PVS5120-Series

Portable Samplers

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PVS5120-Series Portable Samplers

1. Introduction

The PVS5120-series samplers are automatic liquid samplers for water and wastewater applications. These samplers gather fluid automatically from a variety of sources including containers, open channels, sewers, pipes, and any open source of water. They are lightweight, portable, battery-powered water samplers designed for reliable unattended sample collection.

The PVS5120-series portable samplers use the VSC100 controller that allows a Modbus® RTU master, SDI-12 master device, simple pulse input, or Campbell Scientific PakBus® datalogger to control and communicate with the water sampler. The PVS5120 can also run in a time-controlled, stand-alone mode.

The PVS5120C is a composite sampler that deposits its water samples into one 9 L container; the PVS5120D is a discrete sampler that deposits its water samples into 1 to 24 containers.

2. Precautions

- READ AND UNDERSTAND the *Safety* section at the back of this manual.

- CAUTION: Damage resulting from running the sampler under freezing conditions will not be covered under the product warranty.

- Wiring to remote/external sensors should avoid all ac power lines if possible and/or be run in shielded cable terminating the shield at the ac ground terminal at the remote site.

- The intake hose should be 7.6 m (25 ft) or longer. Shorter hoses do not provide sufficient back pressure to the metering chamber, allowing the pump to efficiently expel all solids into the sample container.

- The liquid sensing rod and the volume control tube must be kept clean to ensure the conductivity necessary to detect the presence of the fluid.

- CAUTION: Do not program the sampler using the generic SDI-12 sensor option in Campbell Scientific's *Short Cut*. The wiring diagram generated by *Short Cut* is incorrect for connecting the PVS5120 to a datalogger. It shows a power wire (12 V) connection that is not necessary for running the sampler as an SDI-12 sensor. Connecting the control cable's red wire to the datalogger's 12 V terminal causes problems in the sampler. See Section 8.2.3, *SDI-12 Control (p. 32)*, for more information.

3. Initial Inspection

- Upon receipt of the sampler, inspect the packaging and contents for damage. File damage claims with the shipping company.

- Immediately check package contents against the shipping documentation. Contact Campbell Scientific about any discrepancies.

4. Overview

The PVS5120-series can have a standard or a large pump. At sea level, the standard pump takes samples at 1.6 m/s (5.1 ft/s) for horizontal draws of 7.6 m (25 ft), and the large pump takes samples at 2.2 m/s (7.1 ft/s) at 7.6 m (25 ft).

When sampling is initiated, liquid travels through the intake hose to the volume control tube into the metering chamber. The amount of water taken is set mechanically using the liquid sensing rod and the volume control tube, which means sample accuracy is precise every time, usually within ±2% or ±2 ml. Sample accuracy increases when you have set the volume control rod and tested the collected sample at setup. Once the pre-set amount has been reached, all excess liquid is purged from the system, and the sample is dropped into a container.

4.1   Component Overview

FIGURE 4-1 shows the sampler's components. FIGURE 4-2 and TABLE 4-1 describe the control panel.

FIGURE 4-1. PVS5120D Sampler
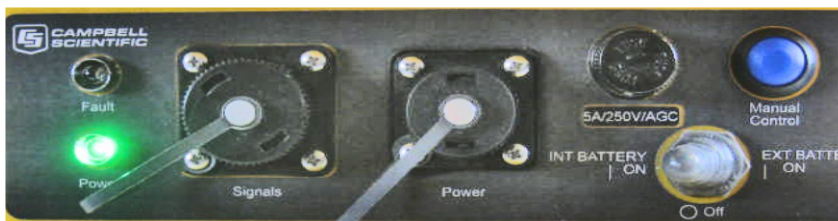
FIGURE 4-2. Control Panel

TABLE 4-1. Control Panel Descriptions	
Label	**Description**
Fault	Red LED flashes to indicate fault errors
Power (LED)	After the power is turned on, this green LED should light up for several seconds and start blinking once per second.
Signals (connector)	Connector for the external control cable that attaches the sampler to a datalogger, MD485, or other external device that controls or monitors the sampler.
Power (connector)	Connector for attaching a 12 Vdc charger or external battery.
5A/250V/AGC or 10A/32V/MDL	Fuse that protects the control panel. Varies depending on pump choice. The 10 A version is for the large pump.
Manual Control	Blue button used to Service, Manually Sample, and Auto Deploy the sampler (see Section 4.1.1.1, *Manual Control Button (p. 4)*, for more information).
INT BATTERY ON Off EXT BATTERY ON	Three way toggle switch used to select whether the sampler is running off of the internal or external battery or turns the power off.

