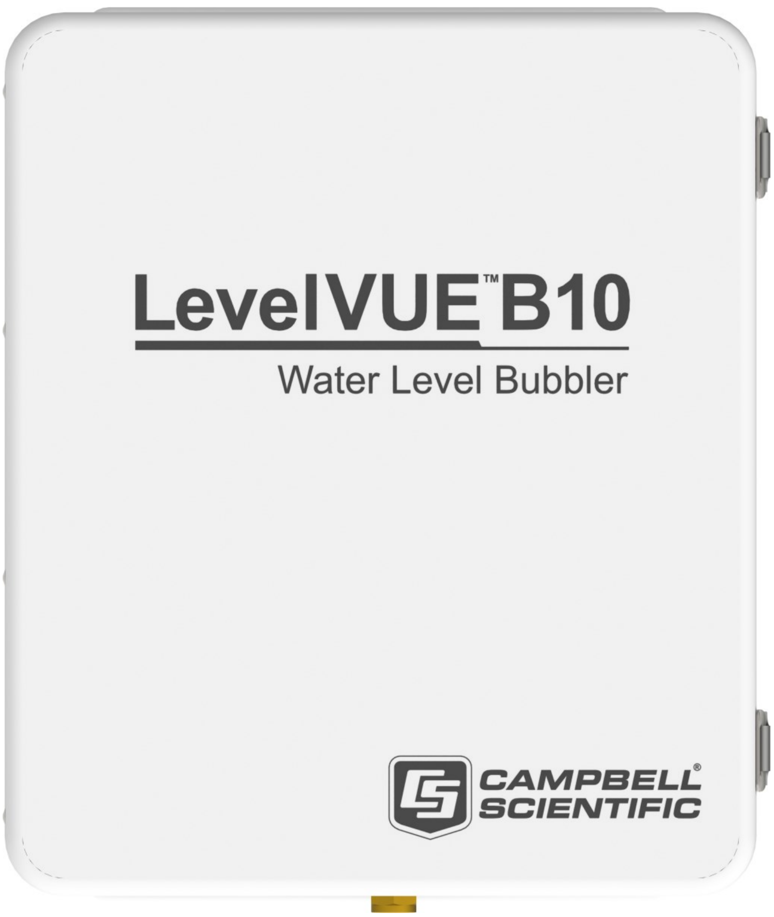
Product Manual

Sensor

LevelVUE™ B10

Water-Level Continuous Flow Bubbler with Integrated Screen



Revision: 03/2021

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1. Introduction

The LevelVUE B10 is a continuous-air-flow bubbler that measures ground water, surface water, or any liquid level. It consists of an integrated circuit board, pressure sensors to measure and control tank and line pressures, a 12 VDC industrial compressor, a 0.8 liter air tank, and an integrated keypad/display. Three pressure ranges are available: 15 psi (34.6 ft, 10.5 m), 30 psi (69.2 ft, 21.0 m), or 50 psi (115 ft, 35.0 m). The bubbler communicates with a data logger or RTU using either SDI-12 or Modbus protocols. Although this document only includes example programs for Campbell Scientific CRBasic data loggers, any data logging device capable of SDI-12 or Modbus communications can be used to retrieve the LevelVUE B10 measurements.

2. Precautionary statements

- READ AND UNDERSTAND the Safety section at the back of this manual.
- Not using a desiccator will void your warranty. Campbell Scientific offers a desiccator kit, which is recommended for use with the LevelVUE B10.
- The sensor can survive temporary operation for 1.5 times the maximum rated pressure (Table 5-1 (p. 4). However, measurements made beyond the rated pressure range will be inaccurate.
- Do not use quick connect fittings as these tend to leak.
- Mount the LevelVUE B10 in a location where it will not get jarred or shift during operation.

3. Initial inspection

- Upon receipt of the LevelVUE B10, inspect the packaging for shipping damage, and, if found, report the damage to the carrier in accordance with policy.
- Carefully open the package to avoid damaging or cutting the orifice-line tubing (if ordered). A thorough inspection of the tubing is prudent.

- Compare the pressure range printed on the bottom of the enclosure with the pressure range listed in the shipping document to ensure that the correct pressure range was received.
- Verify that the orifice line Swagelok® fitting and air intake line barbed fitting were shipped with the LevelVUE B10. They are shipped in a small bag inside the enclosure. Do the following to locate these items:
  - Open the enclosure lid
  - Press on the black magnet
  - Lift the keypad panel
- > **NOTE:**
  > The orifice line Swagelok® fitting may already be installed on the LevelVUE B10.
- Verify that all bubbler accessories were sent. The following accessories (ordered separately) are often shipped with the LevelVUE B10:
  - Orifice line
  - Desiccator kit
  - Desiccant

4. Overview

The LevelVUE B10 bubbler incorporates all the components of a self-contained pressurized air supply system. It has an air compressor, air tank, and other components of older conoflow systems. However, instead of pressurized air tanks and manual valves used in conoflow systems, the LevelVUE B10 meters the airflow to create a constant flow in the line regardless of the water depth above the orifice. Precision sensors monitor the tank and line pressures to consistently maintain the same airflow. The precision sensor monitoring the pressure on the orifice line precisely detects the pressure required to push air through the line. This pressure value is directly related to water depth. A simple conversion is applied to the pressure value to generate water depth in feet, meters, or other units. Proprietary electronics control the pump and calculate the measurements. The LevelVUE B10 has a digital SDI-12 or RS-485 output that allows any data logger that supports SDI-12 or Modbus protocols to retrieve the LevelVUE B10 measurements. FIGURE 4-1 (p. 3) shows a LevelVUE B10-based system that uses a Campbell Scientific data logger and SDI-12 protocol.

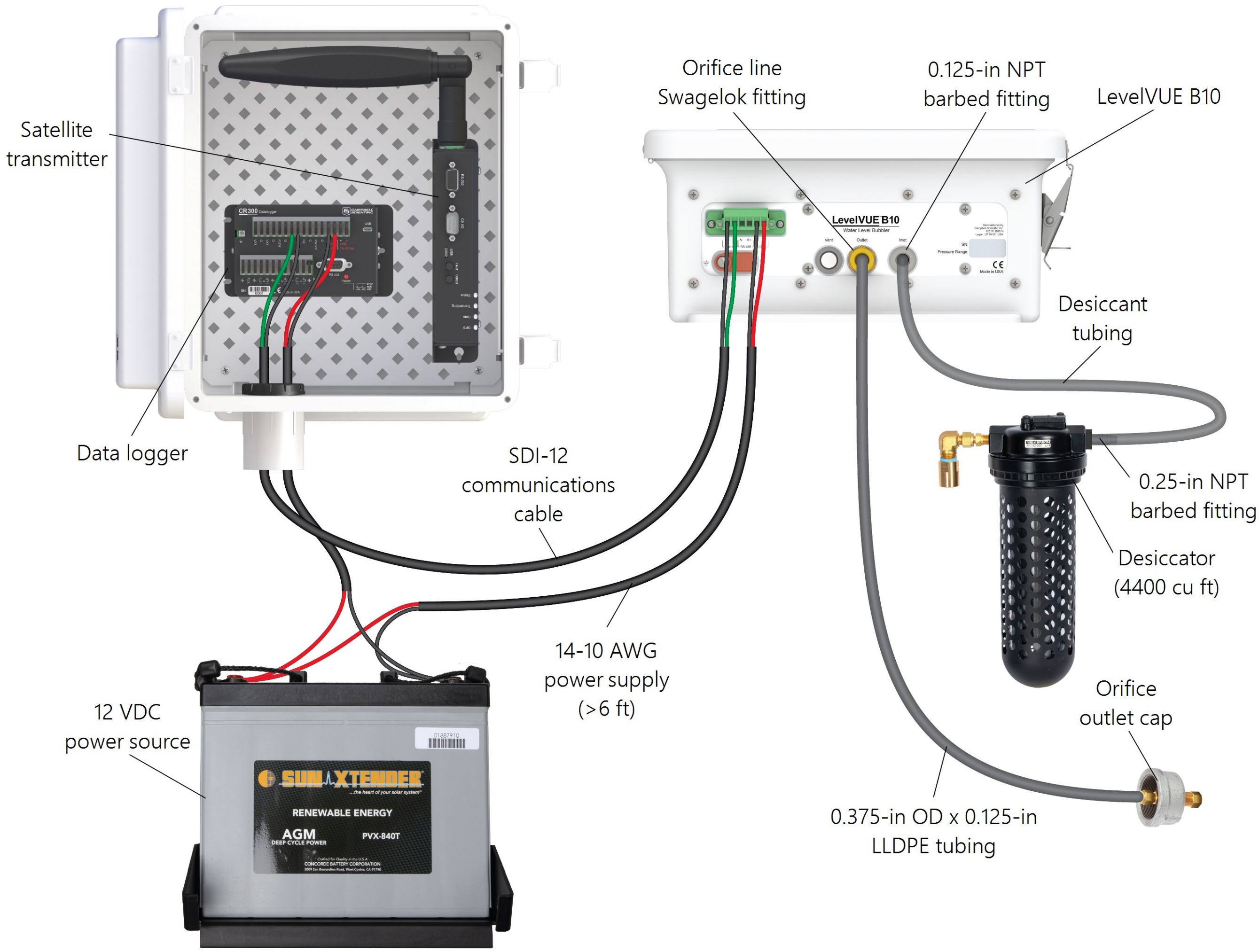


FIGURE 4-1. Components in a LevelVUE B10-based system

The LevelVUE B10 environmental enclosure can be mounted next to rivers, in stilling wells, or on or near bridges. Only the orifice line contacts the water, which allows the bubbler to work in areas that would damage submersed sensors due to corrosion, contamination, flood-related debris, lightning, or vandalism. It also can be used in stream beds that periodically dry up or in sub-zero temperatures if the water is still flowing. Unlike radar gages, bubbler measurements are not affected by wind.

Features:

- Proprietary high-pressure/high-volume purge operation to prevent sediment buildup
- High-volume industrial air compressor
- Low power consumption
- –40 to 60 °C operation

- Three pressure ranges: 15 psi, 30 psi, and 50 psi
- Built-in keypad/display for full setup, measurement, and maintenance operations
- Proprietary air flow/bubble generation for years of trouble-free operation
- Large volume desiccator to minimize maintenance frequency
- Incorporated SDI-12 version 1.4 metadata commands for identification of data
- Compatible with SDI-12 and Modbus controllers including Campbell Scientific CR300 series, CR6 series, CR800 series, CR1000X series, CR3000, and GRANITE-series data loggers
- High water mark detection (crest stage) between normal SDI-12 measurement requests

5. Specifications

Compliance documents: View at www.campbellsci.com/levelvueb10

5.1 Pressure transducer

Table 5-1: Pressure range, depth, and resolution

Pressure range	Water depth range[1]	Resolution
0 to 15 psi	0 to 10.54 m (34.6 ft)	±2.1 mm (0.007 ft)
0 to 30 psi	0 to 21 m (69.20 ft)	±4.26 mm (0.014 ft)
0 to 50 psi	0 to 35.16 m (115.35 ft)	±7.11 mm (0.023 ft)

[1]Level calculations assume 1 psi = 0.7031 m (2.3067 ft) of water.

Accuracy: ≤ 0.02% of full scale output (FSO) over temperature range

Sensor overpressure rating: 1.5 times the pressure range

5.2 Air flow

Description: Microprocessor controlled constant air flow over full pressure range and temperature.

Bubble rate: Programmable 30 to 120 bubbles per minutes; based on 6.35 mm (0.25 inch) inner-diameter outlet.

60 bubbles per minute default

Purge operation

Manual:	Requested from keypad/display
SDI-12:	Command for purge under program control
Modbus:	Command for purge under program control
Automatic-timed purge:	Once a day to once a month with 1 day resolution
Purge pressure:	30 to 90 psi, programmable
Purge sustain time:	0 to 30 s, programmable
Pressure inlet port:	1/8-inch female NPT
Orifice-line outlet port:	1/8-inch female NPT

5.3 Power

Input voltage range:	11.5 to 16.5 VDC
Current	
Standby:	5 mA
Compressor active:	7 A typical, 10 A maximum
Start-up surge current:	18 A maximum

5.4 Communications

SDI-12	SDI-12 V 1.4 compliant
Response time:	10 s for **M!** SDI-12 command with default averaging time of 5 seconds
Default address:	0
RS-485	
Protocol:	Modbus
Default address:	1
Default configuration:	8-bit, even parity, 1 stop bit, 19200 bps baud rate
Data type:	32-bit float, no reversal of the byte order (ABCD)
Built-in keypad/display:	Graphical 8-line-by-20-character display. Menu fully supports system setup.

5.5 Enclosure

Material:	Fiberglass
Width:	28.9 cm (11.4 in)
Height:	34 cm (13.4 in)
Depth:	13 cm (5.2 inch)
Weight:	7.5 kg (16.5 lb)

5.6 Environmental

Operating temperature:	–40 to 60 °C
Storage temperature:	–40 to 80 °C
Relative humidity:	0 to 95%, non-condensing

6. Installation

6.1 Verify operation

Before installing the LevelVUE B10, verify its operation using the following procedure:

1. Remove the plug from the orifice line **Outlet** fitting on the LevelVUE B10. Save the plug for use later.
2. Connect the LevelVUE B10 to the power supply (Wiring (p. 7)). After connecting the bubbler to the power supply, the bubbler will take an initial atmospheric measurement and

calibrate itself. The compressor also will turn on to initially charge the tank and start the flow of air out of the system. If the compressor does not turn on, check the power supply. The LevelVUE B10 must be connected directly to the battery.

