USER MANUAL
RADAR LEVEL TRANSMITTER
SP-10

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Symbol used

Symbol	Opis
	**Warning** to proceed strictly in accordance with the information contained in the documentation in order to ensure the safety and full functionality of the device.
	Information particularly useful during installation and operation of the device.
	Information on disposal of used equipment.

Warning: Read this manual before working with the product. For personal and system safety and for optimum product performance, ensure that you thoroughly understand the contents before installing, using, or maintaining this product.

 **Failure to follow safe installation and servicing guidelines could result in serious injury.**

Ensure the transmitter is installed by qualified personnel and in accordance with applicable code of practice.

Inspection and maintenance of this equipment shall be carried out by suitably trained personnel, in accordance with the applicable standards and code of practice. Use the equipment only as specified in this manual. Failure to do so may impair the protection provided by the equipment.

Repair, e.g. substitution of components, etc. may jeopardize safety and is under no circumstances allowed.

 **Process leaks could result in serious injury.**

Handle the transmitter carefully.

Install and tighten process connectors before applying pressure.

Do not attempt to loosen or remove process connectors while the transmitter is in service.

 **Physical access.**

Unauthorized personnel may potentially cause significant damage to and/or misconfiguration of end users' equipment. This could be intentional or unintentional and needs to be protected against.

Physical security is an important part of any security program and fundamental in protecting your system. Restrict physical access by unauthorized personnel to protect end users' assets. This is true for all systems used within thefacility.

 **Hot surfaces.**

The transmitter and process seal may be hot at high process temperatures. Allow to cool before servicing.

Contents

List of figures

List of tables

1. Introduction

1.1 Using this manual.

The sections in this manual provide information on installing, operating, and maintaining the Radar Level Transmitter SP-10. The sections are organized as follows:

Transmitter overview provides an introduction to theory of operation, a description of the transmitter, information on typical applications, and process characteristics.

Mechanical installation contains mechanical installation instructions.

Electrical installation contains electrical installation instructions.

Configuration provides instructions on configuration of the transmitter.

Operation and maintenance contains operation and maintenance techniques.

Service and troubleshooting provides troubleshooting techniques for the most common operating problems.

Specifications and reference data supplies reference and specification data.

Configuration parameters provides extended information about the configuration parameters.

1.2 Product certifications

See the Radar Level Transmitter SP-10 Product Certifications document for detailed information on the existing approvals and certifications.

1.3 Open source licenses

This device uses open source software. Further information can be found in the License Information document available at Aplisens.com

1.4 Product recycling / disposal

Recycling of equipment and packaging should be taken into consideration and disposed of in accordance with local and national legislation or regulations.

2. Transmitter overview.

2.1 Measurement principle

The Radar Flow Transmitter is a device for continuous level measurements using fast-sweep Frequency Modulated Continuous Wave (FMCW) technology.

The device continuously emits signal sweeps with a constantly varying frequency towards the product surface. Since the device continuously changes the frequency of the transmitted signal, there will be a difference in frequency between the transmitted and the reflected signals (see Figure 2-1).

The frequency of the reflected signal is subtracted from the frequency of the signal transmitted at that moment, resulting in a low frequency signal which is proportional to the distance to the product surface. This signal is further processed to obtain fast, reliable, and highly accurate level measurements.

Δf ~ d = distans

A. Frequency (GHz)
B. Time (s)
C. Transmitted signal
D. Reflected signal

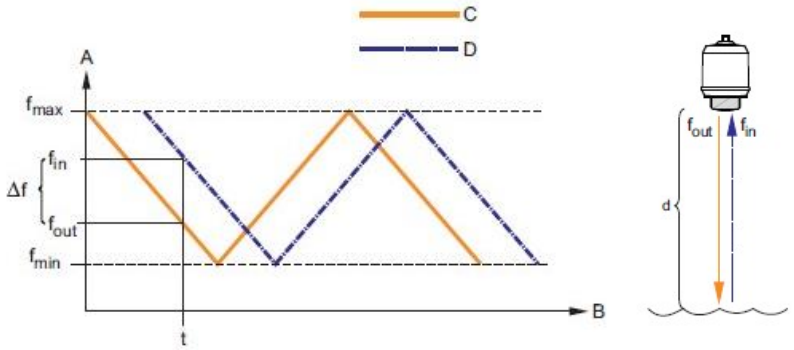


Figure. 2.1 FMCW method.

2.1.1 Volume flow measurement

The Radar Level Transmitter can calculate the volume flow rate in an open channel.

2.2 Process characteristics.

2.2.1 Dielectric constant.

A key parameter for measurement performance is reflectivity. A high dielectric constant of the medium provides better reflection and enables a longer measuring range.

2.2.2 Foam and turbulance.

Foaming liquids or turbulence may cause weak and varying surface echo amplitudes. Surface turbulence is not normally a problem unless it is excessive.

Measurement in foamy applications depends largely on the foam properties. When the foam is light and airy, the actual product level is measured.

2.3 Vessel characteristics.

2.3.1 In-tank obstructions.

The device should be mounted so that objects such as heating coils, ladders, and agitators are not within the radar beam. These objects may cause false echoes resulting in reduced measurement performance. However, the device has built-in functions designed to reduce the influence from disturbing objects where such objects cannot be totally avoided. Vertical and inclined structures cause minimal effect since the radar signal is scattered rather than directed back to the antenna.

2.4 Non-contacting radar technology.

Non-contacting radar technology is ideal for a wide range of applications as it is maintenance-free, has a top-down installation that reduces the risk of leakages, and is unaffected by process conditions such as density, viscosity, temperature, pressure, and pH.

The Radar Level Transmitter uses Frequency Modulated Continuous Wave (FMCW) technology and smart algorithms to maximize measurement accuracy and reliability, even in small tanks and challenging fast-filling vessels.

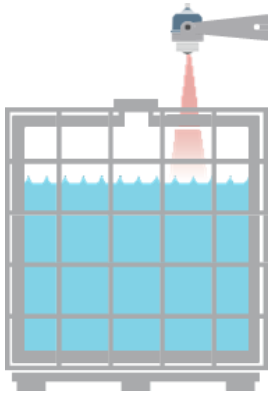
2.4.1 Application examles.

Storage tanks.

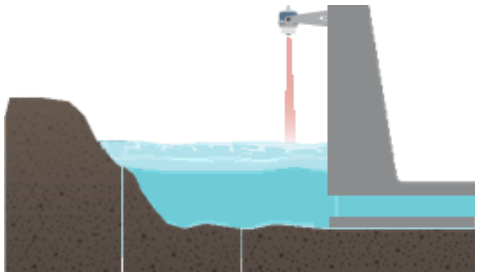
Gain insights into your tank and ensure production runs smoothly without interruption.

Plastic tanks.

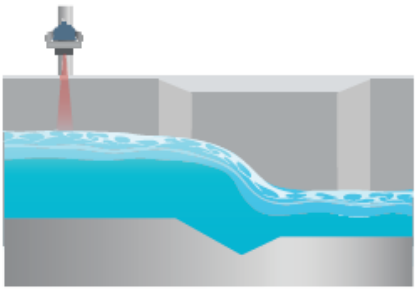
Monitor the inventory of your small and medium sized plastic tanks by measuring through the plastic roof.



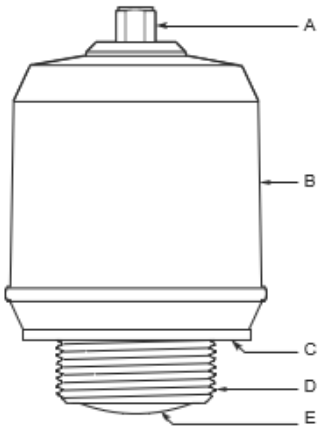
Open air applications.
Get reliable level measurements of sumps or ponds, regardless of challenging surface and weather conditions.



Open channel flow
Use the Radar Level Transmitter SP-10 for volume flow measurement of water and wastewater in open channels



2.5 Components of the transmitter.



A. M12 male connector (A-coded)
B. Transmitter housing
C. Gasket for G threaded version
D. G1 ½ - in - ISO 228/1
E. Antenna

Figure 2.2 Components.

3. Mechanical installation.

3.1 Safety messages.

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Do not attempt to loosen or remove process connectors while the transmitter is in service.

3.2 Installation considerations

Before installing the device, follow recommendations for mounting position, sufficient free space, nozzle requirements, etc.

3.2.1 Mounting position.

When finding an appropriate location on the tank for the device, the conditions of the tank must be carefully considered.

Consider the following guidelines when mounting the device:

- For optimal performance, the device should be installed in locations with a clear and unobstructed view of the product surface.
- The device should be mounted with as few internal structures as possible within the radar beam.
- Do not mount close to or above the inlet stream.
- Do not mount the device on a manway cover.
- Do not position the device directly over a side manway door.
- Multiple SP-10 devices can be used in the same tank without interfering with each other.

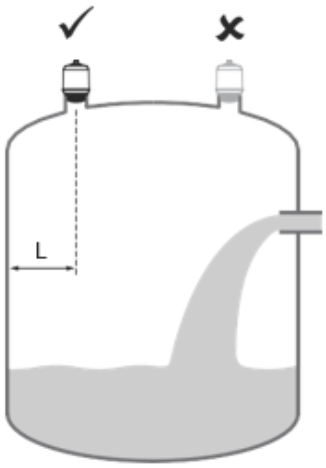


Figure 3.1 Recommended Mounting Position

3.2.2 Free space reguirements.

If the device is mounted close to a wall or other tank obstruction such as heating coils and ladders, noise might appear in the measurement signal. See Table 3-1 for recommended clearance.

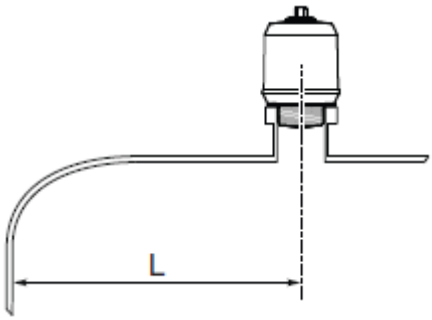


Figure 3.2 Free space requirements

Minimum	Recommended
8 in. (200 mm)	½ of tank radius

Table 3.1 Distance to tank wall (L)

3.2.3 Inclination.

The device should be mounted vertically to ensure a good echo from the product surface.
See Figure 3-3 for recommended maximum inclination.

