USER GUIDE

LWT300 Series

Guided Wave Radar Level Transmitter (HART)



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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.

Definitions

This document uses the following symbols 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 electrical code designation stamped on the instrument data plate (refer to part no. 3KXL001072U0100) 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 current loop.
- 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 and on signal isolators' 4–20 mA output.
- 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.



NOTICE

The presence of noise on the instrument 4–20 mA output can be a sign of poor or intermittent grounding, insufficient cable shielding, or noisy power line in the vicinity.

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, refer to the LWT300 series recycling instructions and environmental information (ABB part no. AA021648-01) or contact your distributor before disposing of the instrument.

Cybersecurity

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

Users shall establish and maintain any and all 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 theft of data or information.

ABB 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

HART Protocol Disclaimer

The HART communication protocol used in the LWT series of instruments **is inherently insecure.** It can be successfully exploited by spoofing techniques that would allow access to instrument data and configurations. To prevent the use of such techniques, 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. As such, before implementation, the intended application should be assessed to ensure that this communication protocol is suitable.

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 HART 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 47).

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

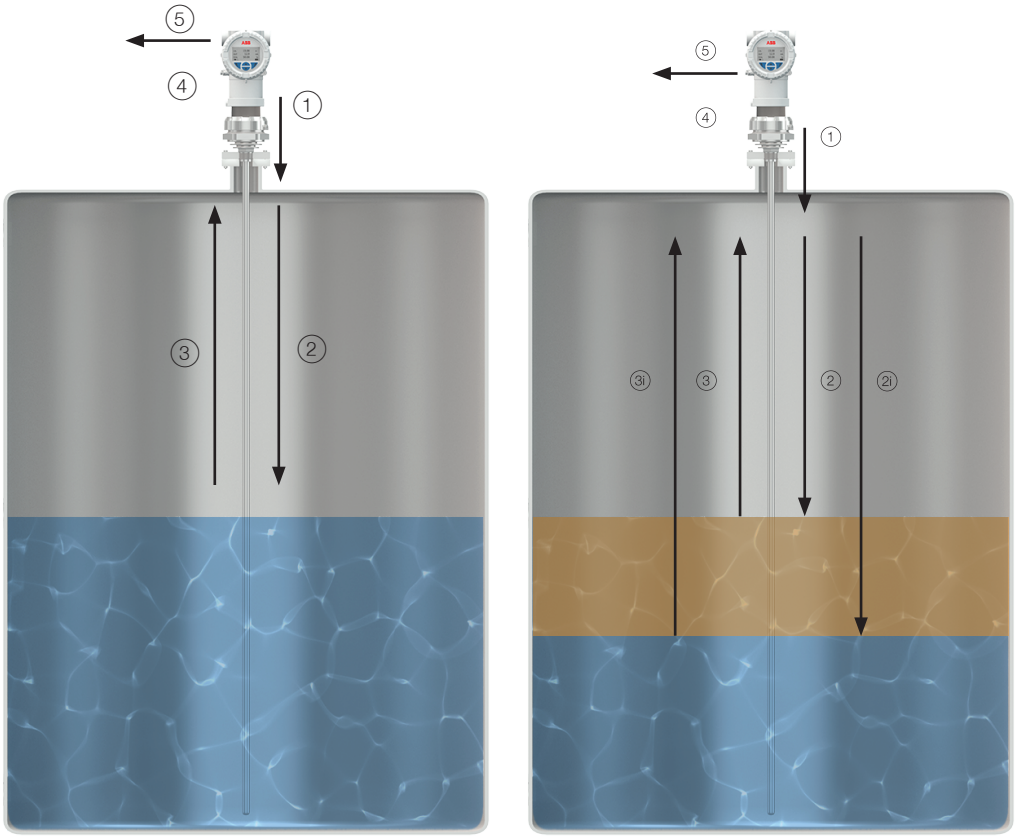
This user guide is intended for personnel using LWT series instruments for routine monitoring. It contains installation, usage, maintenance, and troubleshooting instructions.

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) (2i) and, when it encounters the product surface, some of the energy is reflected and travels back towards the coupler (3) (3i). 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).

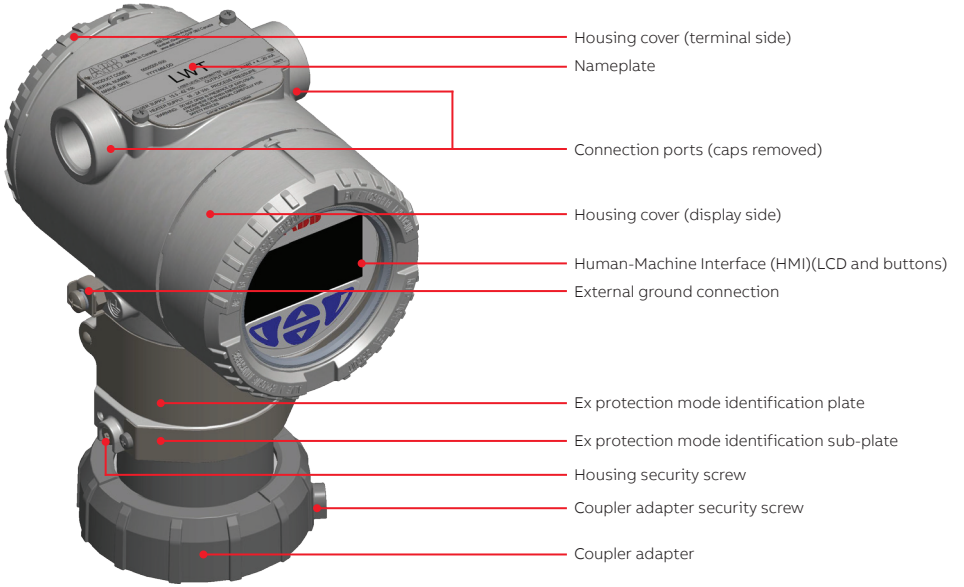
Since microwave energy travels at the speed of light, one complete measurement cycle is made up of several thousand pulses. The electronics use the time domain reflectometry (TDR) sampling technique to reconstruct, from these numerous pulses, a waveform that can be processed by the microprocessor (see “Diagnosing From a Waveform” on page 84). 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:

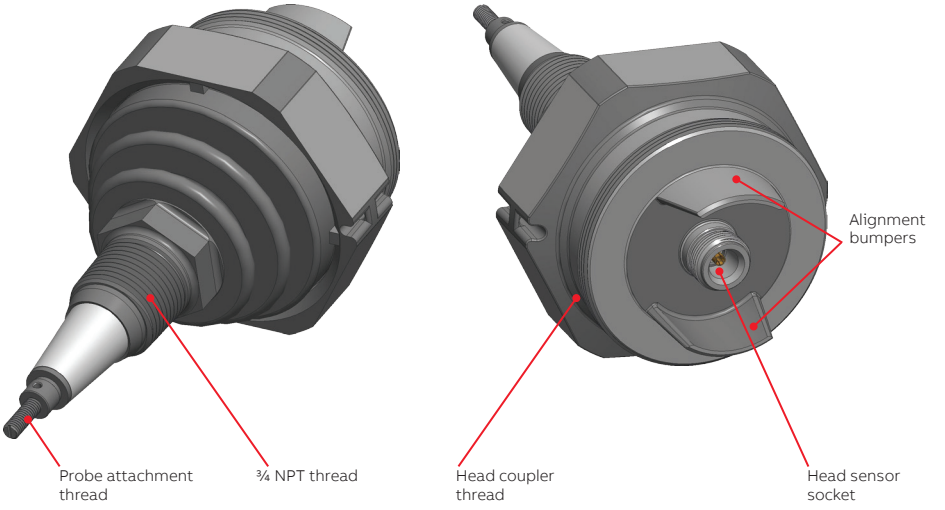
The Head

Figure 2 LWT Instrument Head



The Coupler

Figure 3 Typical ¾ NPT LWT300 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 43).

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.

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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 LWT instrument as far as possible from the product fill stream.
- Install the assembled LWT system (probe/coupler/head assembly) (see page 22) as far as possible from the fill/drain stream.
- When inserting probes, avoid internal obstructions such as tubing, ladders, and agitators.
- 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 56).

- Threaded connections should be installed with thread sealant approved for use by the customer.
- 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 or monitored process.

Environmental Considerations

The LWT instrument should be installed in an area that is within its specified temperature range (see “Appendix A” on page A91), 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 58). 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 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-specific Considerations

- For maximum power supply voltage, refer to the instrument identification plate or see “Appendix A” on page A91.
- For signal and power loop connections up to 1500 meters (4900 feet) in length, use Ø 0.80 to 0.35 mm² (18 to 22 AWG) twisted, stranded pair wiring. Longer loops will require larger wires.
- The 4–20 mA DC output signal and the DC power supply to the LWT instrument are carried by the same pair of wires.
- Supply voltage at the instrument terminals must be between 15.5 and 42 V DC. If using a 250 Ω resistor for the HART connection, the loop power supply must be between 21 and 42 V DC if there is no other load on the line to achieve the required voltage at the instrument terminals (see Figure 19 on page 30).

Cable- and Cable Gland-specific 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 customers' 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 shield 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 non-metallic vessels 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, 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.

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 84).
- 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 bushings with a good electrical contact with the LWT threaded coupler (avoid rust and the use of Teflon tape 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 probe 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 such as

- 3 mm hexagonal key
- ¼", 5⁄16", 3⁄8" 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.

