# Level TROLL NC

## Operator's Manual

For regulatory compliance information including local compliance representatives and the product Declaration of Conformity, see www.in-situ.com/compliance-information.

# Contents

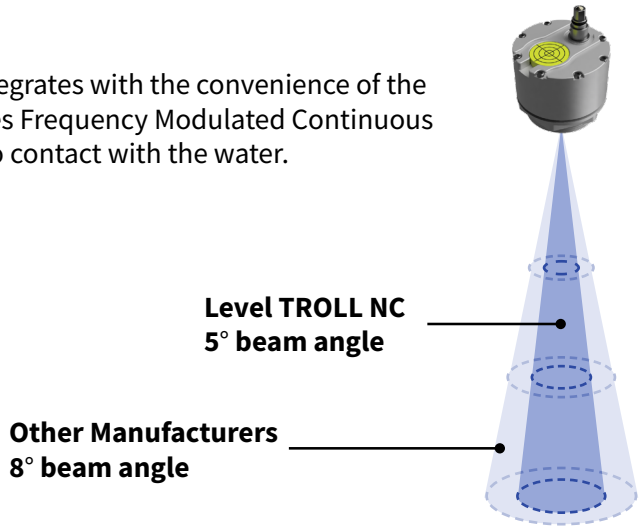
# Introduction

## Instrument Description

The Level TROLL NC is a non-contact radar level sensor that integrates with the convenience of the In-Situ ecosystem. The instrument sits above the water and uses Frequency Modulated Continuous Wave (FMCW) radar to measure water level without coming into contact with the water.

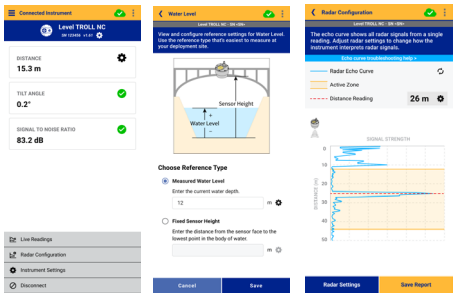
## Accuracy and Flexibility

The Level TROLL NC has a narrow beam angle of just 5°, which allows for more flexibility in deployment locations and requires less open area under the sensor than other non-contact level sensors. It meets the stage accuracy requirements for USGS gaging stations.



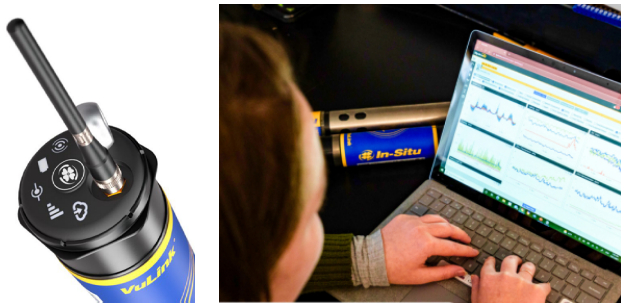

## Intuitive Setup and Integration

**Intuitive setup in the VuSitu mobile app**



The VuSitu mobile app makes it easy for beginners to set up the instrument and gather initial data, and for experts to dive into diagnostic information and detection algorithms.

**Flexible remote monitoring**



Use VuLink telemetry to transmit data for remote viewing with HydroVu data services, or integrate the instrument into a custom Modbus or SDI-12 system.

## Applications

Because the instrument and its cable never come directly in contact with the water, it is ideal for applications where traditional pressure transducers may not make sense:

- locations where the instrument or cable might be damaged by debris, pumps, severe turbulence, or corrosive liquids
- rapid deployment gages
- inline process monitoring where the liquid needs to be kept clean from contamination
- applications where temperature, humidity, barometric pressure, water pressure, or specific gravity could affect traditional pressure level readings

# Safety

## Safety and Damage Warnings

Read the safety information on this page before deploying or configuring your instrument. If you have questions, contact In-Situ Technical Support for assistance.

- Do not submerge the Twist-Lock connector or expose the connector to liquid when it is not attached to a cable.
- Pay attention to potential hazards during installation. Use appropriate fall protection and look out for nearby traffic.
- Secure tools, accessories, and other loose items during installation to avoid dropping them into the water.
- Check that all mounting structures will be secure in the full range of conditions expected at the site.
- When not in use, store the instrument in a cool, dry area.
- Do not allow lubricant, debris, or water to get into the connector. Use the dust cap to protect the O-ring and connector when the cable is not attached.
- Do not use abrasives, solvents, or sharp tools to clean the instrument. They can scratch the instrument finish and leave it susceptible to corrosion.

## Intended Use

The Level TROLL NC instrument is designed to be safe:

- during indoor or outdoor use;
- in ambient temperatures from -40 to 85° C;
- in any relative humidity levels;

If the equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

# Technical Support

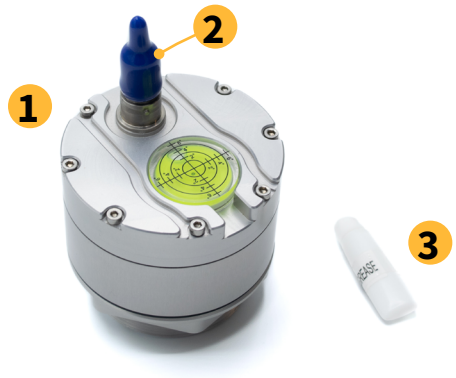
For service, repair, or technical support, scan the QR code or visit www.in-situ.com/technical-support to contact our skilled support team in your area by chat, email, or phone. Be sure to have the following information available:

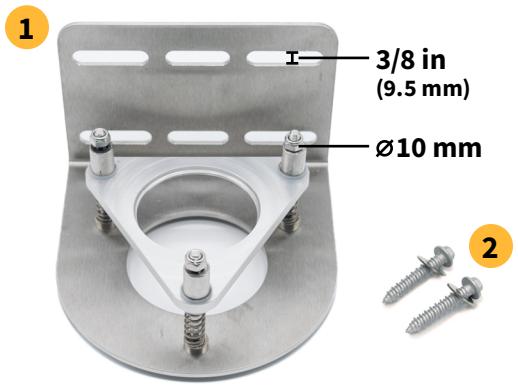
- Product model
- Serial number located on the instrument label
- Description of the problem, including how the product was used and the conditions noted at the time of the malfunction

Your equipment was carefully inspected before shipping. Save packing materials for future storage and shipping of your equipment. Check the equipment for any physical damage sustained during shipment. Notify In-Situ and file a claim with the carrier if there is any such damage. Do not attempt to deploy or operate the equipment.

For regulatory compliance information including local compliance representatives and the product Declaration of Conformity, visit www.in-situ.com/compliance-information.

# Level TROLL NC
## Quick Start Guide




## Box Contents

1. Level TROLL NC
2. Dust Cover
3. Grease

## Required Tools (not included)

1. Communication device (VuLink or TROLL Com Plus. Not compatible with Wireless TROLL Com)
2. VuSitu mobile app
3. Level tape, staff gauge, or reference datum for collecting a manual level reference measurement
4. Socket wrench with 10 mm deep socket
5. Mounting hardware for your deployment site (band straps, U-bolts, etc.) compatible with 3/8 inch slots on bracket

## Mounting Bracket Contents

1. Mounting Bracket
2. Concrete Mounting Screws with Washers

# Getting Started

See the following pages for guidelines on Choosing an Installation Location to ensure accurate data.

## 1 Connect instrument to cable.


Remove protective caps from instrument and cable.


Apply a small drop of grease to the O-ring if it is dry.


Align flat edges of cable and connector.


Twist and push the sleeve until it clicks into place.



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# 2 Install mounting bracket.

Check that the mounting structure will be secure, solid, and level in the full range of conditions expected for the entire duration of the deployment.

## Mounting options

Strap mounting bracket to vertical pole with U-bolts.

Strap mounting bracket to horizontal railing.

Bolt mounting bracket to secure structure.

Install mounting bracket inside a box or enclosure.

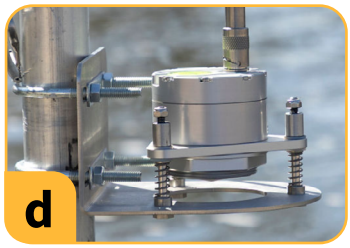
Check that there is a clear radius under the bracket that is free from metal and other potential radar interference. See the following pages for guidelines on Choosing an Installation Location.

# 3 Install instrument in mounting bracket.


Remove the nut from the base of the Level TROLL NC.


Thread Level TROLL NC into instrument holder. You may need to disconnect longer cables to complete this.


Reconnect the cable if you removed it from the instrument.



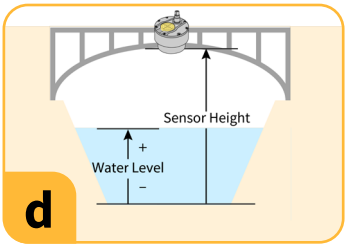

Optional: Reinstall the nut onto the instrument base for added security.

# 4 Adjust instrument level.


Use the bubble level on the top of the instrument to view sensor tilt.


Use a socket wrench with a 10 mm deep socket to adjust the leveling bolts.


Adjust the bolts until the bubble level shows that the instrument is roughly level.

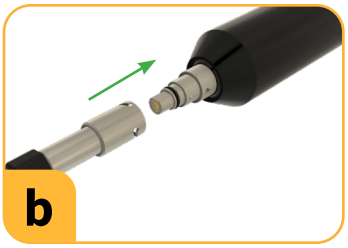



Once you've finalized your deployment site, collect reference measurements.

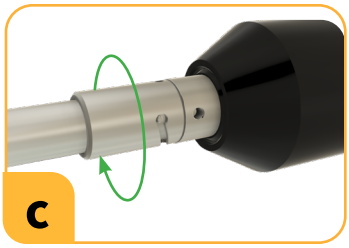
Make sure your instrument is level in its final installation location before continuing. Water Level references will need to be re-entered in VuSitu if the instrument is moved or tilted after setup.

# 5 Connect to communication device.


If you are using VuLink, install Li-$MnO_2$ batteries.




Align communication device connector with cable end.



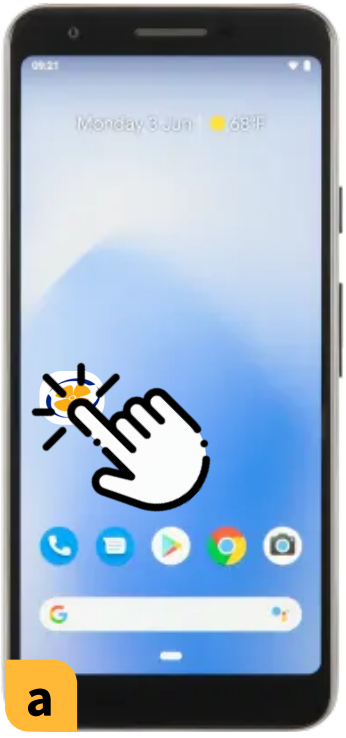

Twist and push the sleeve until it clicks into place.


Follow the instructions for the communication device to turn it on.

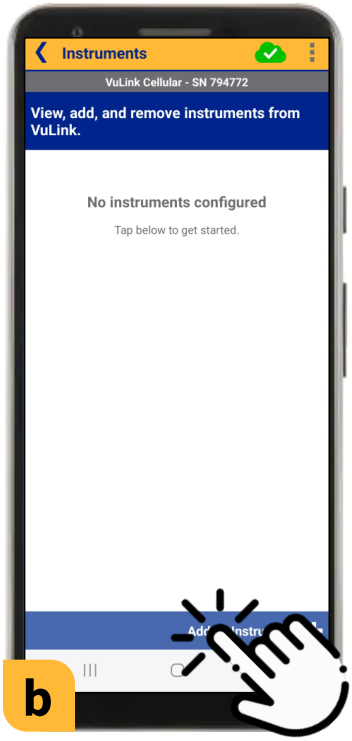
Radar level sensors use more power than other instruments. You must use Li-$MnO_2$ batteries in your VuLink with a maximum of one instrument connected. VuLink will not collect Level TROLL NC data without sufficient power.