3. Connect a short piece of orifice line tubing to the **Outlet** fitting and place the end of the tubing in a bucket or tube of water, and bubbles should appear in 15 to 20 seconds.
4. Press the soft key button directly under **Measure** on the display to initiate a measurement sequence. Once the measurement is complete ensure that the reading is reasonable based on the depth of the orifice line and an offset of 0.00.
5. Press the soft key button directly under **Purge** on the display to initiate a line purge. The compressor will charge the tank to 60 psi and release the air out the orifice line. This may take a few seconds.

6.2 Wiring

Terminals and connectors are on the bottom of the LevelVUE B10 enclosure (FIGURE 6-1 (p. 7)).

FIGURE 6-1. LevelVUE B10 connector panel

Table 6-1 (p. 8) provides wiring to a data logger when using SDI-12 and Table 6-2 (p. 8) provides wiring to a data logger when using Modbus. The air compressor and electronics connect directly to the battery using a 16 to 20 AWG wire. Keep wire lengths less than 3 m (6 ft).

The SDI-12 output can be directly read by many devices including all Campbell Scientific data loggers. RS-485 output can be directly read by a CR6-series, CR1000X-series, or Modbus RTU RS-485 network. Other Campbell Scientific data loggers can use an MD485 multidrop interface to read the RS-485 output. Refer to the MD485 manual for information about using the MD485.

Table 6-1: LevelVUE B10 terminal, function, and connections for SDI-12 measurements			
LevelVUE B10 terminal	Function	Data logger or RTU terminal	Power supply
SDI-12 Data	SDI-12 signal	**SDI-12 Data**, **C**, **SDI-12**, or **U** configured for SDI-12[1]	
SDI-12 G	Ground	⏚ or **G** (digital ground connection)	
12Vdc +	Power		**12V**
12Vdc –	Power ground		**G**, **GND**

[1]**U** and **C** terminals are automatically configured by the measurement instruction for Campbell Scientific CR6 data logger.

NOTE:
For Campbell Scientific CR6 and CR1000X data loggers making SDI-12 measurements, conflicts may occur when a companion terminal is used for a triggering instruction such as `TimerInput()`, `PulseCount()`, or `WaitDigTrig()`. For example, if the LevelVUE B10 is connected to **C3** on a CR1000X, **C4** cannot be used in the `TimerInput()`, `PulseCount()`, or `WaitDigTrig()` instructions.

Table 6-2: LevelVUE B10 terminal, function, and connections for Modbus measurements			
LevelVUE B10 terminal	Function	Data logger or RTU terminal[1]	Power supply
RS-485 A–	RS-485A	**A–**, **C** odd	
RS-485 B+	RS-485B	**B+**, **C** even	
12Vdc +	Power		**12V**
12Vdc –	Power ground		**G**, **GND**

[1]Assumes the sensor directly connects to the data logger.

6.3 Power considerations

The current load of the internal compressor requires the LevelVUE B10 to be connected directly to the 12 VDC battery. The battery should be recharged using AC power or a solar panel. Do not power the LevelVUE B10 using the 12 V excitation terminal from the data logger and do not use the PS150 or PS200 because the current limit switch on these devices will trip when the compressor tries to turn on. Specific power requirements depend on communications methods, frequency of site visits, and site location. Contact Campbell Scientific for more information.

6.4 Default settings

For most applications, the default settings (Table 6-3 (p. 9)) allow the LevelVUE B10 to work out of the box with only minor changes such as setting an offset. Settings can be changed by using the keypad/display, the SDI-12 extended commands, or Modbus commands (Modbus register map (p. 30)).

Table 6-3: LevelVUE B10 user options

Option	Default value	Comments/quick reference
Stage setup menu options		
Stage	N/A	Displays the last measured stage value. Enter a floating point value of the desired stage reading to automatically calculate the stage offset
Units	Feet	Options are feet, meters, inches, centimeters, millimeters, psi, and user-defined
Slope	2.3067 (feet)	Automatically set based on stage units. If stage units are user defined, this option accepts a floating point value.
Offset	0.0	Either automatically calculated based on the stage entry or entered as a floating point value
Num Stage Digits	2	Digit range is 2 to 4. Sets the number of digits to the right of the decimal for the stage value
Measure Average	5 s	Range is 1 to 255 s
Bubbler setup menu options		
Bubble Rate	60 bubbles per minute	Bubble-rate range is 30 to 120 bubbles per minute
Purge Pressure	60 psi	Purge-pressure range is 30 to 90 psi
Purge Sustain	10 s	Purge-sustain range is 0 to 60 s

Table 6-3: LevelVUE B10 user options		
Option	**Default value**	**Comments/quick reference**
Auto Purge	0	Range is 0 to 30 days 0 disables auto purge 1 to 30 = once a day to once every 30 days
System setup menu options		
Date	Does not reset	System date in format of yyyy/mm/dd
Time	Does not reset	System time in format of hh:mm:ss
Display Sleep	5 minutes	Range is 1 to 15 minutes
Display Brightness	80%	Range is 10 to 100%
Temperature Units	° C	Options are ° C or ° F
Reset to Defaults	N/A	Resets options to default values
Communications setup menu options		
SDI-12 Address	0	Possible addresses: 0 to 9 (Standard), A to Z, a to z
Modbus Address	1	Possible addresses: 1 to 247.
RS-485 Baud Rate	19200 bps	Standard baud rates from 9600 to 115200 bps
RS-485 Parity	even	Options are even, odd, none
RS-485 Stop Bits	2	Options are 1 or 2
Diagnostics/test menu options		
Status Errors	N/A	Displays error (Table 7-1 (p. 24) or none if no errors are detected
Test Line Noise	N/A	Press **Enter** to perform a line noise test
Test Line Leak	N/A	Press **Enter** to perform a line leak test
Reset Min / Max	N/A	Press **Enter** to reset the min and max battery values to the current battery value level
Min Battery Voltage	N/A	Displays the minimum voltage detected on the battery

Table 6-3: LevelVUE B10 user options		
Option	**Default value**	**Comments/quick reference**
Max Battery Voltage	N/A	Displays the maximum voltage detected on the battery
System information menu options		
Clear Purge Counter	N/A	Press **Enter** to reset purge counter to zero
Clear System Reset Counter	N/A	Press **Enter** to reset the system reset counter to zero
Purge Counter	N/A	Displays the number of purges since last reset
System Reset Counter	N/A	Displays the number of system resets since last reset
Sensor SN	N/A	Displays the sensor serial number
OS version	N/A	Displays the current operating system version

6.5 Setup using keypad/display

The LevelVUE B10 includes a keypad/display to set up, make measurements, and troubleshoot the unit. Although the LevelVUE B10 can be completely setup using the SDI-12 or Modbus protocols, using the keypad/display is more convenient for setting up and testing. Open the enclosure lid to access the keypad/display.

FIGURE 6-2. LevelVUE B10 keypad/display

Press the right arrow key to open a menu and show the available options. Fixed values are shown next to an equal sign (**=**), while editable options are displayed inside square brackets (**[ ]**). To edit a menu, press the right arrow key at the chosen menu and use the up and down arrow keys to make the changes to the parameter.

The following example shows the process for changing the stage setting.

1. Press the down arrow key to move to the setup screen.
2. Press the right arrow key to access the stage setup screen.
3. Press the right arrow key and press the **Enter** key.
4. Use the right and left arrow keys to move the cursor to the digit you want changed, then use the up and down arrow keys to change the number.
5. Press **Enter** when the number is changed to the correct value.

6.6 Campbell Scientific data logger programming

A data logger or RTU can remotely control and retrieve LevelVUE B10 data. Programming basics for Campbell Scientific CRBasic data loggers are provided in the following sections. If using another manufacturer's data logger or RTU, refer to their documentation for programming information. An SDI-12 program example for a Campbell Scientific data logger is provided in Example program (p. 46).

6.6.1 SDI-12 programming

The `SDI12Recorder()` instruction is used to measure a LevelVUE B10 configured for SDI-12 measurements. This instruction sends a request to the sensor to make a measurement and then retrieves the measurement from the sensor. See SDI-12 measurement and extended commands (p. 27) for more information.

For most data loggers, the `SDI12Recorder()` instruction has the following syntax:

```
SDI12Recorder(Destination, SDIPort, SDIAddress, “SDICommand”, Multiplier,
Offset, FillNAN, WaitonTimeout)
```

For the `SDIAddress`, alphabetical characters need to be enclosed in quotes (for example, `“A”`). Also enclose the `SDICommand` in quotes as shown. The `Destination` parameter must be an array. The required number of values in the array depends on the command (see Table 7-2 (p. 28)).

`FillNAN` and `WaitonTimeout` are optional parameters (refer to CRBasic Help for more information).

6.6.2 RS-485 programming

The RS-485 output can be directly read by a CR6-series, CR1000X-series, or Modbus RTU RS-485 network. Other Campbell Scientific data loggers can use an MD485 multidrop interface to read the RS-485 output. Refer to the MD485 manual for information about using the MD485.

A CR6 or CR1000X data logger programmed as a Modbus Master can retrieve the values stored in the Input Registers (). To do this, the CRBasic program requires `SerialOpen()` followed by `ModbusMaster()`. The `SerialOpen` instruction has the following syntax:

```
SerialOpen (ComPort, Baud, Format, TXDelay, BufferSize, Mode)
```

The `Format` parameter is typically set to logic 1 low; even parity, one stop bit, 8 data bits. The `Mode` parameter should configure the ComPort as RS-485 half-duplex, transparent.

The `ModbusMaster()` instruction has the following syntax:

```
ModbusMaster (Result, ComPort, Baud, Addr, Function, Variable, Start, Length,
Tries, TimeOut, [ModbusOption])
```

The `Addr` parameter must match the sensor Modbus address. To collect all of the values, the `Start` parameter needs to be 1 and the `Length` parameter needs to correspond with the register count (see Modbus register map (p. 30). For `ModbusOption` parameter use 2, which means the Modbus variable array is defined as a 32-bit float or a Long, with no reversal of the byte order (ABCD).

6.7 Field installation

6.7.1 Site selection

The site selection is often based on the type of water being measured. Water in rivers and streams will act differently than in lakes and reservoirs. In rivers and streams, choose a location where the water velocity remains constant regardless of water levels. Care must also be taken to prevent errors caused by drawdown and buildup such as around a bridge pier. In lakes and reservoirs, wind can cause wave action and buildup on the face of the dam or other structure. Select a location that will be less affected by these conditions.

6.7.2 Enclosure mounting

1. Choose a location that is accessible for servicing electrical connections and plumbing fittings, but will not get jarred or shifted during operation.
2. Place the enclosure at the desired height with connectors pointing down so that moisture or condensation that could collect on the connectors do not access the inner components of the equipment.

3. Secure the enclosure to a wall or flat surface using user-supplied bolts. The enclosure includes holes at the top and bottom of the enclosure for mounting the LevelVUE B10.
4. Route a 14 AWG copper wire from the enclosure grounding lug to an earth ground.

6.7.3 Desiccator installation

> **WARNING:**
> Not using a desiccator will void your warranty.

An external desiccator is required to dry the compressor intake air and prevent accumulation of moisture in the tank, manifold, and other areas in the system. Campbell Scientific offers a desiccator kit (FIGURE 6-3 (p. 16)), which is recommended for use with the LevelVUE B10.

FIGURE 6-3. Desiccator kit (indicating desiccant not shown)

Desiccator installation procedure:

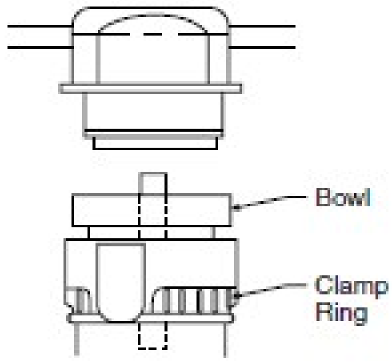
1. Use the desiccator kit bracket to mount the desiccator as close to the LevelVUE B10 enclosure as possible.

> **NOTE:**
> Campbell Scientific offers a long desiccant tube if the desiccator needs to be located farther away from the bubbler than normal, such as when air must be drawn from outside the main enclosure.

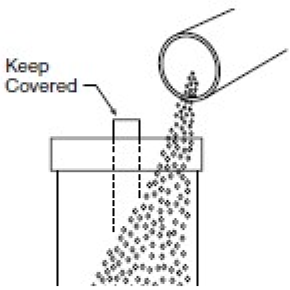
2. Insert the threaded end of the 1/4-inch NPT barbed fitting included in the desiccator kit into the desiccator connector.
3. Insert the threaded end of the air-intake 1/8-inch NPT barbed fitting into the **Inlet** port of the LevelVUE B10, then connect the desiccator output tubing to both barbed fittings.

