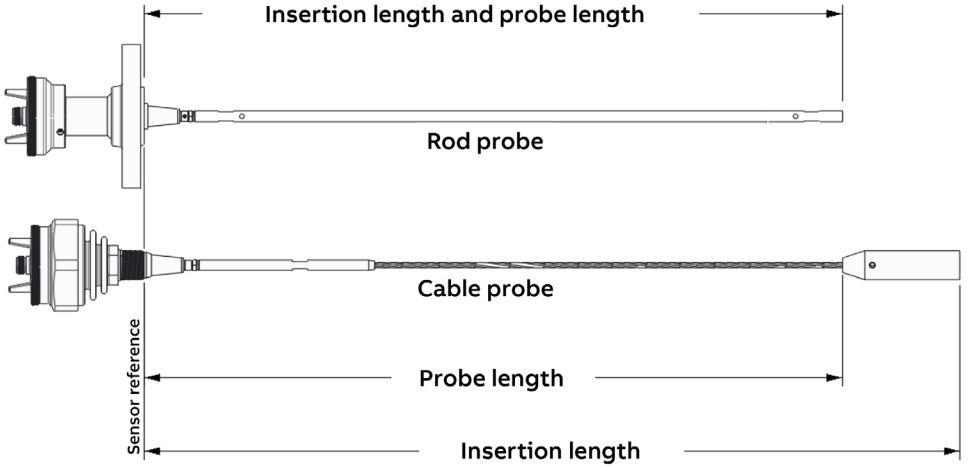
1 Select **Device Setup** > **Application Setup** > **Probe Length**.

2 Press **Edit**.

3 Set the length of the shortened probe and press **OK**.

The probe length is measured as such:

Figure 39 Measuring the probe length



Selecting Tank Type

You can set the type of vessel in which the probe will be hanging. The type of vessel impacts the quality and nature of the signal sent down the probe. The default tank type is **Metallic**.

To do so:

1 Select **Device Setup** > **Application Setup** > **Tank Type**.

2 Press **Edit**.

3 Select the type of tank in which the probe will be immersed and press **OK**.

Setting Nozzle Length

You can set the length of the nozzle present on your tank. For an illustration of the concept, see Figure 42 on page 58.

To do so:

1 Select **Device Setup** > **Application Setup** > **Nozzle Length**.

2 Press **Edit**.

3 Set the length of the nozzle present on your tank and press **OK**.

Changing End of Probe Mode

The end of probe mode depends on your type of probe. By default, if you have a coaxial probe, your LWT is factory-set as **Grounded**.

To change the factory-set end-of-probe mode:

1 Select **Device Setup** > **Application Setup** > **End of Probe Mode**.

2 Press **Edit**.

3 Highlight the other end-of-probe mode and press **OK**.



NOTICE

Isolated end of probes are only compatible with rod probes.

Toggling Remote Transmitter State

If your instrument came with a remote transmitter unit, the head unit is configured to recognize that remote transmitter. However, should you remove the transmitter, or should you choose to add a transmitter at a later date, you need to toggle the remote transmitter state to represent the new configuration.

To do so:

1 Select **Device Setup** > **Application Setup** > **Remote Transmitter**.

2 Press **Edit**.

3 Highlight **On** or **Off** and press **OK**.

Setting Process Conditions

Various conditions can occur inside of a tank (residue buildup, agitation, high levels of vibration, etc.) In your instrument, you have to enable the management of these conditions if you want measurement levels to account for their presence.

At this moment, your instrument can only manage high levels of vibration. Enabling the management of this condition will allow measurements in situations where high levels of vibration on-site might bring the accuracy level above the 2% range defined by the SIL [Safety Integrity Level] requirements.

Management of this condition is disabled by default.

To enable management of high levels of vibration:

1 Select **Device Setup** > **Application Setup** > **Process Condition** > **High Vibration**.

2 Press **Edit**.

3 Highlight **Enable** and press **OK**.

Setting Data Filtering Parameters

Processes can induce noise in level measurements. The LWT filtering feature is designed stabilize measurements by filtering out extraneous data that could negatively impact the resolution of the measured level (spikes, obstructions by mixer blades, lack of signals, etc.).

These parameters are set in the **Filtering** menu under the **Device Setup** menu.

Figure 40 The Device Setup menu



The various filters available are applied in a sequence as follows:

Damping — Median filter — Max Level Rate — Amplitude Threshold

Selecting Maximum Level Rate

The maximum level rate is the rate at which the process will reach its Full limit. This influences the processing speed of the instrument. The default value is **Medium: <25cm/min (10in./min)**.

To set the maximum level rate:

1. Select **Device Setup** > **Filtering** > **Max Level Rate**.
2. Press **Edit**.
3. Highlight the appropriate maximum level rate and press **OK** (select a value that is equal to or greater than the real process maximum level rate).

Setting Up a Median Filter

The median filter is designed to filter out noisy measurement spikes in applications with fast transients (e.g., rapidly varying processes, positioning applications). It is used for discarding occasional false measurements resulting from any occasional unwanted phenomena that might occur in the process.

The value entered corresponds to the number of measurements kept in the buffer. The filter then generates and returns a median value of all the measurements kept in the buffer. The buffer size can range from 1 to 50 measurements. The default value is **1**.

NOTICE

Selecting 1 measurement effectively disables the median filter as no averaging can be performed.

To set a median filter:

1. Select **Device Setup** > **Filtering** > **Median Filter**.
2. Press **Edit**.
3. Set the number of measurements that you want kept in the filter buffer (between 1 and 50) and press **OK**.

Setting Up a Damping Period

The instrument damping filter is designed to smooth out measurement noise in applications with slow dynamics (e.g., liquids with slow waves).

The damping value corresponds to the time constant (ranging from 0.0 to 99.9 s) applied to the measurement returned by the median filter. The default value is **2.0 s**.

To set a damping period:

1 Select **Device Setup** > **Filtering** > **Damping**.

2 Press **Edit**.

3 Set the damping period and press **OK**.

Setting Amplitude Threshold

The amplitude threshold is a threshold at which the instrument considers measured amplitudes as valid. It is indicated as a percentage of the amplitude full scale.

A classic use of this threshold value is when, for any reason, you have a very noisy signal and you do not want that noise to be measured. You can achieve this by setting the amplitude threshold above that noise level.

To set the amplitude threshold:

1 Select **Device Setup** > **Filtering** > **Amplitude Threshold**.

2 Press **Edit**.

3 Set the amplitude threshold and press **OK**.

Setting Process Parameters

Certain parameters linked to the process itself need to be configured, chiefly process safety parameters. The following pages explain how to set these parameters.

Setting Process Safety Parameters

Safety parameters can be configured to determine LWT behavior in cases where level measurements become uncertain or impossible (e.g., levels getting exceedingly high or loss of signal [echoes]).

Process safety parameters (as illustrated in Figure 42) are set from the **Device Setup** menu.

Figure 41 The Device Setup menu



Setting a blocking distance

The blocking distance is the distance **where you do not want the instrument to take measurements** because you know that these measurements will include erroneous or useless data (e.g., right at the junction between a nozzle and the inside of the vessel, where a giant pulse usually forms).

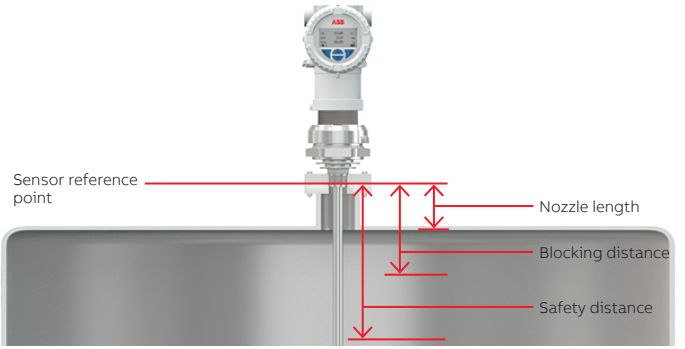
To set a blocking distance:

1 Select **Device Setup** > **Safety Setting** > **Blocking distance**.

2 Press **Edit**.

3 Set the necessary blocking distance and press **OK**.

Figure 42 Blocking and safety distances



Setting a Safety Distance

The safety distance is a specific distance **where you can take measurements,** at levels preceding the blocking distance, in case you might want to be informed when such levels are reached.

To set a safety distance:

1 Select **Device Setup** > **Safety Setting** > **Safety distance**.

2 Press **Edit**.

3 Set the necessary safety distance and press **OK**.

Activating a Safety Distance-Related Alarm

You can raise an alarm when the safety distance threshold is reached.

To do so:

1 Select **Device Setup** > **Safety Setting** > **Safety Dist. Reaction**.

2 Press **Edit**.

3 Highlight **Alarm** and press **OK**.

Managing Lost Echoes

A lost echo event happens when your instrument loses the signal returning to the sensor, e.g., when the instrument restarts. The power-up process lasts typically 40 seconds during which no measurement is available (echo lost). In this particular case, the current output is set to alarm low (3.6 mA) during less than 10 seconds and then is set according to the Echo Lost Reaction until a new valid measurement is available or the Echo Lost Period is over.

You can set the parameters that help your instrument manage such situations according to your context of operation.

Reaction

You can configure the instrument 4–20 mA current output reaction when echoes are lost:

- hold the last valid measurement acquired before the event (Hold Last Value, default),
- set a fixed current (Constant Value),
- raise an alarm (Alarm).

This reaction only applies during the defined period of time following the event (Echo Lost Period).

To configure the reaction:

1 Select **Device Setup** > **Safety Setting** > **Echo Lost Reaction**.
2 Press **Edit**.
3 Highlight the necessary reaction and press **OK**.

NOTICE

For convenience, this feature is also available in **Easy Setup** menu.

Period

The lost echo period is the period during which the instrument waits before reacting.

To set a lost echo period:

1 Select **Device Setup** > **Safety Setting** > **Echo Lost Period**.
2 Press **Edit**.
3 Set the period of time for lost echoes and press **OK**.

Preventing Unnecessary Alarms

During operation, the instrument might encounter alarm-raising, but very temporary, conditions (e.g., sporadic EMC interference). To prevent raising unnecessary alarms, you can configure an alarm delay that will let a specified amount of time pass before an alarm is raised.

To set such a delay:

1 Select **Device Setup** > **Safety Setting** > **Alarm Delay**.
2 Press **Edit**.
3 Set a value (the default is **10**) for the delay that you want to allow before the instrument raises alarm and press **OK**.

Setting Up Linearization

In your LWT instrument, the linearization function allows more accurate level, volume and flow measurements by referring to a preset linearization table.