4.1.1.1 Manual Control Button

The blue Manual Control button is located at the top right of the control panel. This button allows the user to Service the sampler, collect a Manual Sample, or run the Auto Deploy routine. A label on top of the sampler shows the button's function (FIGURE 4-3).
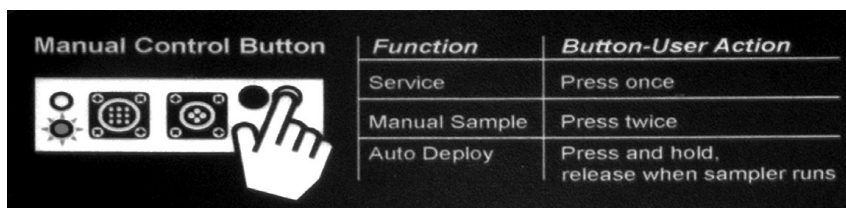
FIGURE 4-3. Manual Control Button

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1. **Service the sampler:** Push the button once and release. Servicing the sampler tells the controller to zero all the sample counts and return to the first bottle or home position. It assumes the user has emptied or replaced the bottles. The next sample collected and logged by the datalogger is bottle 1, sample number 1.

2. **Manual Sample collection:** Push the button twice and release. This directs the sampler to collect a manual sample into whichever bottle the sampler is currently on independent of the datalogger. This sample is logged by the controller. The next time the datalogger tells the sampler to collect a sample, the count increments by two.

    For example, if the sampler is collecting only one sampler per bottle and it is on bottle two, the manual sample drops in bottle 2 and the arm moves to bottle 3. The next time the datalogger initiates a sample, the sampler deposits it into bottle 3. The controller then returns to the datalogger the following status values: bottle 3, sample 1, response code 0, and the sampler battery voltage.

3. **Auto Deploy routine:** Push and hold the button until the sampler begins running and then release the button. The Auto Deploy routine runs the sampler through an entire sampling sequence while keeping track of the time to move water from the water source to the metering chamber. It uses this information to set the purge and the vacuum times within the controller. The user can see these times and keep them or change them by connecting to the VSC100 with our *Device Configuration Utility* (*DevConfig*).

4.2   Composite and Discrete Overview

4.2.1 Discrete Sampling

The PVS5120D is a discrete system that places samples into more than one container. It has a stepper assembly that moves a distributor arm. The distributor arm revolves 360° and can deliver samples into 24 separate containers. An encoder senses the distributor arm position. The PVS5120D samplers can have 500 mL or 1 L bottles (FIGURE 4-1). Available bottle configurations are 1, 2, 3, 4, 6, 8, 12, and 24.

Discrete sampling is beneficial in situations where change over time needs to be measured, such as measuring different water characteristics over 24 hours. Labs and monitoring personnel tend to rely on discrete sampling.

4.2.2 Composite Sampling

The PVS5120C composite sampler draws water samples into one 9 L container (FIGURE 4-4). Composite sampling is the simplest method for taking samples and is often used when the sampler is measuring effluent in one location. The composite sampler is also less expensive than the discrete model.

FIGURE 4-4. PVS5120C Composite Sampler

5. Specifications

Features:

- Diagnostic feedback provided to the master device: bottle number, sample number, response code/message, sampler battery voltage
- Auto Deploy routine that automatically sets the purge and the vacuum times based on hose length
- Repeatable volume collection via metering chamber
- Selectable internal or external power via three-way power switch
- One control cable for all control types
- An optional water present sensor detects the presence of water at the mouth of the sampler intake hose to ensure a sample is available
- Compatible with Campbell Scientific CRBasic dataloggers: CR200(X)-series, CR6, CR800-series, CR1000, CR3000, and CR5000