# 6 Configure instrument in VuSitu.

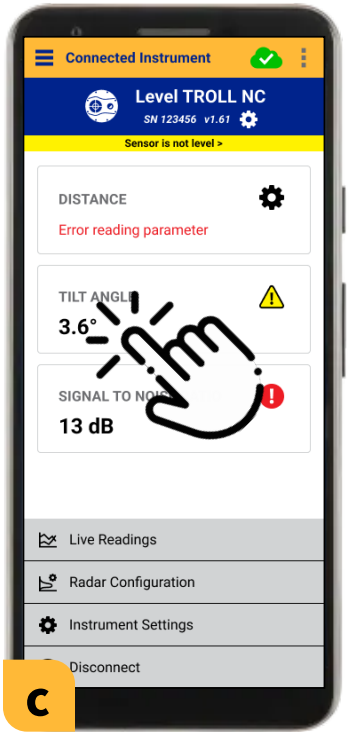
You must have the VuSitu mobile app to use the instrument with a mobile device. Download VuSitu from the Google Play Store or the Apple App Store.



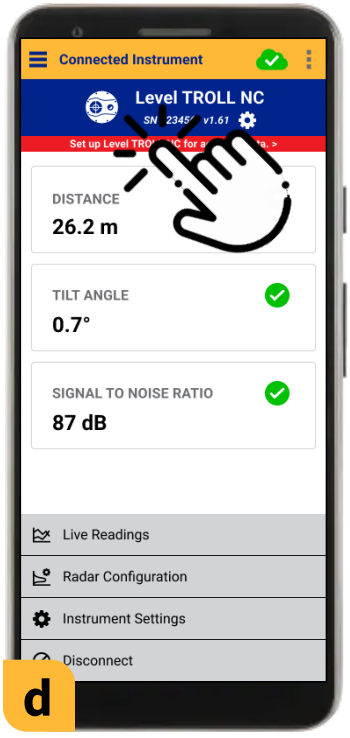

Connect to the VuSitu mobile app.




If you are using VuLink, add the instrument. Then tap the instrument to connect.




View diagnostic parameters. Tap each parameter to learn more or troubleshoot.



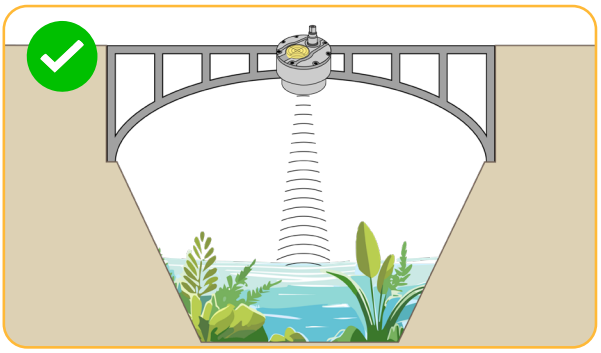

When the instrument is level in its final location, tap the banner to finish setup.

View the full instrument manual, help videos, compliance information, and more at www.in-situ.com.

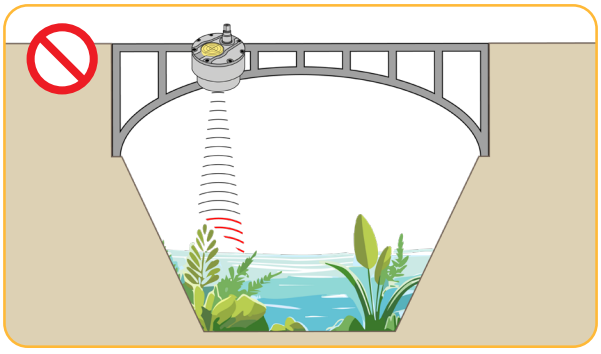
# Choosing an Installation Location

Follow the location guidelines below to ensure data accuracy and stability.

### AVOID VEGETATION, ROCKS, AND OBSTACLES

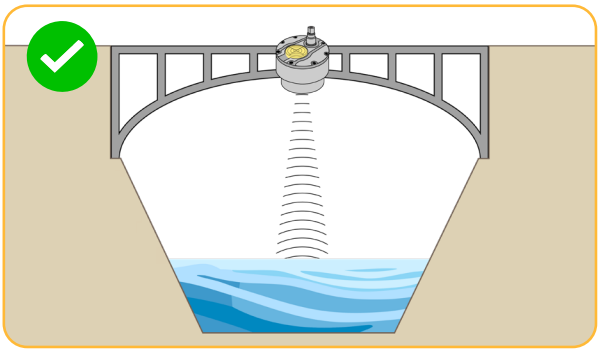


Ensure there is a direct, unobstructed line between the sensor and the water surface.

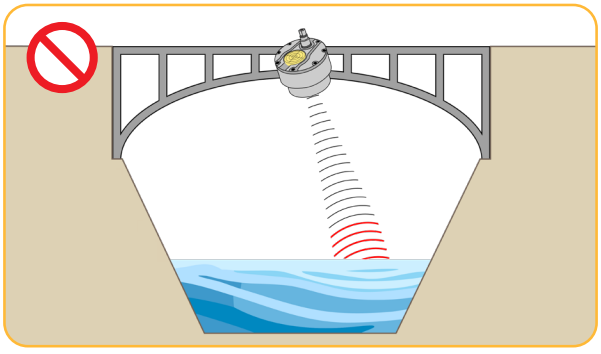


Vegetation, rocks, sand, metal objects, and other obstacles can interfere with measurements.

### MAKE SURE INSTRUMENT IS LEVEL

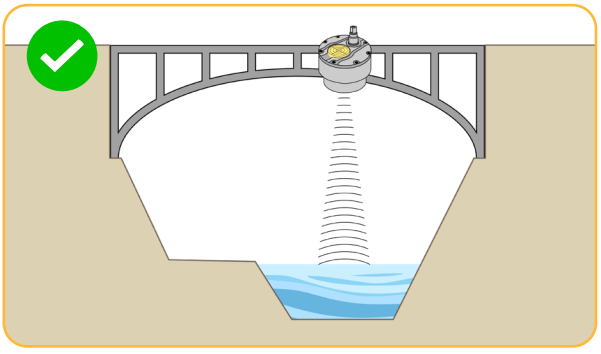


Check that the instrument is level. Tilt angle should be no more than 3° in any direction.

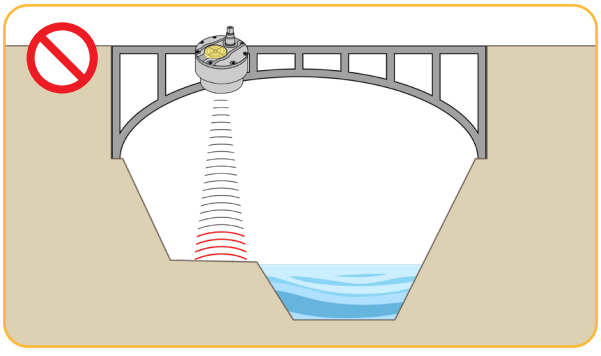


A tilted sensor will not provide accurate measurements.

### CENTER OVER DEEPEST POINT

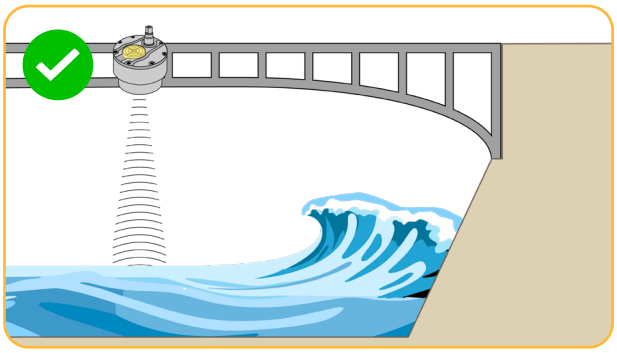


Center the instrument above the deepest point where level will show across the entire active zone.

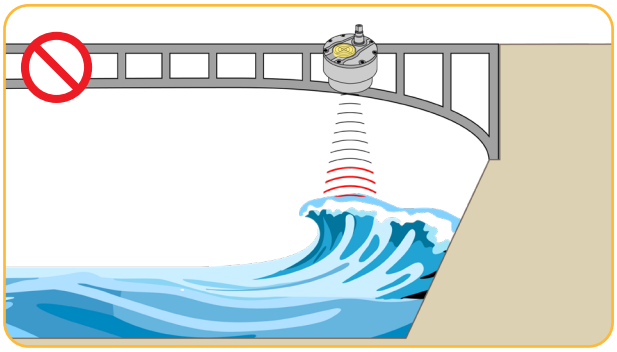


Low water readings may be inaccurate if the instrument is mounted above a shallow area.

### CENTER ABOVE CALM WATER

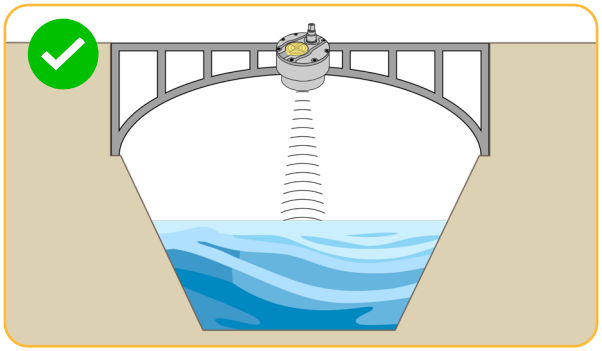


Center the instrument above calm water.

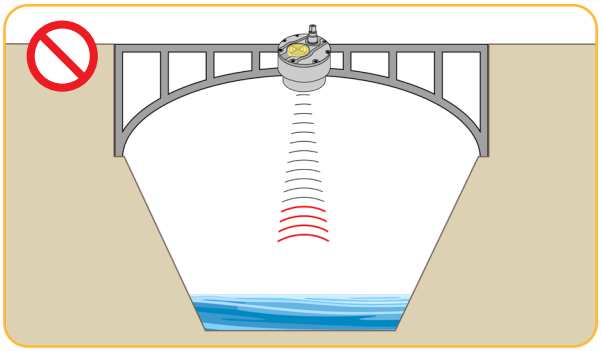


Turbulence and surface roughness can cause readings to fluctuate.

### MOUNT WITHIN USABLE RANGE FROM THE WATER SURFACE

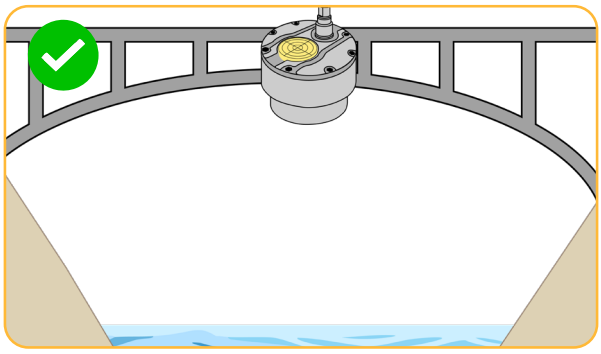


Mount the instrument at least 0.2 m from the highest expected water level, and within range of the lowest expected water level.

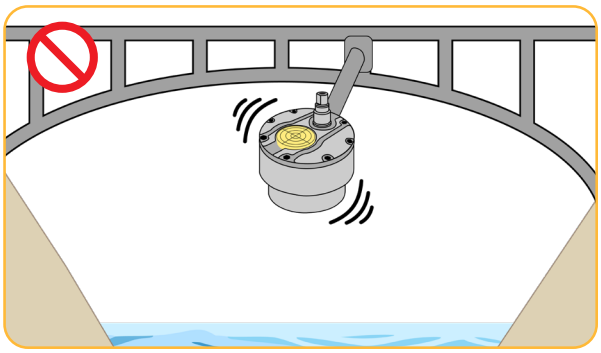


Readings may not be accurate if the instrument is too close or too far from the water.

### ENSURE MOUNTING STRUCTURE IS STABLE



Mount the instrument on a secure, stable structure.



Significant vibration can cause readings to fluctuate.

## Factors That Won't Interfere With Readings

Precipitation including rain, snow, wind, and fog will not affect sensor accuracy.