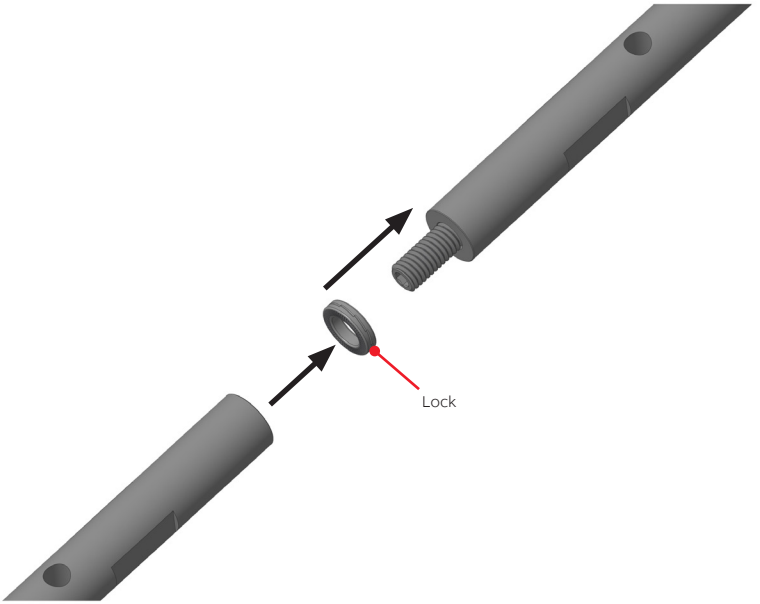
Assembling a Segmented Probe

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 5 Assembling Two Segments of a Segmented Probe



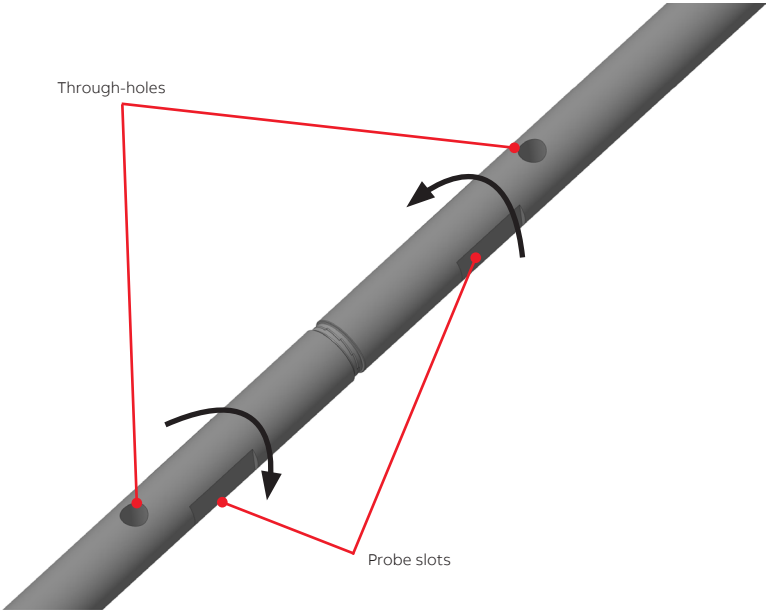
3. Use two wrenches (each one holding the probe slot of the segment) to apply the recommended torque (see below) in opposite directions at the same time (see Figure 5).

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

Figure 6 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 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 Probes To Couplers” on page 20.

Attaching Probes To Couplers

Depending on your specific application, you might have to install a flexible 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

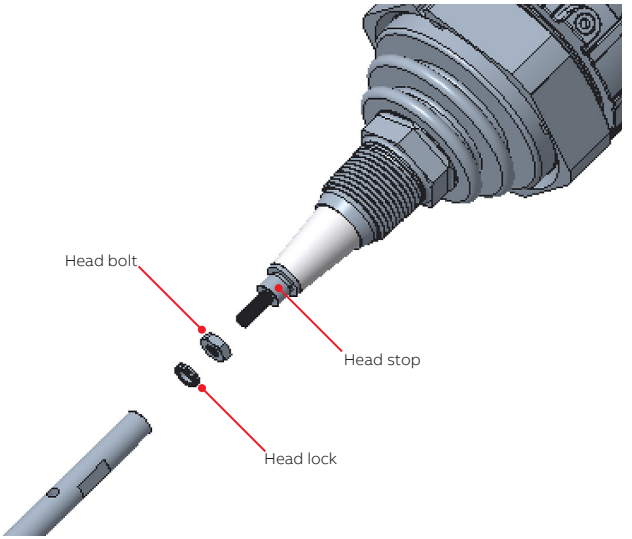
LWT instruments come in a wide variety of configurations. They can come with probes already attached and/or external flanges soldered on, or neither. The following pages explain the procedures to perform although those procedures might have already been performed at the factory.

Attaching Probes (Cable/Rigid) On Standard Couplers

To attach a probe on a standard coupler:

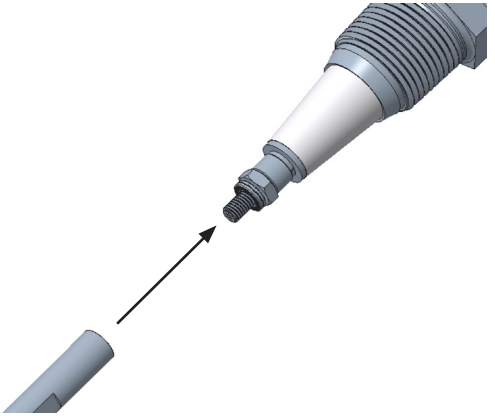
1. Screw the provided head bolt on the screw-in end and tighten by hand until it reaches the head stop.
2. Insert the lock behind the provided bolt.

Figure 7 Installing the Probe



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

Figure 8 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 9 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 8.9 mm locks: 2.8 N·m (2.1 lbf.ft).
- For 13.5 mm lock: 13.5 N·m (10.0 lbf.ft).

Installing the LWT System

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 the 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 between the process and coupler flanges, and fix the flange with the appropriate nuts and bolts to the torque required by the flange class.

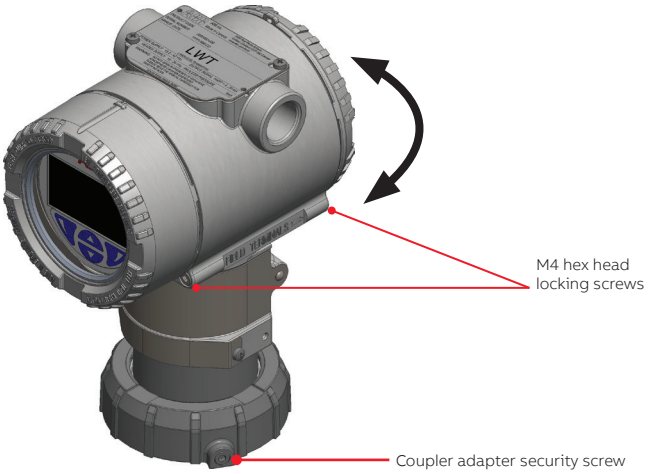
Rotating the Housing

To improve HMI visibility or field access to the wiring, you may rotate the LWT housing 360° from its initial position, and fix 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 10).

Figure 10 Rotating the Housing



2 Loosen the coupler 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 coupler adapter.
5 Re-tighten the coupler adapter security screw to secure the coupler 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:

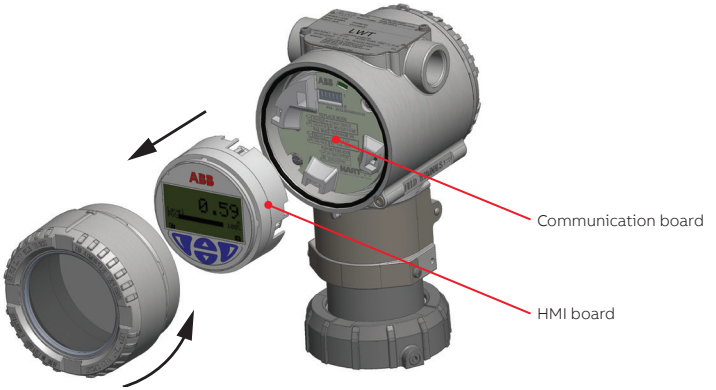
1 Make sure that the instrument is powered off and that the M4 hex head locking screws are screwed in (see Figure 10).
2 Unscrew the housing cover on the display side (hazardous area warnings must be heeded; see “Safety” on page 1).

CAUTION

Do not grab the instrument by its threaded interface. Thread edges are sharp and constitute a risk of personal injury (see Figure 20).

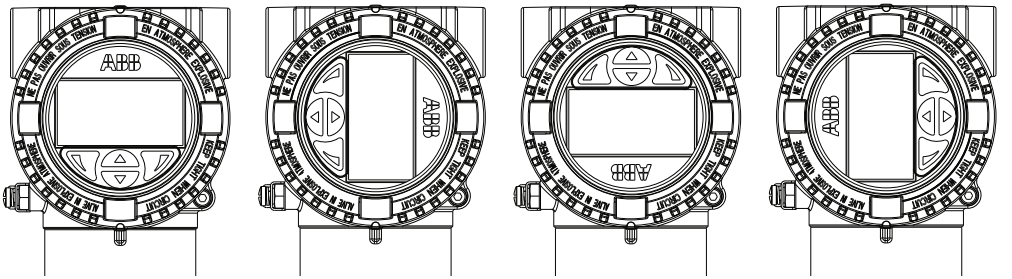
3 Pull the HMI board away from the communication board.

Figure 11 Pulling Out the HMI



4 Turn the HMI according to the new desired position.

Figure 12 The Four Positions of the Instrument HMI



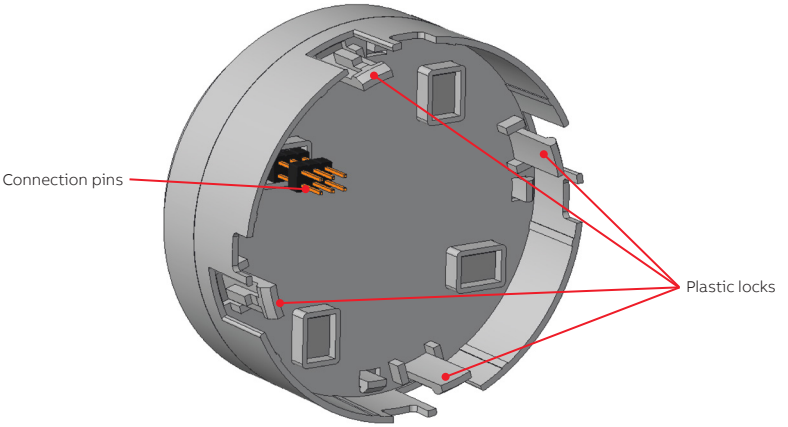
0° (default) +90° +180° +270°

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 13) when pushing the display back in.