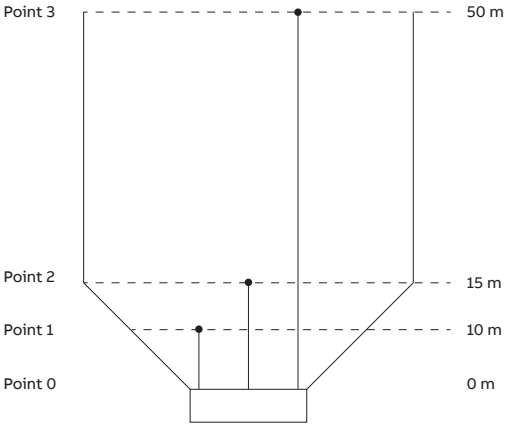
Understanding Linearization

Linearization is especially useful in irregularly shaped vessels (cylindrical lying tanks, spherical gas tanks, etc.), but in all applications, regardless of vessel shape, it is used to convert the media level to a linearized level, or volume or flow.

The linearization table provides the instrument with data regarding known volumes at specific levels in the irregularly shaped part of a vessel.

Below is an example of the relationship between a linearization table actual measured levels:

Figure 43 Actual level vs. linearization table points



If Figure 43 were translated into actual values, it could be put in a table as such:

Table 2 Level vs. Volume in linearization feature

Linearization point	Level (m)	Associated volume (m^3)
0	0	0
1	10	100
2	15	300
3	50	1500

As you can see, the level-to-volume conversion does not progress in a linear fashion because of the irregular shape of the vessel. By creating a linearization table with proper values, this function allows to compensate for the irregular shape of the vessel.

In LWT instruments, there is an order in which to perform operations and make the feature functional:

- Access the function.
- Set the linearization table.
- Enable the function.
- Reconfirm the primary value (PV) (see “Setting Variables” on page 47).

All these operations are performed from the **Device Setup** menu.

Figure 44 The Device Setup menu



Accessing the Linearization Function

To access the linearization function:

1. Select **Device Setup** > **Linearization** > **Setup** > **Output Type**.
2. Press **Edit**.
3. Highlight the measurement value that you want to use (**Level**, **Volume** or **Flow**) and press **OK**.
   This activates a series of parameters that will be explained and configured below.

Setting Linearization Input Unit

To set the input unit used by the linearization function:

1. Select **Device Setup** > **Linearization** > **Setup** > **Input Unit**.
2. Press **Edit**.
3. Highlight the unit that will be used to input data into the linearization calculation and press **OK**.

Setting Linearization Output Unit

To set the volume of flow output unit resulting from the linearization calculation:

1. Select **Device Setup** > **Linearization** > **Setup** > **Output Unit**.
2. Press **Edit**.
3. Highlight the level, volume or flow unit that will be used with data output from the linearization calculation and press **OK**.

Setting Maximum Level, Volume or Flow Value

To set the maximum level, volume of flow value to measure:

1. Select **Device Setup** > **Linearization** > **Setup** > **Maximum**.
2. Press **Edit**.
3. Set the maximum level, volume or flow value that the instrument will have to measure and press **OK**.

Setting Vessel Parameters

NOTICE

The following parameters are available if you selected **Volume** as your output type (see “Accessing the Linearization Function” on page 61).

When measuring volumes, you must set the following vessel (tank) parameters:

- Orientation

- Diameter
- Length

Setting the Vessel Orientation

To set the vessel orientation:

1 Select **Device Setup** > **Linearization** > **Volume Calculation** > **Cylinder Orientation**.

2 Press **Edit**.

3 Highlight the orientation of your tank (**Vertical** or **Horizontal**) and press **OK**.

Setting the Vessel Diameter

To set the vessel diameter:

1 Select **Device Setup** > **Linearization** > **Volume Calculation** > **Cylinder Diameter**.

2 Press **Edit**.

3 Set the vessel diameter and press **OK**.

Setting the Vessel Length

To set the vessel length:

1 Select **Device Setup** > **Linearization** > **Volume Calculation** > **Cylinder Length**.

2 Press **Edit**.

3 Set the vessel length and press **OK**.

Generating a Linearization Table Automatically

Once you have set your vessel parameters, you can generate a linearization table automatically by selecting **Device Setup** > **Linearization** > **Volume Calculation** > **Gen Linearization** and clicking **OK**.

This automatically creates a linearization table based on your vessel parameters.

Setting Up Linearization Points

The first point is always the point with the lowest value and all other points must be set in increasing order.

To properly configure the linearization feature:

1 Select **Device Setup** > **Linearization** > **Set LIN. Points**.
The **00** linearization point is highlighted (see below).

2 Press the Left action key to select the measured level (**In**).

3 Press the Right action key to edit the **In** value, and press **OK** when you are done.

4 Press the Left action key to select the output associated with the measured level (**Out**).

5 Press the Right action key to edit the **Out** value, and press **OK** when you are done.

6 Press the Left action key to highlight the linearization point again.

7 With the Up and Down arrow keys, change the linearization point.

8 Repeat steps 2 to 7 for all the required linearization points.

9 All your linearization points that you just created compose your linearization table.

NOTICE

If you need to modify any linearization point or the maximum value in the future, you **MUST** first disable the linearization function (see “Enabling the Linearization Function” on page 63) or use the automatically-generated table (see “Generating a Linearization Table Automatically” on page 62).

Saving the Linearization Table

To save the linearization table that you just created (see “Setting Up Linearization Points” on page 62):

1 Select **Device Setup** > **Linearization** > **Saved Tables** > **Save**.

2 Press **OK**. Your linearization table is saved in memory.

Enabling the Linearization Function

To activate the linearization function:

1 Select **Device Setup** > **Linearization** > **Setup** > **Table State**.

2 Press **Edit**.

3 Highlight **Enabled** and press **OK**.

The linearization function is now active and linearized levels, volumes (or flows) are being measured accordingly.

NOTICE

Disabling the linearization table deactivates all volume measurements settings.

NOTICE

Do not forget to reconfirm that the PV, SV, TV, QV values are set to **Volume** or **Flow** (see “Setting Variables” on page 47) after enabling the linearization function.

Managing Saved Linearization Tables

You can clear an existing linearization table if you want to start from scratch (e.g., if you moved your instrument to a different tank) and you can restore the existing table if you want to erase the linearization table under development and reload the saved table.

Deleting the linearization table

To delete the saved linearization table that you just created (see above):

1 Select **Device Setup** > **Linearization** > **Saved Tables** > **Clear**.

2 Press **OK**. Your linearization table is erased.

NOTICE

Clearing the linearization table deactivates all volume measurements settings.

Restoring a linearization table

To restore your saved linearization table:

1 Select **Device Setup** > **Linearization** > **Saved Tables** > **Restore**.

2 Press **OK**. Your saved linearization table is restored.

Managing Device Setups

Configuring or reconfiguring your instrument could take a non-trivial amount of time. With that in mind, once you have properly configured your instrument, you can save your setup as a baseline configuration that you can revert to if necessary. The following pages explain how to proceed.

Saving Default User Setup

To save your current configuration as your default user setup:

1 Select **Device Setup** > **Save Setup & reset** > **Save as User Default**.

2 Press **OK**. Your current setup is saved in the instrument non-volatile memory.

Resetting to Default User Setup

Provided that you have already saved a setup as your default setup, you can return to that default user setup at any time.

To do so:

1 Select **Device Setup** > **Save Setup & reset**> **Reset to User Default**.

2 Press **OK**. Your current setup is erased and replaced with the default user setup.

Resetting to Factory Default

Should you be in a situation where the default user setup does not work anymore (e.g., you have moved the LWT instrument to a new vessel), you can simply revert to the factory default setup and start configuring your instrument anew.



NOTICE

When resetting to the factory default configuration, all parameters **and passwords** return to their original factory settings

To do so:

1 Select **Device Setup** > **Save Setup & reset** > **Global Factory Reset**.

2 Press **OK**. Your current setup is erased and replaced with the default factory setup. The LWT instrument will complete the reset after about 15 seconds.

Configuring the LWT300 Remotely

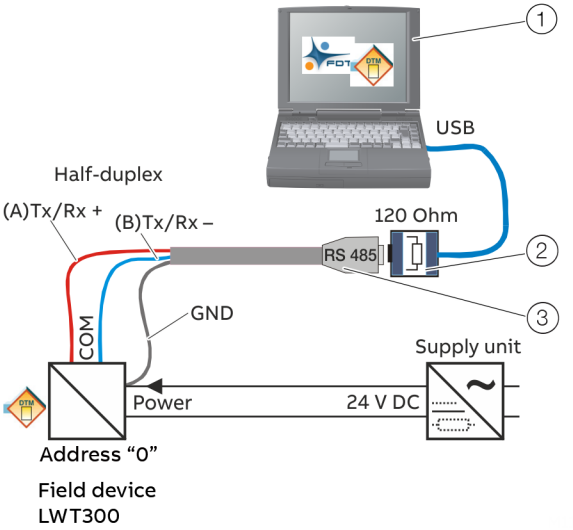
LWT300 instruments can also be configured with a computer. All configuration options explained previously can be performed either via a software communication tool and a HART driver (see also “Configuring HART Communication” on page 75), or via a flow computer/RTU over Modbus protocol. The following provides an overview of the configuration setup.

NOTICE

For instrument configuration with software tools running on a PC, you must disconnect the LWT from the flow computer/RTU

Over HART Protocol

Figure 45 LWT instrument Modbus connection to a PC or laptop via a USB/RS485 converter



	Description
1	Software tool Driver and device management tool for configuration and parameterization of intelligent field devices.
2	USB/RS 485 converter (**not provided by ABB**) At end of Modbus interface, with 120 Ω resistance between ‘(A) Tx/Rx+’/‘(B) Tx/Rx–’
3	RS 485 cable (**not provided by ABB**) Half-duplex wiring with (A) Tx/Rx+, (B) Tx/Rx– and GND • Connect ‘Tx+’ and “Rx+’ • Connect ‘TX–’ and ‘Rx–’

LWT guided wave radar level transmitters can be configured with the aid of various software communication tools such as ABB Field Information Manager, a software configurator that can be downloaded at www.abb.com/measurement.

With the graphical user interface, all configuration possibilities are available. The procedure for program installation is described in the appropriate installation manual delivered with the software.

The transmitter can be configured, read out and tested via the program. Each configuration step is subject to a plausibility check.

Immediately after receipt of the transmitter or after changing the configuration, we recommend that you back up the existing configuration on a separate data medium.