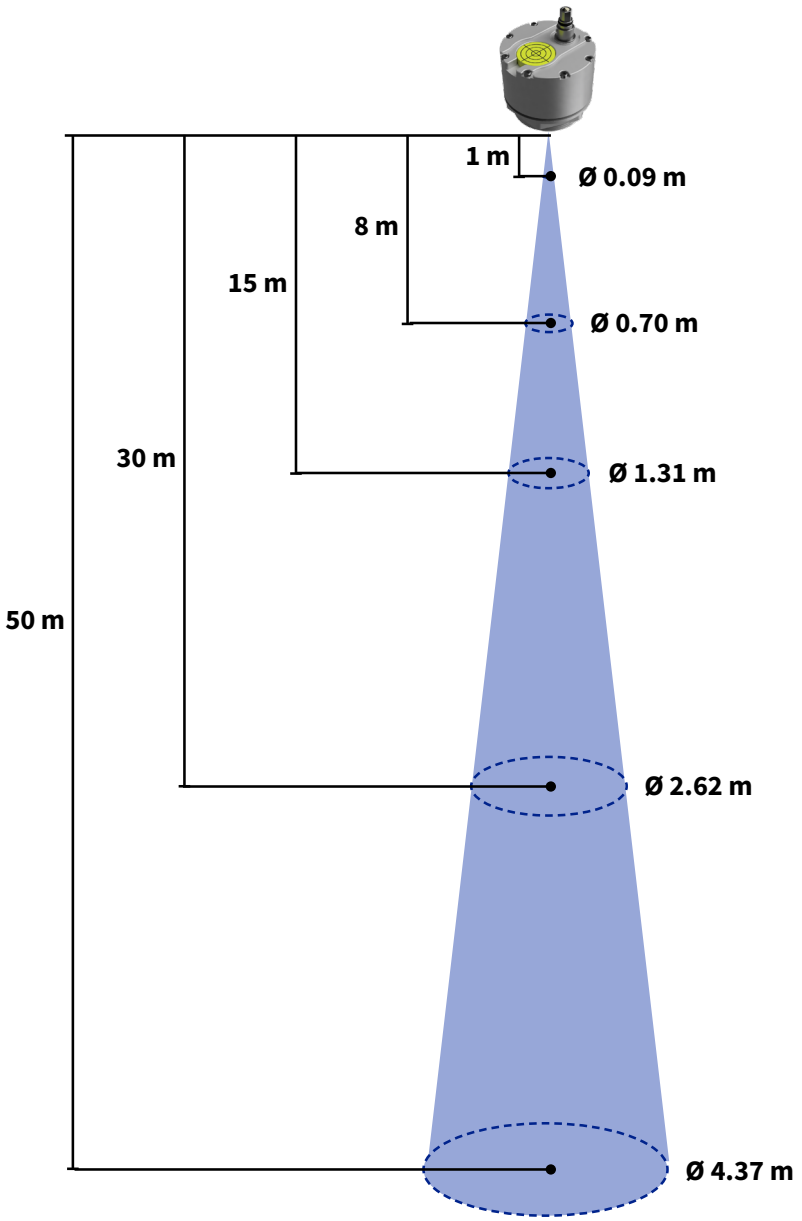
The radar sensor uses the W-band from 77 GHz to 81 GHz with linear frequency modulation. Other radar sensors in this range won't interfere with sensor readings in most applications.

# Other Installation Considerations

## Measurement Area

The diagram and table below illustrate the diameter of the radar beam at different distances from the sensor. Make sure that this area is representative of the overall water level and clear of obstacles that might interfere with readings.

| DEPTH TO WATER | DIAMETER |
|---|---|
| 1 m | 0.09 m |
| 2 m | 0.17 m |
| 3 m | 0.26 m |
| 4 m | 0.35 m |
| 5 m | 0.44 m |
| 6 m | 0.52 m |
| 7 m | 0.61 m |
| 8 m | 0.70 m |
| 9 m | 0.79 m |
| 10 m | 0.87 m |
| 15 m | 1.31 m |
| 20 m | 1.75 m |
| 25 m | 2.18 m |
| 30 m | 2.62 m |
| 35 m | 3.06 m |
| 40 m | 3.50 m |
| 45 m | 3.94 m |
| 50 m | 4.37 m |




**Illustrative purposes only. Drawing is not to scale.*

## Tank Installations

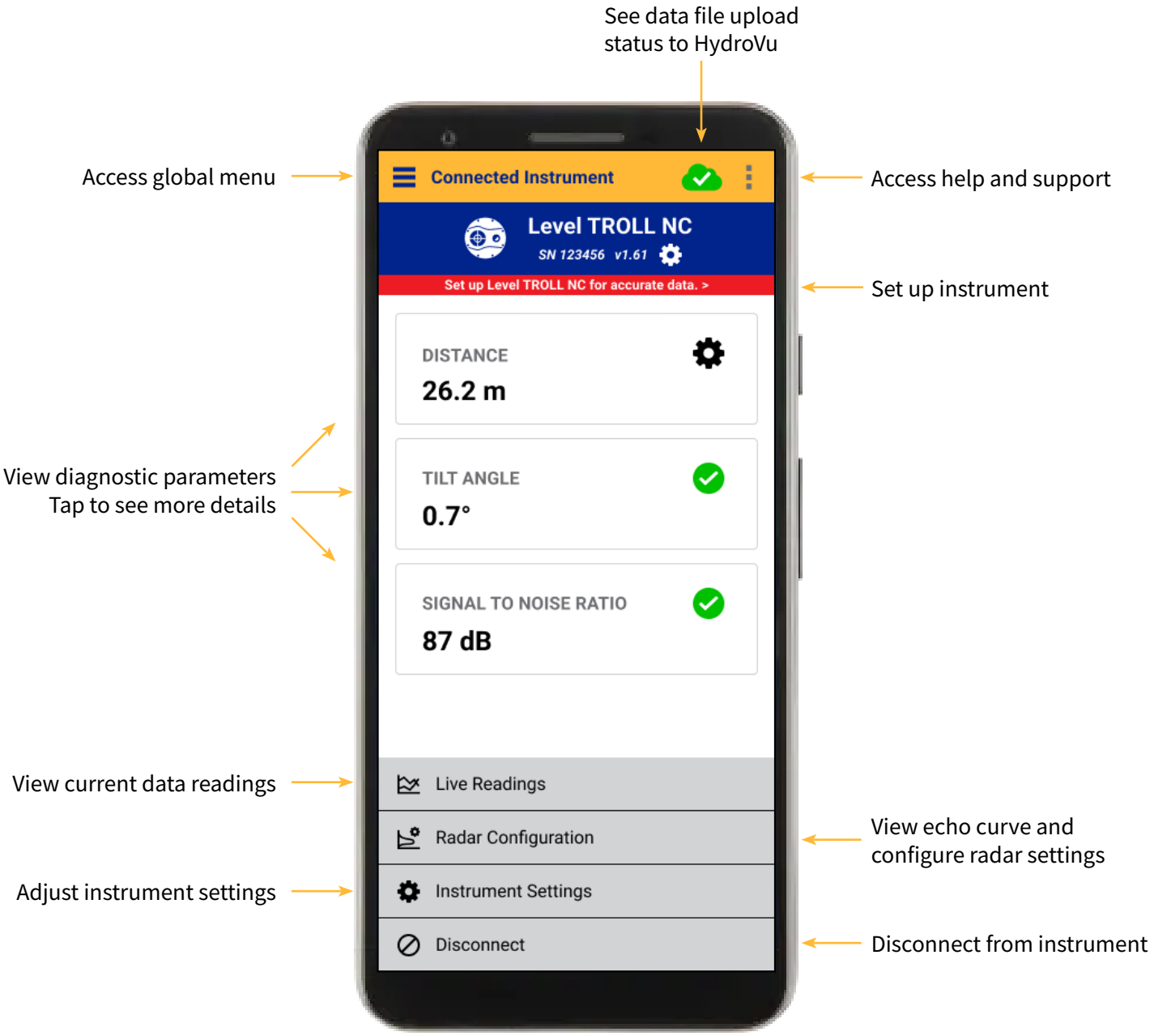
You can mount the instrument on the outside of most tanks made of a non-conductive material like ABS, PVC, Nylon, PTFE, Polycarbonate, Plexiglas, Polyamide, or Polypropylene, up to a tank thickness of 0.7 mm.

# VuSitu Mobile App

Use the VuSitu mobile app to program your instrument and view readings. You can download VuSitu from the Google Play Store or Apple App Store.

## Connected Instrument Screen

You'll see the connected instrument screen every time you connect to your Level TROLL NC in VuSitu. Here's how to access the main features on this screen:



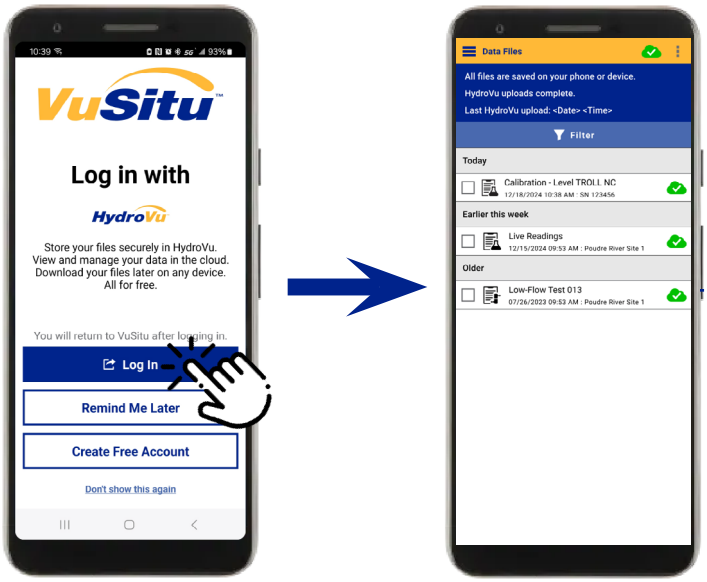
# Logging in With HydroVu

You can log in with HydroVu when you first connect to VuSitu, or any time from the Log In & Connect page. As you work, any new data files you save will automatically upload to your HydroVu account when you have an internet connection so you can easily transfer and manage your data:

- Live Readings
- Daily Snapshots
- Echo Curve Reports

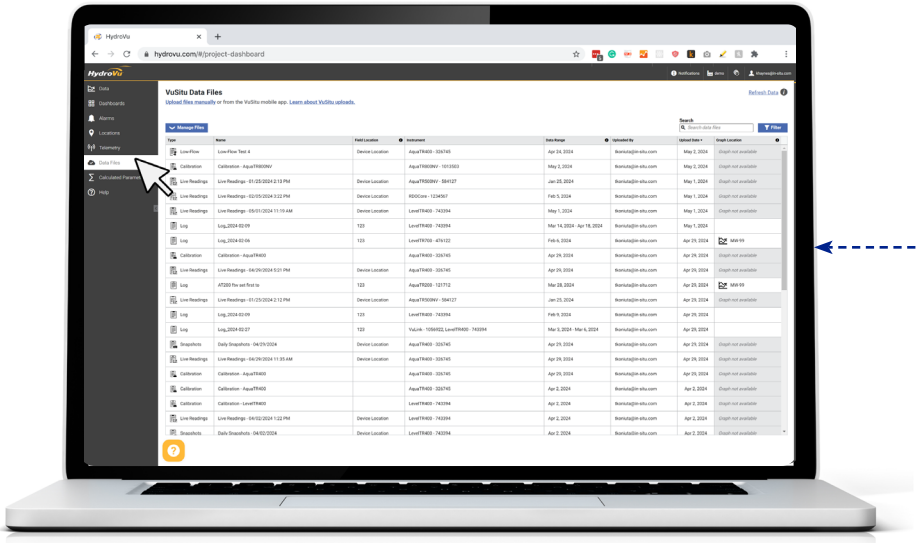
View, download, and manage your data at www.hydrovu.com.