Figure 13 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 32.

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 17 and/or “Attaching Probes To Couplers” 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.

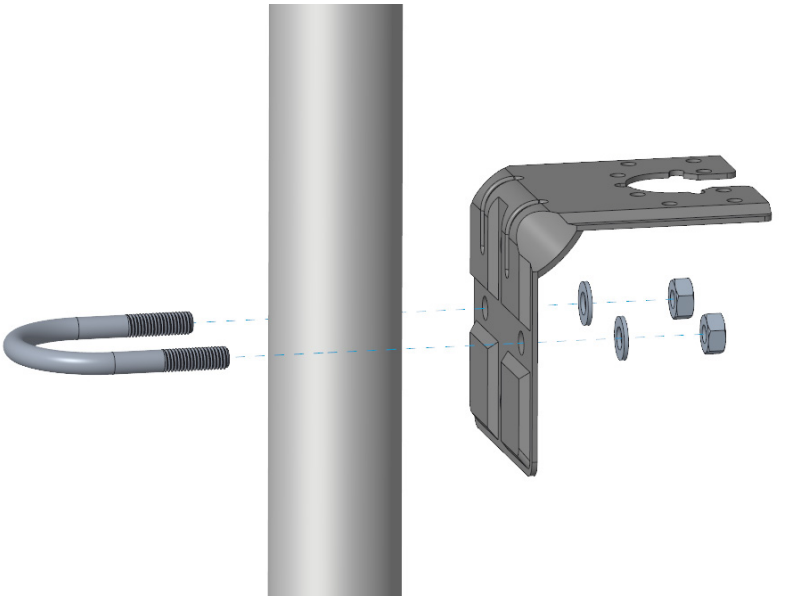
NOTICE

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 14).

Figure 14 Positioning the Support Bracket

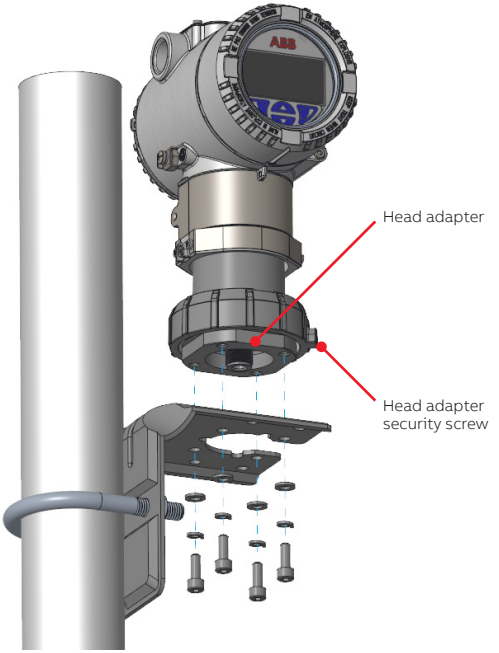


3 Place the instrument equipped with the coupler-head adapter on top of the support bracket and install the four screws to secure the instrument (see Figure 15).

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 15 Positioning the Instrument Head on the Support Bracket



4 Completely unwind the coaxial cable.

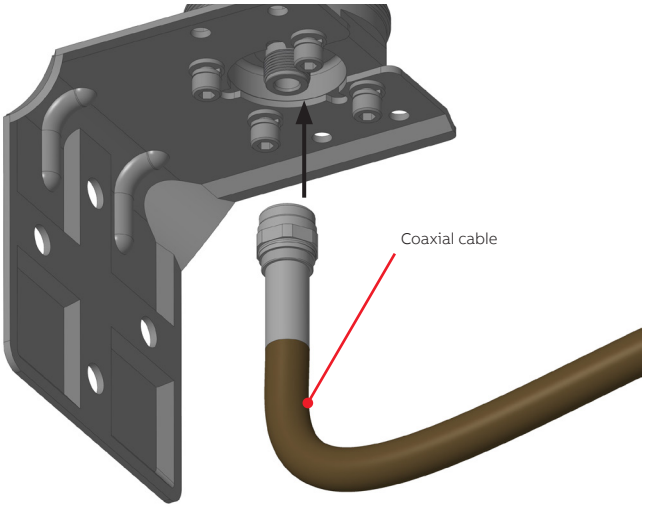
5 Connect one end of the coaxial cable to the bottom of the head-coupler adapter (see Figure 16).

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).

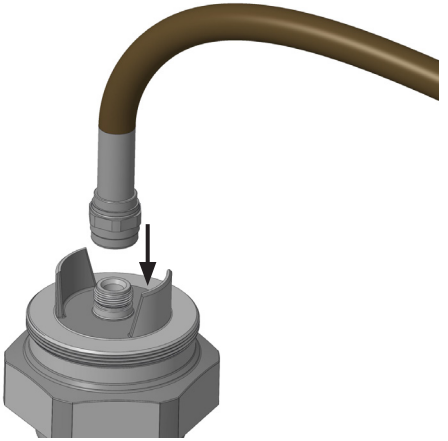
The coaxial cable bend radius shall not be less than 150 mm (6 in).

Figure 16 Connecting the Coaxial Cable to the Head-Coupler Adapter



6 Connect the other end of the coaxial cable to the top of the coupler (see Figure 17).

Figure 17 Connecting the Coaxial Cable to the Top of the Coupler



Grounding the Instrument

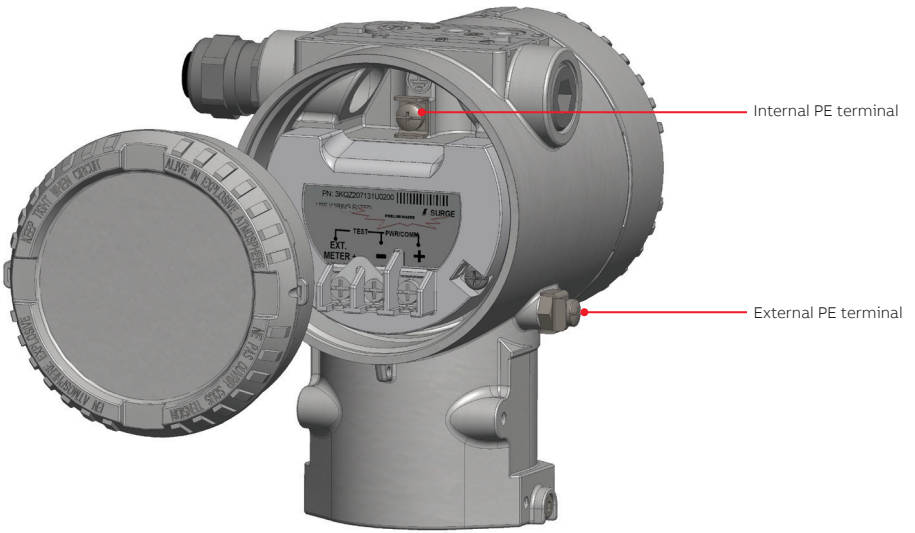
NOTICE

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

The LWT instrument 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 (12 AWG).

PE terminals are available inside and outside the instrument housing (see Figure 18). Both terminals are electrically interconnected.

Figure 18 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.

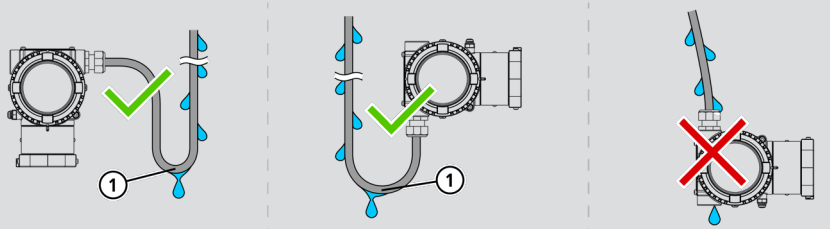
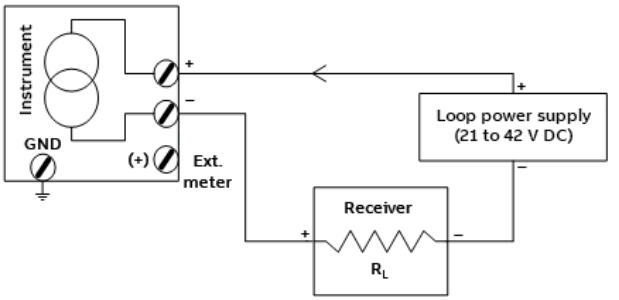


Figure 19 Typical LWT HART Connection



To connect the LWT instrument:

1 Remove the temporary plastic cap from the most convenient of the two electrical connection ports (see Figure 20).

WARNING

In the particular case of explosion-proof installations, remove the temporary plastic caps and close the unused opening with a cap certified and appropriately rated for explosion containment.