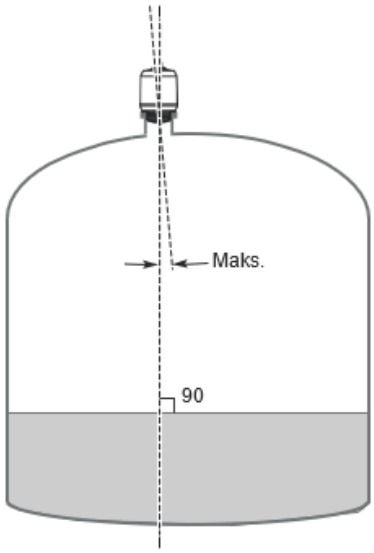


Figure 3.3 Inclination

3.2.4 Non-metallic tanks.

Nearby objects outside the tank may cause disturbing radar echoes. Wherever possible, the device should be positioned so that objects close to the tank are kept outside the radar beam.

3.2.5 Beam angle and beam width.

The device should be mounted with as few internal structures as possible within the radar beam.

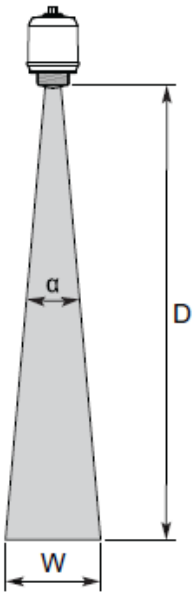


Figure 3.4 Beam angle and beam width

Beam angle (α)

8°

Beam width

See Table 3-2 for beam width at different distances.

Distance (D)	Beam width (W)
6.6 ft. (2 m)	0.9 ft. (0.3 m)
13.1 ft. (4 m)	1.8 ft. (0.6 m)
19.7 ft. (6 m)	2.8 ft. (0.8 m)
26.2 ft. (8 m)	3.7 ft. (1.1 m)
32.8 ft. (10 m)	4.6 ft. (1.4 m)
49.2 ft. (15 m)	6.9 ft. (2.1 m)

Table 3.2 Beam width

3.2.6 Nozzle requirements.

See Table 3-3 for recommended nozzle dimensions. The inside of the nozzle must be smooth (i.e. avoid bad welding, rust, or deposit).

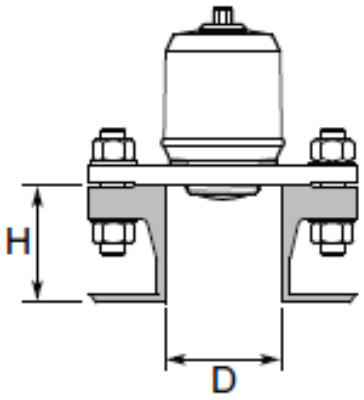


Figure 3.5 Mounting in nozzles

Nozzle diameter (D)	Maximum nozzle height (H)
1.5 in. (40 mm)	5.9 in. (150 mm)
2 in. (50 mm)	7.9 in. (200 mm)
3 in. (80 mm)	11.8 in. (300 mm)
4 in. (100 mm)	15.8 in. (400 mm)
6 in. (150 mm)	23.6 in. (600 mm)

Table 3.3 Nozzle requirements

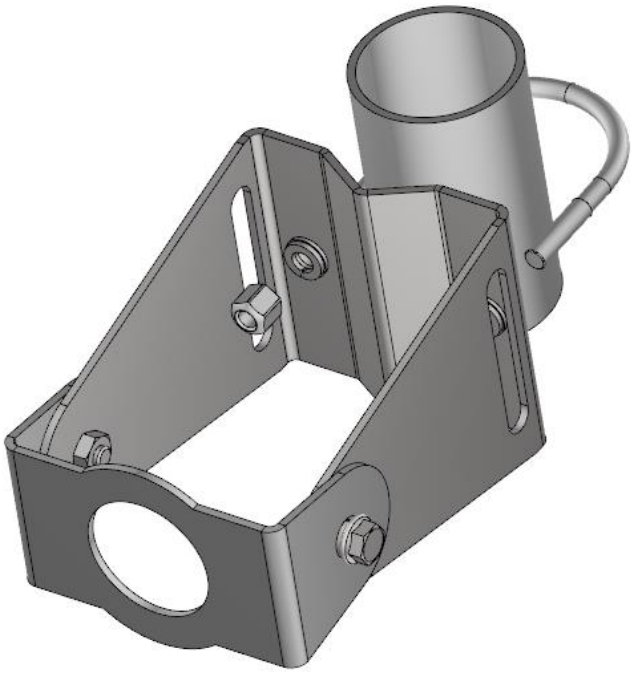
3.3 Bracket mounting

3.3.1 Mount the standard bracket

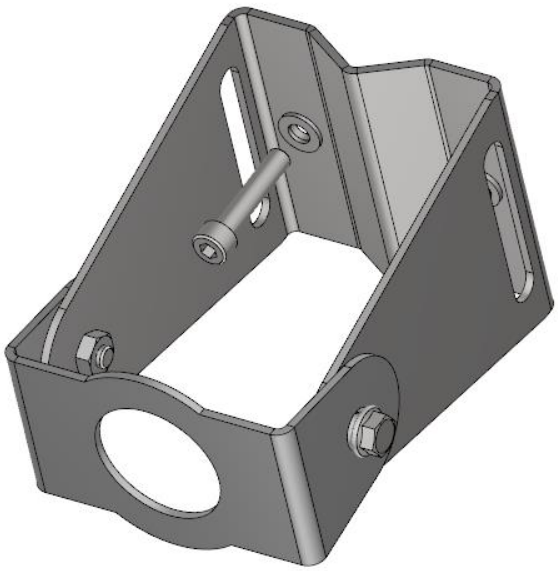
Procedure

1. Mount the bracket on the pipe/ceiling/wall.

On pipe:



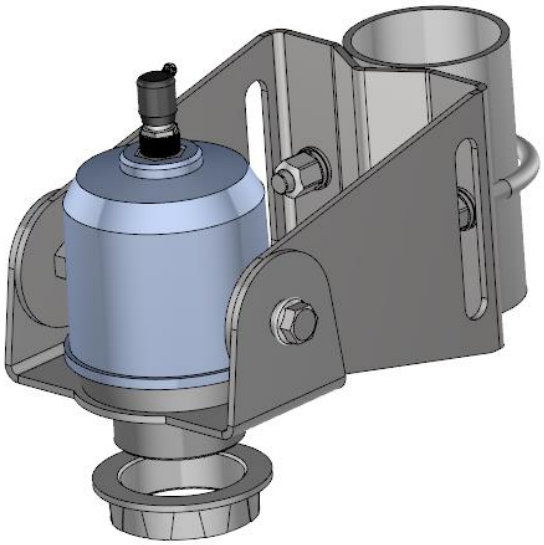
On wall:



2. Ensure the adjustable holder is directed toward the ground.
3. Install and hand tighten the transmitter.

   Note

   Each transmitter is shipped with a counter nut (also available as accessory).



Related information

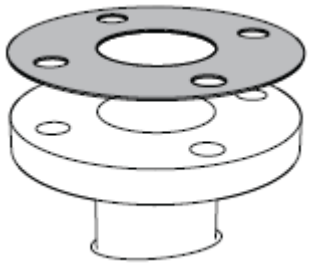
Bracket hole pattern

3.4 Installing on the tank

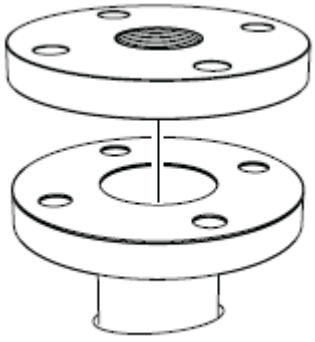
3.4.1 Mount the flange

Procedure

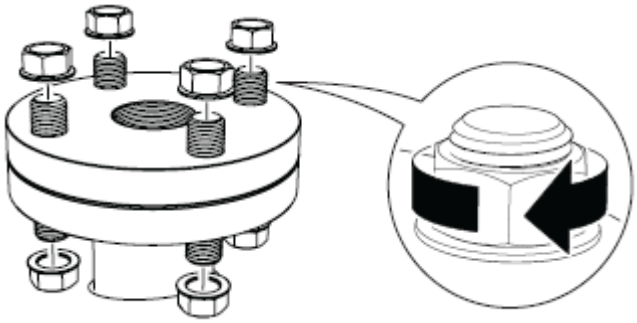
1. Place a suitable gasket on the tank flange.



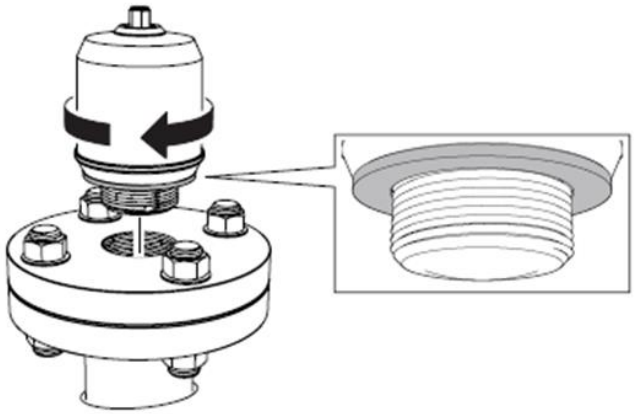
2. Place the flange over the gasket.



3. Tighten the bolts and nuts with sufficient torque for the flange and gasket choise.



4. Apply appropriate thread sealant to the transmitter threads.



5. Install and hand tighten the transmitter.

Note

The gasket is necessary for the G threaded version only.

4. Electrical installation.

4.1 Safety messages

WARNING

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WARNING

Process leaks could result in serious injury.

Handle the transmitter carefully.

Install and tighten process connectors before applying pressure.

Do not attempt to loosen or remove process connectors while the transmitter is in service.