A RS485 interface will be needed for communication between a PC and the transmitter.

- The driver for this interface must support a COM port.
- The software communication tool must be set to the same COM port as the RS485 interface.
- The baud rate for configuration of the transmitter is fixed to 1200 baud and must be set to the same value inside the communication software tool.
- The communication protocol of the transmitter has to be set to 'CONFIG/HART-RS485' on the communication board or to Configuration with the HMI (**Communication>Device Mode**) (see "Toggling Communication Modes" on page 71).

For operating with a Modbus master after configuration, the transmitter must be set back to 'OPERATE/MODBUS' on the communication board or to **OperateModbus** with the HMI (**Communication>Device Mode**).

Before starting configuration via a software communication tool, the transmitter function must be switched from 'Operate' to 'Configuration' mode (using the HMI or a software remote access) (see "Toggling Communication Modes" on page 71).

Over Modbus Protocol

When connected to a Modbus Master device (see Figure 20) like a RTU or a flow computer, LWT300 guided wave radar level transmitters can be configured using the registers decribed in "Appendix B" on page B93 (section Holding Registers).

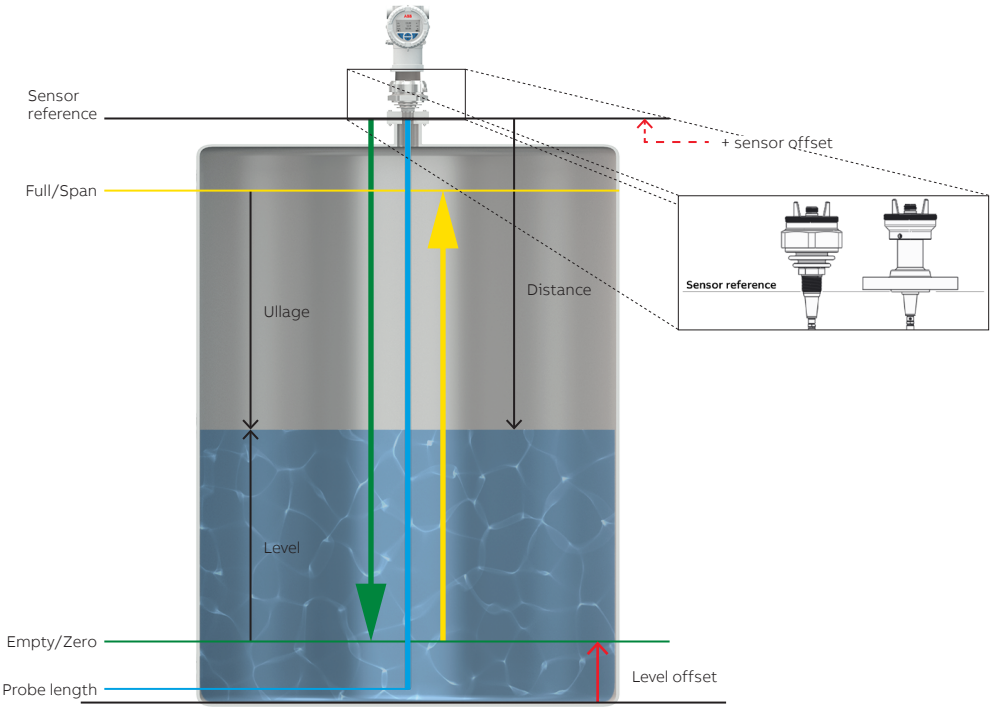
The communication protocol of the level transmitter has to be set to 'OPERATE/MODBUS' on the communication board or to ModbusOperation with the HMI (see "Toggling Communication Modes" on page 71).

CHAPTER 7

Setting Calibration Parameters

Part of your instrument measurement accuracy resides in proper calibration of the vessel empty and full states. The values associated with these states are usually configured upon starting the instrument via the **Easy Setup** menu. Should the configuration performed via the **Easy Setup** menu prove incorrect, you will have to recalibrate your instrument and enter new values. This can be done in software (via the **Calibrate** menu; see Figure 47) or by emptying and then filling the vessel whose level you want to measure. The following pages explain how to do this.

Figure 46 Calibration parameters



NOTICE

Depending on the installation, sensor reference is calculated either from the bottom of the flange or the last thread of the coupler (see zoom-in on Figure 46 above).

Figure 47 The Calibrate menu



Changing the Empty/Zero Value

This value (probably set initially from the **Easy Setup** menu) represents the lowest-level measurement value in your vessel. If you set this value first with the **Easy Setup** menu, you can change it later.

To set this value:

1. Select **Calibrate** > **Level Calibration** > ↓**Empty/Zero**.
2. Press **Edit**.
3. Set the value as necessary and press **OK**.

NOTICE

The selected value must be between the min and max numbers shown at the bottom of the HMI. Those min and max numbers are based on the probe length.

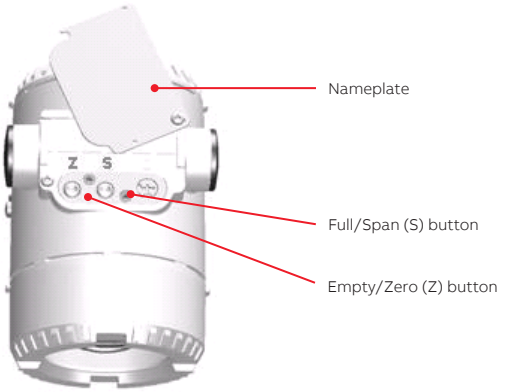
Changing Empty/Zero Value in Hardware

To set this value in hardware, you first need to completely empty the vessel whose level you want to measure.

Once the vessel is empty and you have inserted the probe in the vessel:

1. On the instrument head, unscrew and remove the nameplate. This exposes two buttons (identified **Z** and **S**) and the write-protection screw.

Figure 48 Accessing the Empty/Zero and Full/Span buttons



2. Once the probe is fully deployed in the vessel, press the **Z** button for a few seconds. This sets the empty/zero calibration value.

Changing the Full/Span Value

This value (probably set initially from the **Easy Setup** menu) represents the highest level measurement value in your vessel (distance from the empty/zero position).

To set that value:

1. Select **Calibrate** > **Level Calibration** > ↑**Full/Span**.
2. Press **Edit**.
3. Set the value as necessary and press **OK**.

Changing Full/Span Value in Hardware

To set this value in hardware, you first need to completely fill the vessel whose level you want to measure.

Once the vessel is full and you have inserted the probe in the vessel:

1. On the instrument head, unscrew and remove the nameplate. This exposes two buttons (identified **Z** and **S**) and the write-protection screw (see Figure 48 on page 68).
2. Once the probe is fully deployed, press the **S** button for a few seconds. This sets the full/span calibration value.

Adding a Level Offset

A level offset is a distance that you might add and that represents the distance between the bottom of the tank and the empty/zero value.

The default value for this parameter is **0** m. The value can be set between –50 and 50 m.

To set that value:

1. Select **Calibrate** > **Level Calibration** > **Level Offset**.
2. Press **Edit**.
3. Set the value as necessary and press **OK**.

Adding a Sensor Offset

A sensor offset is a small distance that you might need to add to the sensor reference value (e.g., if the probe in angled slightly at the junction with the sensor).

The default value for this parameter is **0** m. The value can be set between –30 to 30 m.

To set that value:

1. Select **Calibrate** > **Level Calibration** > **Sensor Offset**.
2. Press **Edit**.
3. Set the value as necessary and press **OK**.

Changing the Distance Calibration

Distance Calibration (Offset and Slope) are parameters normally set at the factory. The Offset parameter can be adjusted if you change the LWT head vs. coupler. The slope can be adjusted if a concrete or plastic wall affects the speed of the propagation of the RF pulse.

To modify the Offset Calibration:

1 Select **Calibrate > Distance Calibration > Distance Offset Calib**.

2 Press **Edit**.

3 Set the value as necessary and press **OK**.

To modify the Slope Calibration:

1 Select **Calibrate > Distance Calibration > Distance Slope Calib**.

2 Press **Edit**.

3 Set the value as necessary and press **OK**.

CHAPTER 8

Configuring Communications

There are two types of communication at play in the Modbus LWT300 instruments. For general **data exchange** operations with external computer systems (PCs, flow computers, etc.) communications go over the Modbus protocol (Modbus RTU) or Totalflow® LevelMaster with 2-wire half-duplex RS-485 serial interface. For **instrument configuration**, both the HART communication protocol (with software tools running on a computer) or the Modbus protocol (via a RS-485 serial interface) could be used.

Communication parameters for these protocols are set from the **Communication** menu.

Figure 49 The Communication menu



Toggling Communication Modes

LWT300 instruments always operate in one of two modes: Operation or Configuration. Operation mode is the normal mode for data exchange, and configuration of the instrument over the Modbus protocol whereas Configuration mode is the mode to use when configuring the instrument over the HART protocol. These modes can be set either in software or hardware.

Toggling via HMI (recommended)

To toggle communication mode via the instrument HMI:

1. From the **Communication** menu, select **Device Mode**.
2. Click **Edit** and select **Modbus Operation**, **LevelMaster Operation** or **Configuration** (HART), as necessary.
3. Click **OK**. Your instrument is now in communicating in the mode that you chose.

NOTICE

If communication does not seem to work after toggling communication mode, verify the communication parameters set via the dip switches (next page).

NOTICE

For instrument configuration with software tools running on a PC and HART protocol, you must disconnect the LWT from the flow computer/RTU.

When you are done configuring the instrument remotely via a HART/RS-485 connection with a PC, **you must** toggle the communication mode back to **Operation**; otherwise the instrument will not be able to resume sending data when reconnected to the Modbus/ LevelMaster network.

Toggling via Hardware

Hardware configuration can be performed via dip switches, as explained below.

WARNING

All connections must be established in a de-energized state. Before working on the circuit, secure the breaker to prevent any accidental power-up.

In an explosion proof/flameproof installation, do not remove the covers while the instrument is energized.

NOTICE

Settings configured via DIP switches always have priority over the ones set with the HMI or a software remote access.