2 Make sure that the M4 hex head locking screws are screwed in (see Figure 10).

3 Remove the housing cover on the “terminals” side (see Figure 20).

WARNING

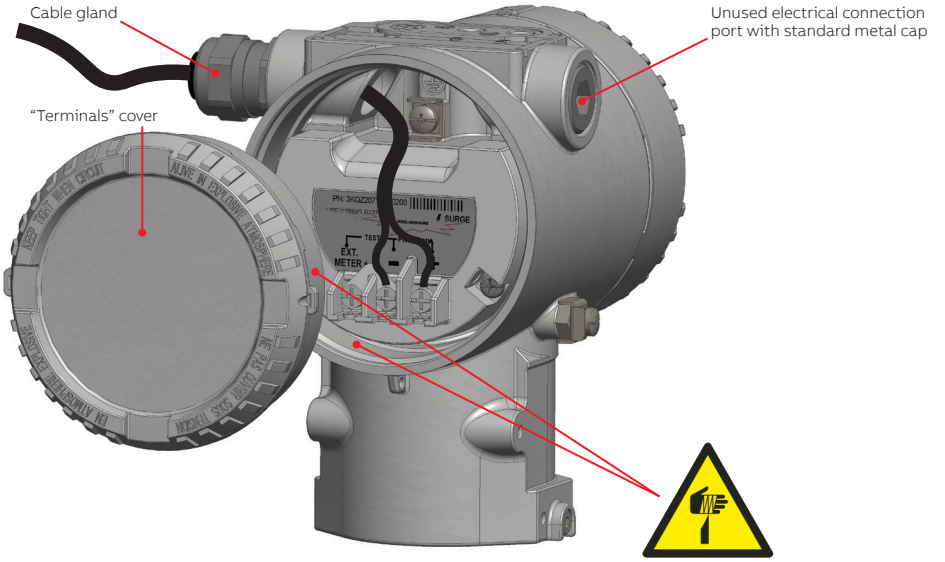
Do not handle the instrument by the threaded interface. Threaded edges are sharp and could cause personal injuries.

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.

Figure 20 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 positive lead to the **PWR+** terminal, and the negative lead to the **PWR–** terminal.

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-on-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.

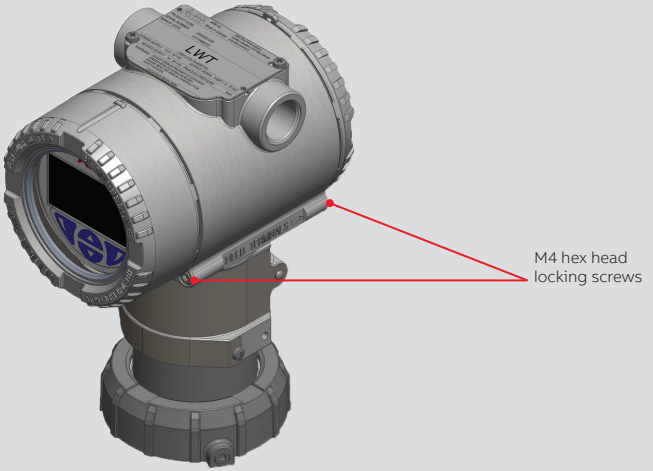
NOTICE

After power-on, wait for the HMI calibration process to complete (±30 seconds) 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.

Establishing Communication With the Instrument

Communication with your instrument is achieved using the HART communication protocol over the instrument's 4–20 mA current loop.

The HART (Highway Addressable Remote Transducer) communication protocol is a hybrid analog and digital industrial automation protocol. It allows remote configuration of LWT instruments over legacy 4–20 mA analog device current loops, sharing the pair of wires used by analog-only host systems.

ABB provides a HART communication package. Once installed in your preferred HART application, it will allow communication with your LWT instruments.

NOTICE

Cybersecurity Disclaimer

The HART communication protocol used in the LWT series of instruments **is inherently insecure.** It can be successfully exploited by spoofing techniques that would allow access to instrument data and configurations. To prevent the use of such techniques, 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. As such, before implementation, the intended application should be assessed to ensure that this communication protocol is suitable.

NOTICE

The communication board for HART (located behind the interface board) cannot be replaced in the field and cannot be moved between LWT instruments. In case of failure, the instrument must be sent back to ABB for calibration and repair.

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

After power-on, wait for the HMI calibration process to complete (±30 seconds) before operating the HMI.

Figure 21 Instrument HMI on Power-on

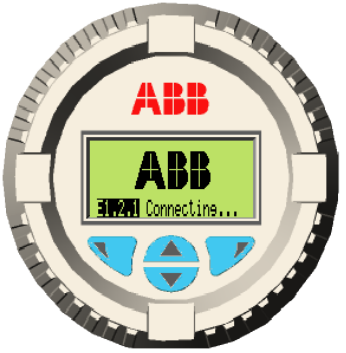


Figure 22 Initial Operator Page With Values Based on Default Configuration



NOTICE

During the boot process, no level information is displayed.

For more information on Operator pages, see “Configuring Operator Pages” on page 44.

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.

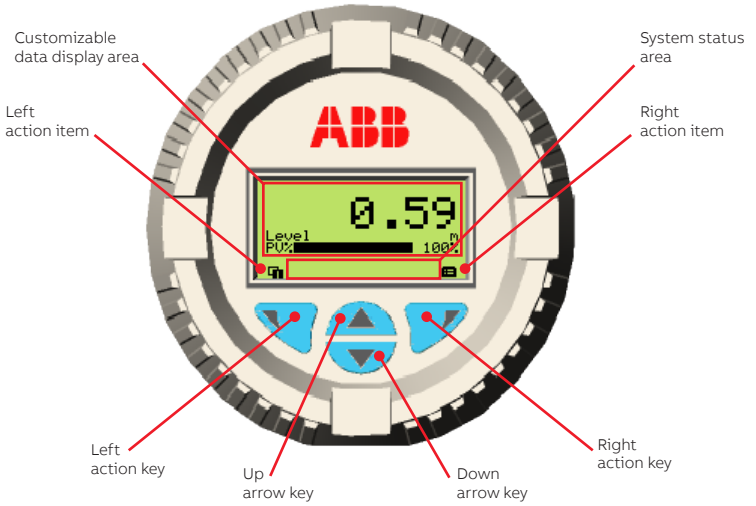
Introducing LWT User Interfaces

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[1].

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

Figure 23 Typical Operator Screen



1 The other method requires a HART modem and a handheld HART terminal or DTM/FDI software with a PC.

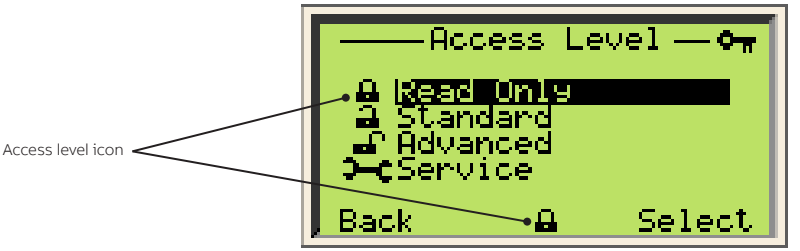
Table 1 Action Items and Explanation

Action item	Title	Action
Left		Gives access to the Diagnostics page (see “Diagnosing Problems” on page 79), the four Operator pages (see “Configuring Operator Pages” on page 44).
	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 43).
	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 24 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** menu can only be accessed by or under the supervision of ABB service personnel.

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

For more information on setting passwords, see “Protecting Access to Instrument Data” on page 46.

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:

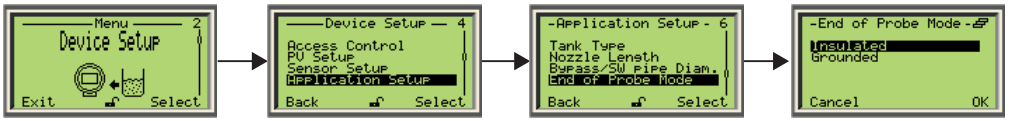
1 Using the arrow and action keys, move up, down, left or right within a menu.

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 25 Selecting an existing option



Setting a Value

Contrary to options, you can modify values. To do so:

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 26 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 27 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.

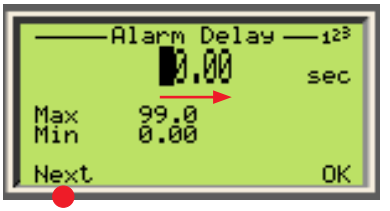
6 Once you are done modifying values, press the right action key (**OK**). The modified value becomes effective immediately.

7 Press **Back** repeatedly to exit the menu.

Figure 26 Selecting a Value to Edit



Figure 27 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 B93.

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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 basic configuration items in succession until the basic configuration is complete. This menu was designed to cover most typical uses.

Figure 28 The Easy Setup Menu



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

- the language needed on the display;
- what you want to measure (level, ullage, 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 Press **Select**. The **Language** menu appears immediately.
   - **a** Press **Edit**. The list of available languages appears (default value: **English**).
   - **b** Scroll up or down the list and highlight the desired language.
   - **c** Press **OK**. The interface immediately changes to the selected language.

For more information, see “Language” on page 43.

2 Press **Next**. 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 51.

3 Press **Next**. The **Set PV (4-20mA)** 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 Up the Primary Value (PV)” on page 49.

4 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 (default value: **m**).
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 “Selecting the Primary Value Unit” on page 49.

5 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 72.

6 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 73.

7 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 set.

For more information, see “Selecting a Maximum Level Rate” on page 59.

8 Press **Next**. The **Display Line1 View1** screen appears (this sets the measurement displayed on the first line of text, as illustrated in Figure 30 on page 44).
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 set.

For more information, see “Configuring the Display” on page 43.

9 Press **Next**. The **Echo Lost Reaction** screen appears. This sets the behavior of the displayed measurement should the level echo be lost (see “Managing Lost Echoes” on page 63).

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.

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CHAPTER 6

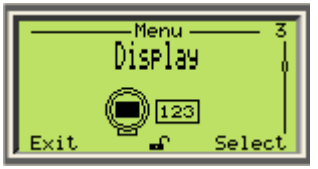
Configuring the Instrument

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.

Configuring the Display

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

Figure 29 Display Menu



Language

To set language in which the interface is displayed:

1. Select **Display** > **Language**.
2. From the **Language** menu, highlight the language in which you want to display the interface.
   English is selected by default, but you can also select German (**Deutsch**), French (**Français**).
3. Press **OK**.

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**.