4.2 Prepare the electrical connections

4.2.1 Connector type

M12 male (A-coded)

4.2.2 Power supply

The transmitter operates on 18-30 V DC at the transmitter terminals.

4.2.3 Outputs

The transmitter provides two configurable outputs:

Output 1 Digital output

Output 2 Digital output or active 4-20 mA analog output

4.2.4 Internal power consumption

< 2 W (normal operation at 24 V DC, no outputs)

< 3.6 W (normal operation at 24 V DC, digital and analog outputs active)

4.2.5 Wiring diagram

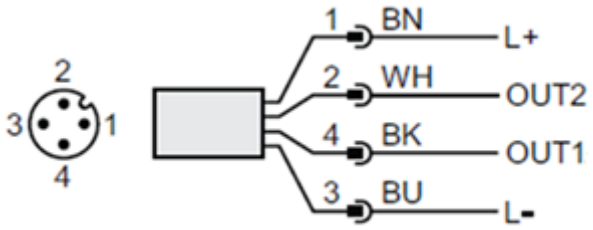
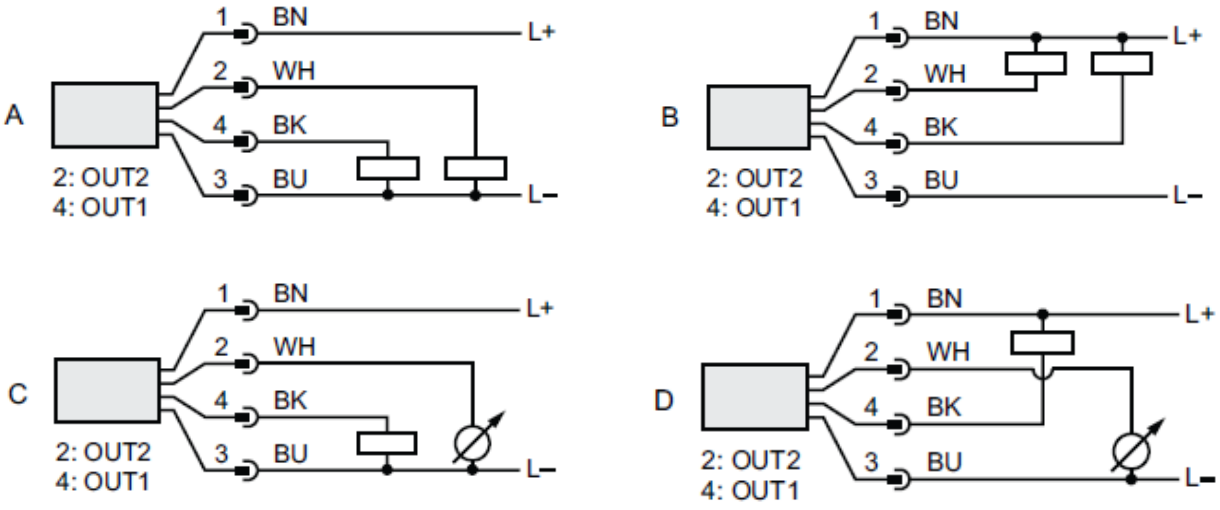


Figure 4.1 Connection

Pin	Wire color(1)		Signal	
1	BN	Brown	L+	24 V
2	WH	White	OUT2	Digital output or active 4-20 mA analog output
3	BU	Blue	L-	0 V
4	BK	Black	OUT1	Digital output

Table 4.1 Pin assignment. (1) According to IEC 60947-5-2



A. 2x Digital output PnP
B. 2x Digital output NpN
C. 1x Digital output Pnp / 1x Analog output
D. 1x Digital output Npn / 1x Analog output

Figure 4.2 Example circuits

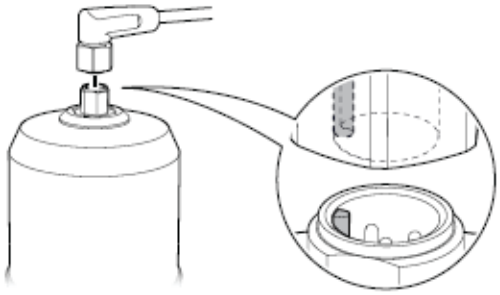
4.3 Power up transmitter

Procedure

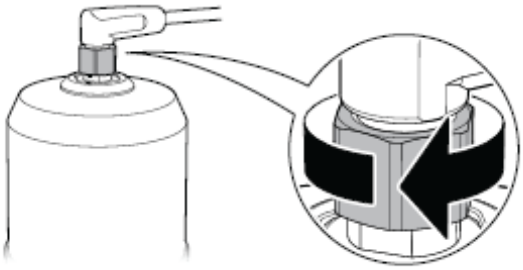
3. Verify the power supply is disconnected.
4. Insert the M12 connector gently.

Note:

Do not force the connector into place. Check that it is aligned properly.



5. Once fully inserted, turn the screw ring until tight.
   See the manufacturer`s instruction manual for recommended torque.



6. Connect the power supply.

5. Configuration

5.1 Safety messages

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5.2 Overview

This chapter provides information about configuration and configuration tools. Appendix Configuration parameters provides extended information about the configuration parameters.

5.3 Get started with configuration tool

5.3.1 Wireless configuration via Bluetooth® technology

Download AMS Device Configurator

Procedure

Download and install the mobile or desktop version.

Software available on **Google Play.**

Configure via Bluetooth® wireless technology

Prerequisites

Bluetooth connectivity is available for devices with option code BLE.

Procedure

1. Start AMS Device Configurator.
   The ***Communication Type*** dialog opens on the desktop version.
2. If using the desktop version, select Bluetooth as the communication type.
   This can also be changed from the Settings menu.
3. Click on the device you want to connect to.
4. On first connection, enter the key for this device.
5. If using the mobile version, select the menu icon at the top left to navigate the desired device menu.

Bluetooth® UID and key

You can find the UID and key on the paper tag attached to the device.

Note:

Keep the paper tag in a safe place as it cannot be retrieved if lost.

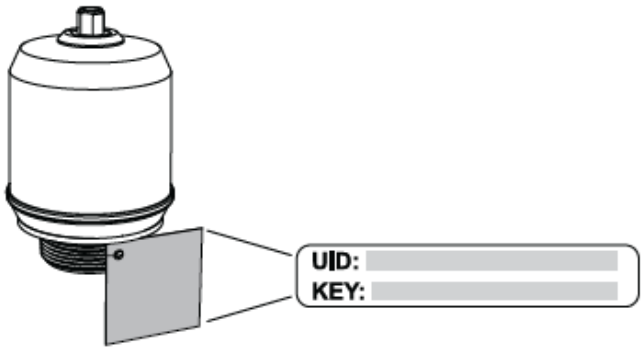


Figure 5.4 Bluetooth® Security Information

Turn off Bluetooth® wireless technology

The Bluetooth functionality is enabled by default. If you are not using this wireless capability, it is recommended to disable it using a standard device configuration tool.

Procedure

1. Under Menu, select Parameter → Bluetooth Configuration.
2. In the Bluetooth Radio list, select Disable.
3. Select Write to device.

5.4 Perform the basic setup

5.4.1 Set the engineering units

Procedure

1. Under Menu, select Parameter → Basic Setup.
2. In the Engineering Units list, select Metric or Imperial.
3. Select Write to device.

5.4.2 Enter the reference height

Procedure

1. Under Menu, select Parameter → Basic Setup.
2. Enter the Reference Height.
3. Select Write to device.

5.4.3 Configure the analog output

The transmitter can be set to output the level or volume flow as a 4-20 mA signal.

Procedure

1. Under ***Menu***, select Parameter → OUT2 Analog Output.
2. In the ***OUT2 Configuration*** list, select Analog Output 4-20 mA.
3. In the ***Analog Control Variable*** list, select Level or Volume Flow.
4. In the ***Alarm Mode*** list, select Low Alarm or High Alarm.
5. Select Analog Range Values, and then enter the desired Upper Range Value (20 mA)
1. and Lower Range Value (4 mA).
6. Select Write to device.

5.4.4 Configure the analog output

The transmitter can be set to output a switching signal for high and low limits (using the same pin).

Procedure

1. Under ***Menu***, select Parameter → Basic Setup.
2. In the ***Digital Outputs P-n*** list, select PnP or nPn.
3. Select OUT1 Digital Output or OUT2 Digital Output.
4. In the ***OUT1 Configuration*** or ***OUT2 Configuration*** list, select Digital Output Normally Open.
5. In the ***DO Control Variable*** list, select Level or Volume Flow.
6. Select Set Point Configuration, and then set the alarm parameters as desired.
7. Select Write to device.

5.4.5 Set up the volume flow measurement

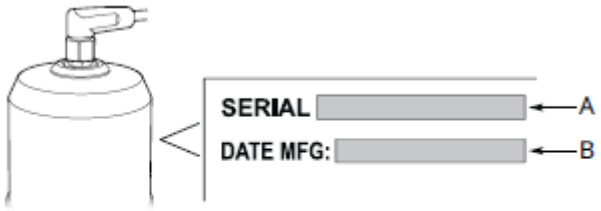
Procedure

1. Under *Menu*, select Parameter → Volume Flow.
2. In the *Volume Flow Calculation Method* list, select the preferred method. Choose from:
   - Linearization table
   - Parshall flume
   - Khafagi-Venturi flume
3. Select Volume Flow Table/Formula, and then set the parameters as desired.
4. Select Write to device.

5.5 Advanced setup

5.5.1 Change the sweep mode

Contact your local Aplisens representative for further instructions. You need to provide the manufacturing date and serial number.



A. Serial number
B. Manufacturing date

Figure 5.5 Main Label

6. Service and troubleshooting

6.1 Safety messages

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6.2 Diagnostic messages

6.2.1 Device hardware fault

Alarm classification

Event	Device hardware fault – Device exchange
Device status	Failure
Class	Error

Possible cause

An electronics error has occurred.

Recommended actions

1. Restart the device.
2. If the condition persists, replace the device.

Related information:

Perform a device reset

6.2.2 Device software fault

Alarm classification

Event	Device software fault – Check firmware revision
Device status	Failure
Class	Error

Possible cause

The software has detected an internal error.