1 Make sure that the instrument is powered off and that the M4 hex head locking screws are screwed in (see Figure 50).

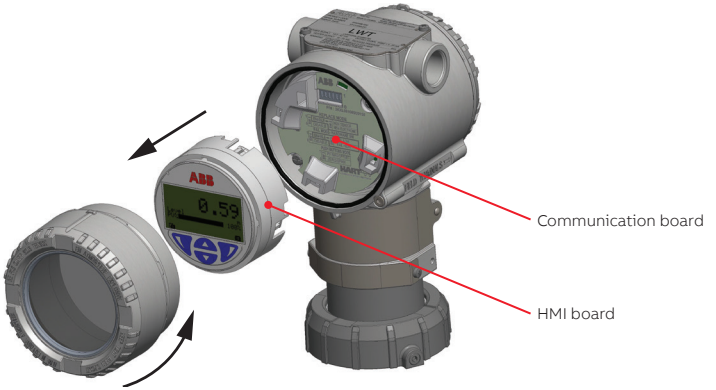
2 Unscrew the housing cover on the HMI side (hazardous area warnings must be heeded; see “Safety” on page 1).

CAUTION

Do not grab the instrument by its threaded interface. Thread edges are sharp and constitute a risk of personal injury (see Figure 21 on page 31).

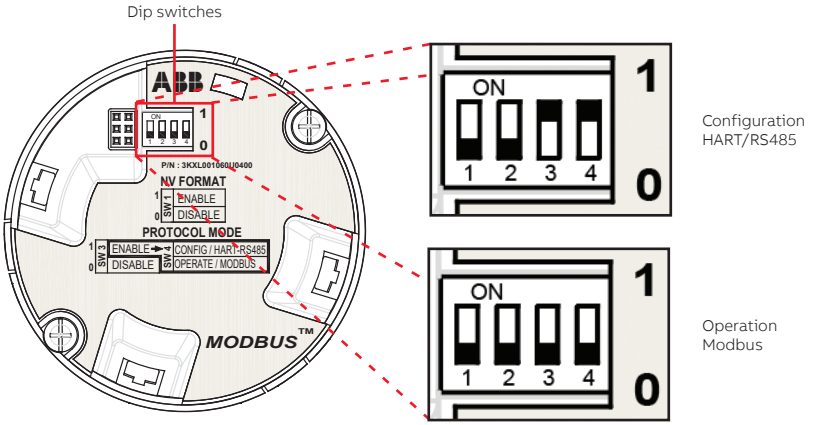
3 Pull the HMI board away from the communication board. You gain access to the communication board.

Figure 50 Pulling out the HMI board



4 On the communication board, set dip switches 3 and 4 to position 1 (see Figure 51). Your LWT instrument is now ready to be configured via your preferred software tool over HART protocol.

Figure 51 Modbus communication board



For more information on the configuration setup that you need to start communicating with your instrument, see “Configuring the LWT300 Remotely” on page 65.

NOTICE

When you are done configuring the instrument remotely via HART, **you must** toggle the communication mode back to **Operation** (switches 3 and 4 to position 0); otherwise, the instrument will not be able to resume sending data when reconnected to the Modbus/ LevelMaster network.

WARNING

If dip switch 3 is left in position 1, the communication toggling can only be done with the dip switches (toggling with the HMI will not be possible). To avoid this risk, communication toggling via HMI is recommended over toggling via hardware.

Configuring Modbus Communication

The following subsections refer to the Modbus configuration of your LWT300 instrument. You will also find more information about Modbus registers in “Appendix B” on page B93.

NOTICE

You do not need to adjust speed, parity, stop bit, base number and swap mode for LevelMaster operation (see “Appendix F” on page F109 for more information about the LevelMaster protocol).

Setting the Modbus Network Address

To set the instrument address so that it can be identified on a network:

1. Select **Communication** > **Modbus** > **Address**.
2. Press **Edit**.
3. Set an address between 1 and 247 (1 to 31 for LevelMaster) and press **OK** (see “Setting a Value” on page 37). Your instrument should now appear on a network.

Selecting the Communication Speed

To set the instrument communication speed:

1. Select **Communication** > **Modbus** > **Baud Rate**.
2. Press **Edit**. A list of standard communication speeds (in bps) appears (**1200**, **2400**, **4800**, **9600**, **19200**).
3. From that list, select a baud rate compatible with your network.

Selecting the Parity Status

To set the communication protocol parity status:

1. Select **Communication** > **Modbus** > **Parity**.
2. Press **Edit**. A list of parity statuses appears (**No Parity**, **Even**, **Odd**)
3. From that list, select a parity status compatible with your network and press **OK**.

Selecting the Stop Bit

To set the communication protocol stop bit:

1. Select **Communication** > **Modbus** > **Stopbit**.
2. Press **Edit**. Available stop bits appear (**1**, **2**).
3. From that list, select a stop bit compatible with your network and press **OK**.

Setting the Response Delay

The response delay is the length of time that must elapse before the LWT sends out a response. To change this time:

1 Select **Communication** > **Modbus** > **RespDelay Time**.

2 Press **Edit**.

3 Set the response delay (see “Setting a Value” on page 37) and press **OK**.

Selecting the Register Base Number

The default Modbus register base number is 1. Should you need to change this base number:

1 Select **Communication** > **Modbus** > **Address Offset**.

2 Press **Edit**. A list of available base numbers appears (**0**, **1**).

3 From that list, select the required base number and press **OK**.

Setting the Swap Mode

In the LWT300 Modbus communication, the default byte order for the floating-point format is CDAB. Should you need to change this byte order:

1 Select **Communication** > **Modbus** > **Swap Mode**.

2 Press **Edit**. A list of byte orders appears (**ABCD**, **CDAB**, **DCBA**, **BADC**).

3 From that list, select the appropriate byte order and press **OK**.

Configuring HART Communication

HART communication is only used in the LWT300 for remote configuration via your preferred software tool.

NOTICE

The LWT series MODBUS/HART FDI package is required to communicate via HART. You can download it from https://new.abb.com/products/measurement-products/level/guided-wave-radar-level-transmitters/lwt300-series-guided-wave-radar.

Setting the HART Network Address

To set the instrument address so that it can be identified for configuration purposes with your software tool:

1 Select **Communication** > **HART** > **Device Address**.

2 Press **Edit**.

3 Set an address between 0 and 63 and press **OK**. Your instrument can now be identified by your software tool for configuration purposes.

Locating an Instrument With Tags

A tag is intended to simplify identifying the location of an LWT instrument on the network, in the plant, etc.

To create a tag for the instrument:

1 Select **Communication** > **Tag**.

2 Press **Edit**.

3 Set a tag name (see “Setting a Value” on page 37) and press **OK**.

Browsing Communication Info

From the **Communication** menu, you can quickly browse through the various factory-set communication parameters such as:

- The last command received
- The device ID
- The manufacturer ID
- The device type
- The device descriptor
- The device revision number
- The HART revision number



NOTICE

Error and Warning can be disabled using the parameter in the **Communication > Device Warning Code** menu.

CHAPTER 9

Maintenance and Troubleshooting

LWT instruments are designed to withstand many industrial environmental conditions.

They contain no moving parts and, aside from the probe, no field-replaceable parts. For this reason, no regular maintenance is required to keep the instrument in compliance.

Additionally, no user/operator adjustments inside LWT instruments are necessary or recommended by ABB. Service tasks that are not explained in this documentation are to be performed at the factory by qualified service personnel only.

Contact ABB for any additional information, or in the event of specific problems not covered in this user guide.

NOTICE

Opening the instrument for any reason other than the procedures indicated in this documentation **voids the warranty.**

NOTICE

Since the instrument may form part of a safety chain, ABB recommends replacing the instrument immediately if any defects are detected.

Diagnosing Problems

If the LWT instrument is malfunctioning in any way, the LCD displays specific event messages destined to help you identify and understand the situation.

When an event happens, a message consisting of an icon and text appears at the bottom of the LCD.

Figure 52 LCD before and during an error



Before an error

During an error

This short message gives you a quick indication of the nature of the situation at hand. The text beside the icon provides information about the potential source of the problem.

All these text messages are saved in a diagnostic history. You can browse through this diagnostic history and clear this history when all events have been accounted for.

The following table gives you a quick way to identify the basic problems.

Table 3 Basic problem identification from LCD

Icon	Description	Error text
	Error/Failure	Configuration Electronic Operation Process Transmitter
	Functional check (e.g., during simulation)	
	Out of specification	
	Maintenance required	

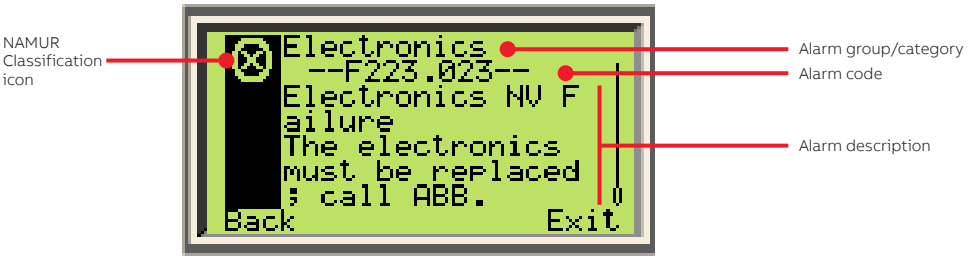
To obtain more information about the currently diagnosed error, you need to access the **Diagnostics** *operator* menu.

To do so:

1 From the displayed Operator page, press the left action key () to access the operator menus.

2 Highlight and select **Diagnostics**.

Figure 53 The Diagnostic operator screen



In the error description, the error code number is displayed on the second line (e.g., **--F223.023--**). For more information on event messages, see "Event Codes and Recommendations" on page 80.

Browsing the Diagnostics History

To browse through the diagnostics history:

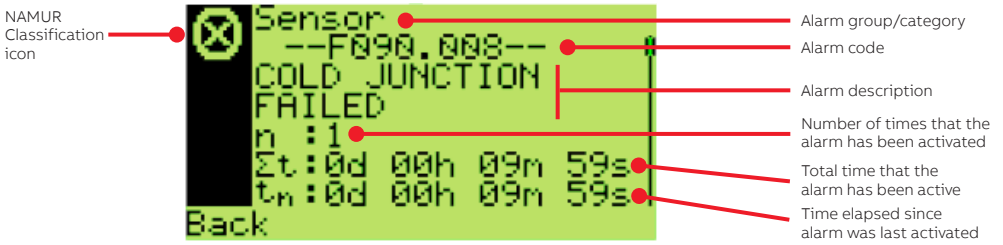
1 From the **Diagnostics** menu, select **Diagnostic History**.

Figure 54 The Diagnostic menu



The last event message appears. To browse through all event messages, press the Up and Down arrow keys.