## Data files upload automatically as you work:




VuSitu HydroVu Cloud Connection

## View and manage all of your data in HydroVu, from any device:

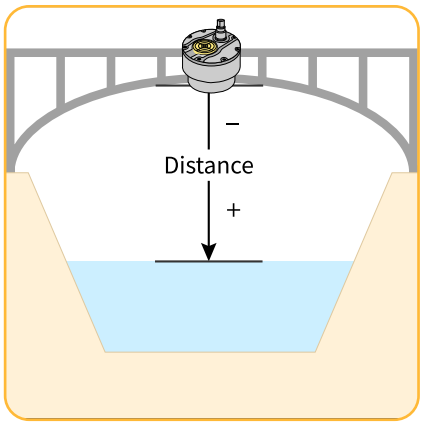


# Diagnostic Parameters

Use these parameters to understand if your sensor is properly deployed and gather data to help you troubleshoot unexpected readings. These parameters are displayed on the Connected Instrument screen and saved with the Echo Curve report.

## Distance

The Distance shown on the Connected Instrument screen and the Echo Curve is the raw sensor distance from the sensor to the water with no offsets applied. Use this measurement to help you check the accuracy of your data and troubleshoot errors.



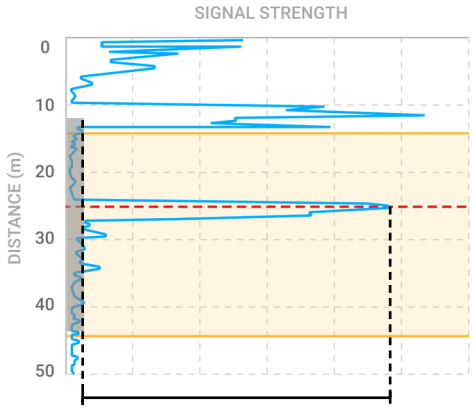

## Tilt Angle

The Tilt Angle is critical for data accuracy. Ensure the sensor is level before performing any other troubleshooting steps.

Tilt Angle shows if the sensor is level. If the tilt angle is greater than 3 degrees in any direction, you will see a warning to correct the instrument. If the tilt angle is greater than 5 degrees in any direction, measurements cannot be displayed and you will see an error.

## Signal to Noise Ratio (SNR)

Signal to Noise Ratio (SNR) shows how strong the measurement signal is relative to other objects that may be causing interference in the radar Echo Curve. If the SNR is less than 30 dB, you will see a warning with troubleshooting recommendations. If the SNR is less than 15 dB, measurements cannot be displayed and you will see an error.



# Level References

The instrument directly measures the distance from the sensor to the water. You can use this measurement to derive other parameters using a level reference as a starting point. Learn about different types of level references below.

Make sure your instrument is level in its final installation location before setting any level references. If the instrument is moved after a reference is set, you may need to enter a new reference for accurate data.

## Water Level

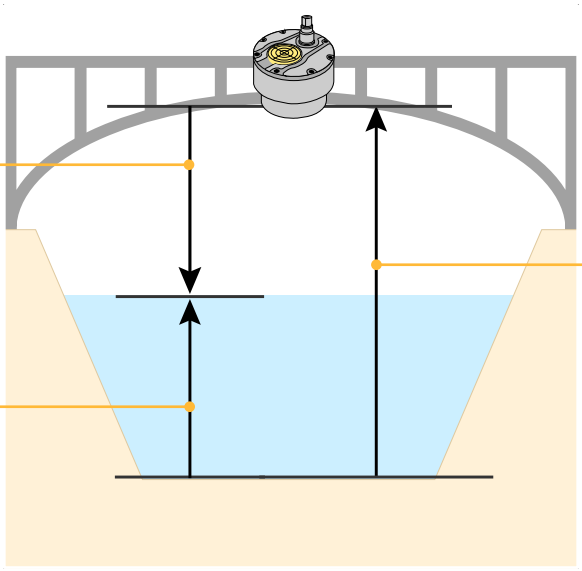
View details about the most recent Water Level reference or set a new one from the Water Level page in VuSitu. The most recent Water Level reference is also included in the Calibration Report.

**DISTANCE**

Distance is measured directly by the instrument. This measurement fluctuates inversely to the water level.

**WATER LEVEL**

Water Level is derived from Distance. You can enter the current measurement as a starting reference.



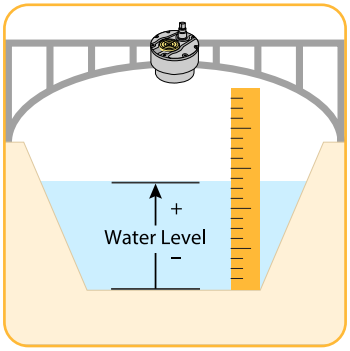
**SENSOR HEIGHT**

Sensor Height is fixed and does not change with fluctuations in water level. You can enter the fixed sensor height as a reference to calculate Water Level.

Water Level = Sensor Height - Distance

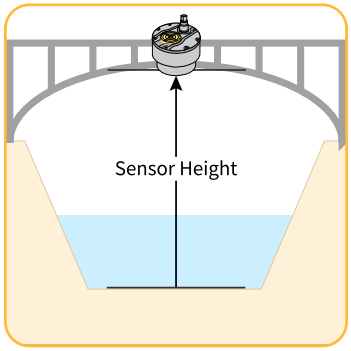
You can measure either the current water level or the fixed sensor height to use as a Water Level reference based on what is easiest at your deployment site.

**MEASURED WATER LEVEL**




Use a staff gauge, steel tape, or other tool to measure the current water level above the bottom of the tank or channel.

**FIXED SENSOR HEIGHT**



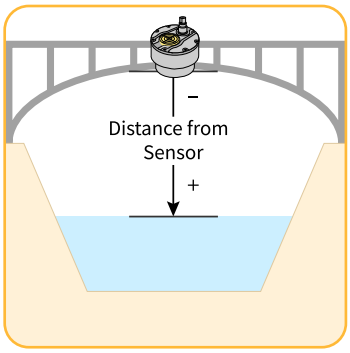

Use a measuring tape, staff gauge, or other tool to measure the fixed sensor height above the bottom of the tank or channel.

# Depth to Water

By default, Depth to Water is distance from the sensor to the water. If you prefer to measure Depth to Water from an external location like the top of a river bank, well casing, or tank, use a custom refererence.

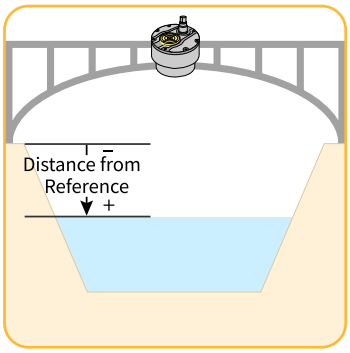
This setting only affects how Depth to Water is displayed in logs and live readings. Using a custom reference will not affect other settings or calculations that use the distance from the sensor to the water.

**DISTANCE FROM SENSOR (DEFAULT)**




Display the raw measurement received from the sensor.

**DISTANCE FROM REFERENCE**



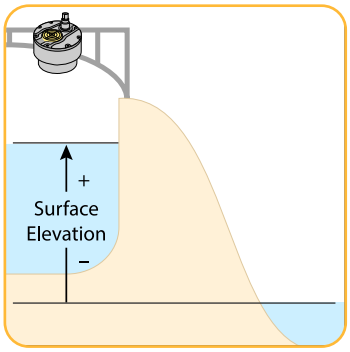

Measure the current distance from the reference to the water surface and enter it in VuSitu.

# Surface Elevation

Use Surface Elevation to measure the water height above a known datum such as Mean Sea Level (MSL). View details about the most recent Surface Elevation reference or set a new one from the Surface Elevation page in VuSitu. The most recent Surface Elevation reference is also included in the Calibration Report.

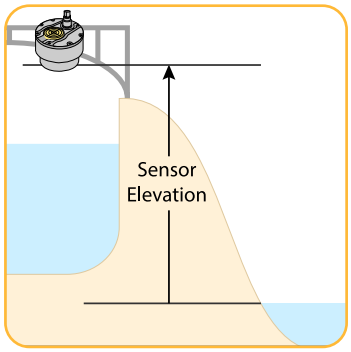
You can measure either the current water surface elevation or the fixed sensor elevation based on what is easiest at your deployment site.

**MEASURED SURFACE ELEVATION**




Use an altimeter, benchmark, or other surveying tool to measure the current water surface elevation.

**FIXED SENSOR ELEVATION**




Use an altimeter, benchmark, or other surveying tool to measure the fixed sensor elevation.

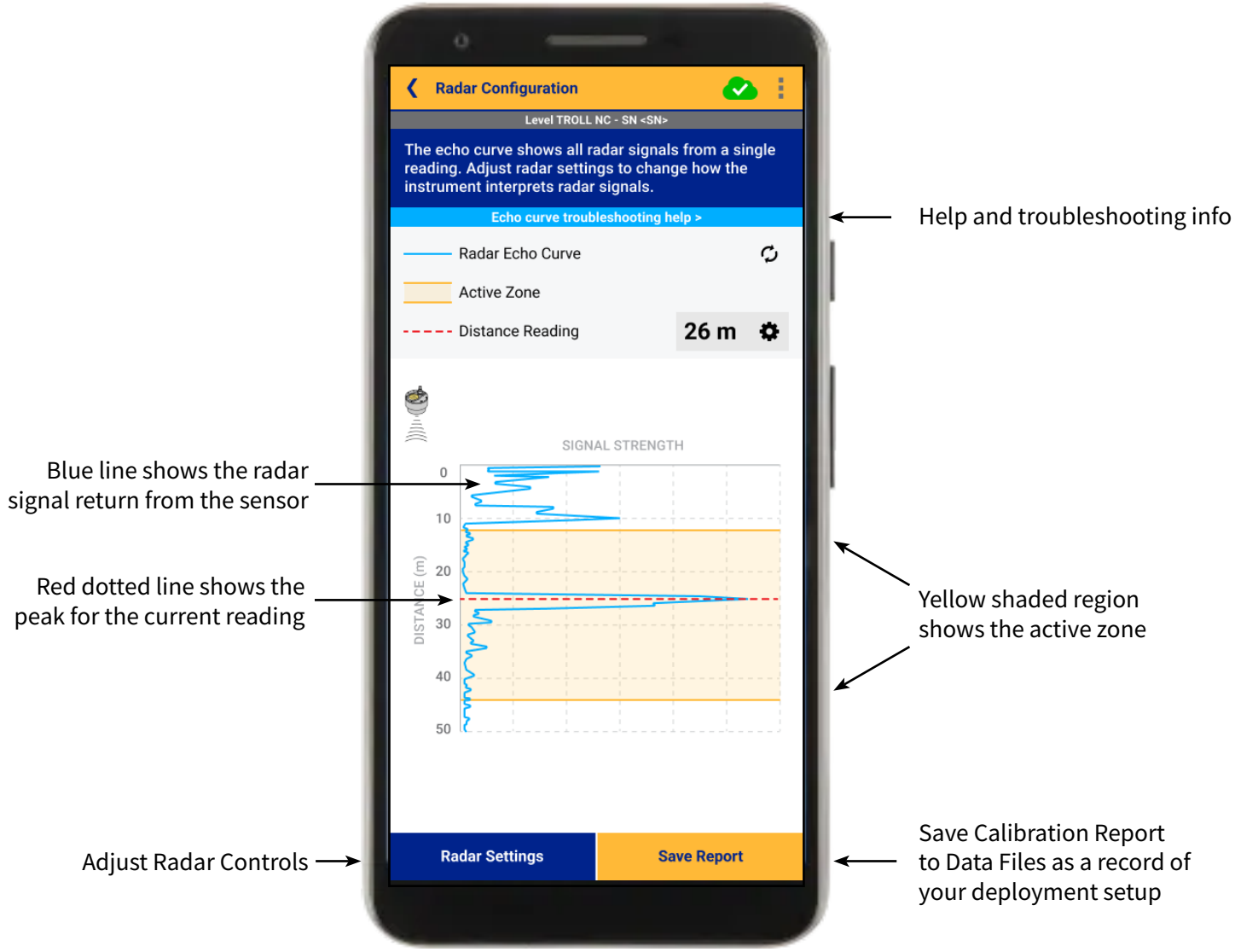
# Echo Curves

The echo curve shows all radar signals from a single reading. You can adjust radar controls like the Active Zone and Peak Detection to help the sensor identify the correct peak for the current reading. See the examples below for common echo curve issues and how to troubleshoot them.