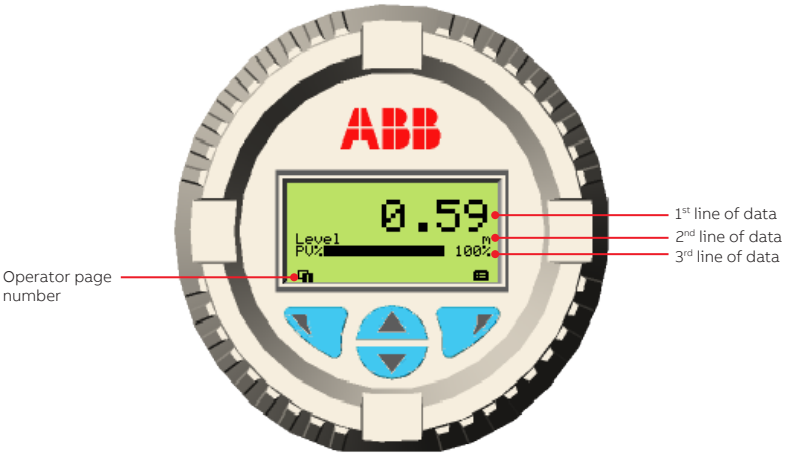
3 From the list that appears, highlight the number of decimals to display (**X**, **X.X**, **X.XX**, **X.XXX**) and press **OK**.

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 “Selecting an Operator Page to Display” on page 45).

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

Figure 30 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 current 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 44).

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**.

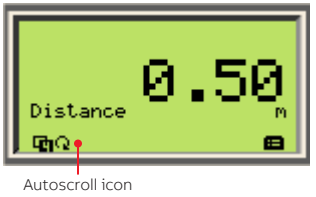
2 Press **Edit**.

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 (see Figure 31 on page 46).

Figure 31 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 (software and hardware) from the **Access Control** menu under the **Device Setup** menu.

Figure 32 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**[1].

   All passwords are reset.

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

Activating hardware or software write-protection prevents all forms of external access to the instrument (HART, DTM, service access, etc.).

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.

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

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.**

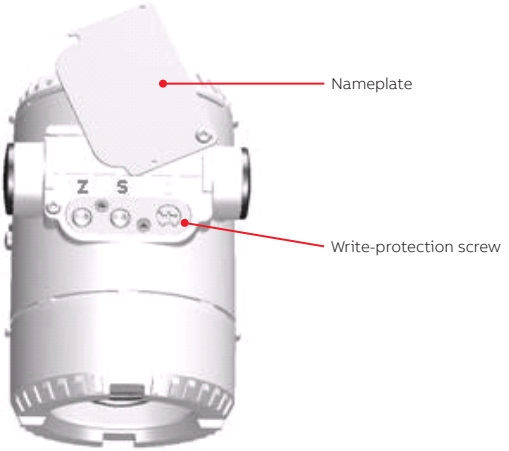
To enable hardware write-protection:

1 On the instrument head, unscrew and remove the nameplate. This exposes two buttons and the write-protection screw (see Figure 33).

NOTICE

DO NOT use a magnetic screwdriver.

Figure 33 Accessing the Write-protection Screw

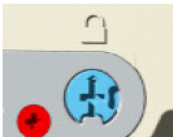


2 Using a suitable screwdriver, fully press down on the write-protection screw and turn 90° clockwise to activate hardware write protection or, if already activated, 90° counterclockwise to deactivate it.

Figure 34 Activating Hardware Write Protection



Deactivated write protection (default)



Activated write protection

3 Put the nameplate back in place.

Setting Up the Primary Value (PV)

The primary value is the value that you want to measure with your LWT instrument. It is configured from the **PV Setup** menu under the **Device Setup** menu.

Figure 35 The Device Setup menu



Selecting the Value

The primary value is the only value directly linked to the 4–20 mA current loop. It impacts other parameters used by the instrument. The default primary value is **Level**.

To select the primary value:

1. Select **Device Setup** > **PV Setup** > **Set PV (4-20mA)**.
2. Press **Edit**.
3. Highlight the primary value that you want to measure and press **OK**.

Selecting the Primary Value Unit

Once you have selected the primary value, you need to select the unit in which this value will be measured. The default primary value unit is **m** (meters).

To set the primary value unit:

1. Select **Device Setup** > **PV Setup** > **PV Unit**.
2. Press **Edit**.
3. Highlight the primary value unit that you want to use and press **OK**.

Unlinking the Primary Value From the Empty/Full States

By definition, the 4 mA value is assigned to the vessel empty state and the 20 mA value is assigned to the vessel full state (as set first in the **Easy Setup** menu). Once you have set these primary values and their associated units, you can choose to unlink the primary value from the empty/zero (4 mA) and full/span (20 mA) states. The default value is **Linked**.

To unlink the primary value from the 4–20 mA values:

1. Select **Device Setup** > **PV Setup** > **Link 4-20mA to Z/S**.
2. Press **Edit**.
3. Highlight **Unlinked** and press **OK**.

NOTICE

Unlinking the primary value from the 4–20 mA values requires that you manually set 4 mA and 20 mA values afterwards. Menu items for these two values appears in the **PV Setup** menu to do just that.

Values are automatically relinked if either the 4 mA or 20 mA value is modified at a later time.

Setting Unlinked 4 mA and 20 mA Values

To set 4 mA and 20 mA values after unlinking them from the empty/full states:

1 Select **Device Setup** > **4 mA (LRV)** or **20 mA (URV)**.
2 Press **Edit**.
3 Set the appropriate value and press **OK**.

Configuring the Sensor

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

Changing the Distance Measurement Unit

The default unit for distance measurements (ullage, level, distance) is the meter (m).

To change that unit:

1 From the **Device Setup** menu, select **Sensor Setup > Length Unit**.
2 Press **Edit**.
3 Highlight the appropriate length unit and press **OK**.

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.

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 85.

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**.

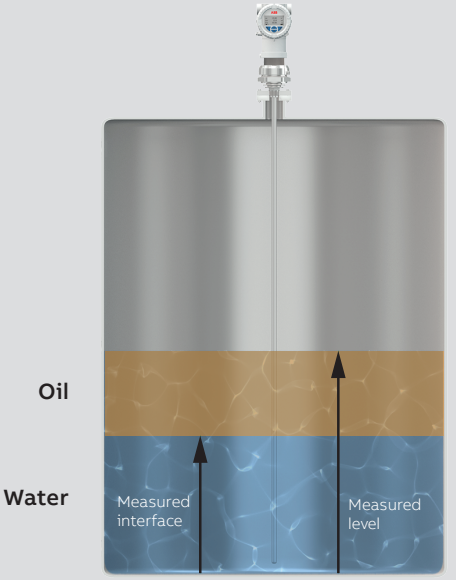
Selecting the Application Category

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 category 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 values.



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 hardware 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**.

Setting the Dielectric Constant of Upper Media

When the application involves measurement of the *interface* between liquids (e.g., oil on top of water), the system requires the dielectric constant (DC) of the first liquid that the pulse will encounter when traveling down the probe (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 a Static Overflow

Some level applications require the use overflow tanks. In such situations, if the movement measurement mode has been selected, it is strongly suggested to 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,** press **OK**, then **Back**.
4. Select **Overflow Distance**.
5. Press **Edit**.
6. Set the overflow distance 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:

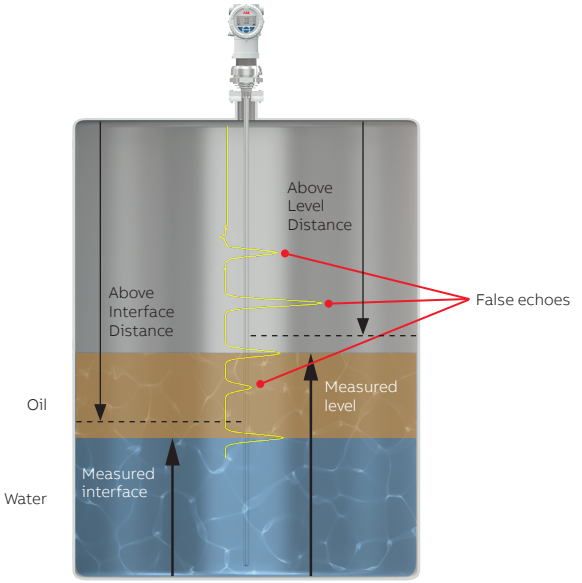
1 Select **Waveform > False Echo Zones > Confirm Zones**.

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 false echo history 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 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 E” on page E107 for more details).
- **Int. Amp. Threshold** (for both measurement modes):
  - Value which determines the minimal amplitude for an interface echo (see “Appendix E” on page E107 for more details).
- **Interface lost period** (for both measurement modes):
  - The 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.
- **Min echo displacement** (for movement measurement mode only):
  - Minimum cumulative echo displacement required for identifying a movement-level track.
- **Max 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 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 the End of Probe Mode” on page 58).

To do so:

1. Select **Device Setup** > **Application Setup** > **Probe Type**.
2. Press **Edit**.
3. Highlight the appropriate probe type and press **OK**.

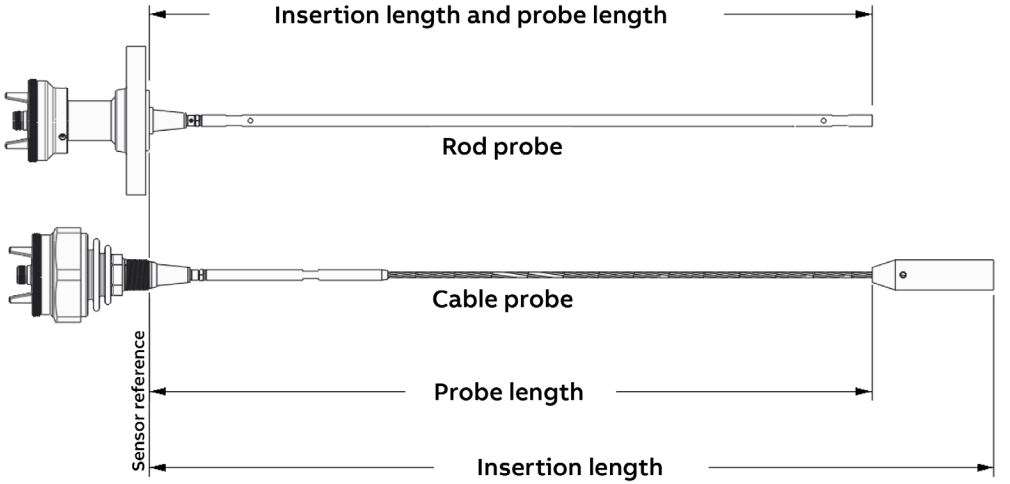
Changing Probe Length

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**.