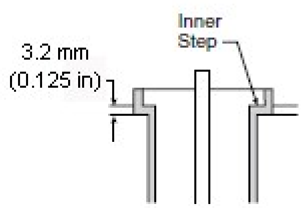
> **NOTE:**
> The LevelVUE B10 is shipped with a plug inserted in the intake port that needs to be removed before inserting the 1/8-inch NPT barbed fitting.

4. Loosen the clamp ring on the desiccator and remove the bowl from the top housing.



5. Pour desiccant into the bowl; shake and tap bowl while filling to settle desiccant. Fill to 3 mm (0.1 in) below inner step of bowl.





6. Replace the bowl and bowl guard.

CAUTION:
Ensure that the clamp ring is securely locked in place before operating the unit.

6.7.4 Orifice line and conduit installation

To ensure accurate data, consider the following while siting and installing the orifice line:

- Install the orifice line in an area that will remain relatively calm. A stilling well is a good option.
- Install the orifice line at a continuous downward slope from the LevelVUE B10 to the outlet, avoiding swells, dips, and depressions.
- If possible, use one continuous orifice line to eliminate junctions or splices, which are potential sources for leaks. Campbell Scientific offers orifice line that comes in 152 m (500 ft) rolls, which suits most applications. If a continuous line is not possible, install the junction or splice in a serviceable enclosure.
- Do not use quick connect fittings as these tend to leak.

- Protect the orifice line inside a 53 mm (2-inch) steel conduit that is fastened to a permanent and secure structure such as bridge pier, cement slab, or pilings.
- Avoid sharp bends in the conduit during installation. Sharp bends can result in kinks and make installation more difficult.
- If the orifice line crosses a road, ensure that it is buried deep enough to prevent the line from being crushed from vehicles using the road.
- Use an orifice-line cap to secure the orifice line output to the conduit. The orifice-line cap offered by Campbell Scientific works for most installations. Refer to Orifice-line outlet types (p. 38) for more information.
- Mount the orifice-line outlet vertically or slightly turned to the horizontal position and perpendicular to the primary direction of flow. Refer to Orifice-line outlet orientation (p. 37) for more information.

The installation procedure follows:

1. Secure the conduit to a permanent and secure structure such as bridge pier, cement slab, or pilings.
2. Route the orifice line inside the conduit.
3. Insert the orifice line into the Swagelok® compression fitting of the orifice outlet cap and tighten the fitting (FIGURE 6-4 (p. 18)).

FIGURE 6-4. Orifice outlet cap

4. Loosen the big nut on the outside of the cap to allow the brass fitting to freely turn inside the end cap.
5. Screw the end cap onto the 2-inch conduit. While screwing on the end cap, ensure that the brass fitting does not move, which means the orifice line is not being twisted.
6. Once the end cap is secure, tighten the big nut on the end of the cap to secure the brass fitting.
7. At the bubbler end, cut off excessive amount of orifice line.

8. Remove the plug from the Swagelok® fitting on the **Outlet** port.
9. Insert this orifice line into the Swagelok® compression fitting on the bubbler outlet and tighten.
10. Secure any extra orifice line and orient it horizontally to avoid low points in the line.

7. Operation

7.1 Principles of operation

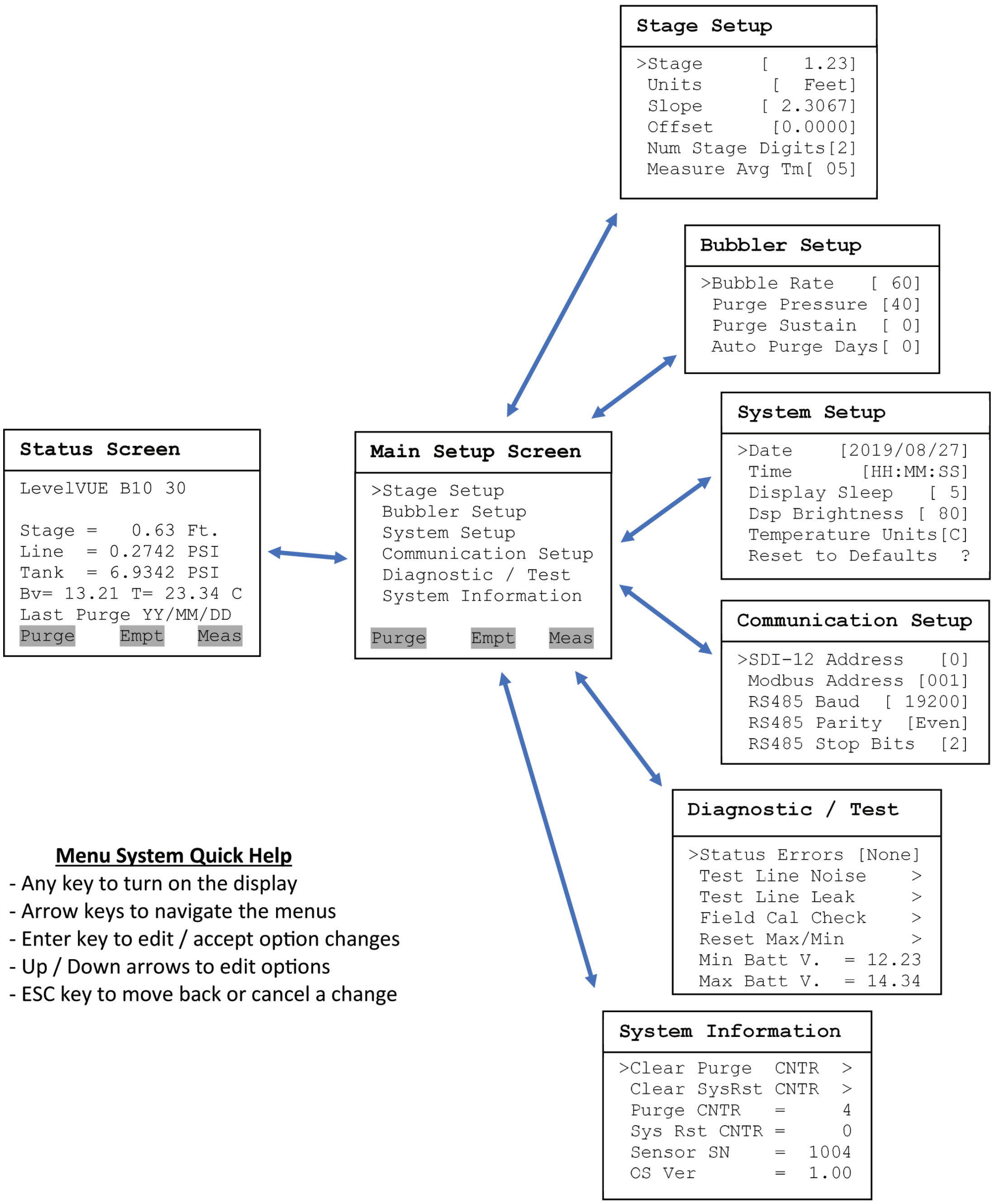
A bubbler operates by establishing a constant flow of air that is independent of the water level (pressure) above the orifice line outlet. As the water level rises, the bubbler increases the pressure in the tank to maintain a constant flow of bubbles. The water level is proportional to the pressure required to move the air to the end of the orifice line. The bubbles indicate air at the end of the line:

Pressure = $\rho \times g \times h$

Where:

Pressure (Pa)
ρ = density of the water (1000 kg/m^3)
g = gravitational constant (9.8 m/s^2)
h = height of the column of water (m)
100 kPa = 14.5 psi

7.2 Keypad/display menu



Menu System Quick Help

- Any key to turn on the display
- Arrow keys to navigate the menus
- Enter key to edit / accept option changes
- Up / Down arrows to edit options
- ESC key to move back or cancel a change

7.2.1 Stage setup

```
Stage Setup
>Stage       [   1.23]
 Units        [  Feet]
 Slope       [ 2.3067]
 Offset       [0.0000]
 Num Stage Digits[2]
 Measure Average[05]
```

Stage: Displays the last measured stage. The user can enter a new stage and the system will calculate a new offset based on the new stage.

Units: Units used to report the water level. Default is feet. When changed, the slope value is automatically adjusted to provide water level measurements in the selected units. The user-defined option allows the user to manually enter a slope that does not match a predefined value.

Slope: Slope or conversion factor used to convert the raw psi reading into units of feet, meters, or user-defined. If the **Units** option is set to user-defined, the slope can be changed to any value.

Offset: Difference between the water-level reference point and the level of the orifice-line outlet. The user can enter the offset here. Alternatively, the user can enter a value for the **Stage [xx.xx]** option and the LevelVUE B10 will calculate the correct offset.

Num Stage Digits: Number of digits used to display the stage value on the display. Default is 2.

Measure Average: Averaging time (in seconds) that the LevelVUE B10 uses to make a water level measurement. Default is 5 seconds. Entering a longer averaging time can reduce noise caused by water conditions such as waves or turbulence. Please note that the actual measurement time will be 3 to 4 seconds longer than this value due to internal processing.

7.2.2 Bubbler setup

```
Bubbler Setup
>Bubble Rate    [ 60]
 Purge Pressure [40]
 Purge Sustain  [ 0]
 Auto Purge Days[ 0]
```

Bubble Rate: Rate of the airflow in the orifice line. Range is 30 to 120 bubbles per minute. The rate is affected by the orifice-outlet size, orientation of the outlet, and the pressure difference in the tank and line, etc. With a lower bubble rate, the air compressor may run less frequently. Higher rates allow the system to respond more quickly to water level increases. Default setting is 60 bubbles per minute, which is sufficient for most applications. With a standard 1/8 ID orifice line and a 1/4 inch outlet, 60 bubbles per minute tracks a rise of 1 foot per 10 seconds. A rise faster than 1 foot per 10 seconds requires a faster bubble rate.

Purge Pressure: Default is 60 psi. Regularly use a high-pressure purge to keep the orifice line clear of debris. Silty streams or installations with long orifice lines may require a higher purge pressure. More frequent purges are also recommended for silty streams.

Purge Sustain: Length of time (in seconds) that the compressor runs after reaching the purge pressure and opening the purge valve. Default is 10. Increasing the purge sustain time may make the purge more efficient and may increase the air flow.

Auto Purge: Automatic purge rate (in days). The automatic purge rate can be once a day to once every 30 days. A setting of 0 disables automatic purging.

> NOTE:
> See the note following the **Date** and **Time** options (System setup (p. 22)) for more information on the **Auto Purge** function.

7.2.3 System setup

```
System Setup
>Date      [2019/08/27]
 Time        [HH:MM:SS]
 Display Sleep    [ 5]
 Dsp Brightness [ 80]
 Temperature Units[C]
 Reset to Defaults  ?
```

Date: A correct date is needed for the **Auto Purge** option. Set this up when you initially set up the system.

Time [HH:MM:SS]: The correct time is needed for the **Auto Purge** option. Set this up when you initially set up the system or if it changes.

> NOTE:
> The **Date** and **Time** are only used for the **Auto Purge** option and should be set to the local time. The **Auto Purge** occurs immediately after the measurement at or just after 12:00 noon, local time. This schedule allows the line to stabilize before the next measurement and ensures that the purge occurs during the day light hours when the battery is at a higher charge level when using solar power. If the **Date** and **Time** are not set, the **Auto Purge** occurs at an unpredictable schedule.

Display Sleep: Amount of time (in minutes) that the keypad can be idle before the display turns off. Default is 5 minutes.

Dsp Brightness: Brightness or contrast of the display. Default is 80.

Temperature Units: Options are degree C and F.

Reset to Defaults ?: Resets to default values (Table 6-3 (p. 9)).

NOTE:
This option does not reset the date, time, minimum and maximum battery voltage, and error and status flags.

CAUTION:
Resetting the LevelVUE B10 to the defaults changes the SDI-12 and Modbus addresses to the defaults. Therefore, SDI-12 or Modbus communications will be unresponsive until the data logger program is changed to match the default addresses or the SDI-12 or Modbus address in the LevelVUE B10 is changed to match the data logger.

7.2.4 Communication setup

```
Communication Setup
>SDI-12 Address    [0]
 Modbus Address [001]
 RS485 Baud   [ 19200]
 RS485 Parity   [Even]
 RS485 Stop Bits   [2]
```

SDI-12 Address: Valid addresses are 0 through 9, a through z, and A through Z. Each SDI-12 device connected to the same SDI-12 signal terminal needs a unique SDI-12 address. Default is 0.

Modbus Address: Each Modbus device connected to the same RS-485 terminals needs a unique Modbus address. Default is 001.

RS485 Baud: Baud rate for the RS-485 port used for Modbus operations. Default is 19200.

RS485 Parity: Setting must match the data logger or Modbus RTU setting. Default is Even.

RS485 Stop Bits: Number of stop bits used for the RS-485 (Modbus) interface. Default is 2.

7.2.5 Diagnostic/Test

```
Diagnostic / Test
>Status Errors [None]
 Test Line Noise    >
 Test Line Leak     >
 Field Cal Check    >
 Reset Max/Min      >
 Min Batt V.   = 12.23
 Max Batt V.   = 14.34
```

Status Errors

Displays True if errors are detected or None if errors are not detected. If errors are detected, press the **Enter** key and the first error will be displayed (Table 7-1 (p. 24)).