Figure 55 The Diagnostic History screen



2 Once you are done browsing, press **Back**.

Clearing the Diagnostic History

To clear all diagnostic messages kept in the history:

1 From the **Diagnostics** menu, select **Clear History**.

2 Press **OK**. All event messages kept in the diagnostic history are erased.

Event Codes and Recommendations

Below is a list of the event codes that your LWT instrument might display should a problem arise, and recommended action for each event. The first letter of the code refers to NAMUR codes:

- F: Failures
- S: Function check
- C: Out of specifications
- M: Maintenance request

Table 4 Event codes and recommended action

No.	Event message	Recommended action
S080.000	Maximum level rate exceeded	Make sure max level rate matches the process
S081.001	GPC alarm, last valid gpc used	Check installation, GPC marker, process cond.
F203.002	Sensor has lost surface echo	Check installation and parameter adjustments.
S088.003	No interface detected	Check process conditions
S085.004	Emulsion has been detected	Check process conditions
F234.005	Electronic failure or harsh env	Check installation for vibrations or EMC interference
S087.007	Lower Measurement Accuracy	Check installation and process conditions
S060.010	PV value out of range	Check process conditions and device config.
C153.011	Device In Initialization	Wait for initialization to finish
S083.012	Too many echos detected	Check installation or device parameters.
F233.013	Reference echo not detected	Check installation and coupler connection.
F210.016	Invalid device parameters	Enter valid parameters
F236.017	Sensor NV Failure	The sensor should be replaced ASAP
S110.018	Successful sensor reboot	Successful sensor reboot
S062.019	Surface inside blocking distance	Check process conditions and device config.
F237.020	Sensor Board communication error.	Restart sensor. If condition persists, call ABB
F223.023	Electronics NV Failure	The electronics must be replaced; call ABB.
S082.024	Weak echo amplitude	Check installation and process conditions.
F232.025	Unconnected coupler or probe	Check connection of head, coupler and probe
S061.026	Surface inside safety distance	Check process conditions and/or device config.
M30.031	Maintenance required	Verify sensor functionality, clear diagn. Mess.
M011.033	Temperature out of range	Check ambient temperature. Use remote option
F230.034	First coupler seal leak	Check coupler.
F235.035	Load sensor configuration failure	Restart sensor. If condition persists, call ABB
C151.036	Data Simulation warning	The Output value is derived from simulated value
C150.037	Alarm Simulation warning	Alarm condition is being simulated by the device
M012.042	NV replace error.	Restart sensor. If condition persists, call ABB
M035.045	HMI validation test failure	Replace the HMI; call ABB.
F231.046	Broken probe or wrong length	Replace probe or adjust probe length.
M026.047	Build-up on probe	Clean probe.

Masking Classes of Events

Instrument event codes are recorded according to the NAMUR classification (see page 79). By default, these events are displayed in the diagnostic history, but you can choose to mask certain classes of events. Masked events are still recorded and kept in the event history log.

To do so:

1 Select **Diagnostics** > **Class Masking**.

2 Select the class of events that you want to mask (**Failures cannot be masked**):
- **Maintenance Required**
- **Check Function**
- **Off Specification**
- **Info/None**

3 In the selected class masking, select **Edit > Level** or **Distance > Maintenance Required > Enabled** and press **OK**.

This class of events for the selected application will now be masked. Events recorded before activation of this feature are kept in the event history log but stop being displayed.

To deactivate an active class masking, repeat the previous procedure, but select **Disabled** instead of **Enabled** at the end.

Diagnosing From a Waveform

Most echo-related problems, as listed in Table 4, can also be diagnosed with the help of the integrated waveform displayed on the LCD. Waveform management is performed from the **Diagnostics** menu.

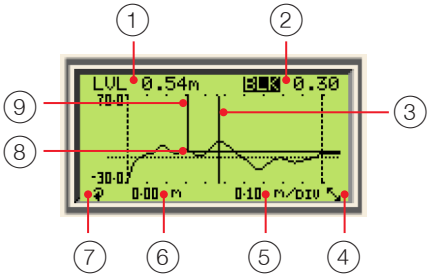
Figure 56 Accessing the waveform display



Introducing the Waveform Display

The waveform display illustrates the signal traveling along the probe.

Figure 57 The waveform display



(1)	Display of the level (LVL), distance (DIS), ullage (ULL) or interface (INT) value
(2)	Display of the blocking distance (BLK), safety distance (SFD), level amplitude threshold (LAT) or interface amplitude threshold (IAT) (see "Appendix G" on page G111 for more details) **Note:** This is the only highlighted option that is editable (see (4))
(3)	Level or interface marker
(4)	Exit (↵) or Edit (✎) indicator
(5)	Zoom information
(6)	Reference distance
(7)	Display value selector
(8)	Level amplitude threshold (or Interface amplitude threshold, if INT is selected in (1)) marker
(9)	Blocking distance (or safety distance, if SFD is selected in (2)) marker

Accessing the Waveform Display

You access the waveform display from the **Waveform** menu by selecting around which point along the waveform you want to center your main marker.

- To access the waveform display, select **Waveform** > **[desired centering location]**. (**At Sensor Ref. Point**, **At Level**, **At Interface**, **At Distance**, or **At End of Probe**).

You can also access the **Waveform** menu from the **Diagnostics** menu.

Selecting a Level Echo

Once you have accessed the waveform display, you can browse through and select various echoes, and see their respective distances.

Obtaining the distance for the current level

The current distance displays the measured distance between the reference point and the level. This feature allows you to select another echo as the level echo (previous or next) and confirm that the measured distance matches the real distance.

To display the current distance:

1 Select **Diagnostics** >**Waveform** > **Level Echo Selection** > **Current Distance**.

The distance of the current level echo appears.

2 Press **Back**.

Selecting another echo (for movement measurement mode only)

When several false echoes are detected in addition to the actual level, it is possible to select which echo is the actual level.

To select the previous or next echo measured on the probe:

1 Select **Diagnostics** > **Waveform** > **Level Echo Selection** > **Select Previous Echo** or **Select Next Echo**.

2 Press **OK**. The chosen echo is selected.

3 Press **Back.**

4 Select **Current Distance** to verify that this is the echo that you wanted to select. If not, repeat steps 1 to 3 until you have selected the echo that you want.

5 Once you have selected the echo that you want, select **Confirm Current Echo** and press **OK**.

Once confirmed, the selected echo is memorized and is maintained even after restarting the instrument (power cycle).

To cancel the selection of a specific echo, see "Resetting Echo Tracking" on page 53.



NOTICE

When the current level echo is the first (closest) echo after the blocking distance, using **Select Previous Echo** selects the last (furthest) echo. Similarly, when the current level echo is the last echo, using **Select Next Echo** selects the first echo.

Recording a Waveform

The recorded waveform can be used for comparison purposes, and can only be reviewed using FDI tools.

To record the waveform:

1 Select **Diagnostics** > **Waveform** > **Record Waveform**.

2 Press **OK**. The waveform is recorded in the LWT.

Performing Simulations and Tests

The simulation tools, found in the **Simulation** menu under the **Diagnostics** menu, help confirm proper communication of measured values. There are six standard simulations all performed in a similar way (distance, level, ullage, interface, volume and flow). All are explained below.

Figure 58 The Diagnostics menu



Performing Standard Simulations

Standard simulations are performed by setting a value that you want to communicate and enabling the simulation afterwards. The procedure below explains the procedure for level simulations, but a similar method can be used for interface, distance and ullage simulations.

To perform a level simulation

1 Select **Diagnostics** > **Simulation** > **Level Sim** > **Level Sim**.

2 Press **Edit**.

3 Set the level value that you want to simulate and press **OK**.

4 Press **Back**.

5 Select **Enable** and press **Edit**.

6 Press **OK**.

The instrument sends level data signals on the network and the value set should appear as a reading on a software communication tool interface.

Obtaining Device Status Data

For commissioning purposes, you may need to gather data about the status of the instrument (probe length, current electronics temperature [as well as minimum and maximum recorded] and total instrument run time).

Probe Length



NOTICE

Probe length confirmation can only be performed if the tank in which the probe is installed is completely empty.

To confirm probe length:

1. Select **Diagnostics** > **Device Status**> **Probe Length Status**.
   The probe length is indicated.
2. Press **Back** to return to the **Device Status** menu.

Electronics Temperature

To confirm the actual electronics temperature:

1. Select **Diagnostics** > **Device Status** > **Electronic Temp.** > **Electronic Temp.**.
   The electronics temperature is indicated.
2. Press **Back** to return to the **Device Status** menu.

Minimum/maximum electronics temperature recorded

To obtain the minimum and maximum electronics temperature recorded:

1. Select **Diagnostics** > **Device Status**> **Electronic Temp.** > **Min Electronic Temp.** or **Max Electronic Temp.**.
   The minimum or maximum electronics temperature recorded is indicated.
2. Press **Back** to return to the **Device Status** menu.

Resetting the minimum/maximum electronics temperature recorded

To reset the minimum and maximum electronics temperature recorded:

1. Select **Diagnostics** > **Device Status** > **Electronic Temp.** > **Reset Min/Max**.
2. Press **OK** to reset the values.
3. Press **Back** to return to the **Device Status** menu.

Total Run Time

To confirm the total instrument run time:

1. Select **Diagnostics** > **Total Run Time**.
   The total run time of the instrument is indicated.
2. Press **Back** to return to the **Device Status** menu.

Performing a Self-test

Self-tests are used to compare the electrical signature of the instrument's PCBs with a factory "thumbprint". This test is usually performed every two to three years to confirm SIL compliance)

To perform the self-test:

1. Select **Diagnostics** > **Self Test** > **Start Self Test** > **OK**.
2. Press **Back** once the test is completed (the progress bar has returned to its "empty" state). You return to the **Self Test** screen.

3 From that screen, select **Result Seft Test**. The result of the self-test appears (**Ok, Not OK** or **Check Not Done**).

If the result is **Not Ok**, other errors have most likely happened and you should investigate the diagnostics history more carefully.

If the result is **Check Not Done**, it is likely due to the electrical thumbprint having been erased during a firmware update. This does not preclude your instrument from working properly.

Setting Distance Calibration Parameters

LWT300 probes are calibrated before leaving the plant. ABB service personnel will inform you if distance calibration needs to be performed.

Accessing Device Information

When calling an ABB service representative, you might be asked to provide any of the following information, available from the **Device Info** menu:

Figure 59 The Device Info menu



- Manufacturer
- Name
- Model
- Device ID
- Device Serial number
- Order code
- Manufacturing date
- Installation date
- Last modify date
- Address
- City
- Phone number
- Hardware revision
- Software revision

APPENDIX A

LCD Menu Tree

The following pages provide an overview of the various menu items accessible through the instrument liquid crystal display (LCD).