For convenience during field setup, you can also access information and troubleshooting help directly from the Echo Curve page in VuSitu.

## Interpreting Echo Curves

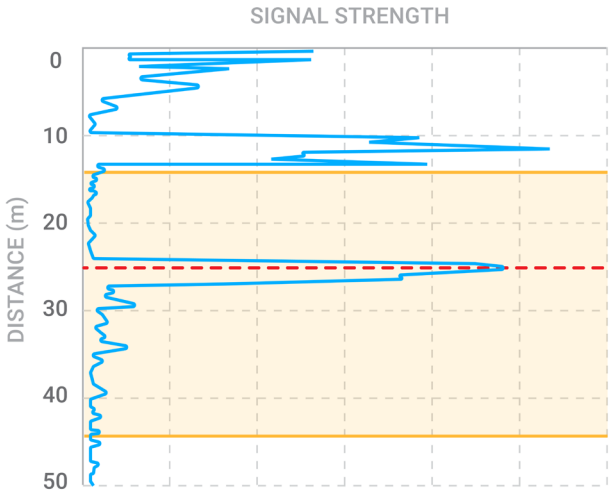
Each peak on the echo curve represents a potential water surface detected by the sensor. The y-axis shows the distance of each signal from the sensor. The x-axis shows the strength of each signal.

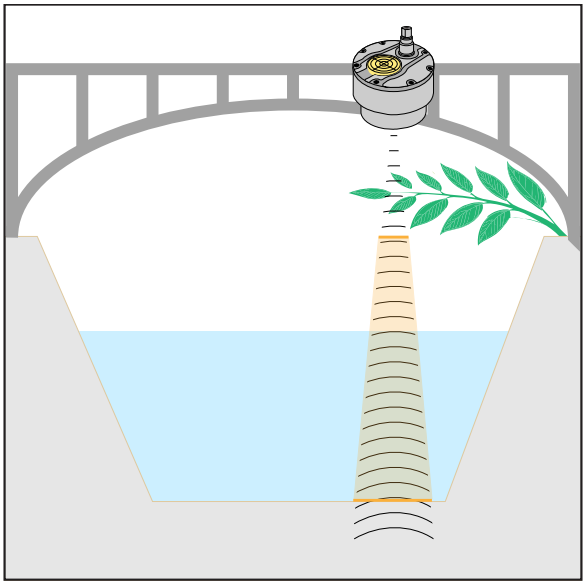


# Troubleshooting Echo Curves

**PROPERLY CONFIGURED CURVE**

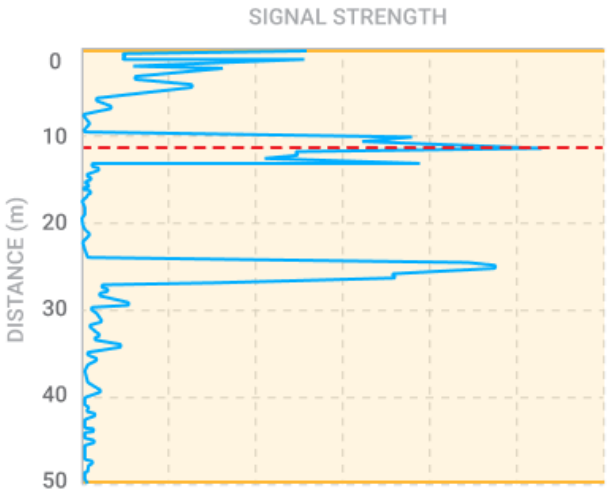
The active zone contains the expected range of water level, and the sensor has properly identified the correct peak as the current reading.

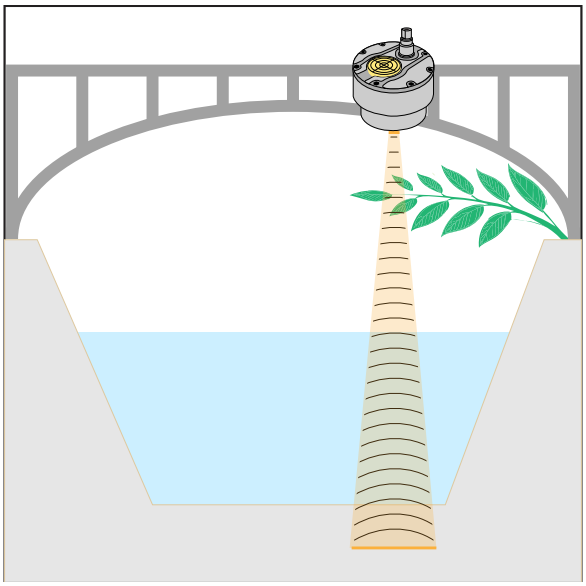


**MULTIPLE PEAKS**

The active zone contains multiple peaks, and the sensor has identified an incorrect peak as the current reading.



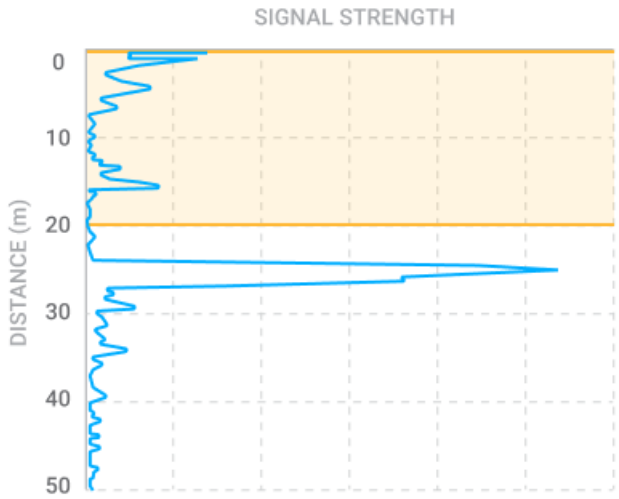



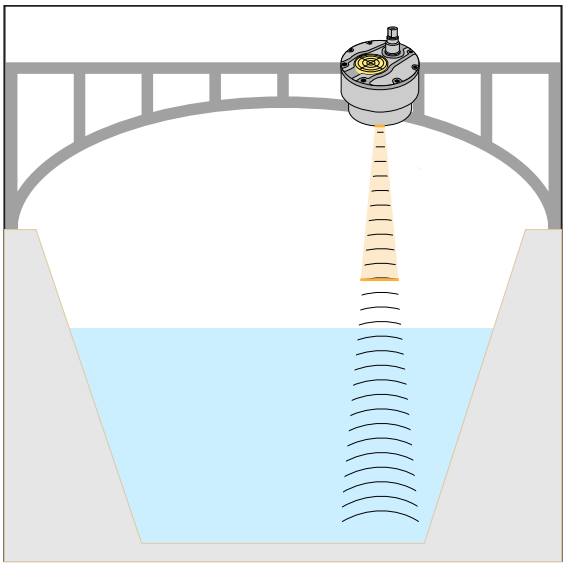
**Troubleshooting Steps:**

- Ensure that the sensor is as far as possible from physical interferences.
- Adjust the active zone to exclude interferences outside the expected range of water level.
- If interferences can't be excluded from the active zone, change the Peak Detection setting to better identify the correct peak.

**PEAK OUTSIDE ACTIVE ZONE**

The correct peak for the current reading is outside the active zone, and the sensor can't identify the correct peak or has identified an incorrect peak.



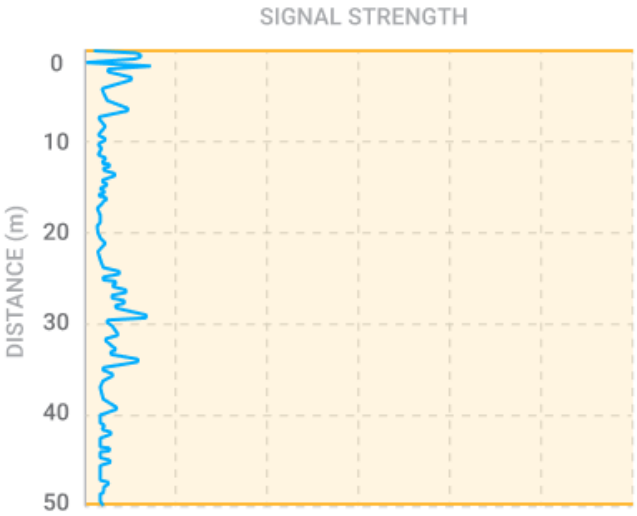



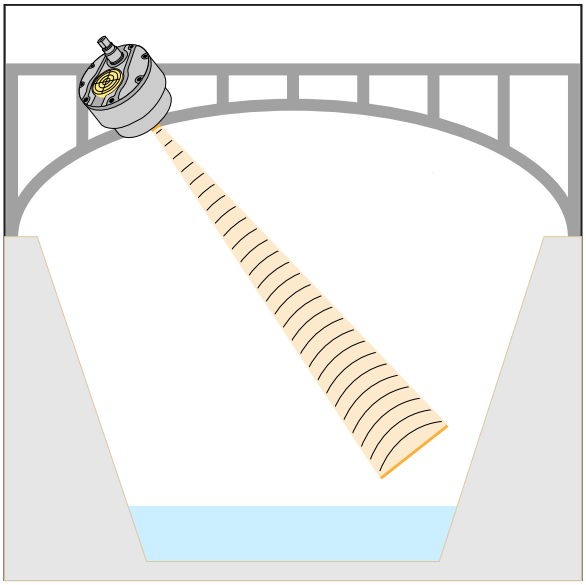
**Troubleshooting Steps:**

- Adjust the active zone to contain the full expected range of water level.

**NO PEAKS**

No significant peaks appear on the Echo Curve.



**Troubleshooting Steps:**

- Check that the sensor is level.
- Ensure there is water under the sensor to detect.
- Check that the water is at least 0.2 m from the sensor face.

# Radar Settings

Radar Settings allow you to adjust how the instrument reads and interprets radar signals to turn them into usable data. Use radar controls to help filter out interference.

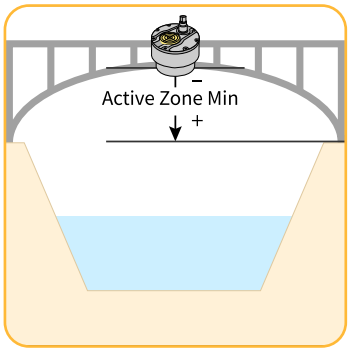
As you adjust Radar Settings, use the Echo Curve to understand how each of these settings affect sensor data at your deployment location.

## Active Zone

The active zone is the region where the instrument detects fluctuations in water level. The instrument will ignore signals outside the active zone. For example, if a bird flies under the sensor outside of the active zone, it will not impact water level readings.

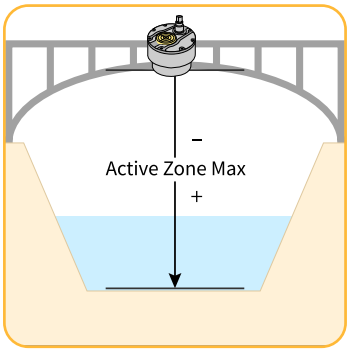
The active zone is the most important setting for filtering out interference from sensor readings. Adjust the active zone to include only the range of water fluctuation you expect at your deployment site.

**ACTIVE ZONE MINIMUM**




Use a staff gauge, steel tape, or other tool to measure the closest distance you expect the water to be from the sensor when the water level is high.