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 61.

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 the 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 proper end-of-probe mode and press **OK**.

NOTICE

Isolated end of probes are only compatible with rod probes.

Toggling the 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 specifications.

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 to 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:

Max Level Rate — Median filter — Damping — Amplitude Threshold

Selecting a 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.

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.

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.

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 alarms and process safety parameters. The following pages explain how to set these parameters.

Setting Process Alarms

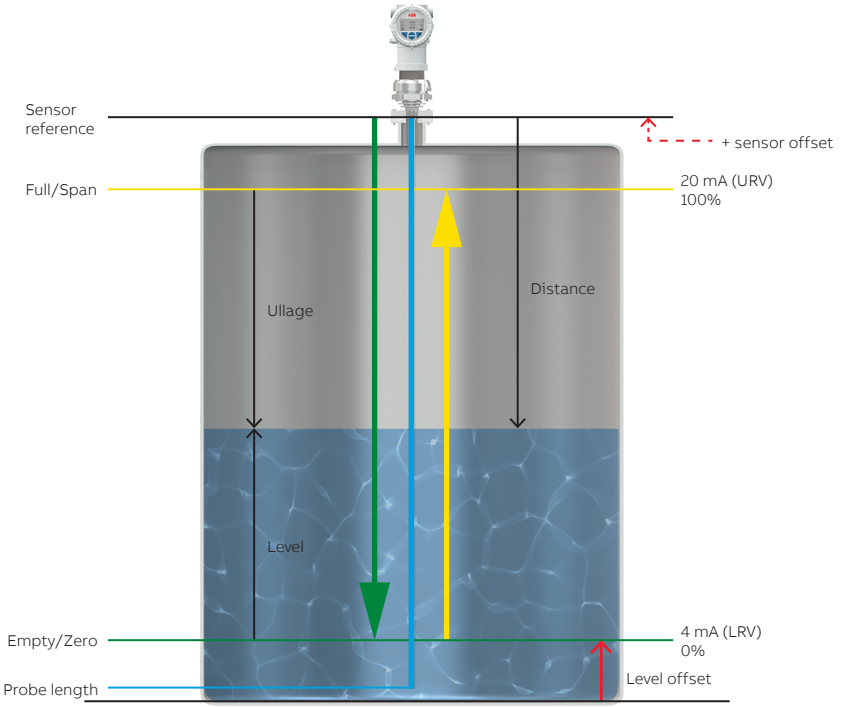
Alarms can be raised when process levels reach certain thresholds. **Low and high alarm thresholds are factory set and cannot be modified.** Low alarms are set at 3.6 mA and high alarms are set at 21.5 mA. Other process alarm parameters are configured from the **Process Alarm** menu.

Figure 41 The Process Alarm Menu



Figure 42 illustrates these alarm-triggering thresholds.

Figure 42 Measurement Concepts



The following pages explain how to set those threshold values.

Setting Failure Mode

You can specify whether high or low failures (saturations and alarms) raise an alarm. The default value is **Low**.

To specify the failure mode:

1 Select **Process Alarm** > **Failure Mode**.

2 Press **Edit**.

3 Highlight **High** or **Low** and press **OK**.

Setting Saturation Limits

Although process **alarm** levels cannot be modified, you can modify saturation limits.

To do so:

1 Select **Process Alarms** > **Saturation Limits** > **High Saturation** or **Low Saturation**.
The low saturation default value is **3.80** mA. This value can be edited between 3.80 and 4.00 mA.
The high saturation default value is **20.50** mA. This value can be edited between 20.00 and 20.50 mA.

2 Press **Edit**.

3 Set the new saturation value and press **OK**.

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 44) are set from the **Device Setup** menu.

Figure 43 The Device Setup Menu



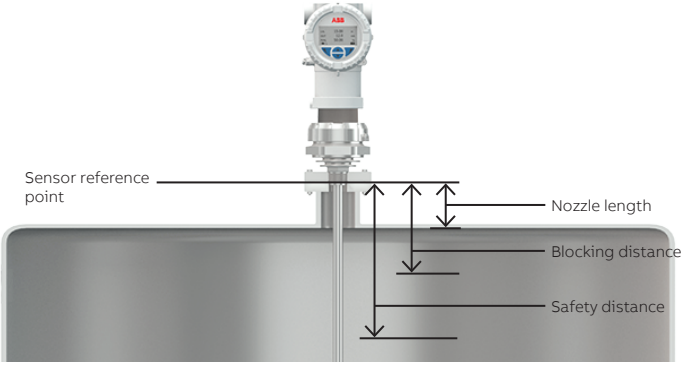
Setting a Blocking Distance

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 44 Blocking and Safety Distances



Setting a safety distance

The safety distance is a 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 the **Easy Setup** menu.

Period

The echo lost period is the period of time after the event during which the instrument reacts according the selected echo lost reaction. During this period, if the echo reappears, the device recovers and the echo lost reaction and period are canceled. After this period, if the event remains, an alarm is raised.

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**.

Value

This is the value to hold on the 4–20 mA current output if you select **Constant Value** from the **Echo Lost Reaction** menu.

To set the constant value to hold:

1. Select **Device Setup** > **Safety Setting** > **Echo Lost Value**.
2. Press **Edit**.
3. Set the value 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 raising an alarm.

To set an alarm delay:

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

Setting Up Linearization

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

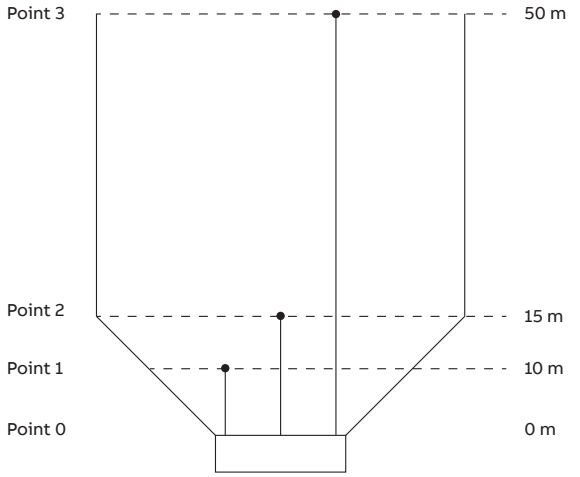
Understanding Linearization

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 45 Actual Level vs. Linearization Table Points



If Figure 45 was translated into actual values, it could be put in a table as such:

Table 1 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.
- Activate the function.
- Reconfirm the primary value.

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

Figure 46 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 the 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 the 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 Value for Level, Volume or Flow

To set the maximum level, volume or 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 only available if you selected **Volume** as your output type (see “Accessing the Linearization Function” on page 66).

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

- Orientation
- Diameter
- Length

Setting 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 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 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

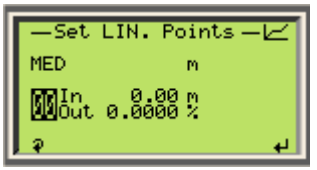
The first point is always the point with the lowest value and all other points must be set in increasing order.

To properly configure the linearization feature:

1 Select **Device Setup** > **Linearization** > **Set LIN. Points**.

The **00** linearization point is highlighted (see below).

Figure 47 Setting the First Linearization Point



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 volume 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 6 for all the required linearization points.

All the 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 68) or use the automatically-generated table (see “Generating a Linearization Table Automatically” on page 67).

Saving the Linearization Table

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

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 and volumes (or flow) are being measured accordingly.

NOTICE

Disabling the linearization table deactivates all volume measurements settings.

Do not forget to reconfirm that the PV, SV, TV, and QV values are set to **Volume** or **Flow** 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 the 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 a 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 > 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. The LWT instrument will complete the reset after about 15 seconds.



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.

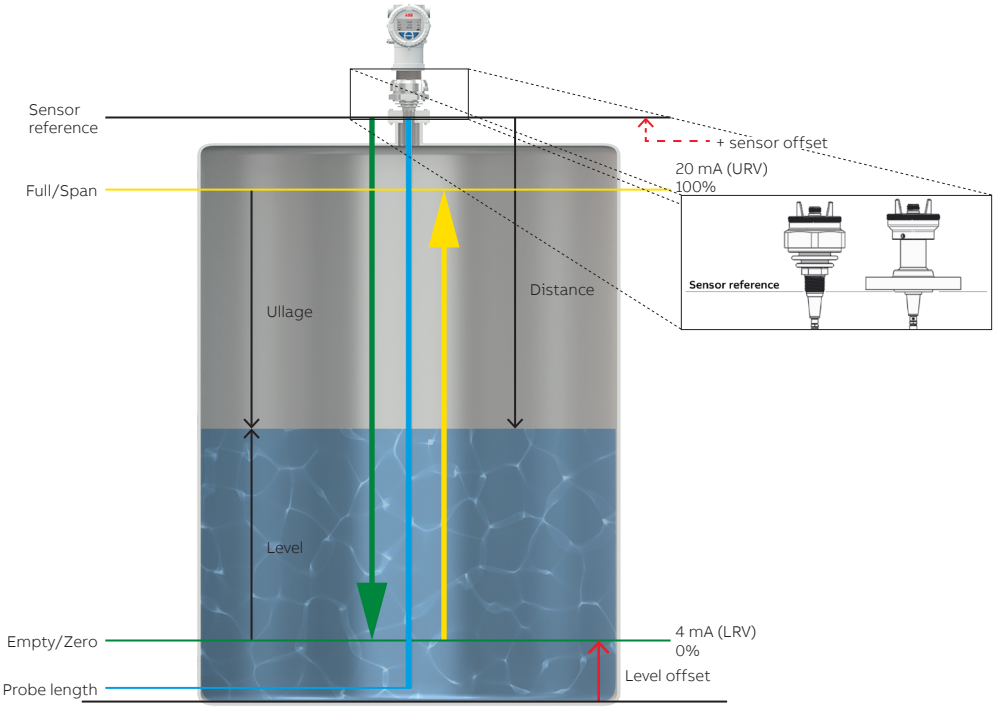
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CHAPTER 7

Setting Calibration Parameters

Should configuration with the **Easy Setup** menu not be enough to meet your needs, you will have to calibrate your instrument and enter specific values to perform this calibration. The following pages explain how to do this.