First-level Menu

Menu item	Details	Main chapters
Access Level	page A87	
Easy Setup	page A87	
Device Setup	page A88	
Display	page A88	
Calibrate	page A90	
Diagnostics	page A90	
Device Info	page A91	
Communication	page A92	
Waveform	page A92	

Access Level Menu

Item
Logout
Read Only
Standard
Advanced
Service

Easy Setup Menu

Item
Application Category
Set PV
PV Unit
↓Empty/Zero
↑Full/Span
Max Level Rate
Display Line1 View1
Echo Lost Reaction

Device Setup Menu

Item	Submenus	
Access Control	Standard Password	
	Advanced Password	
	Reset Password	
	Service Account	
	Write Protect	Software WP
		Hardware WP
Dynamic Variables	Set PV	
	Set SV	
	Set TV	
	Set QV	
	Length Unit	
	Flow Unit	
	Volume Unit	
	Temperature Unit	
Sensor Setup	Application Category	
	Measurement Mode	
	Gas Phase comp.	GPC Mode
		GPC Marker Distance
		GPC Static Factor
	Upper Media DC	
	Static Overflow	
	Reset Tracking	
	Algo Parameters	
Application Setup	Probe Type	
	Probe Length	
	Tank type	
	Nozzle Length	
	End Of Probe Mode	
	Remote Transmitter	
	Process Conditions	High Vibration
Filtering	Damping	
	Median Filter	
	Max Level Rate	
	Amplitude Threshold	

Item	Submenus	
Safety Settings	Blocking Distance	
	Safety Distance	
	Safety Dist. Reaction	
	Echo Lost Period	
	Echo Lost Reaction	
	Alarm Delay	
Linearization	Setup	Table State
		Output Type
		Input Unit
		Output Unit
		Maximum
	Volume Calculation	Cylinder Orientation
		Cylinder Diameter
		Cylinder Length
		Gen. Linearization
	Set Lin. Points	
	Saved Tables	Clear
		Restore
		Save
Setup Save & Reset	Save as user default	
	Reset to user default	
	Global Factory Reset	

Display Menu

Item	Submenus
Contrast	
Operator pages	Operator page 1
	Operator page 2
	Operator page 3
	Operator page 4
Autoscroll	
Length format	
Flow format	
Volume Format	

Calibrate Menu

Item	Submenus
Level Calibration	↓Empty/Zero
	↑Full/Span
	Level Offset
	Sensor Offset
Distance Calibration	Distance Offset Calibration
	Distance Slope Calibration

Diagnostics Menu

Item	Submenus	
Waveform	At Sensor Ref Point	
	At Level	
	At Interface	
	At Distance	
	At End of Probe	
	Record Waveform	
	Reset Tracking	
	Measurement Mode	
	Level Echo Selection	Current Distance
		Select Previous Echo
		Select Next Echo
		Confirm Current Echo
	False Echo Zones	Above Level Distance
		Above Interface Distance
		Confirm Zones
Diagnostic History		
Clear History		
Class Masking	Maintenance Req.	
	Check Function	
	Off Specification	
	Info/None	
Simulation	Distance Sim	
	Level Sim	
	Interface Sim	
	Volume Sim	
	Flow Sim	
	Ullage Sim	

Item	Submenus	
Device Status	Probe Length Status	
	Electronic Temp.	Electronic Temp.
		Min Electronic Temp.
		Max Electronic Temp.
		Reset Min/Max
	Total Run Time	
Self Test	Start Self Test	
	Result Self Test	
Reset Tracking		

Device Info Menu

Item
Manufacturer
Name
Model
Device ID
Device Serial Number
Order Code
Manufacturing Date
Installation Date
Last Modification Date
Address
City
Phone Number
Hardware revision
Software revision

Communication Menu

Item	Submenus
HART	Devices Address
	Tag
	Message
	Last Command
	Device ID
	Manufacturer ID
	Device Type
	Descriptor
	Device Revision
	HART Revision
Modbus/LevelMaster	Address
	Baud Rate
	Parity
	Stopbit
	RespDelay Time
	Address Offset
	Swap Mode
Device Mode	

Waveform Menu

Item	Submenus
At Sensor Ref Point	
At Level	
At Interface	
At Distance	
At End of Probe	
Record Waveform	
Reset Tracking	
Measurement Mode	
Level Echo Selection	Current Distance
	Select Previous Echo
	Select Next Echo
	Confirm Current Echo
False Echo Zones	Above Level Distance
	Above Interface Distance
	Confirm Zones

APPENDIX B

Modbus Registers

NOTICE

The map register offset in this Appendix is Base 0 (first register address is at 0).

Holding Registers

The Holding registers consist of 16 bits. They can be read and written. The address (2 bytes) is sent before each command. A CRC (2 bytes) is sent after each command.

Register name	Register address	Data type	Swap mode	Value range	Default value	Description
Address	200	USIGN8		1 – 247	247	Also known as Slave ID
Baud rate	201	TABENUM8		1 = 1200 2 = 2400 3 = 4800 4 = 9600 5 = 19200	4 = 9600	This is the baudrate used during Modbus communication
Parity	202	TABENUM8		0 = None 1 = Even 2 = Odd	0	This is the parity bit in the Modbus frame
Stop bit	203	TABENUM8		1 = One stop bit 2 = Two stop bits	1	This is the number of stop bits in the Modbus frame
Map Register Offset	204	TABENUM8		0 = 0 1 = 1	1	This offset is added from the address received in the Modbus frame message. Defines the register base number
Delay Time	206	USIGN8		1 – 200 ms	50 ms	Define the period of time before the LWT sends out a response
Swap Mode	3000	TABENUM8		0 = ABCD, 1 = CDAB, 2 = DCBA, 3 = BADC	1 = CDAB	Define the byte order for the Floating Point Format Code register
N/A	4000	TABENUM8				

Register name	Register address	Data type	Swap mode	Value range	Default value	Description
Application Category	4001	TABENUM8		1 = Water-based (DC>10) 2 = Liquid mix. (3<DC<10) 3 = Oil Based (DC<3) 4 = Solid (Organic) 5 = Solid (Others) 6 = Interface	1 = Water-based (DC>10)	Define the type of applications
Communication mode	4002	TABENUM8		0 = Configuration mode 1 = Modbus/ Operational mode 2 = LevelMaster operation mode	1 = Modbus/ Operational mode	Define the communication mode
N/A	4003	TABENUM8				
Cylinder Orientation	4004	TABENUM8		0 = Vertical 1 = Horizontal	0 = Vertical	Define the cylinder orientation for volume calculation
Echo Lost Reaction	4005	TABENUM8		0 = Hold Last Value 1 = Constant 2 = Alarm	0 = Hold Last Value	Define the behavior of the output in case the echo is lost
End of Probe Mode	4006	TABENUM8		1 = Insulated 2 = Grounded 3 = Centering Disk 4 = Weight	1 = Insulated	Define the type of end-of-probe
Service only	4007	TABENUM8				
Global Save-Reset Setup	4008	TABENUM8		0 = Save as User Default 1 = Reset to User Default 2 = Global Factory Reset	N/A	Manage user and factory settings
GPC Mode	4009	TABENUM8		1 = Off 2 = Static 3 = Dynamic	1 = Off	Enable Gas Phase Compensation mode
Tank Type	4010	TABENUM8		1 = Metallic vessel 2 = Nonmetallic vessel 3 = Bypass Part. Filled 4 = Bypass Fully Flooded 5 = Open	1 = Metallic vessel	Define the type of installation

Register name	Register address	Data type	Swap mode	Value range	Default value	Description
N/A	4011	TABENUM8				
Length Unit	4012	TABENUM8		9 = Feet 1 = Meters 10 = Inches 3 = Centimeters 4 = Millimeters	1 = Meters	Select the distance unit
N/A	4013	TABENUM8				
Max Level Rate	4014	TABENUM8		1 = No Filter 2 = Very Slow 3 = Slow 4 = Medium 5 = Fast 6 = Very Fast	1 = No Filter	Define the maximum rate at which the level is expected to change
Measurement Mode	4015	TABENUM8		1 = Threshold 2 = Movement	1 = Threshold	Select the measurement mode
Static Overflow Mode	4016	TABENUM8		0 = Disable 1 = Enable	0 = Disable	Enable the static overflow mode
Probe type	4017	TABENUM8		1 = Rod 2 = Cable 3 = Coax	1 = Rod	Select the type of probe
Remote transmitter	4018	TABENUM8		0 = Off 1 = On	0 = Off	Enable a remote transmitter
Safety Distance Reaction	4019	TABENUM8		0 = Off 1 = Alarm	0 = Off	Define the behavior in case the safety distance error is trigged
Software Write Protection Status	4020	TABENUM8		0 = Off 1 = On	0 = Off	Enable the write protect on the device parameters
N/A	4021	UINT8				
Alarm Delay	4022	UINT16		Min = 0 s Max = 3600 s	10 s	Define the delay between the triggering of an error and the activation of an alarm
Echo Lost Period	4023	UINT16		Min = 0 s Max = 9999 s	10 s	Define the delay between the disappearance of the level echo and the triggering of an error
Service only	4024	UINT16				
Service only	4025	UINT16				
Service only	4026	UINT16				
Service only	4027	UINT16				
Process condition - High Vibration	4033	UINT16		0 = Disable 1 = Enable	0 = Disable	Activate the process condition related to high vibration
Amplitude Threshold	8000	Float32	Reg. 3000	Min = 0% Max = 100%	2.44%	Define the threshold above which an echo is detected
Blocking Distance	8002	Float32	Reg. 3000	Min = 0 m Max = 75 m	0 m	Define the distance below which echoes are ignored
N/A	8004	Float32	Reg. 3000			