**ACTIVE ZONE MAXIMUM**



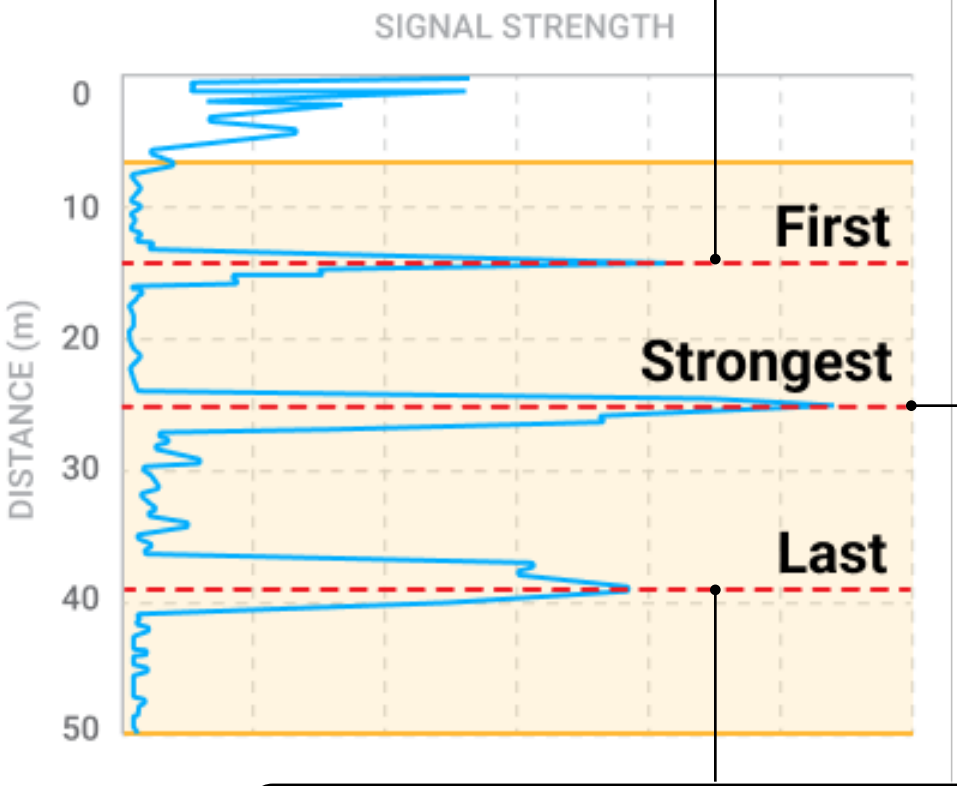

Use a staff gauge, steel tape, or other tool to measure the farthest distance you expect the water to be from the sensor when the water level is low.

## Peak Detection

If the active zone isn't enough to filter interference, use the Peak Detection setting to further refine the signal detection algorithm.

Choose **First** to use the signal closest to the sensor.

This may be useful when the instrument is in a closed system like a tank, where radar signal reflections may cause incorrect readings.




Choose **Strongest** to use the strongest signal.

This is the default setting and suitable for most applications.

Choose **Last** to use the signal farthest from the sensor.

This may be useful when vegetation or debris is present between the instrument and the water surface.

# Data Averaging

The instrument collects 20 seconds of data for each reading to reduce fluctuations caused by small ripples, precipitation, vibration, or radar interference (birds, leaves, etc).

You can view live readings and continue to work in VuSitu while the averages are building. The data may show more fluctuations in the first few seconds of readings and will become smoother as the averaging window fills with data. In VuLink data logs, each log reading will include a complete average calculated from the full window of data.

If you are reading data with a Modbus PLC, wait the averaging window + 5 seconds before taking a reading to ensure the average is complete. If you are reading data over SDI-12, the reading will be ready to retrieve when the averaging window is complete.

# Maintenance, Cleaning, and Storage

This instrument does not require routine maintenance or calibration. Follow the instructions below to replace worn or damaged parts. See the Accessories section of this manual for replacement part numbers.

## Replacing the Connector O-Ring

Do not allow lubricant, debris, or water to get into the connector. Use the dust cap to protect the O-ring and connector when the cable is not attached.


Remove and discard the O-ring.


Clean the O-ring groove on the instrument to remove dirt or residue.


Install the new O-ring in the groove.


Apply a pea-sized amount of grease to the new O-ring.

## Replacing the Bubble Level

Do not use metal tools to remove the bubble level. They can scratch the instrument finish and leave it susceptible to corrosion.


Use a plastic or wooden tool to gently remove the bubble level.


Clean the groove with the included wipe to prepare a smooth adhesive surface.


Peel the paper from the back of the new level to expose the adhesive.


Press down on the new level to secure it in place on the instrument.

## Cleaning the Instrument

Clean the instrument using a damp cloth and mild soap to remove debris or fouling. Do not use abrasives, solvents, or sharp tools which can damage the instrument components or finish.

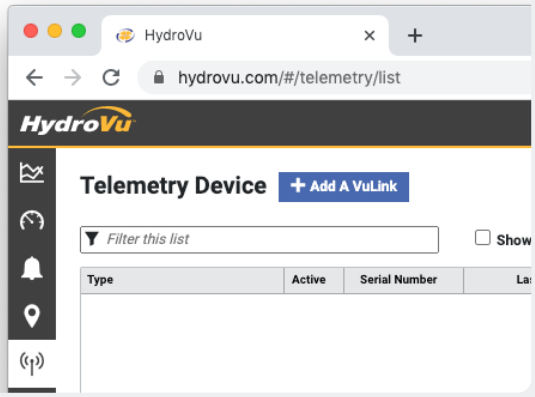
## Storage

When not in use, store the instrument in a cool, dry area. Use the dust cap to protect the o-ring and connector when the cable is not attached.

# Remote Monitoring with VuLink

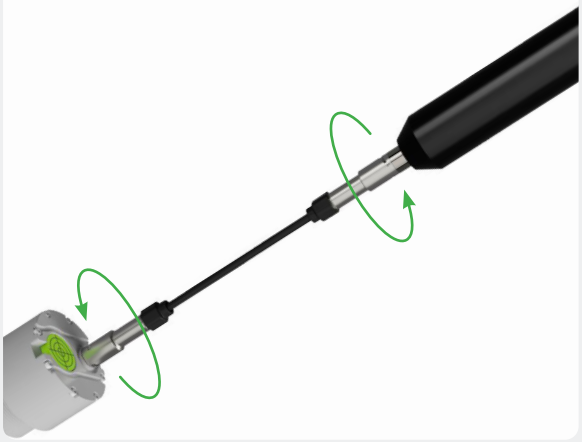
Use VuLink telemetry to upload data to HydroVu where you can view, manage, and share your data remotely. For more information on remote monitoring, refer to the VuLink manual at www.in-situ.com.

## 1 Activate VuLink.



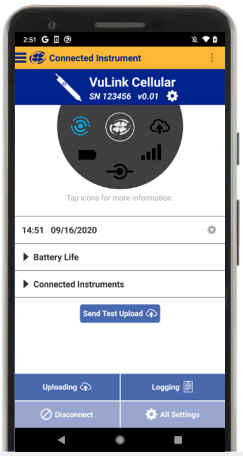

Log into your HydroVu account and add your VuLink from the Telemetry page.

## 2 Connect instrument.



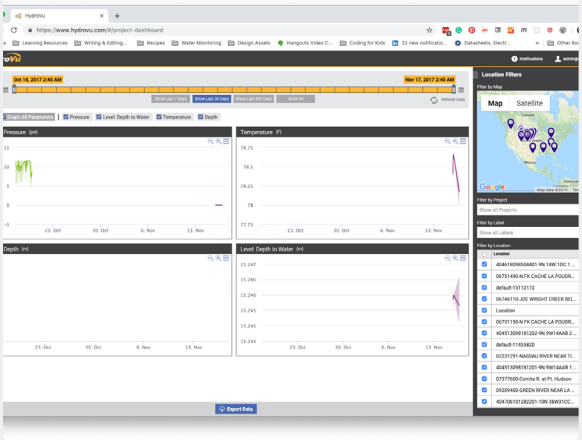
Connect the instrument to VuLink with a Rugged Twist-Lock Cable.

## 3 Configure and deploy.




Create a log and adjust instrument settings with the VuSitu mobile app. Then deploy the instrument.

## 4 View data in HydroVu.



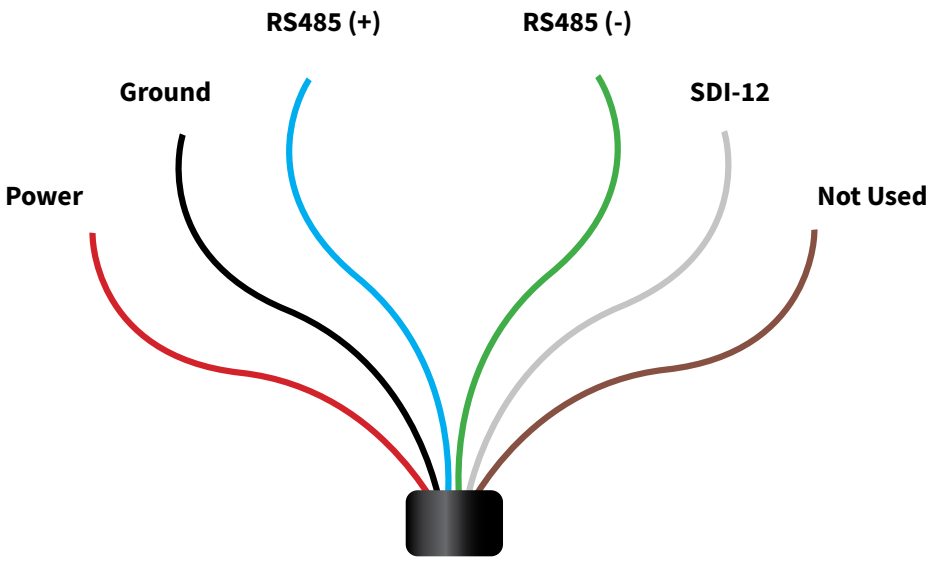
See graphs of your data and make changes to VuLink in HydroVu.

Radar level sensors use more power than other instruments. You must use Li-$MnO_2$ batteries in your VuLink with a maximum of one instrument connected. VuLink will not collect Level TROLL NC data without sufficient power.

# Connecting to a PLC or Data Logger

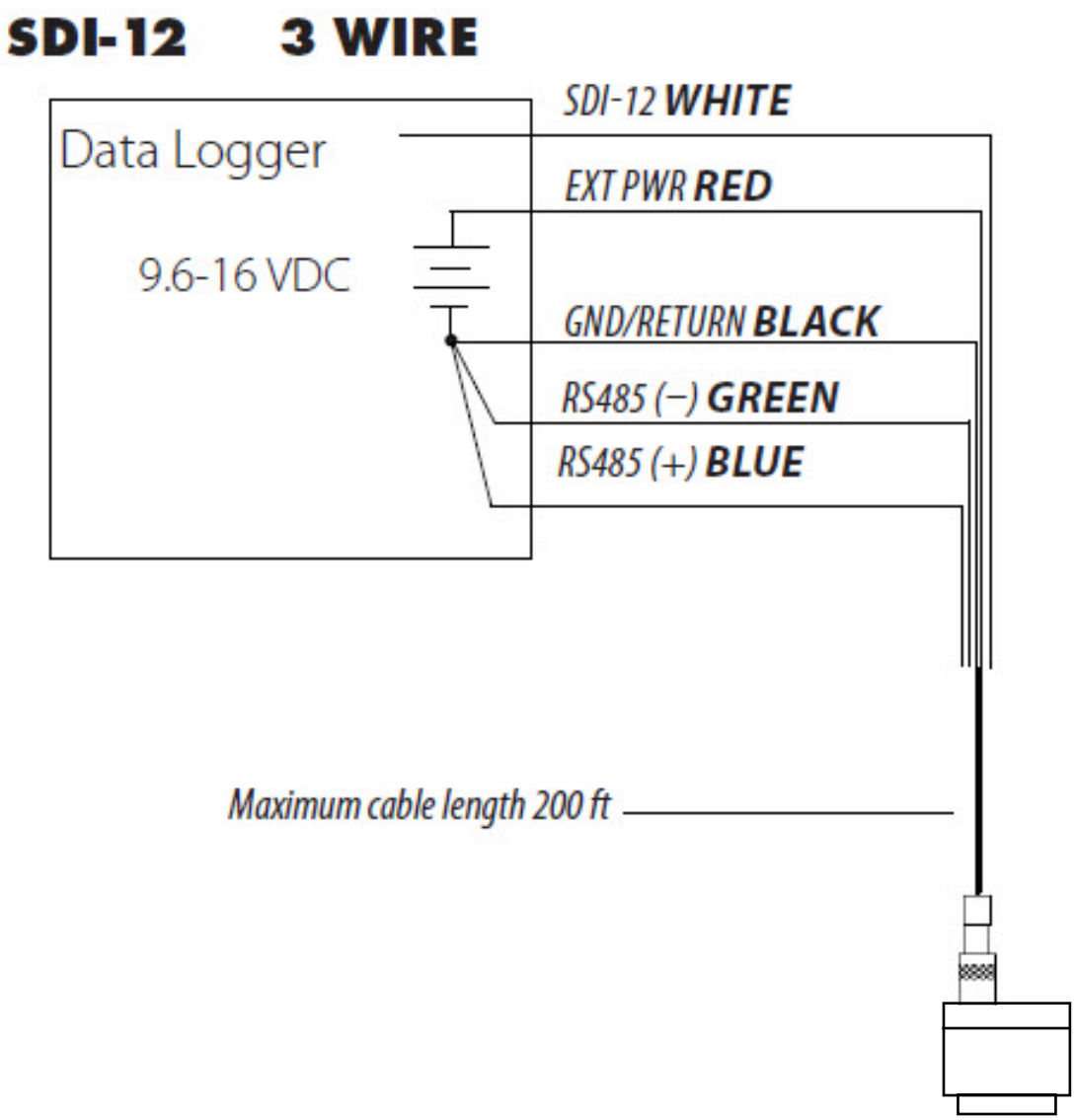
## Flying Leads Wire Diagram

Refer to the diagrams on the following pages for PLC wiring diagrams. Unused leads should not be touching.