The error code returned with an SDI-12 command is the sum of the weighted value for each error. Weighted values were chosen to ensure the sum is unique for each error combination. For example, if error 1 and error 6 were detected, the SDI-12 error code will be 33 (1+32).

Some errors or status messages are automatically cleared once the error is resolved. The more serious errors remain active until they are manually reset by the user.

Table 7-1: Error flag descriptions

Error number	SDI-12 Weighted Value	Type	Error description and recommended action	Message displayed on screen	Reset
1	1	Error	Line sensor exceeded pressure range. Check for plugged line.	Line Sen Rnge Err	Manual
2	2	Error	Tank sensor exceeded pressure range. Check for plugged line.	Tank Sen Rnge Err	Manual
3	4	Error	Temperature value exceeded range.	Temperature Rnge Err	Manual
4	8	Error	Pressure not increasing (stalled compressor or leak).	Pressure Up Err	Manual
5	16	Error	Pressure not decreasing. Check for obstruction or plugged orifice line.	Pressure Dwn Err	Manual
6	32	Error	Tank offset calculation timeout.	Tank Offset TO	Manual
7	64	Error	Tank offset calculation out of range error.	Tank Offset Error	Manual
8	128	Error	Compressor over current. Check battery/charge system.	Compressor Over Amps	Manual
9	256	Error	RTC battery low voltage warning. Change the RTC battery.	RTC Battery Low	Manual

Table 7-1: Error flag descriptions					
Error number	SDI-12 Weighted Value	Type	Error description and recommended action	Message displayed on screen	Reset
13	4096	Status	Input supply or battery voltage is below 10.6 V, which is the voltage needed to power the compressor. The LevelVUE B10 will not do an auto or manual purge while condition persists.	Low Battery	Auto
14	8192	Status	Compressor stall or leak detected. Check battery/charge system.	Stalled Pump or Leak	Auto
15	16384	Status	Compressor on time exceeded time out. Observe tank pressure and power for proper operation during purge.	Purge Pump On TO	Auto
16	32768	Status	Compressor flow on time exceeded time out.	Flow Pump On TO	Auto

Test Line Noise

Checks the integrity of the orifice line regarding noise and stability. Initially, the LevelVUE B10 measures stage, atmospheric pressure, and temperature. This takes about 7 seconds. The LevelVUE B10 stores the initial stage measurement as both the max and min values. The screen displays the difference between the max and min values, which is 0.000 for the initial measurement.

After the initial measurements, the LevelVUE B10 measures stage using the original atmospheric and temperature readings at a 1 second measurement rate. The max and min values are updated as new max or min values are detected and the difference is displayed on the screen. If the line is secure, the difference between the max and min values is small and will not significantly increase. A large difference that continues to increase indicates a problem with the orifice line.

Test Line Noise can be used while installing a new orifice line to find the best orifice line outlet position. Temporarily position the outlet and run this test to see if the position is relatively quiet. Reposition the line if it is too noisy. After the line is repositioned, restart the test.

Test Line Noise can be used to test the bubbler. Disconnect the orifice line and run the test. The difference between the max and min values should be less than the resolution of the system (Table 5-1 (p. 4)). While doing this test, ensure there isn't any breeze or air movement around the outlet port, which can cause noise in the system.

Test Line Leak

Leaks are one of the biggest problems with bubbler systems. Normally, the leak is at the fitting that connects the orifice line to the bubbler or somewhere between that fitting and the end of the orifice line. Tightening the orifice line fitting an 1/8 turn often resolves the problem. When a leak exist, the stage value will remain equal to the offset value.

However, a small percentage (1%) of the leaks are in the bubbler itself. This test verifies the bubbler is not leaking. To use this test, disconnect the orifice line and replace it with the plug shipped on the LevelVUE B10 outlet fitting. This test turns on the compressor and fills the tank to a pressure slightly below the pressure range of the bubbler. The system lets the pressures in the system equalize for about 15 seconds before displaying the max pressure, min pressure, and the difference of the max and min pressures. The test displays a count-down timer and runs for about 5 minutes (300 seconds). The difference value may rise while the system is equalizing, but after 15 seconds, the difference should be less than 0.15. After 1 or 2 minutes, the difference should be stable. Contact Campbell Scientific if the difference value continues to rise significantly.

Field Cal Check

Use this option in conjunction with an off-the-shelf field calibration tool to regularly verify the field calibration. Some agencies require this. Refer to Field calibration check (p. 59) for more information.

Reset Max/Min

Use this option at the end of a site visit to reset the minimum and maximum battery voltage detected. At the beginning of the next site visit look at the value of the minimum and maximum battery voltages detected since the last site visit to help determine the status of the battery and the charging system.

Min Batt V. XX.XX

Displays the minimum battery voltage detected since the last time this was reset. A low reading indicates a weak battery or an inadequate charging system.

Max Batt V. XX.XX

Displays the maximum battery voltage detected since the last time this was reset. A high reading may indicate a faulty regulator or other charging system problem.

7.2.6 System information

```
System Information
>Clear Purge  CNTR  >
 Clear SysRst CNTR  >
 Purge CNTR   =     4
 Sys Rst CNTR =     0
 Sensor SN    =  1004
 OS Ver       =  1.00
```

Clear Purge CNTR: Clears the purge counter. To see if the system is purging as often as expected, use this option at the end of a site visit to set the purge counter to zero. At the beginning of the next site visit, check that the purge counter has a value that corresponds with the expected number of purges.

Clear SysRST CNTR: Sets the system reset counter to 0. See **Sys RST CNTR** that follows.

Purge CNTR = X: Number of orifice-line purges since the last reset.

Sys RST CNTR = X: Number of system resets. If the **Clear SysRST CNTR** is used at the end of each site visit, this will show the number of resets since the last visit. System resets indicate that the battery may be weakening, inadequate power wiring, or the charge system needs servicing.

Sensor SN = XXXX: Serial number of the LevelVUE B10. A support person may ask for this number if the LevelVUE B10 needs servicing.

OS Ver = X.XX: Operating system (OS) version number currently loaded into the system. Campbell Scientific recommends using the latest OS. Use Campbell Scientific Device Configuration Utility to update the OS. Also, if service is needed, a support person may ask for the OS version number.

7.3 SDI-12 measurement and extended commands

The LevelVUE B10 responds to the SDI-12 commands shown in Table 7-2 (p. 28). Because of delays, the `M!` commands require, the measurement scans should be 10 seconds or more. The `C!` commands follow the same pattern as the `M!` commands with the exception that they do not require the data logger to pause its operation until the values are ready.

> **NOTE:**
> SDI-12 sensor support (p. 48) describes the SDI-12 commands. Additional SDI-12 information is available at www.sdi-12.org.

Table 7-2: LevelVUE B10 SDI-12 measurement and extended commands		
SDI-12 command (*a* is the sensor address)	Values returned or function	Description
a`M!`, *a*`C!`, *a*`Mc!`, or *a*`Cc!`	1. Stage (m or ft) 2. Line pressure (psi) 3. Tank pressure (psi) 4. Temperature (°C) 5. Battery voltage (VDC) 6. Error code[1] 7. Stage crest (m or ft) 8. Stage crest time	The stage crest time is a time offset. It is the number of seconds in the past from the current measurement that the crest stage value was detected.
a`XWSR=`*rrr.rr*`!` Where, *rrr.rr*= stage reference	Write stage value	Use to change stage reference to *rrr.rr* in configured units.
a`XWSU=`*x*`!` Where, *x* = units value	Write stage units	Use to change the stage units, where: 0=in 1=ft 2=mm 3=cm 4=m 5=psi 6=user-specified (used with the **`aXWSS=s.sssssss!`** command)
a`XRSU!`	Read stage units	
a`XWSS=`*s.sssssss*`!` Where, *s.sssssss*=2.3066587 or 0.7032496	Write stage slope	Use to change the units for stage. This command is only used when the stage units are set to user-specified (**`aXWSU=6!`**). Feet = 2.3066587 (default) Meters = 0.7032496

Table 7-2: LevelVUE B10 SDI-12 measurement and extended commands		
SDI-12 command (*a* is the sensor address)	Values returned or function	Description
*a*XRSS!	Read stage slope.	
*a*XWCO=*o.oo*! Where, *o.oo*= stage offset	Write calculated stage offset	Use to update stage offset.
*a*XRCO!	Read calculated stage offset.	
*a*XWBR=*bb*! Where, *bb*= bubble rate	Write bubble rate (bubbles per minute)	Use to change the bubble rate. Default = 60 bubbles per minute
*a*XRBR!	Read bubble rate	Bubbles per minute
*a*XWPP=*pp*! Where, *pp*= purge pressure	Write purge pressure (psi).	Use to change the purge pressure. Default = 60 psi Range: 30 to 90 psi
*a*XRPP!	Read purge pressure (psi)	
*a*XP!	Initiate bubbler purge sequence	
*a*XWPA=*tt*! Where, *tt*= purge time	Write purge assist time (seconds)	Use to set the time the compressor runs during the purge sequence after the purge valve opens. Default = 20 s
*a*XRPA!	Read purge assist time (seconds)	
*a*XWSD=*dd*! Where, *dd*= digits	Write stage digits	Use to set the number of digits to the right of the decimal for the stage value. Default = 2
*a*XRSD!	Read stage digits	

Table 7-2: LevelVUE B10 SDI-12 measurement and extended commands		
SDI-12 command (*a* is the sensor address)	Values returned or function	Description
*a*XWMT=*tt*! Where, *tt*= stage mean time	Write stage mean time (seconds)	Use to increase or decrease the averaging time of stage measurements Default = 5 s
*a*XRMT!	Read stage mean time (s)	
*a*XWAP=*tt*! Where, *tt*= auto purge setting	Write auto-purge setting (days)	0 = off (no auto-purge) Range = 1 to 30 days
*a*XRAP!	Read auto-purge setting (days)	
*a*XATZ!	Reset sensor to defaults (Default settings (p. 9))	
*a*XTEST!	1. Stage (m or ft) 2. Line pressure (psi) 3. Tank pressure (psi) 4. Temperature (°C) 5. Battery voltage (VDC) 6. Error code[1]	Use to put the sensor into a continuous output mode with data being transmitted to the terminal every second. Any command will interrupt the continuous output mode and resume normal operation.
*a*XHELP!	Returns the supported SDI-12 commands by the LevelVUE B10	

[1] The error code is the sum of the weighted value for each error. The errors and weighted values are listed in the Error flag descriptions table.

7.4 Modbus register map

The Modbus data type is 32-bit float with no reversal. Table 7-3 (p. 31) provides the input register map (function code 4). Table 7-4 (p. 32) provides the holding register map (function code 3).

Label	Input Register	Value stored
Stage	30001	Current stage measurement value
Temperature	30003	Current temperature measurement
Tank pressure	30005	Current tank pressure
Line pressure	30007	Current line pressure used to calculate stage with current slope and offset values
Battery voltage	30009	Current battery measurement. Updated every 30 seconds or during the stage measurement
Min battery volt	30011	Minimum battery voltage (normally detected while compressor was running)
Max battery volt	30013	Maximum battery voltage
Purge count	30015	Number of purge events since counter was reset
System resets	30017	Number of system resets since counter was reset
Purge date	30019	Last purge date in the form of YYMMDD.00
Purge time	30021	Last purge time in the form of hhmmss.00
Status bits	30023	256 = RTC battery low voltage warning. Change the RTC battery. 4096 = Input supply or battery voltage is below 10.6 V, which is the voltage needed to power the compressor. The LevelVUE B10 will not do an auto or manual purge while condition persists. 8192 = Compressor stall or leak detected. Check battery/charge system. 16384 = Compressor on time exceeded time out. Observe tank pressure and power for proper operation during purge. 32768 = Compressor flow on time exceeded time out.

Table 7-3: ModBus input register map

Table 7-3: ModBus input register map		
Label	Input Register	Value stored
Crest max	30025	Maximum crest stage observed between two successive stage measurements
Crest offset	30027	This is a time offset. It is the number of seconds in the past from the current measurement that the crest stage value was detected.