5.1 General Specifications

Enclosure:	LLDPE, linear low-density polyethylene, three piece construction and stainless steel fittings
Cooling system:	Insulated container wall cavity. Space for ice.
Height:	80.9 cm (31.875 in)
Height with extended base:	96.2 cm (37.875 in)
Body case diameter:	42.8 cm (16.85 in)

Weight
    Sampler w/standard
    pump and no battery: 10.4 kg (23 lb)
    Sample w/large pump
    and no battery: 11.8 kg (26 (lb)
    7 Ah battery: 1.8 kg (4 lb)
    17 Ah battery: 6.3 kg (14 lb)

Temperature range
    Storage: –20 to 50 °C
    Operating (large pump):   0 to 40 °C
    Operating (standard pump): 0 to 50 °C

CAUTION	Damage resulting from running the sampler under freezing conditions will not be covered under the product warranty.

    Storage: –40 to 60 °C (–40 to 140 °F)

Power requirements
    Input power: 12 Vdc
    Internal battery: 7 Ah or 17 Ah
    External charger: 110 Vac charger or 100 to 240 Vac charger

Compliance: CE Compliant
RoHS Compliant
Complies with the relevant sections of the ISO 5667-10 standard applicable to unrefrigerated portable water samplers (Appendix H)

5.2   VSC100 Controller

Sampler triggering methods: SDI-12 Master Device, Modbus® RTU Master, Campbell Scientific PakBus® datalogger, pulse trigger (1 to 10,000 pulses), time-based sampling (stand-alone)

RS-485 communication: Can return sampler status when triggering samples via pulse or time-based control

Backup power source: Internal 3 V coin-cell lithium battery (pn 15598) to maintain program settings and real-time clock in case of power failure

Bottle position encoder: Verifies arm position and moves to correct bottle if it is out of position

Multi-purpose button: Service sampler, collect Manual Sample, and run Auto Deploy routine

Auto Deploy routine: Automatically sets the purge and vacuum times based on hose length (between 25 to 100 ft)

**Sampler status/feedback
(available after every sample):** Bottle number, sample number, response code, sampler battery voltage are returned to a datalogger after every sample

Clock accuracy: 8.2 minutes/month over the temperature range or 1 minute/month at 25 °C

5.3   Vacuum Pump System

Pinch valve: Fixed – normally open

Purge cycle: Adjustable from 1 to 800 s; 280 s for SDI-12

Suction cycle: Variable (until liquid contacts liquid sensing/conductivity rod in metering chamber or adjusts automatically to two times the purge time)

Metering chamber cover: Nylon (standard), Teflon® (optional)

**Metering chamber
level electrode:** 316 stainless steel

Volume control tube: 316 stainless steel

**Liquid sensing/
conductivity rod:** 316 stainless steel

Intake hose: Ordered as a common accessory. Campbell Scientific offers PVC hose with 25 ft and user-specified lengths. Intake end can have a lead sinker or stainless steel strainer. Sampler end of the hose can have a clamp or quick connect termination.

**Discharge hose material
(composite only):** Latex (standard), Options: Teflon® lined, silicone

**Maximum horizontal
transport distance:** 76.2 m (250 ft) assumes no vertical lift

Maximum vertical lift (assume no horizontal transport distance)
     Standard pump: 4.9 m (16 ft)
     Large pump: 8.2 m (27 ft)

NOTE   For more information, see Appendix A, *Sample Transport Velocity (p. A-1).*

6. *Device Configuration Utility* Overview

Device Configuration Utility (*DevConfig*) software version 2.09 or higher is used to configure the sampler controller (VSC100). The following sections introduce the tabs and settings within the VSC100 portion of *DevConfig*. Please see Section 8, *Operation (p. 26)*, to step through specific control types/scenarios. This section is meant to introduce a new user to each setting in detail.

To use *DevConfig*, the sampler needs to be powered and the VS100 controller needs to be connected to a PC via the 17648 USB cable (FIGURE 6-1).

FIGURE 6-1. VSC100 and 17648 USB cable

6.1 Connecting to the VSC100/Sampler via *DevConfig*

1. Connect the 17648 USB cable to the front of the sampler controller (VSC100) and the other end to the computer's USB port (FIGURE 6-1). Wait for Windows® to install the driver before opening *DevConfig*.