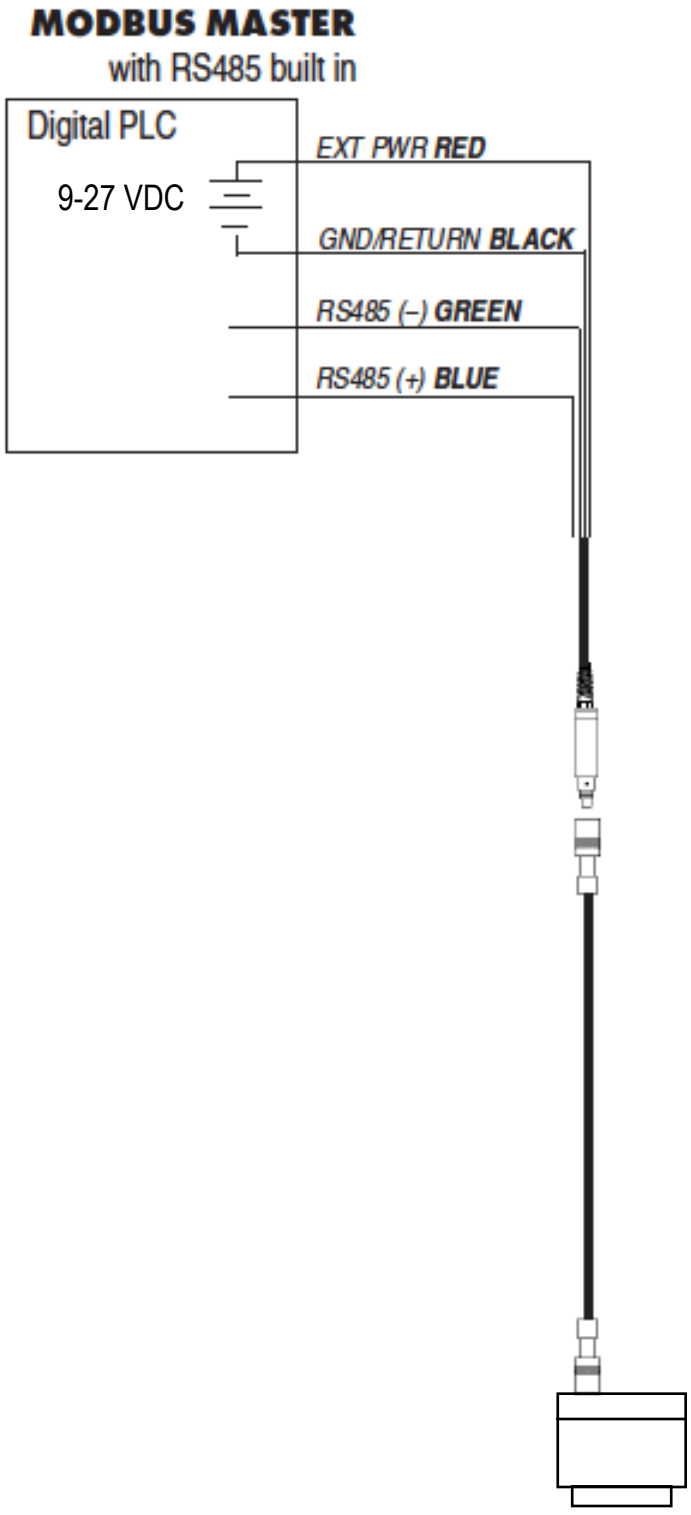



| WIRE COLOR | SIGNAL |
|---|---|
| Red | External Power |
| Black | Ground |
| Blue | RS485 (+) |
| Green | RS485 (-) |
| White | SDI-12 |
| Brown | Not Used |

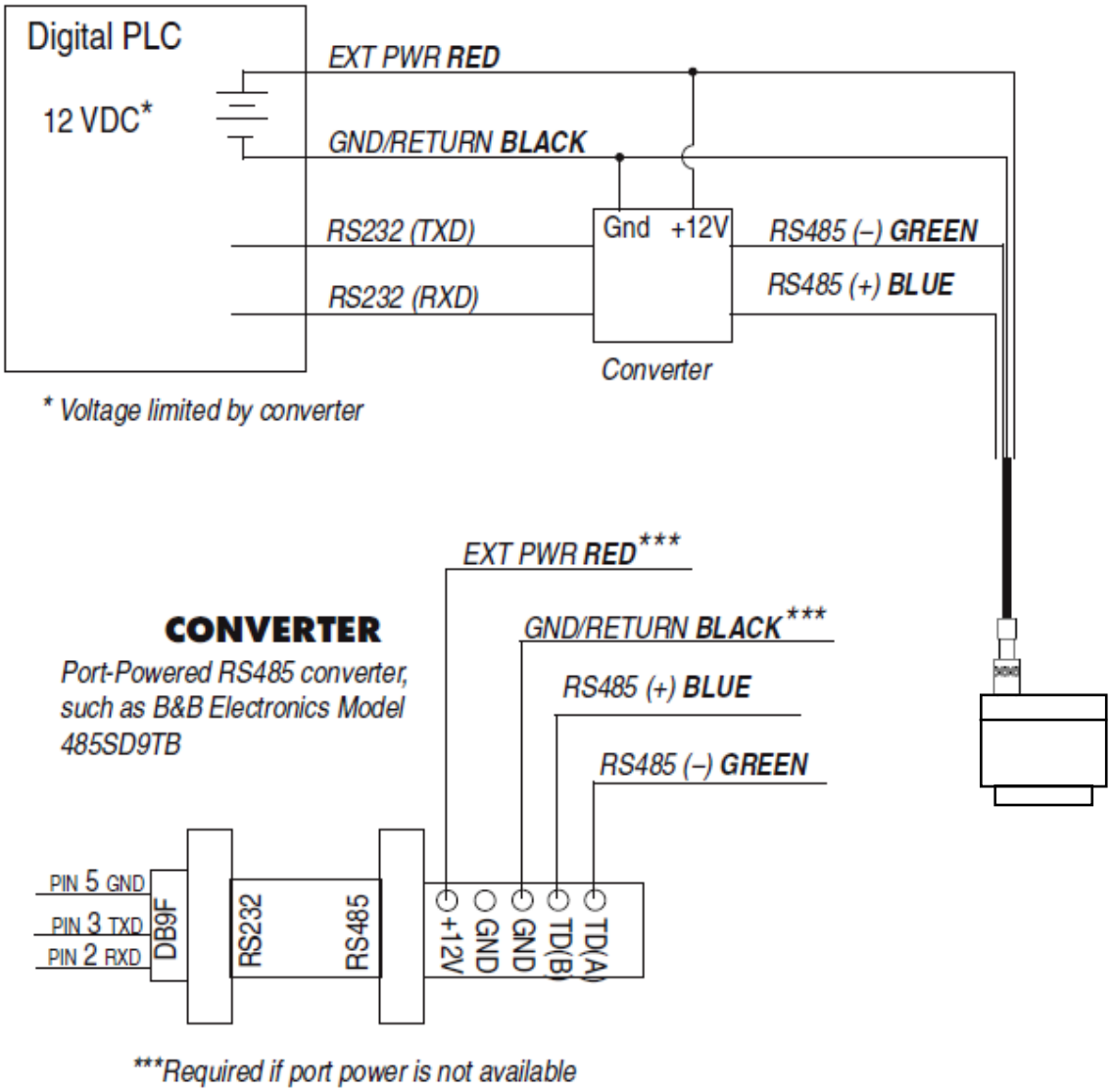
## SDI-12 wiring diagram



## Modbus (RS-485) wiring diagram



# Modbus (RS-232 with converter) wiring diagram



# Modbus PLC Interface

## Overview

The Modbus PLC Interface is a simplified method of communicating with the Level TROLL NC using the Modbus protocol. For information about the specific Modbus registers and Unit IDs for your Level TROLL NC, see Appendices A and B. This instrument conforms to the Modbus standard. For more information about Modbus communication, see www.modbus.org.

## Programming the PLC

This setup uses the instrument's factory default settings. Use VuSitu to reset the instrument to factory defaults if they have been changed. Take note of any changes in default units setup.

1. Set up the serial communication to match the instrument communication settings. Communication settings can be changed with the VuSitu mobile app. The default communication settings are:

| MODE | START BIT | BAUD RATE | DATA BITS | PARITY | STOP BIT |
|---|---|---|---|---|---|
| RTU | 1 | 19200 | 8 | Even | 1 |

2. Set the device address to match the instrument address. The default device address is 1.
3. Read any Modbus register to wake up the instrument. The instrument will return Device Busy for ~5 seconds before readings are available. Send a new wake-up command after 10 seconds of inactivity.
    a. To skip this step in the future, set register 47044 to 1. In this mode, the instrument will take continuous readings whenever power is supplied. After applying power, wait 5 seconds + the data averaging time before taking a reading so the averages can build (See the Data Averaging section of this manual). In power-constrained systems, set the controller to supply power only during readings, and allow time for the averages to build each time power is applied.
    b. In power-constrained systems where the controller cannot remove power between readings, you can leave register 47044 set to 0 to conserve power. The instrument will time out after 10 seconds of inactivity and stop taking readings until another wake-up command is sent. As a result, readings in this mode will include incomplete averages.
4. Select the register to read on the PLC using the information in the following sections.
    a. If your PLC requires a register address, subtract 40001 from the holding register number. For example: Holding Register Number 45451 corresponds to Register Address 5450.
5. Set the type of register to: 32-bit float. If asked by the PLC this is 2 registers.
6. Set the byte order to: Big Endian (MSB). This should be the default and may not be configurable on all PLCs.

## Reading Device Information

Use the following registers to read general information about the instrument.

| HOLDING REGISTER NUMBER | REGISTER ADDRESS | SIZE (REGISTERS) | DATA TYPE | DESCRIPTION |
|---|---|---|---|---|
| 49001 | 9000 | 1 | uint16 | Device Id: 47 = Level TROLL NC |
| 49002 | 9001 | 2 | uint32 | Serial Number |
| 49007 | 9006 | 1 | uint16 | Firmware version (100 = 1.00) |

# Reading Parameters

Each parameter contains a block of 7 registers as shown in the table below. To read measurements for a specific parameter, look up the starting register for that parameter from the list of Parameter Numbers and Locations in Appendix A. Once you have the starting register, add the number of offset registers for additional information about the reading.

| REGISTER OFFSET | SIZE (REGISTERS) | MODE (R/W) | DATA TYPE | DESCRIPTION |
|---|---|---|---|---|
| 0 | 2 | R | float | The measured value from sensor |
| 2 | 1 | R | uint16 | Data Quality ID:<br>0 = No errors<br>3 = Error reading parameter<br>For additional errors or information, contact technical support. |
| 3 | 1 | R/W | uint16 | Units ID for this parameter. See: Appendix B. |
| 4 | 1 | R | uint16 | Parameter ID for this parameter. See: Appendix A. |
| 5 | 2 | R/W | float | Off line sentinel value: The value that's returned on error or if the parameter isn't available. The default sentinel is 0.0 |

For example, you can apply this information to collect a reading for Water Level.