Figure 48 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 48 above).

Setting Level Calibration Parameters

Level calibration parameters are set under the **Calibrate** menu. Figure 49 illustrates this menu.

Figure 49 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.

To set that value:

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

By default, the empty/zero value is linked to the 4 mA value.

NOTICE

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

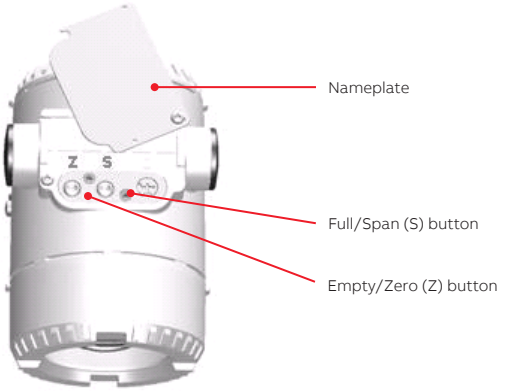
Changing the Empty/Zero Value in Hardware

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 (see Figure 50 on page 73).

Figure 50 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 zero position [LRV]).

To set that value:

1 Select **Calibrate** > **Level Calibration** > **↑Full/Span**.

2 Press **Edit**.

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

By default, the full/span value is linked to the 20 mA value.

Changing the 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 50 on page 73).

2 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.

NOTICE

Extending the offset beyond the probe length requires unlinking the primary value from the empty/full values (see “Unlinking the Primary Value From the Empty/Full States” on page 49) and adjusting the 4–20 mA values accordingly (“Changing Upper/Lower (4–20 mA) Reference Values” on page 74).

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 bent 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 Upper/Lower (4–20 mA) Reference Values

The upper and lower current reference values are automatically linked to the empty/zero and full/span values when configuring the LWT instrument for the first time with the **Easy Setup** menu.

You cannot change these current reference values while they are linked (the instrument will not let you do it). For more information on unlinking the reference values, see “Unlinking the Primary Value From the Empty/Full States” on page 49.

The default value for these parameters is **0** m. The value can be set between **0** and **75 m**.

To set these values (*once unlinked*):

1 Select **Calibrate** > **Level Calibration** > **4 mA (LRV)** or **20 mA (URV)**.

LRV is the lower reference value and URV is the upper reference value.

The LRV default value is **0** m. This value can be edited between **0** and **75** m.

The URV default value is the probe length. This value can be edited between **0** and **75** m.

2 Press **Edit**.

3 Set the new reference value and press **OK**.

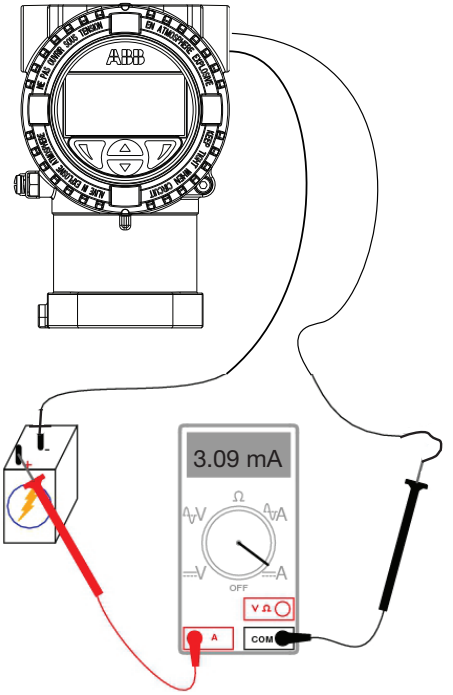
Changing the 4–20 mA D/A Trim

LWT instruments are factory-calibrated to reflect the published declared performance specifications. No further calibration is required in normal usage conditions.

Once an LWT is installed and wired, the field wiring and other current loop components may affect the mA **output** that is received at the point of control. The D/A trim is used to compensate for the presence of the loop components and allow the point of control to receive true 4 mA and 20 mA currents.

Performing this calibration requires a 24 V DC input in series with an ammeter.

Figure 51 Setting the D/A Trim



Changing the 4 mA Trim

To set the 4 mA trim:

1. Select **Calibrate** > **4-20 mA D/A Trim** > **4 mA Trim**.
2. Press **Edit**.
3. Change the default value to the value indicated on the ammeter and press **OK**.

Changing the 20 mA Trim

To set the 20 mA trim:

1. Select **Calibrate** > **4-20 mA D/A Trim** > **20 mA Trim**.
2. Press **Edit**.
3. Change the default value to the value indicated on the ammeter and press **OK**.

Resetting the D/A Trim

To reset the 4–20 mA trim:

1. Select **Calibrate** > **4-20 mA D/A Trim** > **Reset D/A Trim**.
2. Press **OK**. The D/A trim is reset.

Performing a Current Simulation

To validate that calibration was successful, you can simulate a current output.

To perform the simulation:

1. Select **Calibrate** > **4-20 mA D/A Trim** > **Current Simulation**.
2. Press **Edit**.
3. Set a current value (between 3.5 mA and 23.6 mA) that you want the instrument to generate and press **OK**.

   The ammeter should have a reading identical to the value entered.

Adjusting the Distance Calibration

Distance offset and slope calibrations 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 propagation of the RF pulse.

To modify offset calibration:

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

To modify 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

Certain communication parameters are set from the **Communication** menu, including setting of the instrument network address and activation of the multi-instrument feature (a.k.a. multidrop).

Figure 52 The Communication Menu



Setting Dynamic Values

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

The primary value (PV) is the only value directly linked to the 4–20 mA loop. It impacts other parameters used by the instrument. For more information on setting the primary value, see “Setting Up the Primary Value (PV)” on page 49.

To set the remaining values, as necessary:

1. Select **Communication** > **Dynamic Variables** > **Set SV**, **Set TV** or **Set QV**.
2. Press **Edit**.
3. Highlight one of the available values that you want to monitor (level, distance, ullage, amplitude, electronics temperature, terminal voltage, GPC dynamic factor) and press **OK**.

NOTICE

As amplitude, electronics temperature, terminal voltage and GPC dynamic factor) are not directly related to level measurement, they are not available as a primary value.

Activating Multidrop Mode

In multidrop mode, the analog loop current is fixed at 4 mA, and it is possible to have more than one instrument on a signal loop. Each instrument must have a unique address.

To make your instrument available on a network, you need to activate the multidrop mode.

1 Select **Communication** > **Multidrop Mode**.

2 Press **Edit**.

3 Highlight **On** and press **OK**. Your instrument will now be able to appear on a network once you set the instrument address.

Setting Devices Address

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

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

2 Press **Edit**.

3 Set an address between 0 and 63 and press **OK**. Your instrument should now appear on a network if you have activated the multidrop mode.

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

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 53 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 diagnostics 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 2 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.

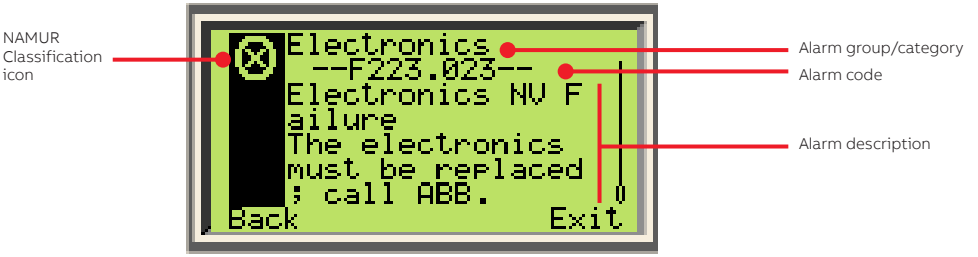
To do so:

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

2 Highlight and select **Diagnostics**.

In the error description, the error number is displayed on the second line (e.g. **––F223.023––**). For more information on event messages, see “Event Codes and Recommendations” on page 82.

Figure 54 The Diagnostic Operator Screen



Browsing the Diagnostics History

To browse through the diagnostics history:

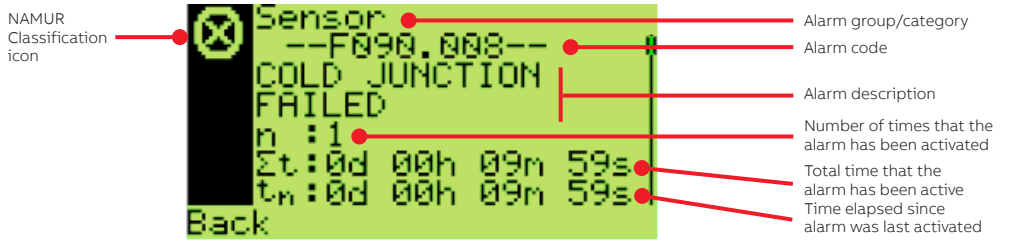
1 From the **Diagnostics** menu, select **Diagnostic History**.

Figure 55 The Diagnostics Menu



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

Figure 56 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.

Masking Classes of Events

Instrument event codes are recorded according to the NAMUR classification (see Table 3 on page 82). 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 Highlight the class of events that you want to mask (**Failures cannot be masked**):
- **Maintenance Required**
- **Check Function**
- **Off Specification**
- **Info/None**

3 Press **Edit**.

4 Highlight **Enable** for the selected class of events and press **OK**.

This class of events 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 **Disable** instead of **Enable** at the end.