Register name	Register address	Data type	Swap mode	Value range	Default value	Description
Service only	8006	Float32	Reg. 3000			
Service only	8008	Float32	Reg. 3000			
Service only	8010	Float32	Reg. 3000			
Service only	8012	Float32	Reg. 3000			
Damping	8014	Float32	Reg. 3000	0 = Disable Max = 99s	0 = Disable	Define the damping time
N/A	8016	Float32	Reg. 3000			
Service only	8018	Float32	Reg. 3000			
Service only	8020	Float32	Reg. 3000			
Service only	8022	Float32	Reg. 3000			
Distance Offset Calibration	8024	Float32	Reg. 3000	Min = –1 m Max = 1 m	0 m	Define the offset to correct the distance measurement
Distance Slope Calibration	8026	Float32	Reg. 3000	Min = 0 Max = 1.5	1	Define the slope to correct the distance measurement
Service only	8028	Float32	Reg. 3000			
Empty distance	8030	Float32	Reg. 3000	Min = 0.1 m Max = 2× probe length	1 m	Define the distance to the lowest expected level
N/A	8032	Float32	Reg. 3000			
Service only	8034	Float32	Reg. 3000			
N/A	8036	Float32	Reg. 3000			
Service only	8038	Float32	Reg. 3000			
Service only	8040	Float32	Reg. 3000			
N/A	8042	Float32	Reg. 3000			
N/A	8044	Float32	Reg. 3000			
GPC Static Factor	8046	Float32	Reg. 3000	Min = 0% Max = +100%	0%	Define the correction of the slope in gas-phase compensation mode
Interface Amplitude Threshold	8048	Float32	Reg. 3000	Min = 0% Max = +100%	5.49%	Define the threshold above which an echo is considered as an interface
Service only	8050	Float32	Reg. 3000			
Level Amplitude Threshold	8052	Float32	Reg. 3000	Min = 0% Max = +100%	5.49%	Define the threshold above which an echo is considered as a level
Maximum Displacement Jump	8054	Float32	Reg. 3000	Min = 0.05 m Max = 0.10 m	0.05 m	Define the maximum permissible displacement for a track to prevent spurious jump
N/A	8056	Float32	Reg. 3000			
Service only	8058	Float32	Reg. 3000			
Minimum Echo Displacement	8060	Float32	Reg. 3000	Min = 0.01 m Max = 1.00 m	0.15 m	Define the minimum value of accumulated signed displacement required to identify a moving level

Register name	Register address	Data type	Swap mode	Value range	Default value	Description
Nozzle length	8062	Float32	Reg. 3000	Min = 0.00 m Max = 5.00 m	0 m	Define the length of the nozzle
Overflow Distance	8064	Float32	Reg. 3000	Min = 0 m Max = 1 m	0 m	Define the distance between the sensor reference point and the position of the overflow
N/A	8066	Float32	Reg. 3000			
Probe Length	8068	Float32	Reg. 3000	Min = 0.30 m Max = 75.00 m	1 m	Define the length of the probe
Safety Distance	8070	Float32	Reg. 3000	Min = 0.00 m Max = 75.00 m	0 m	Define the distance below which the presence of a level trigs an alarm
Span	8072	Float32	Reg. 3000	Min = 0.01 m Max = 1 × probe length	0.8 m	Define the distance to the highest expected level
Service only	8074	Float32	Reg. 3000			
N/A	8076	Float32	Reg. 3000			
Upper Media DC	8078	Float32	Reg. 3000	Min = 1.4 Max = 10.0	2	Define the dielectric constant of the of the first liquid that the pulse will encounter
Service only	8080	Float32	Reg. 3000	Min = 1.0 Max = 10.0	1.15	Define the uncertainty factor to apply on upper medium DC value
N/A	8082	Float32	Reg. 3000			
N/A	8084	Float32	Reg. 3000			
N/A	8086	Float32	Reg. 3000			
Cylinder Diameter	8088	Float32	Reg. 3000	Min = 0 m Max = 75 m	10 m	Define the cylinder diameter for volume calculation
Cylinder Length/Height	8090	Float32	Reg. 3000	Min = 0 m Max = 75 m	10 m	Define the cylinder length for volume calculation
Above Level Distance	8092	Float32	Reg. 3000	Min = 0 m Max = 75 m	0 m	Define the above level distance for the false echo zones
Above Interface Distance	8094	Float32	Reg. 3000	Min = 0 m Max = 75 m		Define the above interface distance for the false echo zones
Median Filter	9000	UINT32	Reg. 3000	1 = Disable Max. = 50	1	Define the length of the median filter
Interface Lost Period	9002	UINT32	Reg. 3000	Min. = 1s Max. = 99999s	1000s	Define the delay between the disappearance of the interface echo and the triggering of the alarm
Service only	9004	UINT32	Reg. 3000			
Service only	9006	UINT32	Reg. 3000			
Power cycle device	11000	ACTION		Min = –32768 Max = +32767	N/A	Writing any value execute a power cycle of the device

Register name	Register address	Data type	Swap mode	Value range	Default value	Description
Reset tracking	11001	ACTION		Min = –32768 Max = +32767	N/A	Writing any value reset false echo marking and level tracking in movement mode
Level Echo Selection	11002	ACTION		0 = Select previous echo 1 = Select next echo 2 = Confirm current echo selection	N/A	Select level echo in movement mode
False echo zones confirmation	11003	ACTION		Min. = –32768 Max. = +32767	N/A	Activate the false echo zones

Input Registers

The input registers consist of 16 bits. They can only be read out. The address (1 byte) is sent before each command. A CRC (2 bytes) is sent after each command. PV, SV, TV and QV can be adjusted via the sensor FDI.

Register name	Register address	Data type	Swap mode	Description
Status	100	UINT16		Bit 0: Invalid Measurement Value PV Bit 1: Invalid Measurement Value SV Bit 2: Invalid Measurement Value TV Bit 3: Invalid Measurement Value QV
PV Unit	104	UINT16		Unit code based on HART spec - Check UnitCode tab
PV	106	Float32	Reg. 3000	Primary Variable in Byte Order of Register 3000
SV Unit	108	UINT16		Unit code based on HART spec - Check UnitCode tab
SV	110	Float32	Reg. 3000	Secondary Variable in Byte Order of Register 3000
TV Unit	112	UINT16		Unit code based on HART spec - Check UnitCode tab
TV	114	Float32	Reg. 3000	Third Variable in Byte Order of Register 3000
QV Unit	116	UINT16		Unit code based on HART spec - Check UnitCode tab
QV	118	Float32	Reg. 3000	Quarternary Variable in Byte Order of Register 3000
Status	1300	UINT16		See register 100
PV	1302	Float32	Reg. 3000	Primary Variable in Byte Order of Register 3000
SV	1304	Float32	Reg. 3000	Secondary Variable in Byte Order of Register 3000
TV	1306	Float32	Reg. 3000	Third Variable in Byte Order of Register 3000
QV	1308	Float32	Reg. 3000	Quarternary Variable in Byte Order of Register 3000
Advanced Status	1310	UINT16		The device status is obtained from the first 6 bytes of HART command 48
Advanced Status	1311	UINT16		The device status is obtained from the first 6 bytes of HART command 48
Advanced Status	1312	UINT16		The device status is obtained from the first 6 bytes of HART command 48

Register name	Register address	Data type	Swap mode	Description
Diagnostic	1314	UINT16		Obtained from HART command 9, PV_Status
Diagnostic	1315	UINT16		Obtained from HART command 9, SV_Status
Diagnostic	1316	UINT16		Obtained from HART command 9, TV_Status
Diagnostic	1317	UINT16		Obtained from HART command 9, QV_Status
Status	1400	UINT16		See register 100
PV	1402	Float32	Reg. 3000	Primary Variable in Byte Order of Register 3000
Status	1412	UINT16		See register 100
SV	1414	Float32	Reg. 3000	Secondary Variable in Byte Order of Register 3000
Status	1424	UINT16		See register 100
TV	1426	Float32	Reg. 3000	Third Variable in Byte Order of Register 3000
Status	1436	UINT16		See register 100
QV	1438	Float32	Reg. 3000	Quarternary Variable in Byte Order of Register 3000
Level Sensor ID[1]	3001	UINT16		ID = Modbus address, 0-247 Valid[Native Byte]
# Levels	3002	UINT16		1 or 2 Levels Valid[Native Byte]
Error Code	3003	UINT16		Single highest alarm bit value[Native 16 Int]
Warning Alarms	3004	UINT16		Diagnosis Condition Details Priority [0 = No Error, else = Error/Warning with highest priority **NOTE:** The higher the number is, higher is the priority
Level 1 (Top)	7001	Float32	Reg. 3000	Top Liquid height from bottom (Inches)
Level 2 (Interface)	7003	Float32	Reg. 3000	Interface Liquid height from bottom (Inches)
Temperature	7005	Float32	Reg. 3000	Tank Temperature (Deg F)
DIP Switch Status	10000	UINT16		On-Board DIP Switch Status
HMI Software Revision	10001	UINT16		HMI Software Revision
TPROC Alarm	10002	UINT16		External Temperature additionnal status

1 Registers 3001, 3002, 3003, 3004, 7001, 7003 and 7005 are used to emulate an ABB LevelMaster.

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APPENDIX C

Gas Phase Compensation Static Factors

The following tables explain provide the necessary gas phase compensation (GPC) static factors.

Dielectric Constant of Steam

Temperatrure		Pressure							
°C	°F	1 bar 14.5 psi	2 bar 29 psi	5 bar 72.5 psi	10 bar 145 psi	20 bar 290 psi	50 bar 725 psi	100 bar 1450 psi	200 bar 2900 psi
100	212	1.005806							
120	248	1.005227	1.010601						
152	306	1.004476	1.009048	1.023424					
180	356	1.003950	1.007964	1.020432	1.042934				
212	414	1.003458	1.006960	1.017743	1.036765	1.079856			
264	507	1.002840	1.005705	1.014456	1.029597	1.062307	1.192220		
311	592	1.002418	1.004851	1.012252	1.024933	1.051729	1.147384	1.424747	
366	691	1.002036	1.004082	1.010283	1.020834	1.042799	1.116952	1.282623	3.086361

Example with Steam: Resulting Error in the Gas Phase

Gas phase	Temperatrure		Pressure							
	°C	°F	5 bar 72.5 psi	5 bar 72.5 psi	5 bar 72.5 psi	5 bar 72.5 psi	5 bar 72.5 psi	5 bar 72.5 psi	5 bar 72.5 psi	5 bar 72.5 psi
Steam (water vapor)	100	212	0.26%							
	120	248	0.23%	0.50%						
	152	306	0.20%	0.42%	1.14%					
	180	356	0.17%	0.37%	0.99%	2.10%				
	212	414	0.15%	0.32%	0.86%	1.79%	3.9%			
	264	507	0.12%	0.26%	0.69%	1.44%	3.0%	9.2%		
	311	592	0.09%	0.22%	0.58%	1.21%	2.5%	7.1%	19.3%	
	366	691	0.07%	0.18%	0.49%	1.01%	2.1%	5.7%	13.2%	79%

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APPENDIX D

Dielectric Constants Chart

The dielectric constant of common fluids is indicated below. Dielectric constants are generally influenced by

- temperature,
- moisture levels,
- electrical frequency,
- part thickness.