From the list in Appendix A, you can find that the starting register for Water Level is 46137. A reading from holding register number 46137 will return the measured value of Water Level.

Some PLC devices use the holding register number directly in programming statements, others use register addresses. Refer to PLC manufacturer instructions to determine which programming style to use.

You can use the register offsets listed in the table above to collect additional information about the reading. Adding the register offset of 2 to the starting register, you can find that holding register number 46139 will return the Data Quality ID for the most recent Water Level measurement. Likewise, holding register number 46140 will return the Units ID, which can be interpreted from Appendix B. Register number 46141 will return the Parameter ID, which can be interpreted from Appendix A. Register number 46142 will return the sentinel value for this parameter.

The Units ID and Sentinel Value are writeable registers. Measurements can be changed to other units using the Units ID as shown in Appendix B. For example, if holding register number 46140 (Water Level Units ID) returns 35, Water Level is configured to report in m. Looking at Appendix B, you can find that ft is also a valid unit which can be set by writing Units ID 38 to holding register number 46140.

# Troubleshooting Errors

Most errors are related to the Tilt Angle or Signal to Noise Ratio. If these parameters are out of the acceptable ranges, the instrument will not be able to take readings, and all parameters will return the sentinel value with Data Quality ID 3. See the section on Diagnostic Parameters in this manual to learn more about troubleshooting these errors. If the error persists, contact Technical Support for further troubleshooting.

# Configuring SDI-12 Settings

## About SDI-12

This instrument conforms to the general SDI-12 Standard Version 1.3. For more information about SDI-12 commands, see Appendix C.

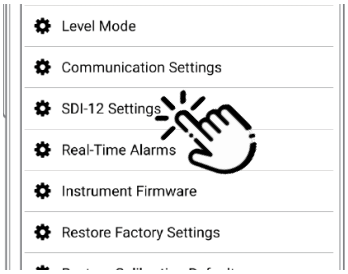
## SDI-12 Parameter Defaults

By default, SDI-12 parameters are enabled and output as described in the table below. You can use VuSitu to enable additional parameters or configure custom parameter outputs.

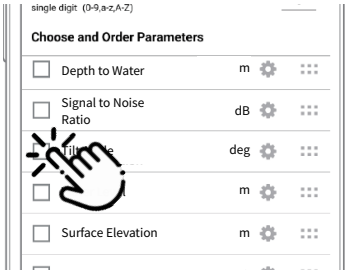
| DEFAULT ORDER | PARAMETER | DEFAULT UNITS |
|---|---|---|
| 1 | Depth to Water | m |
| 2 | Signal to Noise Ratio | dB |
| 3 | Tilt Angle | deg |

VuLink may automatically disable SDI-12 communication to avoid conflicts with other SDI-12 instruments on the VuLink network. To re-enable SDI-12 communication, connect to the instrument with a TROLL Com Plus and go to **Instrument Settings** in VuSitu.

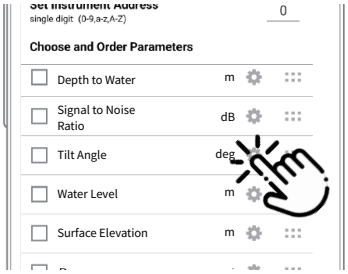
## Configure Custom SDI-12 Parameters in VuSitu



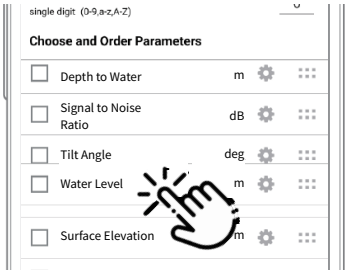

Connect to VuSitu and select **Instrument Settings.** Choose **SDI-12 Settings.**




Use the checkboxes to select parameters to display.




Tap the gear icon to adjust the units for each parameter.




Drag and drop parameters to change the order.

# Accessories

## Accessory Part Numbers

| PART NUMBER | PART NAME |
|---|---|
| 1026010 | Level TROLL NC Bubble Level Replacement Kit |
| 0052530 | Level TROLL Maintenance Kit |
| 1025550 | Mounting Bracket |

# Level TROLL® NC

**The Level TROLL NC is a high-performance, 80 GHz FMCW radar sensor designed for non-contact water level measurement. Seamlessly integrating into our shared ecosystem, it features a twist-lock connector and intuitive VuSitu mobile app compatibility for easy setup and data collection.**

### STREAMLINE DATA MANAGEMENT

- Reduce training and installation time by connecting your instrument to a TROLL® Com Plus[1] for access to the intuitive VuSitu Mobile App.
- VuSitu simplifies instrument setup with user-friendly guides like the Log Setup Assistants. Features like Setup Assistant and Panoramic Live Data make deployment setup quick and easy. And you can tag data with site photos and GPS coordinates for convenient organization.
- VuSitu instantly uploads all logs, live recordings, and other files to your HydroVu® account for secure data access, storage and management.
- Connect Level TROLL NC to VuLink[2] Telemetry to access real-time data and critical event notifications from remote monitoring sites in HydroVu Data Services or a third-party data collection platform.

### ACCURATE, RELIABLE, & LOW MAINTENANCE

- **Contactless Measurement:** Because the instrument and its cable never come directly in contact with the water, it is ideal in locations where the instrument or cable might be damaged by debris, pumps, severe turbulence, or corrosive liquids.
- **Low Maintenance:** The Level TROLL NC is easy to setup and quick to deploy. The bubble level on top of the sensor paired with the In-Situ mounting bracket makes leveling the radar even easier. And, with no periodic calibration required, once you have the radar setup for logging, there should be minimal maintenance.
- **Accuracy:** Setting the Active Zone or enabling Peak Detection further refines the signal detection algorithm of the radar leading to more reliable and accurate water level data. The Level TROLL NC meets United States Geological Survey (USGS) surface water specification of ±0.01 ft for streamgaging.
- **Flexibility:** The Level TROLL NC has a narrow beam angle of just 5°, which allows for more flexibility in deployment locations and requires less open area under the sensor than other non-contact level sensors.

### TOTAL FIELD SUPPORT

- **Receive technical support and online resources.**
- **Order Level TROLL NC from the In-Situ website.**
- **Get guaranteed 7-day service for maintenance (U.S. only).**

## Applications:

- **LAKE AND RIVER STAGE MONITORING**
- **FLOOD MONITORING**
- **SEA LEVEL MONITORING**
- **DREDGING COMPLIANCE**
- **TIDE GAUGING**

| GENERAL | |
|---|---|
| DIAMETER | 80 mm (3.15 in) |
| HEIGHT | 74 mm (2.9 in); 102 mm (4 in) with connnector |
| WEIGHT | 616 g (1.3 lbs) |
| SENSOR RANGE | 15 m, 30 m, and 50 m |
| DEAD ZONE | 0.2 m |
| ACCURACY | ±2 mm |
| RESOLUTION/PRECISION | 0.5 mm |
| READING RATE | 1 Hz |
| UNITS OF MEASURE | Level: mm, cm, m, ft, in |
| METHODOLOGY | W-band 77-81 GHz FMCW Radar |
| DERIVED PARAMETERS | Water Level, Surface Elevation |
| **MECHANICAL** | |
| EXTERNAL POWER VOLTAGE | 9 - 27 VDC (12V 450 mA rating) |
| EXTERNAL POWER CURRENT | Power on: 60 mA for 0.5 s at 16 VDC<br>Average reading: 29 mA at 16 VDC<br>Idle (SDI-12): 6.2 mA at 16 VDC |
| OPERATING TEMPERATURE | -40° C to 85° C |
| CALIBRATED TEMPERATURE | -40° C to 85° C |
| STORAGE TEMPERATURE | -40° C to 85° C |
| ENVIRONMENTAL RATING | IP68 with Twist-Lock cable attached. IP67 with no cable |
| **INSTRUMENT COMMUNICATION** | |
| COMMUNICATION OUTPUT OPTIONS | Modbus/RS485, SDI-12 |
| CABLE | Rugged Cable |
| SOFTWARE INTERFACE | Android/iOS: VuSitu Mobile App (see app store for OS requirements)<br>Data Services: HydroVu |
| **CERTIFICATIONS** | **CE, FCC, UKCA, WEEE** |
| **WARRANTY** | **2 YEAR** |

**NOTES:** [1]When used with a communication device, Level TROLL NC must be powered by a TROLL Com Plus, it will not be powered sufficiently with a Wireless TROLL Com. [2]When paired with the Level TROLL NC, VuLink must be powered using lithium batteries only with a maximum of one instrument connected. VuLink will not collect Level TROLL NC data without sufficient power.

# Appendix

## Appendix A: Parameter Numbers and Locations

| ID | PARAMETER NAME | HOLDING REGISTER NUMBER | REGISTER ADDRESS | DEFAULT UNITS |
|---|---|---|---|---|
| 4 | Depth to Water | 45472 | 5471 | 35 = meters |
| 5 | Surface Elevation | 45479 | 5478 | 35 = meters |
| 99 | Water Level | 46137 | 6136 | 35 = meters |
| 100 | Signal to Noise Ratio | 45514 | 5513 | 385 = decibels |
| 101 | Tilt Angle | 46151 | 6150 | 401 = degrees |

## Appendix B: Unit IDs

| ID | ABBREVIATION | UNITS |
|---|---|---|
| **SIGNAL TO NOISE RATIO** | | |
| 385 | dB | Decibels |
| **ANGLE** | | |
| 401 | deg | Degrees |
| **DISTANCE/LENGTH** | | |
| 33 | mm | Millimeters |
| 34 | cm | Centimeters |
| 35 | m | Meters |
| 37 | in | Inches |
| 38 | ft | Feet |

# Appendix C: SDI-12 Commands

| NAME | COMMAND | RESPONSE | RESPONSE AND COMMENTS |
|---|---|---|---|
| Address Query | ?! | a<CR><LF> | The wildcard address '?' character is supported only for the Address Query command. It is ignored as an invalid address for all other commands. |
| Acknowledge Active | a! | a<CR><LF> | Basic address characters in the range '0' to '9' and extended address characters in the ranges 'A' to 'Z' and 'a' to 'z' are supported. All other characters are ignored as an invalid address. Default address is '0' |
| Change Address | aAb! | b<CR><LF> | Software changeable addresses and the Change Address command are supported. |
| Send Identification | aI! | a13IN-SITU LTNC vvv xxxxxxxxxx<CR><LF> | where: vvv = device firmware version × 100 (1.20 = 120)<br>xxxxxxxxxx = device serial number with leading zeroes |
| Start Verification | aV! | a0001<CR><LF> | One result is available immediately for reading by the Send Data command. |
| Send Data | aD0! | a+v<CR><LF> | v = 0: The device is not ready<br>v = 1: The device is ready |
| Start Measurement | aM! | atttn<CR><LF> | n parameters (up to 9) will be available for reading by the Send Data command within ttt seconds. A service request (a<CR><LF> or a<CRC><CR><LF>) will be sent when the parameters are ready. The number of parameters returned is determined by the SDI-12 configuration in VuSitu. |
| Start Measurement with CRC | aMC! | atttn<CRC><CR><LF> | |
| Send Data | aD0!...aD9! | a<values><CR><LF> or a<values><CRC><CR><LF> | Up to 3 parameters are returned in a Send Data command. If more than 3 parameters have been configured in VuSitu, they are returned using additional data commands. |
| Start Concurrent | aC! | atttnn<CR><LF> | nn parameters will be available for reading by the Send Data command within ttt seconds. No service request will be sent when the parameters are ready. The number of parameters returned is determined by the SDI-12 configuration in VuSitu in the same manner as a Start Measurement command. |
| Start Concurrent CRC | aCC! | atttnn<CRC><CR><LF> | |
| Send Data | aD0!...aD9! | a<values><CR><LF> or a<values><CRC><CR><LF> | Up to 6 parameters will be returned per Send Data command. |