Recommended actions

1. Restart the device.
2. Restore default settings and reconfigure the device.
3. If the condition persists, replace the device.

Related information:

Perform a device reset

Restore to factory settings

6.2.3 General power supply fault fault

Alarm classification

Event	General power supply fault – Check availability
Device status	Failure
Class	Error

Possible cause

Power supply drops below 18 V DC during transmitter start-up.

Recommended actions

Verify voltage is 18-30 V DC at the transmitter terminal.

6.2.4 Parameter error

Alarm classification

Event	Parameter error – Check data sheet and values
Device status	Failure
Class	Error

Possible cause

The device has detected a configuration error.

Recommended actions

1. If analog output is used, check Upper and Lower Range Values.
2. If digital output is used, check High and Low Alarm Set Points.
3. If volume flow table is used, check that the Level points are entered in increasing order.
4. If condition persists, restore default settings and reconfigure the device.

Related information:

Upper/lower range value

Alarm set points

Volume flow table

Restore to factory settings

6.2.5 Device memory failure

Alarm classification

Event	Device memory failure – Restore default settings
Device status	Failure
Class	Error

Possible cause

Configuration data has been corrupted, for example, due to a power loss during writing.

Recommended actions

1. Restore default settings, restart device, and reconfigure the device.
2. If the condition persists, replace the device.

Related information

Restore to factory settings

Perform a device reset

6.2.6 Simulation active

Alarm classification

Event	Simulation active – Check operational mode
Device status	Functional check
Class	Warning

Possible cause

The device is in simulation mode and is not reporting actual information.

Recommended actions

1. If this behavior is not desired, stop simulation mode.
2. If the condition persists, restart the device.

Related information

Use the simulation mode

Perform a device reset

6.2.7 Bluetooh® warning

Alarm classification

Event	Bluetooth warning – Restart the device
Device status	Functional check
Class	Warning

Possible cause

A Bluetooth error has been detected. Reasons may be multiple:

Function limited	Device is unable to send device data over Bluetooth due to an internal error.
Electronics error	Device internal diagnostics detected a Bluetooth electronics error.
Firmware warning	Bluetooth firmware is out of date.

Recommended actions

1. Under *Menu*, select Diagnosis → Bluetooth Information → Bluetooth Diagnostic for more information.
2. Restart the device.
3. If the condition persist, disable Bluetooth or replace the device.

Related information

Perform a device reset

Turn off Bluetooth wireless technology

6.2.8 Level measurement lost

Alarm classification

Event	Level measurement lost – Check application
Device status	Failure
Class	Error

Possible cause

No valid level reading. Reasons may be multiple:

- No valid surface echo peak in the measuring range
- Incorrect device configuration

Recommended actions

1. Analyse the Echo Peaks and check device configuration, especially General Threshold.
2. Check device physical installation (for instance antenna contamination).
3. Consider increasing Measurement Recovery Time parameter for intermittent conditions.
4. Restore default settings, restart device, and reconfigure the device.
5. If the condition persists, replace the device.

Related information

Analyze the echo peaks

Adjust the general threshold

Measurement recovery time

Restore to factory settings

Perform a device reset

6.2.9 Device temperature over-run

Alarm classification

Event	Device temperature over-run – Insulate device
Device status	Out of specification
Class	Warning

Possible cause

The electronics temperature is outside the operating range.

Recommended actions

1. Verify ambient temperature is within the operating range.
2. Clear source of heat.

Related information

Ambient temperature

6.2.10 Device temperature under-run

Alarm classification

Event	Device temperature under-run – Insulate device
Device status	Out of specification
Class	Warning

Possible cause

The electronics temperature is outside the operating range.

Recommended actions

1. Verify ambient temperature is within the operating range.
2. Insulate device.

Related information

Ambient temperature

6.2.11 Short circuit

Alarm classification

Event	Short circuit – Check installation
Device status	Out of Specification
Class	Error

Possible cause

Short circuit on the digital output.

Recommended actions

Check cable and connections.

6.2.12 Primary supply voltage over-run

Alarm classification

Event	Primary supply voltage over-run – Check tolerance
Device status	Out of specification
Class	Warning

Possible cause

Supply voltage is too high.

Recommended actions

Verify voltage is 18-30 V DC at the transmitter terminal.

6.2.13 Primary supply voltage under-run

Alarm classification

Event	Primary supply voltage under-run – Check tolerance
Device status	Out of specification
Class	Warning

Possible cause

Supply voltage is too low.

Recommended actions

Verify voltage is 18-30 V DC at the transmitter terminal.

6.2.14 Maintenance required

Alarm classification

Event	Maintenance required - Cleaning
Device status	Maintenance required
Class	Notification

Possible cause

Product build-up on the antenna.

Recommended actions

Clean the antenna.

Use a damp cloth and a mild cleaning agent suitable for the media and wetted parts of the transmitter.

Related information

Material exposed to tank atmosphere

Components of the transmitter

6.2.15 Max EEPROM write cycles expired

Alarm classification

Event	Max EEPROM write cycles expired – Check master and restart the device
Device status	Maintenance required
Class	Warning

Possible cause

Frequent writing of parameters from master to device.

Recommended actions

1. Check the master configuration.
2. Restart the device.
3. If error persists, contact your local Aplisens representative.

Related information

Perform a device reset

6.2.16 Measurement range over-run

Alarm classification

Event	Measurement range over-run – Check application
Device status	Out of Specification
Class	Error

Possible cause

The level measurement is outside the configured range for the volume flow.

Recommended actions

Ensure that level values within operating range are included in the volume flow table.

6.3 Troubleshooting incorrect level readings

6.3.1 Reported level is too high or low

A. Level
B. Time
C. Actual level
D. Reported level

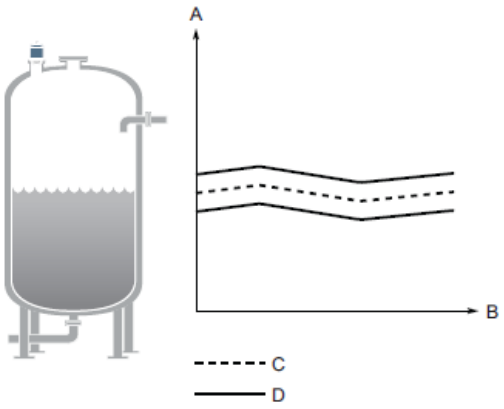


Figure 6.1 Symptom

Possible cause

Incorrect tank geometry configuration.

Recommended actions

- Verify the tank geometry parameters are configured correctly (especially the Reference Height).
- Analyze the Echo Peaks and check General Threshold.
- Restore default settings and reconfigure the device.

Related information

Reference height

Analyze the echo peaks

Adjust the general threshold

Restore to factory settings

6.3.2 Level is stuck in measuring range

A. Level
B. Time
C. Actual level
D. Reported level

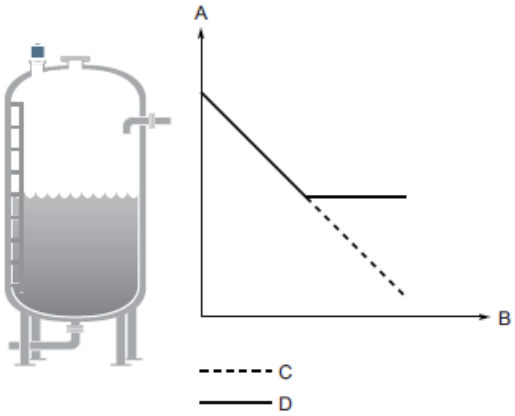


Figure 6.2 Symptom

Possible cause

Disturbing object in the tank.

Recommended actions

- Analyse the Echo Peaks and check General Threshold.
- Remove the disturbing object.
- Put an inclined metal plate on top of the disturbing object.
- Move the device to another position.

Related information

Analyse the echo peaks

Adjust the general threshold

Mounting position

6.3.3 Level is stuck in full tank

A. Level
B. Time
C. Actual level
D. Reported level

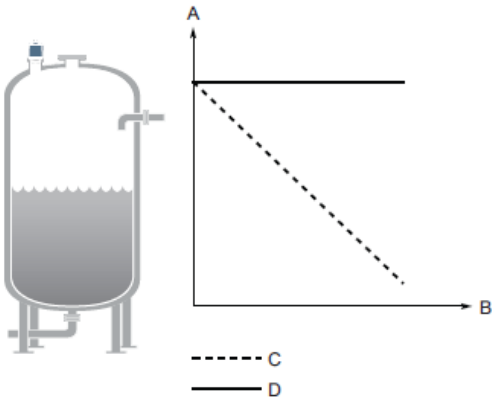


Figure 6.3 Symptom

Possible cause

Disturbing object near the antenna.

Recommended actions

- Analyze the Echo Peaks and check General Threshold.
- Increase the Upper Null Zone.
- Remove the disturbing object.
- Move the device to another position.

Possible cause

Product build-up on the antenna.

Recommended actions

Clean the antenna.

Related information

Analyse the echo peaks

Adjust the general threshold

Change the upper null zone

Mounting position

6.3.4 Level value drops when close to antenna

A. Level
B. Time
C. Actual level
D. Reported level

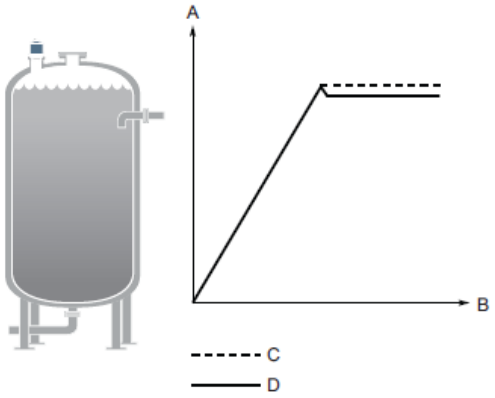


Figure 6.4 Symptom

Possible cause

Product surface is within the Upper Null Zone and a disturbance echo is interpreted as the product surface.

Recommended actions

Check the setting of the Upper Null Zone.