2. Open *DevConfig*. Select **VSC100 Series** under **Sampler**. Click **Communication Port** and select the correct **Communications Port**. Click **Connect** (FIGURE 6-2).
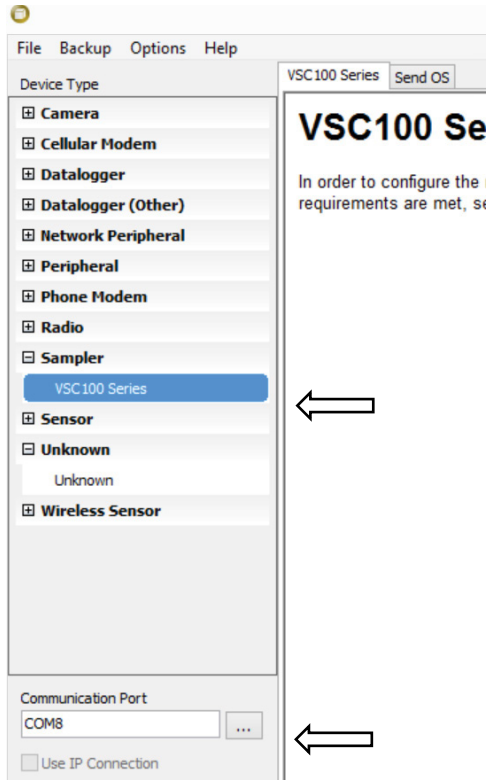
FIGURE 6-2. Device Configuration VSC100

3.   Once connected to the VSC100, you are ready to configure your sampler.

6.1.1 Clock Tab

The **Clock** tab sets the clock on the VSC100 and sampler (FIGURE 6-3).
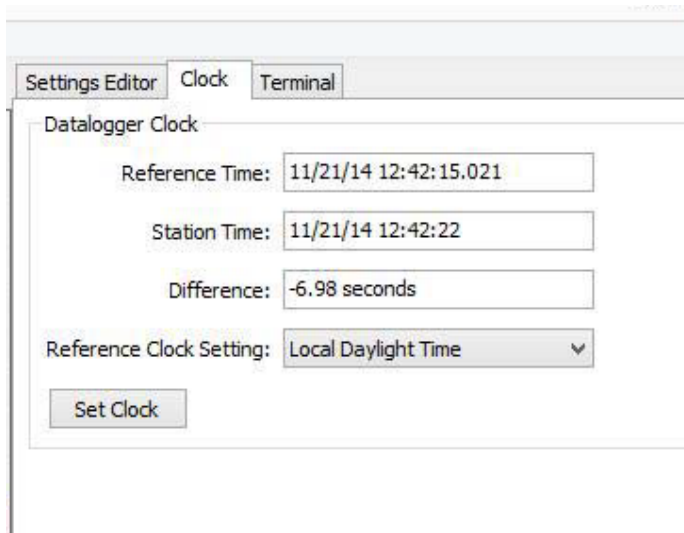
FIGURE 6-3. Clock tab

The **Clock** tab is only available when the user first connects to the VSC100 via *DevConfig*. After the user clicks on a tab within the **Settings Editor** screen, the **Clock** tab will no longer be available.

The **Clock** tab displays the Reference (computer) Time, Station (sampler) Time, and Difference (reference time – station time).

The **Reference Clock Settings** allows the user to choose if the reference clock is running in Local Daylight mode or UTC (Greenwich Mean Time).

Click **Set Clock** button to sync the clocks (FIGURE 6-3).

CAUTION The clock must be synced before deploying the sampler if running the sampler using **Stand-Alone, Time-Based** control or if a new operation system has been loaded to the VSC100.

The sampler clock can have up to 1 minute of drift per month when running at roughly 25 °C. If it is running at the extremes of the temperature range, the user could see up to 8.2 minutes of drift per month between the VSC100 clock and the reference clock. When the sampler is triggered via a datalogger, this drift isn't as critical since the datalogger clock may be more precise or sync on a more regular basis. If running under **Time** control type, the clocks should be synced whenever the sampler is serviced or the bottles collected.