Event Codes and Recommendations

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

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

Table 3 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	Surface has lost surface echo	Check installation and parameter adjustments.
S088.003	No interface detected	Check process conditions and device config.
S085.004	Emulsion has been detected	Check installation and process conditions.
F234.005	Electronic failure or harsh env	Check installation - Vibrations or EMC interf.
S087.007	Lower Measurement Accuracy	Lower accuracy du to environmental conditions
F200.010	PV value out of range	Check process conditions and device config.
C153.011	Device In Initialization	Wait for initialization to finish (GPC and algo)
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
F202.019	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
F201.026	Surface inside safety distance	Check process conditions and/or device config.
M030.031	Maintenance required	Verify sensor functionality, clear diagn. Mess.
M010.032	Supply voltage error	Verify P.S. voltage is >15.5 V DC and <42 V DC.
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
C152.038	Current output in fixed mode	Output current in fixed mode-multidrop or simul.
F224.039	Primary current uncertain	4-20 mA D/A trim should be performed
F221.040	Electronics Board ROM failure	Restart sensor. If condition persists, call ABB

No.	Event message	Recommended action
F220.041	Electronics Board RAM failure	Restart sensor. If condition persists, call ABB
M012.042	NV replace error.	Restart sensor. If condition persists, call ABB
S084.043	Current output saturated	Check process conditions and/or device config.
F222.044	Current output ReadBack error	4-20 mA D/A trim should be performed
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.

NOTICE

Regardless of the success or failure of the recommended action, you can always contact ABB service representatives if a problem occurs.

Diagnosing From a Waveform

Most echo-related problems, as listed in Table 3, can also be diagnosed with the help of the integrated waveform display. Waveform management is performed from the **Diagnostics** menu.

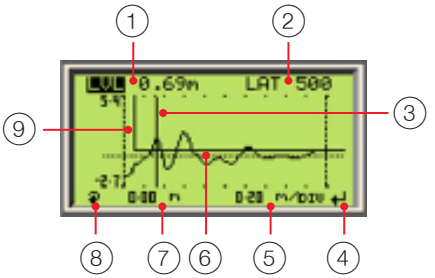
Figure 57 Accessing the Waveform Display



Introducing the Waveform Display

The waveform display illustrates the signal traveling along the probe.

Figure 58 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 E” on page E107 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 (in 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:

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 55.



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 review using DTM/FIM 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 three standard simulations all performed in a similar way (distance, level, ullage). There are also current simulations. All are explained below.

Figure 59 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, flow, volume, 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 DTM/FDI interface or HART terminal.

Performing Current Simulations

To perform a current simulation

1 Select **Diagnostics** > **Simulation** > **Current Simulation**.

2 Press **Edit**.

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

The instrument sends the set current on the network and the value set should appear as a reading on a DTM/FDI interface or HART terminal.

Entering a current of 0.00 mA means that no simulation will be performed.

Obtaining Device Status Data

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

Terminal Voltage

To confirm the actual terminal voltage:

1 Select **Diagnostics** > **Device Status**> **Terminal Voltage** > **Terminal Voltage**.
The terminal voltage is indicated.

2 Press **Back** to return to the **Device Status** menu.

Minimum/maximum terminal voltage recorded

To obtain the minimum and maximum terminal voltages recorded:

1 Select **Diagnostics** > **Device Status**> **Terminal Voltage** > **Min Terminal Voltage** or **Max Terminal Voltage**.
The minimum or maximum terminal voltage recorded is indicated.

2 Press **Back** to return to the **Device Status** menu.

Resetting the minimum/maximum terminal voltage recorded

To reset the minimum and maximum terminal voltages recorded:

1 Select **Diagnostics** > **Device Status**> **Terminal Voltage** > **Reset Min/Max**.

2 Press **OK** to reset the values.

3 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 Self-Tests

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**).

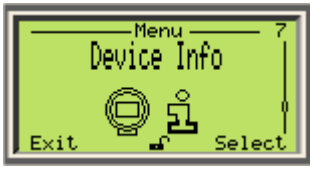
If the result is **Not Ok**, other errors have most likely happened and you should investigate the diagnostics history more carefully.

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.

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 60 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

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APPENDIX A

Specifications

For instrument specifications, refer to the instrument datasheet.

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APPENDIX B

HMI Menu Tree

The following pages provide an overview of the various menu items accessible through the instrument human-machine interface (HMI).

First-level Menu

Menu item	Details	Main chapters
Access Level	page B93	
Easy Setup	page B94	
Device Setup	page B94	
Display	page B95	
Process Alarm	page B96	
Calibrate	page B96	
Diagnostics	page B97	
Device Info	page B98	
Communication	page B98	
Waveform	page B99	

Access Level Menu

Item
Logout
Read Only
Standard
Advanced
Service (if authorized)

Easy Setup Menu

Item
Language
Application Category
Set PV (4-20mA)
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
PV Setup	Set PV (4-20mA)	
	PV Unit	
	Link 4-20mA to Z/S	
	4mA (LRV) (if unlinked)	
	20mA (URV) (if unlinked)	
Sensor Setup	Length unit	
	Measurement Mode	
	Application Category	
	Gas Phase comp.	GPC Mode
		GPC Marker Distance
		GPC Static Factor
	Upper Media DC	
	Static Overflow	Static Overflow Mode
		Overflow Distance
	Reset Tracking	
	Algo Parameters	Level Amp. Threshold
		Int. Amp. Threshold
		Interface lost period
		Min echo displacement
		Max displacement jump

Item	Submenus	
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	
Safety Settings	Blocking Distance	
	Safety Distance	
	Safety Dist. Reaction	
	Echo Lost Period	
	Echo Lost Reaction	
	Echo Lost Value	
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 > User Default	
	Global Factory Reset	

Display Menu

Item	Submenus
Language	
Contrast	
Operator pages	Operator page 1

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

Process Alarm Menu

Item	Submenus
Alarm Source	
Failure Mode	
Low Alarm current	
High Alarm current	
Alarm Delay	
Saturation Limits	Low Saturation
	High Saturation

Calibrate Menu

Item	Submenus
Level Calibration	↓Empty/Zero
	↑Full/Span
	Level Offset
	Sensor Offset
	4mA (LRV) (if unlinked)
	20mA (URV) (if unlinked)
4-20mA D/A Trim	4 mA Trim
	20 mA Trim
	Reset D/A Trim
	Current Simulation
Distance Calibration	Distance Offset Calib
	Distance Slope Calib

Diagnostics Menu

Item	Submenus	
Waveform	At Sensor Ref Point	
	At Level	
	At Interface	
	At Distance	
	At End of Probe	
	Record Waveform	
	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 Reqired	
	Check Function	
	Off Specification	
	Info/None	
Simulation	Distance Sim	
	Level Sim	
	Ullage Sim	
	Volume Sim	
	Flow Sim	
	Current simulation	
Device Status	Probe Length Status	
	Terminal Voltage	Terminal Voltage
		Min Terminal Voltage
		Max Terminal Voltage
		Reset Min/Max
	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 Modify Date
Address
City
Phone Number
Software Revision
Hardware Revision

Communication Menu

Item	Submenus
Dynamic Variables	Set SV
	Set TV
	Set QV
Multidrop Mode	
Devices Address	
Tag	
Message	
Last Command	
Device ID	
Manufacturer ID	
Device Type	
Descriptor	
Device Revision	
Hart Revision	

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

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APPENDIX C

Gas Phase Compensation Static Factors

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

Dielectric Constant of Steam

Temperature		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	Temperature		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
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

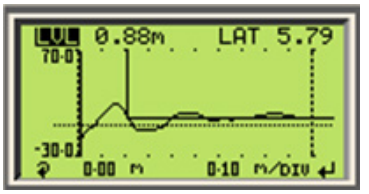
APPENDIX E

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 %.

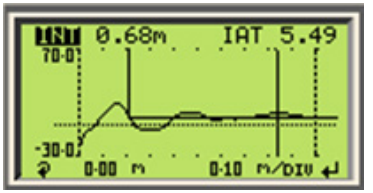
In the following figure, the **Level Amp. Threshold** (LAT) parameter has been set to 5.79 %. An echo needs to have an amplitude equal to or higher than this value to be considered a valid level echo.

Figure 61 Level Amp. Threshold (LAT)



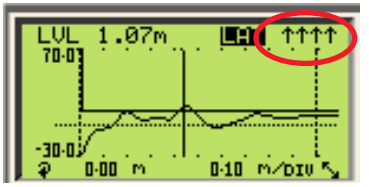
In the following figure (same waveform), the **Int. Amp. Threshold** (IAT) parameter has been set to 5.49%. An echo needs to have an amplitude equal to or higher than this value to be considered a valid interface echo.

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

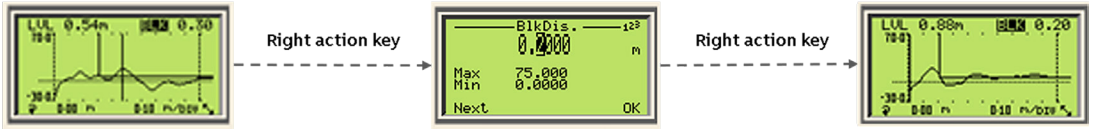
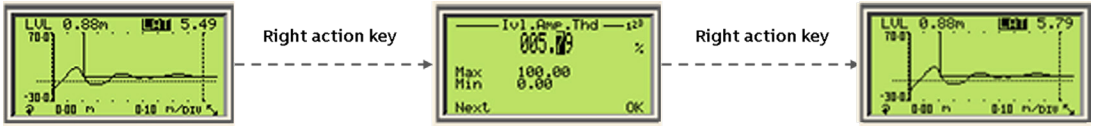


Figure 65 Level Amplitude Threshold Modification



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