Table 7-4: Modbus holding register map			
Label	Holding register	Read (function code 3)	Write (function code 16)
Stage Ref	40001	Last stage value	Measures and recalculates the offset required to make the current stage value equal to the value written to this register
Stage Units	40003	Returns a number from 0 to 6 indicating the units, where: 0 inches 1 feet (default) 2 millimeters 3 centimeters 4 meters 5 psi 6 User-defined	Enter a value in a range of 0 to 6, where: 0 inches 1 feet (default) 2 millimeters 3 centimeters 4 meters 5 psi 6 User-defined (must enter a stage slope value described in the following row)

Table 7-4: Modbus holding register map			
Label	Holding register	Read (function code 3)	Write (function code 16)
Stage Slope	40005	Returns the following values depending on the stage units: 27.68 inches 2.3067 feet (default) 703.08 millimeters 70.308 centimeters 0.70308 meters 1 psi User-defined	To write a user-defined value the stage-units register must first be set to 6.
Stage Offset	40007	Returns the stage offset value.	Enter the stage offset value.
Date	40009	Returns the system date in the format of YYMMDD.00	Enter the system date, as a float, in the format of YYMMDD.00
Time	40011	Returns the system time in the format of hhmmss.00	Enter the system time, as a float, in the format of hhmmss.00
Measurement Average Duration	40013	Returns the measurement averaging time in seconds.	Enter the measurement averaging time in seconds. The range is from 1 to 255.
Temperature Units	40015	Returns: 0 Celsius 1 Fahrenheit	Enter 0 for Celsius or 1 for Fahrenheit
Bubble Rate	40017	Returns the bubble rate. Range is 30 to 120	Enter the bubble rate. Range is 30 to 120

Table 7-4: Modbus holding register map

Label	Holding register	Read (function code 3)	Write (function code 16)
Purge Pressure	40019	Returns purge pressure in psi. Range is 30 to 90.	Enter the purge pressure in psi. Range is 30 to 90.
Purge Sustain Duration	40021	Returns purge sustain time in seconds. Range is 0 to 30.	Enter purge sustain time in seconds. Range is 0 to 30.
Auto Purge Interval	40023	Returns auto purge interval in days.	Enter auto purge interval in days. Range is 0 to 30 days
Display Sleep	40025	Returns display sleep timeout period in minutes.	Enter display sleep timeout period in minutes. Range is 1 to 15.
Display Brightness	40027	Returns the display brightness option. Range is 10 to 100	Enter the display brightness between 10 and 100. Value will be rounded to nearest ten.
Reset Status Values	40029	Returns 0.00	Entering a non-zero value such as 1.00 will reset status values to the following: Purge count: 0 Minimum battery value: current battery voltage Maximum battery value: current battery voltage System Resets: 0
Modbus Address	40031	Returns the Modbus device address	Enter a new Modbus address. Range is 1 to 247.

Table 7-4: Modbus holding register map			
Label	Holding register	Read (function code 3)	Write (function code 16)
Measure Now	40033	Returns a 0.00 or time till current measurement is ready in seconds.	Entering a non-zero value causes the unit to make a stage measurement. The register will then hold the number of seconds till the measurement is complete. Once the register becomes zero, new measurement values will be available in the following Input Registers: Stage, Line Pressure , Tank pressure, Battery Voltage , and Temperature.
Purge Now	40035	Returns a 0 when not purging. Returns a 1 if in the process of running a purge.	Writing a non-zero value (1.00) will cause system to purge.

7.5 Secured orifice line

Campbell Scientific recommends protecting the orifice line inside a 53 mm (2-inch) steel conduit. Fasten the conduit to a permanent and secure structure such as bridge pier, cement slab, or pilings to prevent movement. If the conduit moves, the orifice line can stretch, kink, or break. A stretched orifice line restricts the air flow, which increases pressure, causing erroneously high stage measurements. A broken orifice line leaks. If a leak is present, the measured stage value will be the same or close to the offset value. Kinks create erratic data. These same problems can also occur if the orifice line crosses a road and the line is not properly protected from the traffic on the road.

If the outlet of the orifice line shifts but is still stable, the vertical shift will be seen in the data. This problem occurs when the orifice line mount near the outlet has been hit by large debris such as a log. Scour can also cause mounts to shift. FIGURE 7-1 (p. 36) shows the sharp rise in water level, possibly indicating that the orifice line shifted down by about 0.20 feet.

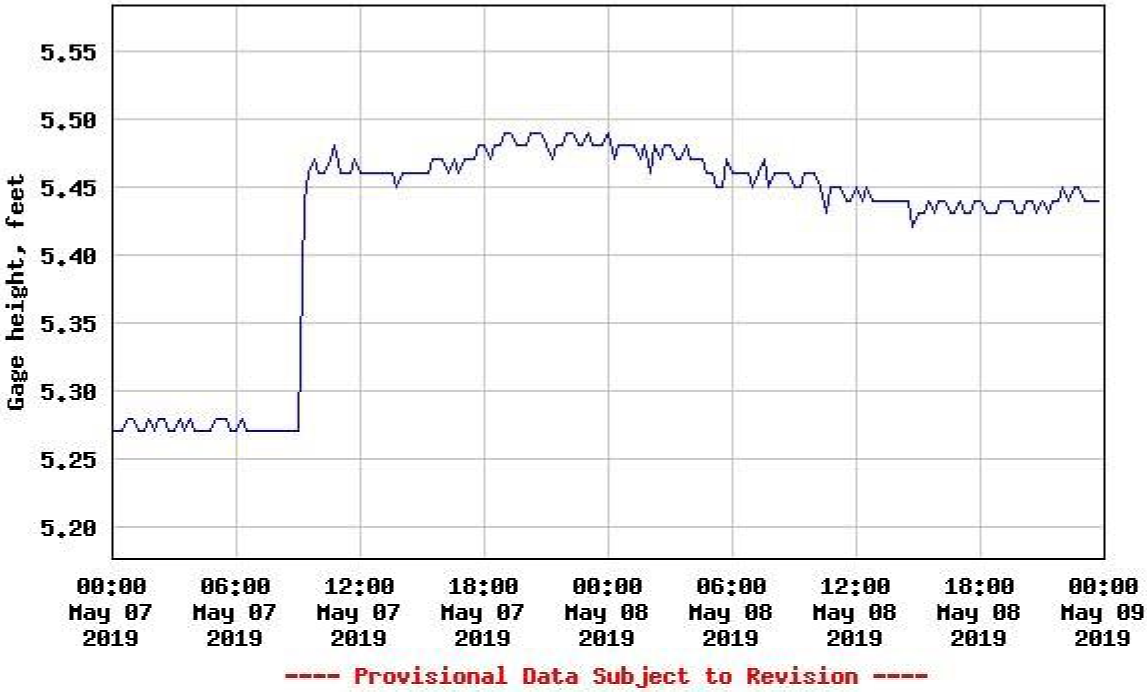


FIGURE 7-1. Sharp rise in water level indicating orifice line shift.

The orifice outlet cap must be secure the keep the outlet of orifice line from moving. If the outlet of the orifice line shifts vertically, the water level measurement will show a sharp rise or fall. Horizontal movement can create an unwanted pressure or vacuum on the line causing noise in the data. This type of noise is often called painting. The frequent fluctuations in gageheight in FIGURE 7-2 (p. 37) could be due to a loose orifice end cap. Regardless of the source of noise, the measurement averaging time can be increased to minimize the noise in the data.

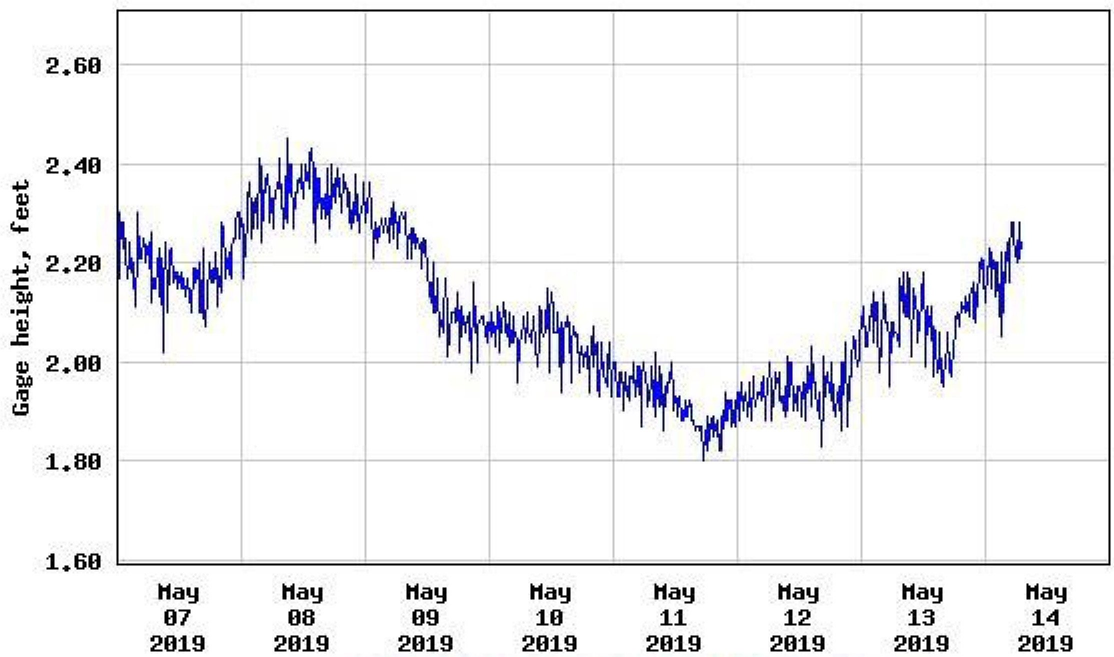


FIGURE 7-2. Data painting

The conduit should be installed to withstand or protected against large debris such as logs or other items that may be in the water from jarring or loosening the conduit from its mounts.

7.6 Long orifice lines

When purging long orifice lines, the friction in the line is significant and the purge is less effective. When the orifice line is longer than a few hundred feet, always set the **Purge Pressure** setting to the highest value and set the **Purge Duration** option to its maximum value. This helps keep the line free from silting or other growth at the outlet.

7.7 Orifice-line outlet orientation

Undesired pressures on the orifice line can affect the water level measurement. The main source of the unwanted pressures is from the flow of the water and the orientation of the outlet. This can be a positive or negative pressure and will change based on water levels and velocities. For example, if the orifice line outlet is slightly horizontal and pointing upstream, as the water flow pushes against the outlet, it will create an artificially high pressure. If the outlet is facing downstream, a vacuum will be imposed on the line. Build up and draw down around a bridge pier will also affect the pressure on the orifice line. Eddie currents are much less predictable and affect the pressure on the orifice line. Wave action is another source of unwanted pressures on the orifice line.

In most cases, the unwanted pressured due to water flow will have less impact on the orifice line when mounted vertically or slightly turned to the horizontal position and perpendicular to the primary direction of flow. However, a bubble can form on a vertically oriented orifice line outlet that adds to the water depth. In still water, this increase can be as much as 0.003 m (0.01 ft). In moving water, the bubble is ripped off the end of the outlet before it has time to grow. In a system that has an error specification of 0.02% or 0.002 m (0.007 ft) of water for a 15 psi unit, this unwanted pressure can double that error percentage if the outlet is not properly oriented.

Bubbler systems are designed to reduce or eliminate the noise caused by the unwanted pressures and the bubble growth. In most cases, the default measurement averaging time of 1 second is sufficient, but if noise is still noticed in the data and the line is stable, increasing this averaging time to 5 to 10 seconds will reduce noise in the system.

7.8 Orifice-line outlet types

Campbell Scientific offers an orifice-line outlet that consists of a 1/4-inch ID fitting mounted in the end cap for the 53 mm (2-inch) conduit. This type of outlet can be mounted vertically or slightly horizontal, and responds quickly to small rises in the water level. The LevelVUE B10 average bubble rate is based on using this type of orifice outlet cap.

An end cap with a large air chamber may be better for sites with quick rises in water levels (faster than 0.3 m/10 s (1 ft/10 s)), heavy wave action, or silting issues. With the standard outlet, water pushes up the orifice line at a rate equal to the rise of the water. Depending on the level change, it may take a few to several seconds for the system to start bubbling again. Measurements made during this time will be lower than the actual level. An end cap with a large air chamber greatly reduces the errors caused by the rapid and large rises in water levels because it acts as an integrator.

In shallow streams, silt may cover the outlet when the river bottom shifts. Silt can restrict the air flow, causing data errors. Silt is less likely to restrict the air flow when the air chamber is large. The **timed purge** option should also be activated when in silty environments.

Drawbacks to an end cap with a large air chamber include that it must be mounted horizontal, it may be harder to protect from large debris, and it takes more time for the system to fill the air chamber. Measurements made while the air chamber is filling will be inaccurate. Noisier data also occurs during small rises in the water level.

8. Maintenance and troubleshooting

NOTE:
All factory repairs and recalibrations require a returned material authorization (RMA) and completion of the "Statement of Product Cleanliness and Decontamination" form. Refer to the Assistance page at the end of this manual for more information.

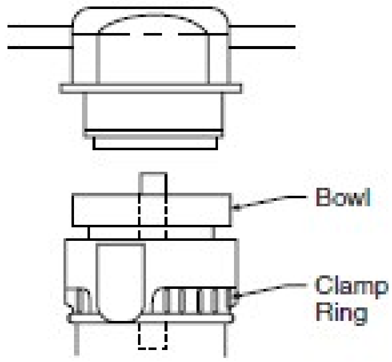
8.1 Replacing desiccant

Regularly replace the desiccant. Desiccant replacement frequency depends on the humidity of the site and the size of the desiccator. For new installations, Campbell Scientific recommends checking the desiccant at least once a month. After a few months, users can adjust how often they check the desiccant. Replacement silica gel desiccant is available at: www.campbellsci.com.