Fluid	Temperature in °C (°F)	Dielectric Constant (ε)
Acetal	25 (77)	3.8
Acetaldehyde		15
Acetamide	76.7 (170)	59.2
Acetic Acid	20 (68)	6.2
Acetone	25 (77)	20.7
Acetophenone		18
Acetyl bromid		16.2
Acetyl chloride		15.9
Acetylacetone		23
Acetylene dibromide		7.2
Acetylene tetrabromide		5.6
Aconite acid ester		6.3
Adipic Acid		1.8
Aerosile		1.0
Aether		4.0
Air (at STP, for 0.9 MHz)		1.00058986 ±0.00000050
Alcohol, allyl		20.6
Alcohol, cetyl	60 (140)	3.6
Alcohol, diacetone		18.2
Alcohol, ethyl (ethanol)	25 (77)	24.3
Alcohol, methyl (methanol)	20 (68)	33.1
Alcohol, propyl	20 (68)	21.8
Allyl chloride		8.2
Allyl iodide		6.1
Aluminum bromide	100 (212)	3.4

Fluid	Temperature in °C (°F)	Dielectric Constant (ε)
Ammonia		15
Ammonia solution 25%		31.6
Amyl amine		4.5
Aniline	20 (68)	7.3
Anisole		4.5
Antimony hydride		1.8
Argon		1.5
Arsine		2.1
Arsole		2.3
Azoxybenzene	36.1 (97)	5.2
Benzene	20 (68)	2.3
Bromine	20 (68)	3.1
Butane	-1.11 (30)	1.4
Butanoic acid		3.0
Caproic acid	71.1 (160)	2.6
Caprylic acid		2.5
Carbon disulfide		2.64
Carbon tetrachloride	20 (68)	2.23
Castor Oil	15.6 (60)	4.7
Chlorine, chlor fluid	0 (32)	2.0
Chlor benzene		5.7
Chloroform	20 (68)	4.8
Coconut oil, refined		2.9
Cotton seed oil		3.1
Cresol	17.2 (63)	10.6
Cumene	20 (68)	2.4
Decane	20 (68)	2.0
Diesel oil, fuel		2.1
Dodecane	20 (68)	2.0
Ether	20 (68)	4.3
Ethylamine	21.1 (70)	6.3
Ethylene glycol	20 (68)	37.0
Fish oil		2.6
Fluorbenzene		6.4
Trichlorofluoromethane refrigerant R-11	25 (77)	2.0
Dichlorodifluoromethane refrigerant R-12	25 (77)	2.0
Chlorodifluoromethane refrigerant R-22	25 (77)	2.0

Fluid	Temperature in °C (°F)	Dielectric Constant (ε)
Furan	25 (77)	3.0
Furfural	20 (68)	42.0
Gasoline, gas	21.1 (70)	2.0
Glycerine		47–68
Glycerol	25 (77)	42.5
Glycerol water		37
Glycol		37
Heptane	20 (68)	1.9
Hexane	–90 (–130)	2.0
Hexanol	25 (77)	13.3
Hydrazine	20 (68)	52.0
Iodine		11.1
Isopropyl alcohol $(CH_3)_2CH_2O$		18.2
Jet fuel	21.1 (70)	1.7
Kerosene	21.1 (70)	1.8
Linoleic Acid	0 (32)	2.6–2.9
Linseed Oil		3.2–3.5
Mercury (vapor)	148 (298)	1.00074
Methane	–173 (–280)	1.7
Napthalene	20 (68)	2.5
Octane	20 (68)	2.0
Oil		2
Olive Oil	20 (68)	3.1
Oxygen	–193 (–315)	1.51
Palmitic Acid	71.1 (160)	2.3
Palm seed oil		1.8
Paraffin		1.6
Pentane	20 (68)	1.8
Phenol	10 (50)	4.3
Pentanol		14.8
Phosgene	0 (32)	4.7
Phosphorus liquid		3.9
Pinene	20 (68)	2.7
Propane	0 (32)	1.6
Propanol $CH_3CH_2CH_2OH$		20.1
Propylene		11.9
Propylether		3.3
Pyridine	20 (68)	1.12
Resorcinol		3.2

Fluid	Temperature in °C (°F)	Dielectric Constant (ε)
Stearic Acid	71.1 (160)	2.3
Styrene	25 (77)	2.4
Terpinene	21.1 (70)	2.7
Toluene		2.0 - 2.4
Transformer oil		2.1
Turpentine (wood), white spirit	20 (68)	2.2
Vacuum (by definition)		1
Vinegar		24
Water	20 (68)	80.4
Water	360 (680)	10
Water, demineralised		29.3
Water, heavy		78.3
Water – oil emulsion		24
Wine		25

APPENDIX E

PT100 Temperature Sensors

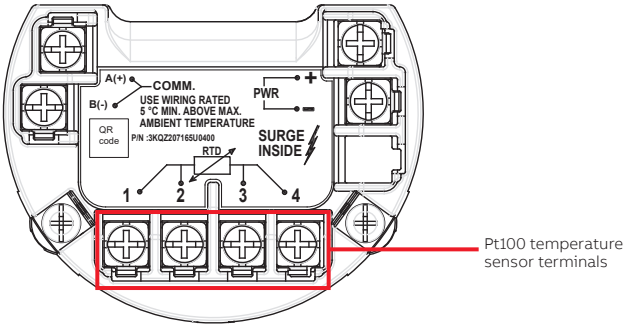
The temperature sensor circuit (PT100) must be connected in accordance with the requirements of the CSA certificate. The temperature sensor circuit (PT100) and the digital output (pulse/limit value output) must be connected in accordance with the requirements of the Ex certificate.

A metal cable gland or conduit should always be used for the PT100 cable since a shielded cable is used.

Connect the shielding within the metal cable gland.

To offer IP rating 4X/6P or IP 66/68, cable glands/sealing plugs must be screwed in using a suitable sealing compound.

Figure 60 Pt100 terminals



***NOTICE* – CONNECTION OF A PT100 TEMPERATURE SENSOR**

You can simulate an external temperature by using a 100-ohm resistor [equivalent to 0 °C (32 °F)] with two jumpers installed between the terminals for the Pt100 connection.

This resistor (including the jumpers in the case of 4-wire connections) must be removed before connecting the Pt100.

If neither a Pt100 nor the resistor is connected, LevelMaster emulation registers will have a –73 °C (–100 °F) value and an error status for the external temperature sensor. The map register offset in this Appendix is Base 0 (first register address is at 0).

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APPENDIX F

Syntax of LevelMaster Commands (ASCII)

Request and response for measurement data:

- Request: Unn?<cr> <lf>
- Response: UnnDlll.llDlll.llFfffEeeeeWwwwwCcccc <cr><lf>
  (if only one level, UnnDlll.llFfffEeeeeWwwwwCcccc <cr><lf>)

Syntax:

- Capital letters are at the beginning of certain data fields
- Small letters stand for data fields (hex value for Error and Warning)
- All commands are terminated with “<cr>” and “<lf>”
- Command starts with “Unn”, whereby “nn” stands for the address (00–31)
- The CRC includes all characters from the start of response including the capital C of the CRC code
- The answer includes <cr>and <lf> at the end

Typical command and response in normal operation:

- Data in ASCII (7 bit, 9600 baud, even parity, 1 stop bit)
- Top level (Inch) = Level
- Water level (Inch) = Interface (second value if interface has been selected)
- Temperature (°F) = external temperature (if external temperature sensor installed, fault value = –100 °F)
- Error: 4 Hex characters representing Failure status (see failure order list in “Table 4 Event codes and recommended action” on page 76)
- Warning: 4 Hex characters representing Out of specification status (see Out of specification order list in “Table 4 Event codes and recommended action” on page 76)

ASCII:

	Address		Level		Interface		Temperature		Error		Warning		CRC		
U	03	D	015.65	D	001.23	F	071	E	0000	W	0000	C	a253	cr	lf

***NOTICE* – CONNECTION OF A PT100 TEMPERATURE SENSOR**

Error and Warning can be disabled using the parameter in the **Communication > Device Warning Code** menu.

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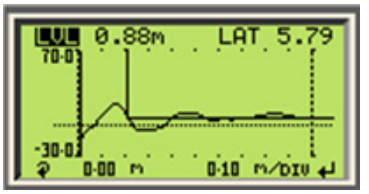
APPENDIX G

Waveform

The following figures show a typical waveform for a level and interface measurement. The echo signal amplitude range is from –100 to +100 (percentage), but the display shows values (Y-axis) from –30 % to 70 %.

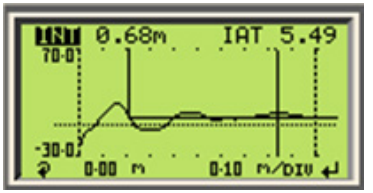
In the following figure, the **Level Amp. Threshold** (LAT) parameter has been set to 5.79 %. An echo needs to have an amplitude equal to or higher than this value to be considered a valid level echo.

Figure 61 Level Amp. Threshold (LAT)



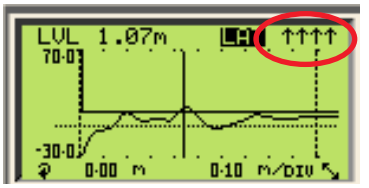
In the following figure (same waveform), the **Int. Amp. Threshold** (IAT) parameter has been set to 5.49%. An echo needs to have an amplitude equal to or higher than this value to be considered a valid interface echo.

Figure 62 Int. Amp. Threshold (IAT)



In cases where the LAT or IAT value is equal or above 10%, the display will show arrows as shown in the figure below. However, the entered value is still properly considered to detect echoes.

Figure 63 LAT or IAT Value Above 10%



In the waveform display, parameters such as blocking distance (BLK), safety distance (SFD), level amplitude threshold (LAT) or interface amplitude threshold (IAT) can be modified by selecting the parameter and using the right action key. The following figures show two examples of this feature in the waveform display.

Figure 64 Blocking Distance Modification

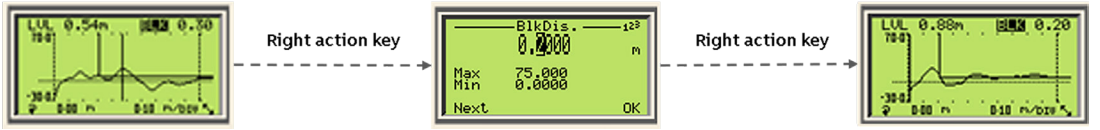


Figure 65 Level Amplitude Threshold Modification



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P/N 3KXL312101R4601 Rev C 08.2026