Related information

Change the upper null zone

6.3.5 Measured level fluctuates

A. Level
B. Time
C. Reported level

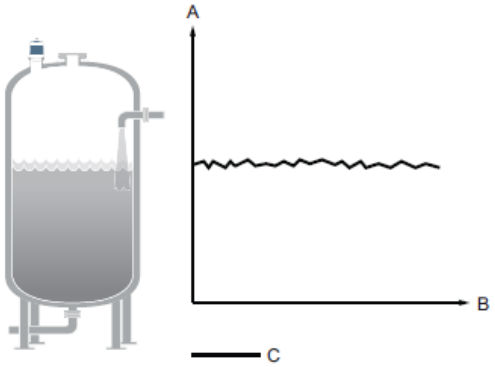


Figure 6.5 Symptom

Possible cause

Excessive foaming or turbulence.

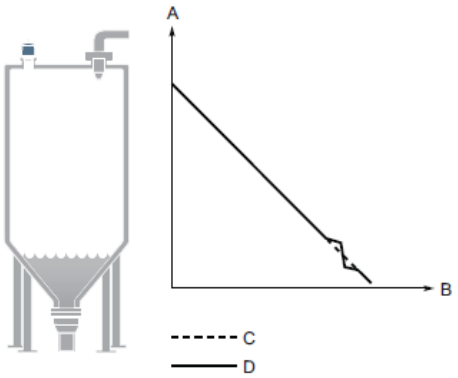
Recommended actions

Under turbulent conditions with low level rates, consider increasing the Damping value.

Related information

Damping value

6.3.6 Measured level is occasionally unstable



A. Level
B. Time
C. Actual level
D. Reported level

Figure 6.6 Symptom

Possible cause

The product surface is close to a suppressed false echo.

Recommended actions

If possible, remove the disturbing object.

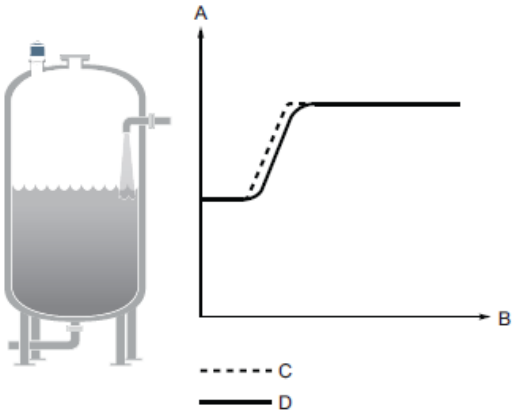
Related information

Analyse the echo peaks

6.3.7 Lagging of measured level

Symptom

Measured level lags during rapid level changes.



A. Level
B. Time
C. Actual level
D. Reported level

Figure 6.7 Symptom

Possible cause

Damping value is set too high.

Recommended actions

If there is a problem with lag during rapid level changes, consider decreasing the Damping value.

Related information

Damping value

6.3.8 Incorrect level at 100% (20 mA)

Symptom

Measured level is correct at 0% (4 mA) but incorrect at 100% (20 mA).

A. Level
B. Time
C. Actual level
D. Reported level

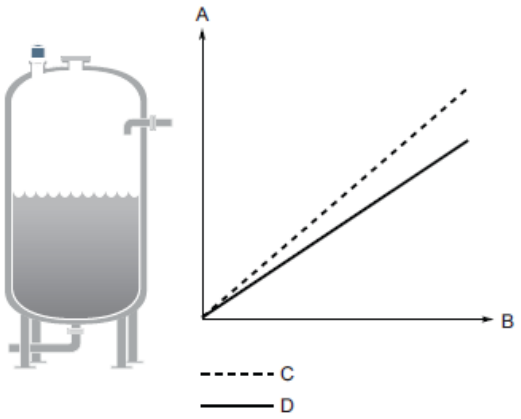


Figure 6.8 Symptom

Possible cause

Upper Range Value is not set correctly.

Recommended actions

Check that the Upper Range Value matches the 100% (20 mA) level in the tank.

Related information

Upper/lower range value

6.3.9 Incorrect level when product surface is above 50 %

Symptom

The reported level is incorrect when the product surface is above the 50% level.

A. Level
B. Time
C. Actual level
D. Reported level

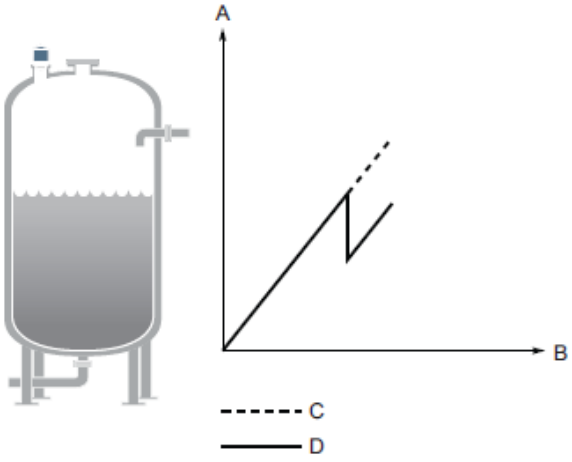


Figure 6.9 Symptom

Possible cause

A strong double bounce echo is interpreted as the product surface.

Recommended actions

Move the device to another position.

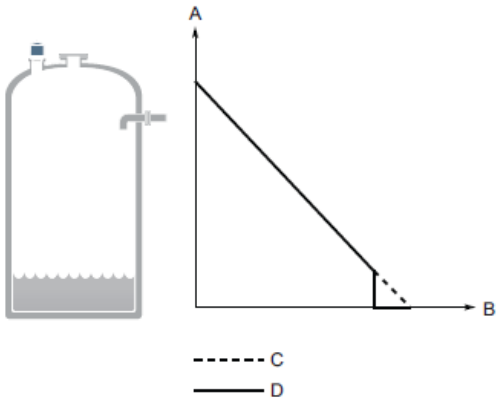
Related information

Mounting position

6.3.10 Dropping of level close to tank bottom

Symptom

Measured value drops to zero level in the tank bottom region.



A. Level
B. Time
C. Actual level
D. Reported level

Figure 6.10 Symptom

Possible cause

Device has locked on a strong tank bottom echo.

Recommended actions

Verify the Reference Height is configured correctly.

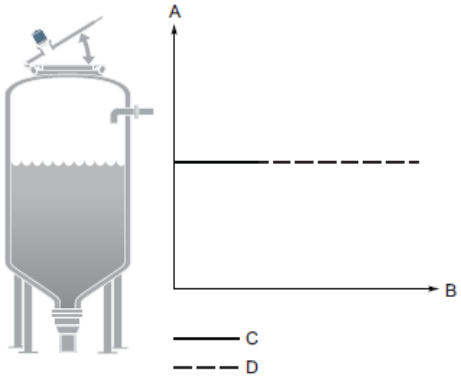
Related information

Reference height

6.3.11 Dropping of level close to tank bottom

Symptom

The device reports "Level measurement lost" when opening/closing the manway cover.



A. Level
B. Time
C. Actual level
D. Level measurement lost

Figure 6.11 Symptom

Possible cause

If mounted on a manway cover, the device may lock on a disturbance echo and report this as surface level when the cover is opened. After closing the cover, the echo is lost and the device reports "Level measurement lost".

Recommended actions

- Before opening the manway cover, disconnect power to the device.
- After closing, restart the device.
- Move the device to another position.

Related information

Perform a device reset

Mounting position

6.3.12 Level measurement is lost in an empty tank

Symptom

The device reports "Level measurement lost" in an empty tank after closing the side manway door.

A. Level
B. Time
C. Actual level
D. Reported level
E. Level measurement lost
F. Manway door open

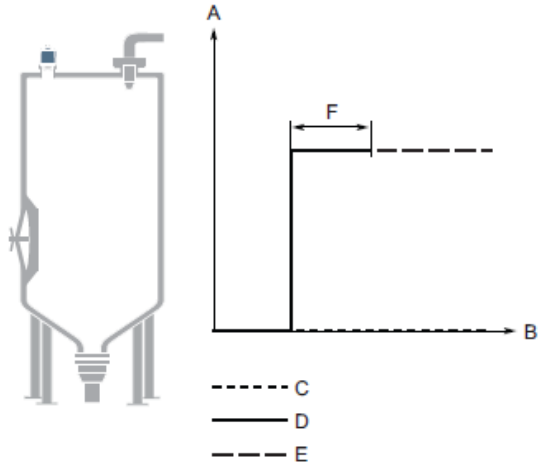


Figure 6.12 Symptom

Possible cause

When the manway door is opened inward, it generates a disturbance echo which is interpreted as the product surface echo. After closing the door, the echo is lost and the device reports "Level measurement lost". The message is cleared when start filling the tank.

Recommended actions

- Before opening the manway door, disconnect power to the device.
- After closing, restart the device.
- Move the device to another position.

Related information

Perform a device reset

Mounting position

6.3.13 Alarm mode close to tank bottom

Symptom

When the product surface is near the sloped tank bottom, the device enters alarm mode.

A. Level
B. Time
C. Actual level
D. Reported level

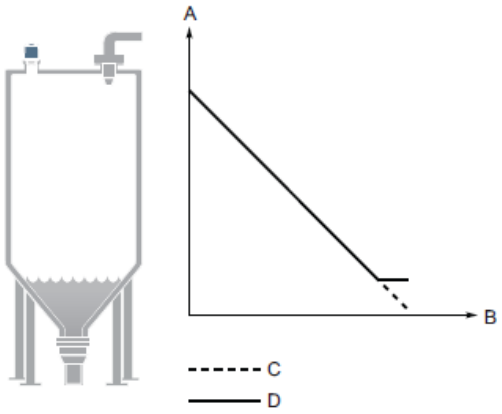


Figure 6.13 Symptom

Possible cause

Reduction of projected surface area close to sloping tank bottom.

Recommended actions

Verify the tank geometry parameters are configured correctly (especially the Reference Height and Bottom Offset).

Related information

Reference height

Bottom offset

6.4 Managing disturbance echoes

There are two general methods for managing disturbance echoes:

- Set general threshold to filter out weak disturbance echoes and noise.
- Increase the Upper Null Zone to block out disturbance echoes at the top of the tank.