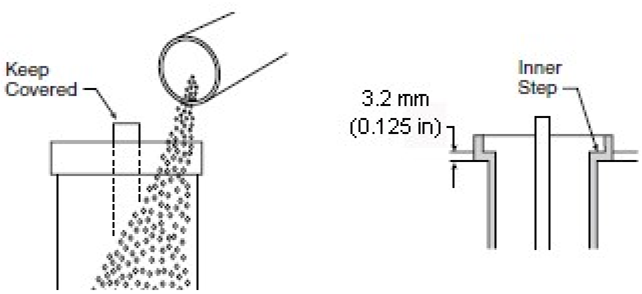
Desiccant replacement procedure:

1. Remove power from the LevelVUE B10.
2. Depressurize the input line.

3. Loosen the clamp ring on the desiccator and remove the bowl from the top housing.



4. Pour out used desiccant and dispose of it according to the safety data sheet originally shipped with the desiccator kit.
5. Open new desiccant container.
6. Pour desiccant into the bowl; shake and tap bowl while filling to settle desiccant. Fill to 3 mm (0.1 in) below inner step of bowl.



7. Replace the bowl and bowl guard.

> **CAUTION:**
> Ensure that the clamp ring is securely locked in place before operating the unit.

8.2 Lithium battery replacement

A 3 V coin-cell lithium battery maintains the system clock when there is no power to the LevelVUE B10. Campbell Scientific recommends replacing the lithium every 2 to 3 years, or more frequently when operating continuously in high temperatures. The battery should be replaced if its voltage falls below 2.4 VDC.

> **NOTE:**
> When the LevelVUE B10 is connected to 12 VDC, there is no power draw from the lithium battery.

Lithium battery replacement procedure:

1. Open the swing panel located at the bottom-left edge of the plate that protects the circuit board below the USB port (FIGURE 8-1 (p. 41)).

FIGURE 8-1. Lithium battery location

2. Remove the old battery.
3. Insert the new battery with the positive side up (plus sign facing the metal plate).

> **NOTE:**
> Although inserting the battery incorrectly will not damage the system, the lithium battery will be drained quickly.

> **DANGER:**
> Misuse of the internal lithium battery can cause severe injury. Do not recharge, disassemble, heat above 100 °C (212 °F), solder directly to the cell, incinerate, or expose contents to water. Dispose of spent lithium batteries properly.

8.3 Plugged orifice outlet

The orifice line outlet can become plugged from silt build up, moss growth, or debris. Often these conditions occur over a long period of time. Silt or moss build up restricts air flow that can increase the water level readings. This restriction in air flow is not consistent causing the data to fluctuate.

Manually purge the system during each site visit to keep the orifice line free from blockage. When the water is lower and the outlet is accessible, inspect the outlet for growth. Clean the outlet with a wire brush, as needed. Use a pipe cleaner or heavy stiff wire such as a coat hanger to remove buildup from inside the outlet. Purge the system while cleaning the orifice outlet to help keep the line cleared.

Relocate the outlet if it is constantly being covered in silt.

8.4 Cold weather

In cold and humid weather areas, disable the purge feature during the cold season. If in a cold and humid area, the desiccant is less effective in preventing frozen particles from accessing areas of the system that could cause problems when the frozen particles melt.

Ice formed at the surface of the water can compress the orifice line and restrict the air flow. Water in the conduit that freezes has no place to expand, causing erroneously high water-level measurements.

8.5 Preventing or fixing orifice-line leaks

Because bubblers contain several tubes, fittings, and valves, leaks are one of the biggest problems with bubbler systems. Campbell Scientific designed and manufactured the LevelVUE B10 to ensure these internal components are installed properly and to be leak free. However, care must also be taken when connecting and installing the orifice line to avoid leaks. Do not use quick connect fittings as these tend to leak, and avoid extra fittings when possible. Try to use one continuous orifice line to eliminate junctions or splices, which are potential sources for leaks. Campbell Scientific offers orifice line that comes in 500-foot rolls, which suits most applications. The rare application that requires orifice lines longer than 500 feet should include the junction or splice in a serviceable enclosure.

Find leaks in orifice lines or connectors by using a mixture of water and dish soap. Apply a small amount of the dish-soap mixture to fittings that are suspected of leaking. The dish-soap mixture will bubble where the fitting is leaking. Always wipe the fitting off with a dry rag.

8.6 Updating operating system

Campbell Scientific Device Configuration Utility is used to update the operating system (OS). The Device Configuration Utility is available as a download on www.campbellsci.com. It is included in installations of ***LoggerNet***, ***PC400***, or ***RTDAQ***.

1. Open the Device Configuration Utility.
2. In the Device Type box, type LevelVUE B10 and click on LevelVUE B10
3. Before connecting this product to your computer for the first time, click the Install USB Driver button to install the driver.
4. Apply power (+12 VDC) to the **Power** connector.
5. Connect a USB cable between one of your computer USB ports and the USB port on the device .
6. In the left panel, select the appropriate serial port. If you browse for the serial port, it should be identified with the LevelVUE B10 designation in the browse dialogue.
7. Click the **Start** button below.
8. A file open dialogue box will appear that will allow you to select the file to be sent. When you have selected the file, click the **OK** button.
9. After the operating system has been successfully sent, the device will reboot and should be ready to use in approximately 30 seconds.

CAUTION:
Do not remove power for at least 30 seconds.

8.7 Troubleshooting

Table 8-1 (p. 44) provide symptoms, causes, and solutions for problems. Most problems are caused by orifice line or programming issues. A line noise test can be used to determine whether noisy data is caused by an orifice line issue or a problem with the LevelVUE B10. Refer to Diagnostic/Test (p. 23) for more information.

Table 8-1: Symptoms, possible causes, and solutions		
Symptom	**Possible cause**	**Solution**
Stage is always the same value as the offset	A leak is in the orifice line between the water surface and the LevelVUE B10. A leak in this area can result in a line pressure value of zero. This causes the stage value to equal the offset value because of the equation used to calculate stage: Stage = Pressure • Slope + offset	Use water/dish soap mixture to look for leaks in the orifice line. Normally the leak will be at one of the fittings connecting the orifice line to the LevelVUE B10. See Preventing or fixing orifice-line leaks (p. 42).
Data is painting	1. Orifice line outlet is not stable. Any movement in the orifice line outlet will have a direct effect on the data. 2. Moisture in the orifice line can create friction for the air flow and cause abnormal pressures in the line that affect the pressure caused by water depth. 3. Waves, choppy water, fluctuations in water flow creates different pressures and vacuums on the orifice line outlet, which creates noise in the line. 4. Loose orifice end cap	1. Ensure that the orifice line is inside a conduit that is fastened to a permanent and secure structure such as bridge pier, cement slab or pilings. The conduit should be protected from large debris such as logs to prevent the debris from jarring or loosening the conduit from its mounts. See Secured orifice line (p. 35). 2. Regularly purge the line to help keep moisture out. Also make sure there are no low points in the orifice line that allow moisture to collect. 3. Increase the averaging time by 5 to 10 seconds. 4. Tighten end cap.
An unexpected sharp rise or fall in water level data	The orifice-line outlet mount may have shifted because of large debris such as a log hitting the orifice line mount near the outlet or because of scour.	Clear debris and secure the mount. Ensure that the conduit is installed to withstand or is protected from large debris that may jar or loosen the conduit from its mounts. . See Secured orifice line (p. 35).

Table 8-1: Symptoms, possible causes, and solutions		
Symptom	**Possible cause**	**Solution**
Compressor seems to run slow.	Battery may not have sufficient voltage to run the compressor.	Make sure the battery is sufficiently charged to handle the needed power requirements to run the compressor. Check the charging system. Clean the solar panel
Water level values drift low at night	The battery may be weak and only able to turn on the compressor when the solar charging system is also supplying power.	Check the battery voltage and replace the battery if needed. Check the charging system. Clean the solar panel
All LevelVUE B10 output values read 0	1. No `SDI12Recorder()` instruction in data logger program. 2. Conditional statement that triggers reading is not evaluating as **true**	1. Add `SDI12Recorder()` instruction to data logger program 2. Check logic of conditional statement that triggers readings
First value reads NAN and all other values read 0 or never change from one measurement to another.	1. LevelVUE B10 SDI-12 address does not match address specified in data logger program 2. LevelVUE B10 is not connected to the SDI-12 terminal specified in data logger program 3. LevelVUE B10 not being powered	1. Change LevelVUE B10 SDI-12 address or modify program so that they match 2. Connect wire to correct terminal or modify program to match wiring 3. Make sure the LevelVUE B10 is wired correctly and matches the data logger program
Readings erratic, including NANs and 9999999s	Multiple devices with same SDI-12 address sharing same **U** or **C** terminal	Connect each SDI-12 device to a different **U** or **C** terminal or give them unique SDI-12 addresses. Ensure that you revise the data logger program to account for these changes.

Appendix A. Example program

Table A-1 (p. 46) provides wiring for the SDI-12 example program (CRBasic Example 1 (p. 46)).

Table A-1: Wiring for SDI-12 example program

LevelVUE B10 terminal	Function	CR1000X terminal	Power supply
SDI-12 Data	SDI-12 signal	C1	
SDI-12 G	Ground	⏚	
12Vdc +	Power		12V
12Vdc -	Power ground		G

CRBasic Example 1: CR1000X program measuring the LevelVUE B10 using SDI-12

```
'CR1000X Series Data Logger
'Declare variables and Units


Public BattV
Public PTemp_C
Public LVData(8)

'Rename the variable names

Alias LVData(1)=Stage
Alias LVData(2)=Line_psi
Alias LVData(3)=Tank_psi
Alias LVData(4)=LVB10_Temp
Alias LVData(5)=LVB10_Batt
Alias LVData(6)=LVB10_ErrorCode
Alias LVData(7)=Crest_Stage
Alias LVData(8)=Crest_Tm_Offs

Units BattV=Volts
Units PTemp_C=Deg C
Units Stage=feet
Units Line_psi=psi
Units Tank_psi=psi
Units LVB10_Temp=Deg C
Units LVB10_Batt=volts
Units LVB10_ErrorCode=code
```

CRBasic Example 1: CR1000X program measuring the LevelVUE B10 using SDI-12

```
Units Crest_Stage=feet
Units Crest_Tm_Offs=seconds

'Define a data table
DataTable(MainData,True,-1)
  DataInterval(0,5,Min,10)
  Sample (1,Stage,FP2)
  Sample (1,Line_psi,FP2)
  Sample (1,Tank_psi,FP2)
  Sample (1,LVB10_Temp,FP2)
  Sample (1,LVB10_Batt,FP2)
  Sample (1,LVB10_ErrorCode,FP2)
  Sample(1,Crest_Stage,FP2)
  Sample(1,Crest_Tm_Offs,FP2)
  Sample(1,BattV,FP2)
  Sample(1,PTemp_C,FP2)
EndTable

'Main program
BeginProg
  'Main scan
  Scan(5,Sec,1,0)

    'Default CR1000X data logger Voltage measurement 'BattV'
    Battery(BattV)

    'Default CR1000X data logger Wiring Panel Temperature measurement 'PTemp_C'
    PanelTemp(PTemp_C,60)

    'LevelVUEB10 Water-Level Continuous Flow Bubbler measurements
    If TimeIntoInterval(0,5,Min) Then
      SDI12Recorder (LVData(),C1,0,"M!",1.0,0)
    EndIf


    'Call the data tables and store data
    CallTable MainData
  NextScan
EndProg
```

Appendix B. SDI-12 sensor support

SDI-12, Serial Data Interface at 1200 baud, is a protocol developed to simplify sensor and data logger compatibility. Only three wires are necessary — serial data, ground, and 12 V. With unique addresses, multiple SDI-12 sensors can connect to a single SDI-12 terminal on a Campbell Scientific data logger.

This appendix discusses the structure of SDI-12 commands and the process of querying SDI-12 sensors. For more detailed information, refer to version 1.4 of the SDI-12 protocol, available at www.sdi-12.org.

For additional information, refer to the SDI-12 Sensors | Transparent Mode and SDI-12 Sensors | Watch or Sniffer Mode videos.

B.1 SDI-12 command basics

SDI-12 commands have three components:

- **Sensor address (a)** – a single character and the first character of the command. Use the default address of zero (0) unless multiple sensors are connected to the same port.
- **Command body** – an upper case letter (the "command"), optionally followed by one or more alphanumeric qualifiers.
- **Command termination (!)** – an exclamation mark.

An active sensor responds to each command. Responses have several standard forms and always terminate with <CR><LF> (carriage return and line feed). Standard SDI-12 commands are listed in Table B-1 (p. 48).

Table B-1: Campbell Scientific sensor SDI-12 command and response set

Name	Command	Response[1]
Acknowledge Active	`a!`	a<CR><LF>
Send Identification	`aI!`	allccccccccmmmmmmvvvxxx...xx <CR><LF>
Start Verification	`aV!`	atttn <CR><LF>

Name	Command	Response[1]
Address Query	`?!`	a<CR><LF>
Change Address	`aAb!`	b<CR><LF>
Start Measurement	`aM!` `aM1!...aM9!`	atttn<CR><LF>
Start Measurement and Request CRC	`aMC!` `aMC1!...aMC9!`	atttn <CR><LF>
Start Concurrent Measurement	`aC!` `aC1!...aC9!`	atttnn<CR><LF>
Start Concurrent Measurement and Request CRC	`aCC!` `aCC1!...aCC9!`	atttnn<CR><LF>
Send Data	`aD0!...aD9!`	a<values><CR><LF> or a<values><CRC><CR><LF>
Continuous Measurement	`aR0!...aR9!`	a<values><CR><LF>
Continuous Measurement and Request CRC	`aRC0!...aRC9!`	a<values><CRC><CR><LF>
Extended Commands	`aXNNN!`	a<values><CR><LF>

Table B-1: Campbell Scientific sensor SDI-12 command and response set

[1] Information on each of these commands is given in the following sections.

B.1.1 Acknowledge active command (a!)

The Acknowledge Active command (`a!`) is used to test a sensor on the SDI-12 bus. An active sensor responds with its address.

B.1.2 Send identification command (aI!)

Sensor identifiers are requested by issuing command `aI!`. The reply is defined by the sensor manufacturer but usually includes the sensor address, SDI-12 version, manufacturer's name, and sensor model information. Serial number or other sensor specific information may also be included.

`aI!`	allccccccccmmmmmmvvvxxx...xx<CR><LF>
a	Sensor SDI-12 address
ll	SDI-12 version number (indicates compatibility)

cccccccc	8-character vendor identification
mmmmmm	6 characters specifying the sensor model
vvv	3 characters specifying the sensor version (operating system)
xxx…xx	Up to 13 optional characters used for a serial number or other specific sensor information that is not relevant for operation of the data logger
<CR><LF>	Terminates the response
Source: *SDI-12: A Serial-Digital Interface Standard for Microprocessor-Based Sensors* (see References).	

B.1.3 Start verification command (aV!)

The response to a Start Verification command can include hardware diagnostics, but like the **aI!** command, the response is not standardized.

Command: **aV!**

Response: *atttn<CR><LF>*

a = sensor address

ttt = time, in seconds, until verification information is available

n = the number of values to be returned when one or more subsequent **D!** commands are issued

B.1.4 Address query command (?!)

Command **?!** requests the address of the connected sensor. The sensor replies to the query with the address, *a*. This command should only be used with one sensor on the SDI-12 bus at a time.

B.1.5 Change address command (aAb!)

Multiple SDI-12 sensors can connect to a single SDI-12 terminal on a data logger. Each device on a single terminal must have a unique address.

A sensor address is changed with command **aAb!**, where *a* is the current address and *b* is the new address. For example, to change an address from *0* to *2*, the command is **0A2!**. The sensor responds with the new address *b*, which in this case is 2.

> **NOTE:**
> Only one sensor should be connected to a particular terminal at a time when changing addresses.

B.1.6 Start measurement commands (aM!)

A measurement is initiated with the `M!` command. The response to each command has the form *atttn<CR><LF>*, where

a = sensor address

ttt = time, in seconds, until measurement data is available. When the data is ready, the sensor notifies the data logger, and the data logger begins issuing **D** commands.

n = the number of values returned when one or more subsequent **D** commands are issued. For the **aM!** command, n is an integer from 0 to 9.

When the **aM!** is issued, the data logger pauses its operation and waits until either it receives the data from the sensor or the time, *ttt*, expires. Depending on the scan interval of the data logger program and the response time of the sensor, this may cause skipped scans to occur. In this case make sure your scan interval is longer than the longest measurement time (*ttt*).

Table B-2: Example aM! sequence	
0M!	The data logger makes a request to sensor 0 to start a measurement.
00352<CR><LF>	Sensor 0 immediately indicates that it will return two values within the next 35 seconds.
0<CR><LF>	Within 35 seconds, sensor 0 indicates that it has completed the measurement by sending a service request to the data logger.
0D0!	The data logger immediately issues the first **D** command to collect data from the sensor.
0+.859+3.54<CR><LF>	The sensor immediately responds with the sensor address and the two values.

B.1.7 Start concurrent measurement commands (aC!)

A concurrent measurement (**aC!**) command follows the same pattern as the **aM!** command with the exception that it does not require the data logger to pause its operation, and other SDI-12 sensors may take measurements at the same time. The sensor will not issue a service request to notify the data logger that the measurement is complete. The data logger will issue the **aD0!** command during the next scan after the measurement time reported by the sensor has expired. To use this command, the scan interval should be 10 seconds or less. The response to each command has the form *atttn<CR><LF>*, where

a = the sensor address

ttt = time, in seconds, until the measurement data is available

nn = the number of values to be returned when one or more subsequent **D** commands are issued.

See the following example. A data logger has three sensors wired into terminal **C1**. The sensors are addresses X, Y, and Z. The data logger will issue the following commands and receive the following responses:

Table B-3: Example aC! sequence

`XC!`	The data logger makes a request to sensor X to start a concurrent measurement.
X03005<CR><LF>	Sensor X immediately indicates that it will have 5 (05) values ready for collection within the next 30 (030) seconds.
`YC!`	The data logger makes a request to sensor Y to start a concurrent measurement.
Y04006<CR><LF>	Sensor Y immediately indicates that it will have 6 (06) values ready for collection within the next 40 (040) seconds.
`ZC!`	The data logger makes a request to sensor Z to start a concurrent measurement.
Z02010<CR><LF>	Sensor Z immediately indicates that it will have 10 values ready for collection within the next 20 (020) seconds.
`ZD0!`	After 20 seconds have passed, the data logger starts the process of collecting the data by issuing the first **D** command to sensor Z.
Z+1+2+3+4+5+6+7+8+9+10<CR><LF>	Sensor Z immediately responds with the sensor address and the 10 values.
`XD0!`	10 seconds later, after a total of 30 seconds have passed, the data logger starts the process of collecting data from sensor X by issuing the first **D** command.
X+1+2+3+4+5<CR><LF>	The sensor immediately responds with the sensor address and the 5 values.

Table B-3: Example aC! sequence	
`YD0!`	Ten seconds later, after a total of 40 seconds have passed, the data logger starts the process of collecting data from sensor Y by issuing the first **D** command.
Y+1+2+3+4+5+6<CR><LF>	The sensor immediately responds with the sensor address and the 6 values.

B.1.8 Start measurement commands with cyclic redundancy check (aMC! and aCC!)

Error checking is done by using measurement commands with cyclic redundancy checks (**aMC!** or **aCC!**). This is most commonly implemented when long cable lengths or electronic noise may impact measurement transmission to the data logger. When these commands are used, the data returned in response to **D** or **R** commands must have a cyclic redundancy check (CRC) code appended to it. The CRC code is a 16-bit value encoded within 3 characters appended before the <CR><LF>. This code is not returned in the data table but checked by the data logger as it comes. The code returned is based on the SDI-12 protocol. See the SDI-12 communication specification for version 1.4 available at www.sdi-12.org to learn more about how the CRC code is developed.

B.1.9 Stopping a measurement command

A measurement command (**M!**) is stopped if it detects a break signal before the measurement is complete. A break signal is sent by the data logger before most commands.

A concurrent measurement command (**C!**) is aborted when another valid command is sent to the sensor before the measurement time has elapsed.

B.1.10 Send data command (aD0! … aD9!)

The Send Data command requests data from the sensor. It is issued automatically with every type of measurement command (**aM!**, **aMC!**, **aC!**, **aCC!**). When the measurement command is a**M!** or a**MC!**, the data logger issues the **aD0!** command once a service request has been received from the sensor or the reported time has expired. When the data logger is issuing concurrent commands (**aC!** or **aCC!**), the Send Data command is issued after the required time has elapsed (no service request will be sent by the sensor). In transparent mode (see SDI-12 transparent mode (p. 55)), the user asserts this command to obtain data.

Depending on the type of data returned and the number of values a sensor returns, the data logger may need to issue **aD0!** up to **aD9!** to retrieve all data. A sensor may return up to 35 characters of data in response to a `D` command that follows an `M!` or `MC!` command. A sensor may return up to 75 characters of data in response to a `D` command that follows a `C!` or `CC!` command. Data values are separated by plus or minus signs.

Command: `aD0!` (`aD1!` … `aD9!`)

Response: *a<values><CR><LF>* or *a<values><CRC><CR><LF>*

where:

a = the sensor address

<values> = values returned with a polarity sign (+ or –)

<CR><LF> = terminates the response

<CRC> = 16-bit CRC code appended if data was requested with a`MC!` or `aCC!`.

B.1.11 Extended commands

Many sensors support extended SDI-12 commands. An extended command is specific to a make of sensor and tells the sensor to perform a specific task. They have the following structure. Responses vary from unit to unit. See the sensor manual for specifics.

Command: `aXNNNN!`

The command will start with the sensor address (**a**), followed by an **X**, then a set of optional letters, and terminate with an exclamation point.

Response: *a<optional values><CR><LF>*

The response will start with the sensor address and end with a carriage return/line feed.

B.1.12 SDI-12 version 1.4 identify measurement commands and responses

Version 1.4 compliant sensors must respond to identify commands for each type of measurement command and each parameter with a command. The broad identify commands return how many variables will be returned with a given measurement command and the time it will take the sensor to respond. The specific identify parameter commands will return a SHEF code, the measurement units, and the type of measurement (sample, count, or average). For more information see the SDI-12 version 1.4 specification.

(http://sdi-12.org/current_specification/SDI-12_version-1_4-May-1-2017.pdf)

Table B-4: Supported V1.4 Commands (Command Information)		
Type of Command	Command[1]	Sensor Response[1]
Identify measurement for M commands	*a*IM!, *a*IMC!	*atttn*<CR><LF>
Identify measurement for C commands	*a*IC!, *a*ICC!	*atttnn*<CR><LF>
Identify measurement for V commands	*a*IV!	*atttn*<CR><LF>
[1]Where *a* is theSDI-12 address; *ttt* is the response time; and *n* is the number of values returned		

Table B-5: Supported V1.4 Commands (Parameter Identification) in the LevelVUE B10		
Parameter	Command [1]	Sensor Response[1]
Stage	*a*IM_001!, *a*IC_001!	*a*,HG,*xx*,sample;<CR><LF>
Line pressure	*a*IM_002!, *a*IC_002!	*a*,LP,PSI,sample;<CR><LF>
Tank pressure	*a*IM_003!, *a*IC_003!	*a*,TP,PSI,sample;<CR><LF>
Temperature	*a*IM_004!, *a*IC_004!	*a*,TMP,*y*,sample;<CR><LF>
Battery voltage	*a*IM_005!, *a*IC_005!	*a*,VB,V,sample;<CR><LF>
Error code	*a*IM_006!, *a*IC_006!	*a*,ERROR,CODE,sample;<CR><LF>
Peak stage	*a*IM_007!, *a*IC_007!	*a*,HG2,*xx*,sample;<CR><LF>
Peak stage offset time	*a*IM_008!, *a*IC_008!	*a*,HG2_TIME,SEC,sample;<CR><LF>
[1]Where *a* is the SDI-12 address; *xx* is either ft or m; and *y* is either C or F.		

B.2 SDI-12 transparent mode

System operators can manually interrogate and enter settings in probes using transparent mode. Transparent mode is useful in troubleshooting SDI-12 systems because it allows direct communication with probes. Data logger security may need to be unlocked before activating the transparent mode.

Transparent mode is entered while the computer is communicating with the data logger through a terminal emulator program. It is accessed through Campbell Scientific data logger support software or other terminal emulator programs. Data logger keyboards and displays cannot be used.

The terminal emulator is accessed by navigating to the **Tools** list in ***PC400*** or the **Datalogger** list in the **Connect** screen of ***LoggerNet***.

Watch videos/sdi12-sensors-transparent-mode ▶ from our website.

Data loggers from other manufacturers will also have a transparent mode. Refer to those manuals on how to use their transparent mode.

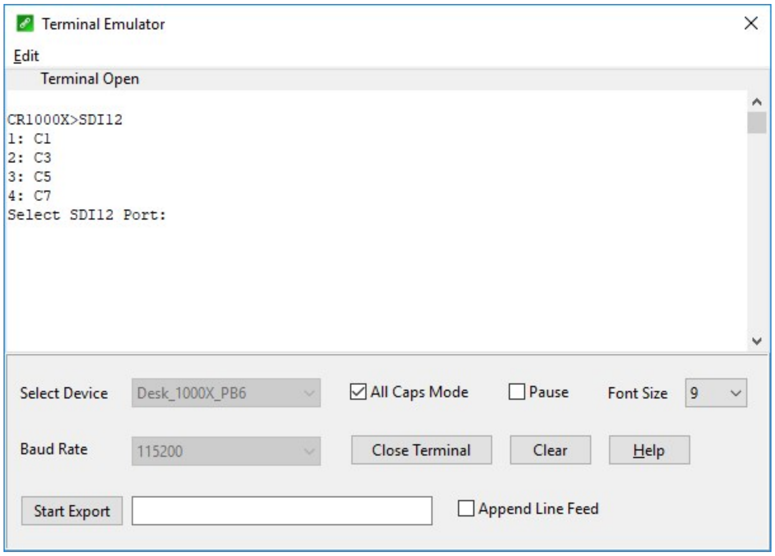
The following examples show how to enter transparent mode and change the SDI-12 address of an SDI-12 sensor. The steps shown in Changing an SDI-12 address (p. 56) are used with most Campbell Scientific data loggers.