6.4.1 Adjust the general threshold

If necessary, the general threshold value can be increased if a disturbance echo is interpreted as the product surface. Alternatively, a lower threshold may be required to handle weak surface echoes (e.g. due to excessive foaming or turbulence).

Prerequisites

The general threshold is set at factory for optimum performance and should not normally need an adjustment.

Before changing the factory default value, study the position and amplitude of the different echo peaks.

Procedure

1. Under *Menu*, select Parameter → Advanced Setup.
2. In the *General Threshold* box, enter the desired value.
3. Select Write to device.

Related information

Analyze the echo peaks

General threshold

6.4.2 Change the upper null zone

The Upper Null Zone defines a zone close to the transmitter where echoes are ignored.

This zone can be extended to block out disturbing echoes at the top of the tank.

Prerequisites

Note:

Make sure the Upper Range Value (100%/20 mA) value is below the Upper Null Zone.

Measurements are not performed within the Upper Null Zone.

Procedure

1. Identify desired Upper Null Zone by analysing the echo peaks.
   - Under ***Menu***, select Diagnosis → Echo Peaks.
   - View the echo peaks to find out if there are disturbing echoes close to tank top.
2. Set the desired Upper Null Zone value.
   - Under ***Menu***, select Parameter → Geometry → Advanced.
   - Enter the desired Upper Null Zone value.
   - Select Write to device.

Related information

Analyse the echo peaks

Upper null zone

6.5 Service and troubleshooting tools

6.5.1 Analyse the echo peaks

Measurement problems can be understood by studying the position and amplitude of the different peaks.

Procedure

Under ***Menu***, select Diagnosis → Echo Peaks.

Echo peaks

See Table 6.1 for a list of possible echo peaks.

Type	Description
Surface	Echo tracked as the current surface echo
Unknown	Echo identified as unknown (can be a surface candidate)
Suppressed	Echoes that are identified but suppressed by the device
Tank bottom echo	Echo considered as an echo from the tank bottom

Table 6.1 Echo peak types

6.5.2 Perform a device reset

The function is used to reset/restart the electronics without re-cycling the power.

Procedure

1. Under ***Menu***, select Parameter → Service Tools → Maintenance.
2. Select Device Reset.

6.5.3 Restore to factory settings

This function restores the transmitter to factory settings (user configuration is overwritten).

Procedure

1. Under ***Menu***, select Parameter → Service Tools → Maintenance.
2. Select Restore Factory Settings.

6.5.4 Reset Bluetooth® security

Procedure

1. Under ***Menu***, select Parameter → Bluetooth Configuration.
2. Select Reset Bluetooth Security.
3. To confirm the reset, reconnect the device to the mobile app using the default key.

6.5.5 Use the simulation mode

It is possible to set the level to a simulated value for testing purposes. The simulated value affects both digital and analog output.

Procedure

1. Under ***Menu***, select Parameter → Service Tools → Simulation.
2. In the ***Simulated Level*** box, enter the desired value. This value will also be used for the volume flow calculation.
3. Select Write to device.
4. Select Start simulation (60 min).

6.5.6 Calibrate analog out

Use this function to calibrate the analog output by comparing the actual output current with the nominal 4 mA and 20 mA currents. Calibration is done at factory and the analog output does not normally need to be recalibrated.

Prerequisites

Connect a calibrated ampere meter to the analog output loop.

Procedure

1. Under ***Menu***, select Parameter → Service Tools → Analog Out Calibration.
2. Perform the calibration of 4 mA.
    - Select Enter 4 mA Fixed Current Mode to set the analog out to 4 mA.
    - Measure the analog output with the ampere meter.
    - In the ***4 mA Measured Current*** box, enter the measured current.
    - Select Write to device.
    - Select Calibrate 4 mA.
    - Measure the analog output with the ampere meter and verify it is within 4±0.01 mA.
3. Perform the calibration of 20 mA.
    - Select Enter 20 mA Fixed Current Mode to set the analog out to 20 mA.
    - Measure the analog output with the ampere meter.
    - In the ***20 mA Measured Current*** box, enter the measured current.
    - Select Write to device.
    - Select Calibrate 20 mA.
    - Measure the analog output with the ampere meter and verify it is within 20±0.01 mA.
4. Select Exit Fixed Current Mode.

6.6 Service support

To expedite the return process, refer to Aplisens.com and contact the nearest Aplisens representative.

CAUTION

Individuals who handle products exposed to a hazardous substance can avoid injury if they are informed of and understand the hazard. Returned products must include a copy of the required Safety Data Sheet (SDS) for each substance.

Aplisens representatives will explain the additional information and procedures necessary to return goods exposed to hazardous substances.

7. Introduction

7.1 Performance specifications

7.1.1 General

Reference conditions

- Measurement target: Stationary metal plate, no disturbing objects
- Temperature: 59 to 77 °F (15 to 25 °C)
- Ambient pressure: 14 to 15 psi (960 to 1060 mbar)
- Relative humidity: 25-75%
- Damping: Default value, 2 s
- Frequency range: 77 to 81 GHz(1)

Instrument accuracy (under reference conditions)

±0.08 in. (±2 mm)(2)

Repeatability

±0.04 in. (±1 mm)

Ambient temperature effect

±0.04 in. (±1 mm)/10 K

Sensor update rate

Minimum 1 update per second (typically 5 updates per second)

Maximum level rate

200 mm/s

7.1.2 Measuring range

Maximum measuring range

49 ft. (15 m)(3)

(1) Radar performance may be affected if it is configured for certain local radio spectrum regulations.

(2) Refers to inaccuracy according to IEC 60770-1 when excluding installation dependent offset. See the IEC 60770-1 standard for a definition of radar specific performance parameters and if applicable corresponding test procedures.

(3) The measuring range is limited to 33 ft. (10 m) for oil-based media (dielectric constant < 10). Also note that a combination of adverse process conditions, such as heavy turbulence, foam, and condensation, together with products with poor reflection may affect the measuring range.

Accuracy over measuring range

Figure 8.1 Illustrates the accuracy over measuring range at reference conditions.

A. Device reference point
B. Accuracy in inches (milimeteres)
C. Distance in inches (milimeteres)

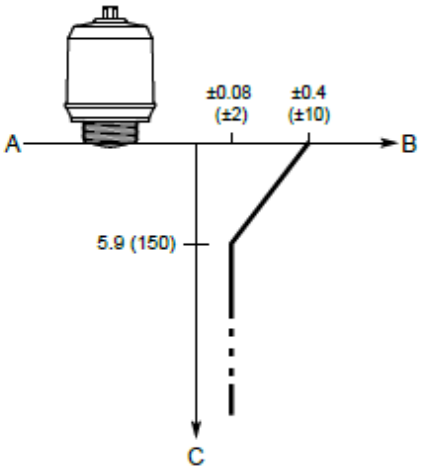


Figure 7.1 Accuracy over measuring range

7.1.3 Environment

Vibration resistance

2 g at 10-1000 Hz according to IEC 61298-3, level “field with general application”

Electromagnetic compatibility (EMC)

- EMC Directive (2014/30/EU): EN 61326-1
- NAMUR recommendations NE21 (only 4-20 mA output)

Pressure Equipment Directive (PED)

Complies with 2014/68/EU article 4.3

Built-in lightning protection

EN 61326, IEC 61000-4-5, level 1kV

Radio approvals

- Radio Equipment Directive (2014/53/EU):
  - — ETSI EN 302 372
  - — ETSI EN 302 729
  - — EN 62479
- Part 15 of the FCC Rules
- Industry Canada RSS 211
- Other country approvals

Related information

Product certifications

7.2 Functional specifications

7.2.1 General

Field of application

Continuous measurement of level and open channel flow.

Solids level measurement

The Radar Level Transmitter is capable of measuring in many solids applications, including limestone and fly ash tanks.

Note:

Sensitivity and performance in solids applications may vary on the reflectivity properties of the media. These properties include dielectric constant, consistency, humidity, grain size, and angle of repose.

Minimum dielectric constant

2

Measurement principle

Frequency Modulated Continuous Wave (FMCW)

Frequency range

77 to 81 GHz (76 to 77 GHz in applicable countries)

Note:

Operating the device without selecting the relevant radio spectrum may constitute a violation of the regulations of the radio approvals of the respective country.

Maximum output power

3 dBm (2 mW)

Internal power consumption

< 2 W (normal operation at 24 V DC, no outputs)

< 3.6 W (normal operation at 24 V DC, digital and analog outputs active)

Humidity

0 - 100% relative humidity, non-condensing

Turn-on time

< 15 s(4)

(4) Time from when power is applied to the transmitter until performance is within specifications

7.2.2 Outputs

The transmitter provides two configurable outputs:

Output 1 Digital output

Output 2 Digital output or active 4-20 mA analog output

7.2.3 Digital outputs

Switching signal for high and low limits (using the same pin)

Output type

PNP/NPN configurable

Switching function

Normally open

Permanent current rating

< 50 mA

Maximum voltage drop

2.5 V

7.2.4 4-20 mA analog outputs

Load limitations

Maximum loop resistance is determined by the voltage level of the external power supply:

Maximum Loop Resistance = 43.5 × (External Power Supply Voltage - 18) + 600 Ω

A. Loop resistance (Ω)
B. External power supply voltage (V DC)

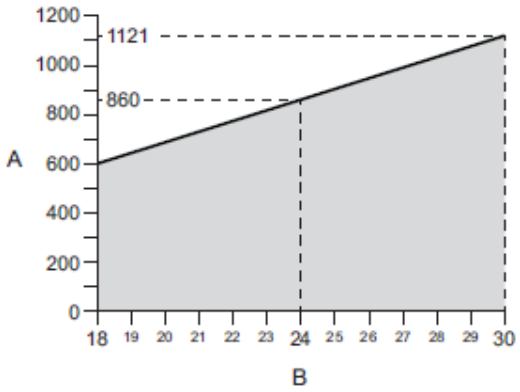


Figure 7.2 Load limits

Analog signal on alarm

The transmitter automatically and continuously performs self-diagnostic routines. If a failure or a measurement error is detected, the analog signal will be driven offscale to alert the user. High or low failure mode is user-configurable.

Level	Custom levels	NAMUR NE43 (default)
Low	3.5 to 4.0 mA	3.5 mA (NAMUR ≤ 3.6 mA)
High	20.0 to 22.5 mA	21.5 mA (NAMUR ≥ 21.0 mA)

Table 7.1 Signal on alarm

Analog saturation levels

The transmitter will continue to set a current that corresponds to the measurement until reaching the associated saturation limit (and then freeze).

Level	Custom levels	NAMUR NE43 (default)
Low	3.5 to 4.0 mA	3.8 mA
High	20.0 to 22.5 mA	20.5 mA

Table 7.2 Saturation levels

7.2.5 Bluetooth® connectivity

Typical range

At least 50 ft. (15 m) line of sight.

Maximum communication range will vary depending on orientation, obstacles (person, metal, wall, etc.) or electromagnetic environment.

7.2.6 Configuration

Damping

User selectable (default is 2 s, minimum is 0 s)

Output units

- Level: in., m
- Temperature: °F, °C
- Volume flow: US gal/h, m3/h
- Signal strength: mV

Output variables

Variable	4-20 mA	DO1 and DO2	Digital, service tools using IODD
Level	✓	✓	✓
Distance (ullage)	N/A	N/A	✓
Volume flow	✓	✓	✓
Electronics temperature	N/A	N/A	✓
Signal strength	N/A	N/A	✓

Table 7.3 Output Variables

Volume flow calculations

- Linearization table
- Parshall flume
- Khafagi-Venturi flume

7.2.7 Process pressure

-15 to 43.5 psig (-1 to 3 bar)

Note:

The PE100 flanges must be used only in non-pressurized applications.

7.2.8 Temperature limits

Process temperature

-40 to 176 °F (-40 to 80 °C)

Ambient temperature

-40 to 176 °F (-40 to 80 °C)

Storage temperature

-40 to 194 °F (-40 to 90 °C),

7.3 Physical specifications

7.3.1 Material selection

The product information presented is intended as a guide for the purchaser to make an appropriate selection for the application. It is the purchaser's sole responsibility to make a careful analysis of all process parameters (such as all chemical components, temperature, pressure, flow rate, abrasives, contaminants, etc.), when specifying product, materials, options, and components for the particular application. Aplisens is not in a position to evaluate or guarantee the compatibility of the process fluid or other process parameters with the product, options, configuration, or materials of construction selected.

7.3.2 Housing and enclosure

Process connection

ISO 228/1-G1½-in. thread with a choice of different brackets, adapters, and flanges

Materials

- Transmitter housing: Polyvinylidene fluoride (PVDF)
- M12 housing: Stainless steel
- M12 contact body: Polyamide (PA)

Transmitter weight

0.8 lb (0.35 kg)

Ingress protection

Enclosures meet NEMA® Type 4X/6P, IP66, and IP68 (33 ft. [10 m] for 1000 hours(5)) when properly installed.

Impact protection

IK07 (4 J impact test)

7.3.3 Housing and enclosure

Materials

- Bracket: Stainless steel 316L
- Nut: PVDF

7.3.4 Flanges

Materials

- Polyethylene PE100
- Stainless steel 316/316L
- Stainless steel 1.4404

7.3.5 Threaded adapters

Materials

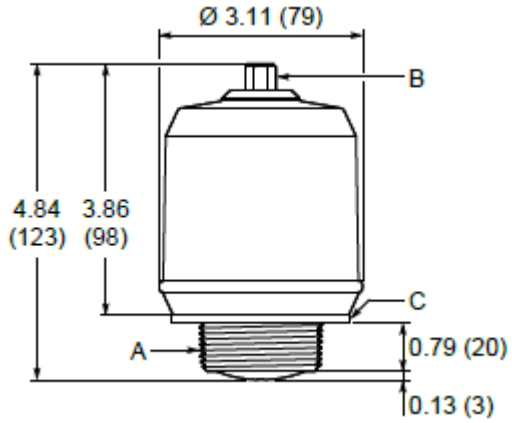
Stainless steel 316/316L/1.4404

7.3.6 Material exposed to tank atmosphere

- Antenna and housing: PVDF
- Gasket: EPDM or FKM GLT
- Flange: PE100, 316/316L, or 1.4404
- Threaded adapter: 316/316L/1.4404

7.4 Physical specifications

7.4.1 Transmitter

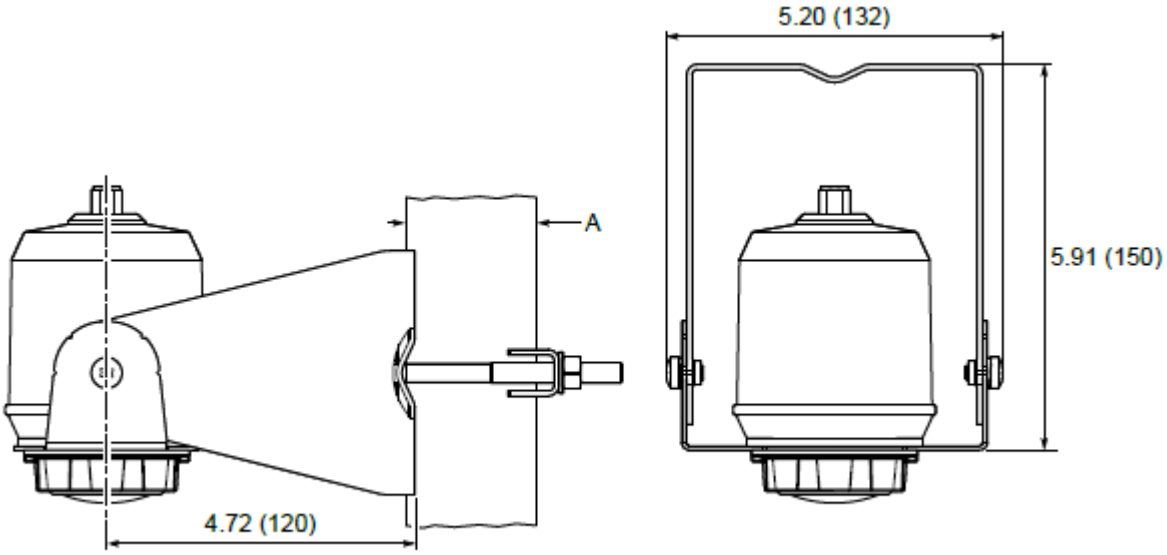


A. G1 ½ - in. ISO 2281
B. M12 male connector (A-coded)
C. Gasket for G threaded version

Dimension are in inches (milometers)

Figure 7.3 Radar Level Transmitter SP-10

7.4.2 Mounting brackets

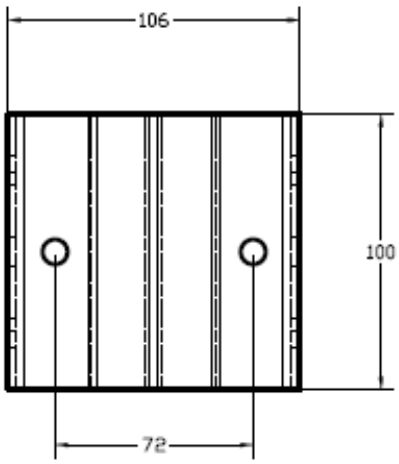


A. For 1- to 2-in. nominal pipe sizes; 2-in. pipe is the recommended size

Dimension are in inches (millimetres)

Figure 7.4 Standard version

Bracket hole pattern



Dimension are in millimetres

Figure 7.5 Pattern for wall mounting

8. Configuration

8.1 Basic setup

8.1.1 Engineering units

Sets the unit of measure for length, temperature, and volume flow.

Option	Length unit	Temperature unit	Volume flow unit
Metric	m	°C	m^3/h
Imperial	inch	°F	US gal/h

Table 8.1 Engineering units

After appropriate units have been selected, all configuration parameters and transmitter variables will be expressed in these units.

8.1.2 Reference height

Distance between the Device Reference Point and Zero Level.

A. *Device reference point*
B. *Reference height*
C. *Zero level*
D. *0.79 in. (20mm)*

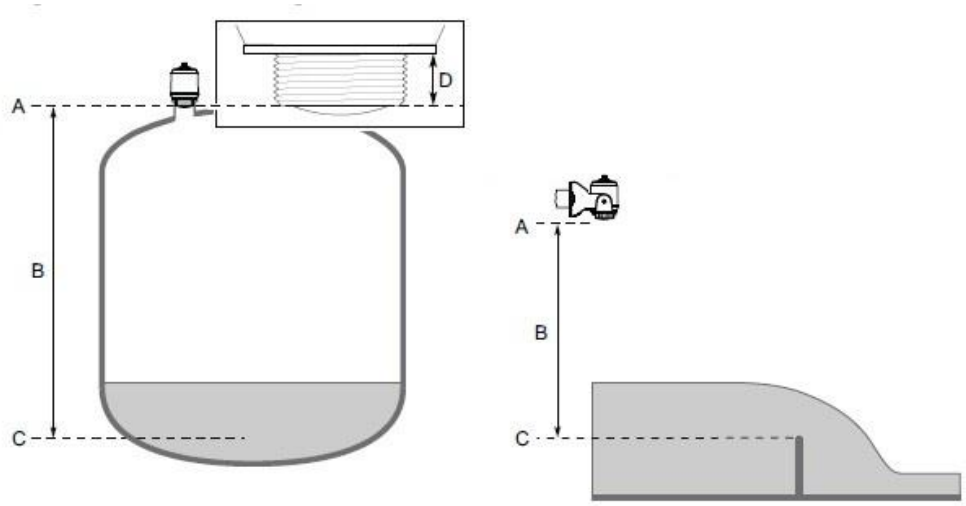


Figure 8.1 Reference height

Ensure the Reference Height is set as accurate as possible. The transmitter measures the distance to the product surface and subtracts this value from the Reference Height to determine the level.

8.1.3 Digital output P-n

The output polarity for the switching outputs (PnP or nPn).

8.1.4 Write protection

The transmitter can be software write protected to prevent unintentional configuration changes.