B.2.1 Changing an SDI-12 address

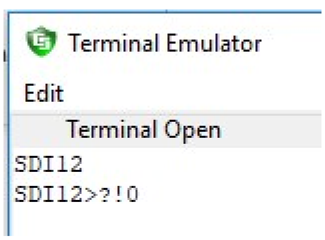
This example was done with a CR1000X, but the steps are only slightly different for CR6, CR3000, CR800-series, CR300-series, CR1000 data loggers.

1. Connect an SDI-12 sensor to the CR1000X.
2. In **LoggerNet Connect**, under **Datalogger**, click **Terminal Emulator**. The terminal emulator window opens.
3. Under **Select Device**, located in the lower left side of the window, select the **CR1000X**
4. Click **Open Terminal**.
5. Select **All Caps Mode**.
6. Press Enter until the data logger responds with the **CR1000X>** prompt.

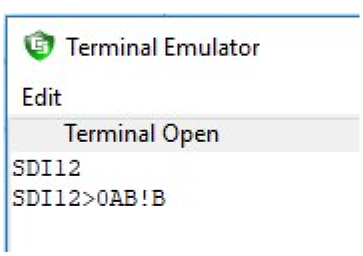
7. Type **SDI12** and press Enter.



8. At the **Select SDI12 Port** prompt, type the number corresponding to the control port where the sensor is connected and press Enter. The response **Entering SDI12 Terminal** indicates that the sensor is ready to accept SDI-12 commands.
9. To query the sensor for its current SDI-12 address, type **?!** and press Enter. The sensor responds with its SDI-12 address. If no characters are typed within 60 seconds, the mode is exited. In that case, simply type **SDI12** again, press Enter, and type the correct control port number when prompted.



10. To change the SDI-12 address, type **aAb!**, where **a** is the current address from the previous step and **b** is the new address. Press **Enter**. The sensor changes its address and responds with the new address. In the following example, the sensor address is changed from 0 to B.



11. To exit SDI-12 transparent mode, click **Close Terminal**.

NOTE:
The transparent mode for the CR6, CR3000, CR800-series, CR300-series, and CR1000 data loggers is similar to that shown for the CR1000X.

B.3 References

SDI-12 Support Group. SDI-12: A Serial-Digital Interface Standard for Microprocessor-Based Sensors – Version 1.4. River Heights, UT: SDI-12 Support Group, 2017. http://www.sdi-12.org/current_specification/SDI-12_version-1_4-Dec-1-2017.pdf.

Appendix C. Field calibration check

Some agencies require the calibration to be verified on a specified schedule. The procedure for verifying the calibration uses an off-the-shelf field calibration tool, such as Druck DPI611 (FIGURE C-1 (p. 59)) or DPI612 series.

FIGURE C-1. DPI611 calibration tool

1. Go to the site.
2. Press the arrows on the LevelVUE B10 keypad to go to the **Diagnostic/Test** menu and select the **Field Cal Check** option.

```
Diagnostic / Test

>Status Errors [None]
 Test Line Noise    >
 Test Line Leak     >
 Field Cal Check    >
 Reset Max/Min      >
 Min Batt V.   = 12.23
 Max Batt V.   = 14.34
```

3. When the following screen appears, disconnect the orifice line and connect the LevelVUE B10 outlet to the calibration tool.

Run Field Cal Check?
Attach Field
Cal. Tool.
YES NO

4. Select **YES** to start the test. The following message will be briefly displayed:

Run Field Cal Check?
Setting Up...
Please Wait
Timeout Counter 899

5. At this point, the purge valve is activated to allow pressures in the system to equalize quickly. Also, the built-in compressor is disabled allowing the pressure to be controlled solely by the calibration tool. The test will time out after about 15 minutes. Once the system pressures equalize the following screen is displayed:

Run Field Cal
Line PSI: x.xxx
Timeout Counter 321
STOP TCRST

6. While the test is running, the pressure measured by the LevelVUE B10 is displayed on the screen. This value should be very close to the value displayed on the calibration tool. Keep in mind, it may take a few seconds for the system to equalize after the pressure is changed. The test can be stopped at any time by pressing the soft key STOP or reset to run longer by pressing the soft key TCRST (Timeout Counter Reset). While the test is running, adjust the pressure as needed to verify proper operation.

> **CAUTION:**
> Do not pressurize the system higher than the rated pressure range.

It is good practice to test the pressure at each end of the range and at a mid-point. For example, on a 0 to 30 psi bubbler, test at about 0.100 psi, 15.000 psi, and at 29.900 psi. To pass the test, the bubbler and the calibrator readings need to be within the system accuracy. For example, a 30 psi unit with a maximum error of ±0.02% passes the calibration test if the bubbler value is within ±0.006 psi (30 psi x 0.02% = 0.006 psi) of the calibrator value.

> **NOTE:**
> The worst-case error is additive. The bubbler accuracy is 0.02% and the calibrator accuracy is typically 0.01%. Therefore, the worst case error is 0.03% (0.02% + 0.01%). For a 30 psi unit, this is ±0.009 psi (0.0003 x 30).

7. Once the test is stopped or the timeout expires, the unit will ask if the field calibrator tool has been removed. After removing the calibrator, reconnect the LevelVUE B10 orifice line. The timeout counter defaults to 30 seconds to provide enough time to switch the line.

```
Run Field Cal

Field Cal Tool
Removed?

Timeout Counter 28
EXIT     TCRST
```

8. After the test, reconnect the orifice line and purge the line to ensure water is out of the orifice line.

Limited warranty

Products manufactured by Campbell Scientific are warranted by Campbell Scientific to be free from defects in materials and workmanship under normal use and service for twelve months from the date of shipment unless otherwise specified on the corresponding product webpage. See Product Details on the Ordering Information pages at www.campbellsci.com. Other manufacturer's products, that are resold by Campbell Scientific, are warranted only to the limits extended by the original manufacturer.

Refer to www.campbellsci.com/terms#warranty for more information.

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Campbell Scientific regional offices handle repairs for customers within their territories. Please see the back page for the Global Sales and Support Network or visit www.campbellsci.com/contact to determine which Campbell Scientific office serves your country.

To obtain a Returned Materials Authorization or Repair Reference number, contact your CAMPBELL SCIENTIFIC regional office. Please write the issued number clearly on the outside of the shipping container and ship as directed.

For all returns, the customer must provide a "Statement of Product Cleanliness and Decontamination" or "Declaration of Hazardous Material and Decontamination" form and comply with the requirements specified in it. The form is available from your CAMPBELL SCIENTIFIC regional office. Campbell Scientific is unable to process any returns until we receive this statement. If the statement is not received within three days of product receipt or is incomplete, the product will be returned to the customer at the customer's expense. Campbell Scientific reserves the right to refuse service on products that were exposed to contaminants that may cause health or safety concerns for our employees.

Safety

DANGER — MANY HAZARDS ARE ASSOCIATED WITH INSTALLING, USING, MAINTAINING, AND WORKING ON OR AROUND **TRIPODS, TOWERS, AND ANY ATTACHMENTS TO TRIPODS AND TOWERS SUCH AS SENSORS, CROSSARMS, ENCLOSURES, ANTENNAS, ETC.** FAILURE TO PROPERLY AND COMPLETELY ASSEMBLE, INSTALL, OPERATE, USE, AND MAINTAIN TRIPODS, TOWERS, AND ATTACHMENTS, AND FAILURE TO HEED WARNINGS, INCREASES THE RISK OF DEATH, ACCIDENT, SERIOUS INJURY, PROPERTY DAMAGE, AND PRODUCT FAILURE. TAKE ALL REASONABLE PRECAUTIONS TO AVOID THESE HAZARDS. CHECK WITH YOUR ORGANIZATION'S SAFETY COORDINATOR (OR POLICY) FOR PROCEDURES AND REQUIRED PROTECTIVE EQUIPMENT PRIOR TO PERFORMING ANY WORK.

Use tripods, towers, and attachments to tripods and towers only for purposes for which they are designed. Do not exceed design limits. Be familiar and comply with all instructions provided in product manuals. Manuals are available at www.campbellsci.com. You are responsible for conformance with governing codes and regulations, including safety regulations, and the integrity and location of structures or land to which towers, tripods, and any attachments are attached. Installation sites should be evaluated and approved by a qualified engineer. If questions or concerns arise regarding installation, use, or maintenance of tripods, towers, attachments, or electrical connections, consult with a licensed and qualified engineer or electrician.

General

- Protect from over-voltage.
- Protect electrical equipment from water.
- Protect from electrostatic discharge (ESD).
- Protect from lightning.
- Prior to performing site or installation work, obtain required approvals and permits. Comply with all governing structure-height regulations.
- Use only qualified personnel for installation, use, and maintenance of tripods and towers, and any attachments to tripods and towers. The use of licensed and qualified contractors is highly recommended.
- Read all applicable instructions carefully and understand procedures thoroughly before beginning work.
- Wear a **hardhat** and **eye protection**, and take **other appropriate safety precautions** while working on or around tripods and towers.
- **Do not climb** tripods or towers at any time, and prohibit climbing by other persons. Take reasonable precautions to secure tripod and tower sites from trespassers.
- Use only manufacturer recommended parts, materials, and tools.

Utility and Electrical

- **You can be killed** or sustain serious bodily injury if the tripod, tower, or attachments you are installing, constructing, using, or maintaining, or a tool, stake, or anchor, come in **contact with overhead or underground utility lines**.
- Maintain a distance of at least one-and-one-half times structure height, 6 meters (20 feet), or the distance required by applicable law, **whichever is greater**, between overhead utility lines and the structure (tripod, tower, attachments, or tools).
- Prior to performing site or installation work, inform all utility companies and have all underground utilities marked.
- Comply with all electrical codes. Electrical equipment and related grounding devices should be installed by a licensed and qualified electrician.
- Only use power sources approved for use in the country of installation to power Campbell Scientific devices.

Elevated Work and Weather

- Exercise extreme caution when performing elevated work.
- Use appropriate equipment and safety practices.
- During installation and maintenance, keep tower and tripod sites clear of un-trained or non-essential personnel. Take precautions to prevent elevated tools and objects from dropping.
- Do not perform any work in inclement weather, including wind, rain, snow, lightning, etc.

Maintenance

- Periodically (at least yearly) check for wear and damage, including corrosion, stress cracks, frayed cables, loose cable clamps, cable tightness, etc. and take necessary corrective actions.
- Periodically (at least yearly) check electrical ground connections.

Internal Battery

- Be aware of fire, explosion, and severe-burn hazards.
- Misuse or improper installation of the internal lithium battery can cause severe injury.
- Do not recharge, disassemble, heat above 100 °C (212 °F), solder directly to the cell, incinerate, or expose contents to water. Dispose of spent batteries properly.

WHILE EVERY ATTEMPT IS MADE TO EMBODY THE HIGHEST DEGREE OF SAFETY IN ALL CAMPBELL SCIENTIFIC PRODUCTS, THE CUSTOMER ASSUMES ALL RISK FROM ANY INJURY RESULTING FROM IMPROPER INSTALLATION, USE, OR MAINTENANCE OF TRIPODS, TOWERS, OR ATTACHMENTS TO TRIPODS AND TOWERS SUCH AS SENSORS, CROSSARMS, ENCLOSURES, ANTENNAS, ETC.

INFO

CAMPBELL SCIENTIFIC
WHEN MEASUREMENTS MATTER

Global Sales & Support Network

A worldwide network to help meet your needs

Campbell Scientific regional offices

Australia

Location: Garbutt, QLD Australia
Phone: 61.7.4401.7700
Email: info@campbellsci.com.au
Website: www.campbellsci.com.au

Brazil

Location: São Paulo, SP Brazil
Phone: 11.3732.3399
Email: vendas@campbellsci.com.br
Website: www.campbellsci.com.br

Canada

Location: Edmonton, AB Canada
Phone: 780.454.2505
Email: dataloggers@campbellsci.ca
Website: www.campbellsci.ca

China

Location: Beijing, P. R. China
Phone: 86.10.6561.0080
Email: info@campbellsci.com.cn
Website: www.campbellsci.com.cn

Costa Rica

Location: San Pedro, Costa Rica
Phone: 506.2280.1564
Email: info@campbellsci.cc
Website: www.campbellsci.cc

France

Location: Vincennes, France
Phone: 0033.0.1.56.45.15.20
Email: info@campbellsci.fr
Website: www.campbellsci.fr

Germany

Location: Bremen, Germany
Phone: 49.0.421.460974.0
Email: info@campbellsci.de
Website: www.campbellsci.de

India

Location: New Delhi, DL India
Phone: 91.11.46500481.482
Email: info@campbellsci.in
Website: www.campbellsci.in

South Africa

Location: Stellenbosch, South Africa
Phone: 27.21.8809960
Email: sales@campbellsci.co.za
Website: www.campbellsci.co.za

Spain

Location: Barcelona, Spain
Phone: 34.93.2323938
Email: info@campbellsci.es
Website: www.campbellsci.es

Thailand

Location: Bangkok, Thailand
Phone: 66.2.719.3399
Email: info@campbellsci.asia
Website: www.campbellsci.asia

UK

Location: Shepshed, Loughborough, UK
Phone: 44.0.1509.601141
Email: sales@campbellsci.co.uk
Website: www.campbellsci.co.uk

USA

Location: Logan, UT USA
Phone: 435.227.9120
Email: info@campbellsci.com
Website: www.campbellsci.com