8.2 Analog output

8.2.1 Analog control variable

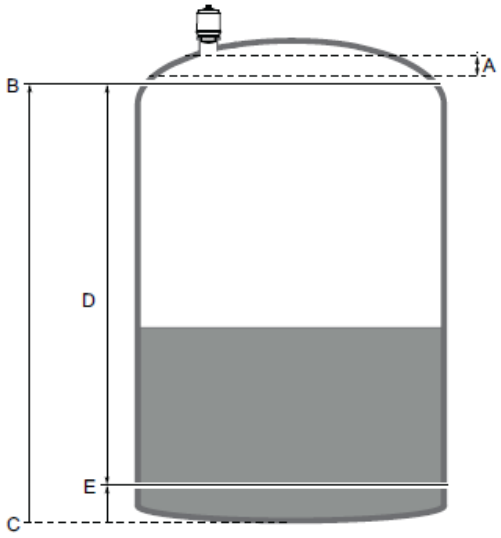
Select between volume flow or level to control the analog output.

8.2.2 Upper/lower range value

Enter the range values that correspond to the analog output values 4 and 20 mA. In normal operation, the transmitter will drive the output in response to volume flow or level from the lower to upper saturation points.

Note:

The 20 mA point should be set below the reduced accuracy zone at the top of the tank.



A. Reduced accuracy zone
B. 100% (20mA)
C. Zero level
D. Level measurement range 0-100%
E. 0% (4mA)

Figure 8.2 Example of range value settings

8.2.3 Alarm mode

The transmitter automatically and continuously performs self-diagnostic routines. If a failure or a measurement error is detected, the transmitter drives the output to selected alarm limit (high or low).

8.2.4 Analog alarm limits

High/low alarm value

The high/low alarm current for the analog output when the device enters the alarm mode.

Related information

Analog signal on alarm

High/low saturation value

The device will continue to set a current that corresponds with the measurement until reaching the upper/lower limit (and then freeze).

Related information

Analog saturation levels

8.3 Bluetooth® configuration

8.3.1 Bluetooth® radio

Indicates whether Bluetooth functionality is enabled or not by the user. When disabled, the Bluetooth interface is incapable of transmitting or receiving any wireless signals and may only be enabled via wired communication to the device.

8.3.2 Reset Bluetooth® security

The Bluetooth security reset process will erase the established login passwords.

8.4 Geometry

8.4.1 Advanced

Calibration offset

Difference between surface distance measured by transmitter and the same distance measured by, for example, hand-dipping with a measurement tape. A positive Calibration Offset value will increase the presented level value.

A. Positive calibration offset value
B. Negative calibration offset value
C. Reported level
D. Actual level

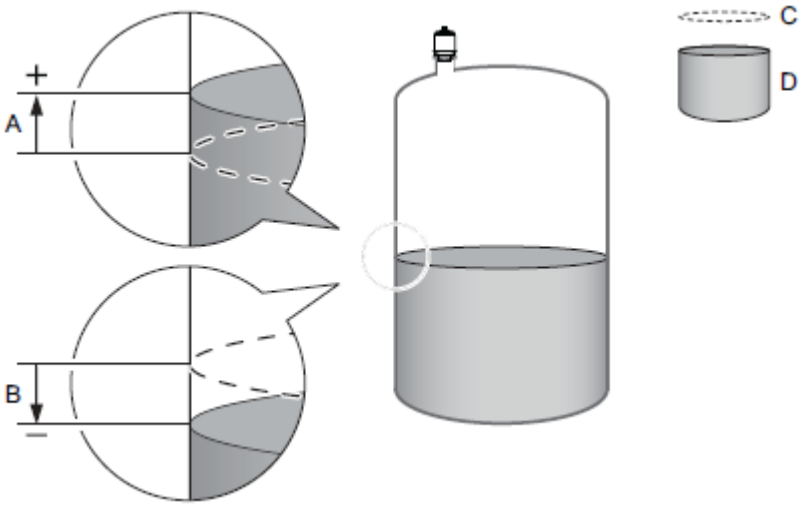


Figure 8.3 Calibration offset

Upper null zone

The Upper Null Zone defines how close to the device's reference point a level value is accepted. You can extend this value to block out disturbing echoes close to the antenna, for example from the tank nozzle.

Note:

Make sure the 20 mA value is below the Upper Null Zone. Measurements are not performed within the Upper Null Zone (UNZ).

A. Upper Null Zone
B. Disturbance echo
C. 100% (20mA)
D. General threshold
E. Product surface echo

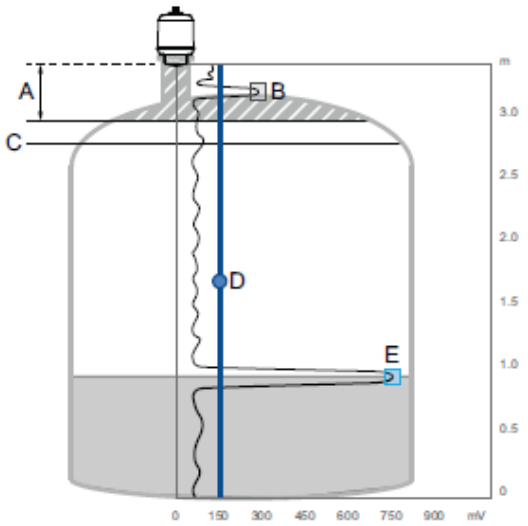
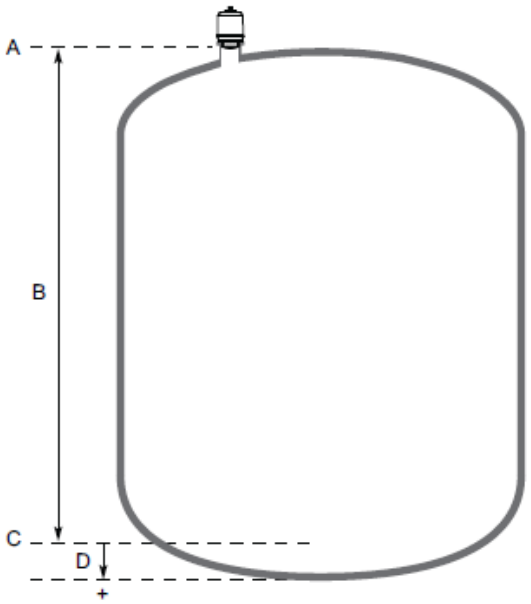


Figure 8.4 Upper Null Zone

Bottom offset

The Bottom Offset is defined as the distance between Zero Level and the tank bottom. The default value is zero. If the Zero Level is not located at the tank bottom, then enter a Bottom Offset. It is needed for the transmitter to know the position of the tank bottom.



A. Device Reference Point
B. Reference Height
C. Zero level
D. Bottom offset

Figure 8.5 Bottom offset

8.5 Volume flow

8.5.1 Volume flow calculation method

Select the preferred volume flow calculation method. The are three options to choose from:

- Linearization table
- Parshall flume
- Khafagi-Venturi flume

Related information

Set up the volume flow measurement

8.5.2 Volume flow table

The volume flow table is used to convert the measured level into a volume flow rate. Up to 30 level-volume flow pairs can be entered. The level points must be entered in increasing order.

8.5.3 Volume flow formula

Parshall Flume

The volume flow is calculated from the formula:

$$Q = K\ x\ H^n$$

Parameter	Description
Q	Calculated volume flow in m^3/h
H	Measured level in m
Constant K	Flume specific factor K
Exponent n	Flume specific factor n
Maximum level value	Flume maximum Level (weir height)

Table 8.2 Parshall flume parameters

Khafagi-Venturi Flume

The volume flow is calculated from the formula:

$$Q = K\ x\ H^{1.5}$$

Parameter	Description
Q	Calculated volume flow in m^3/h
H	Measured level in m
Constant K	Flume specific factor K
Maximum level value	Flume maximum Level (weir height)

Table 8.3 Khafagi-Venturi flume parameters

8.6 Advanced setup

8.6.1 Measurement recovery time

The Measurement Recovery Time (Echo Timeout) parameter controls the maximum time from when measurement is lost (e.g. due to process conditions such as foam or turbulence) until it is annunciated. If measurement is recovered within the time specified by this parameter, then it will not be annunciated.

8.6.2 Damping value

This parameter defines how fast the transmitter reacts to a change of the level value (step response). The default value is 2 seconds.

A high value makes the level reading steady, while a low value allows the transmitter to respond to rapid level changes (but the presented level value may be less steady).

8.6.3 General threshold

The general threshold is used to filter out noise and disturbing echoes from the product surface echo. The transmitter uses certain criteria to decide which type of echo peak that is detected. Only echoes above the general threshold might be considered the product surface.

A. General threshold
B. Product surface echo

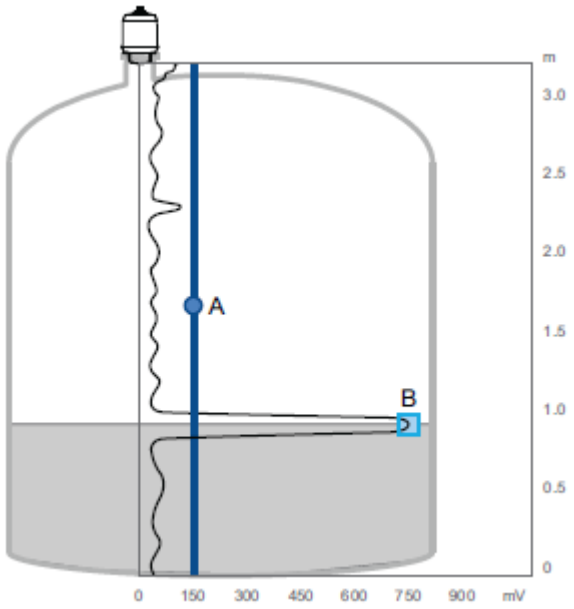


Figure 8.6 Threshold principle

8.6.4 Sweep mode

The device has two sweep modes:

- Mode 1 (77-81 GHz)
- Mode 2 (76-77 GHz)

Sweep mode impacts metrological properties. Use mode 2 only if required by local radio spectrum regulations in your country. The default setting is mode 1.

Related information

Change the sweep mode

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