6.2   Settings Editor Tab

6.2.1 Info Tab
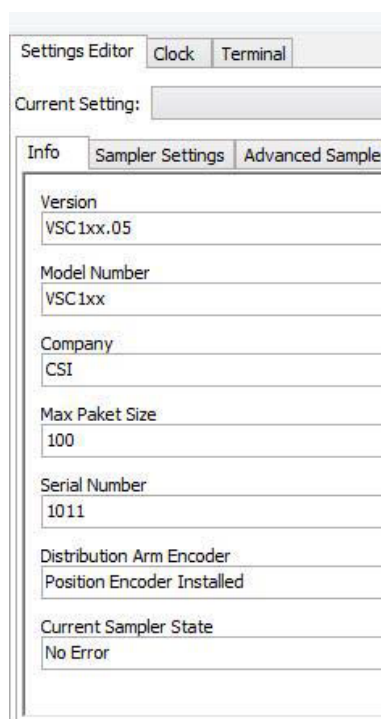
FIGURE 6-4. Info tab

The **Info** tab (FIGURE 6-4) provides the following system information regarding the VSC100:

- **Version** or Operating System identification that is running on the controller.

- **Model Number** of the controller.

- **Maximum Packet Size** that can be received by the VSC100.

- **Serial Number**: Specifies the manufacturer assigned serial number for this Sampler Control Module.

- **Distribution Arm Encoder**: Indicates if a distribution arm position encoder is installed. Composite samplers do not have an arm position encoder present.

- **Current Sample State**: Returns the last sampler response code. See later sections for the eight possible response codes returned by the sampler.

6.2.2 Sampler Settings Tab

FIGURE 6-5. Sampler Settings tab

The **Sampler Settings** tab (FIGURE 6-5) contains the most common settings to configure with regard to the PVS5120.

- **Control Type**: Determines the sampler control and interface method. Options include: PakBus®, Pulse, Modbus®, SDI-12, and Time. When the sampler is controlled via Pulse or Time, it can be monitored

via PakBus® or Modbus®. If SDI-12 control type is selected, RS-485 communication with the sampler is disabled. Similarly, if PakBus® is selected, Modbus® communication is again disabled.

- **PakBus Address**: This setting specifies the PakBus® address for the device if it is being controlled or monitored via PakBus®. It needs to be a unique value for each sampler and datalogger on the network. The default address for all samplers is 95. This address is used in the program on the datalogger to reference the sampler for initiating samples and collecting sampler status.

- **Modbus Address**: Sets the sampler Modbus® address. It is active for sampler control types: Pulse, Modbus®, and Time. It must be unique for each sampler on your network and each datalogger. Range is 1 through 127.

- **SDI-12 Address**: Sampler SDI-12 address. It must be unique to each sampler and SDI-12 sensor connected to a single COM port on your datalogger. It is only active when SDI-12 is selected as the Sampler Control Type. Address values can range from 0-9, A-Z, and a-z.

- **Number of Sampler Bottles**: This is the number of containers within the sampler base.

- **Samples Per Bottle**: Specifies how many samples to place in each bottle. It can range from 1 to 999. This setting is ignored if Never Full is set to "On/Enable".

- **Never Full Option**: Specifies whether the sampler stops or continues sampling when each bottle(s) has been filled with the corresponding samples per bottle setting. This option is most common in applications where the sampler is easily accessible and containers are collected regularly for instance at a wastewater treatment facility.

- **Purge Time:** The amount of time (in seconds) the sampler hose is evacuated before and after the sample is collected. The minimum value is 0 s. The maximum value for PakBus®, Pulse, Modbus®, and Time control types is 800 s. The maximum value for the SDI-12 control type is 280 s. It is possible for the final purge time to be set separately under the **Advanced Sampler Settings** tab and is discussed more below.

- **Water Present Sensor**: Indicates to the sampler controller if an optional water present sensor is installed. If the sensor is to be connected, the sampler checks for the presence of water at the start of each sample cycle. If water is not detected, a response code (TABLE 8-3) is generated and the cycle is aborted (Section 7.3.1, *Water Detection Probe (p. 24)*).

6.2.3 Advanced Sampler Settings Tab

Most users do not need to change the following **Advanced Sampler Settings** if the Auto Deploy routine is completed when the sampler is deployed in the field (FIGURE 6-6).

FIGURE 6-6. Advanced Sampler Settings tab

- **Set Final Purge Time:** Allows the **Final Purge Time** to be set independently from the **Purge Time**.

- **Final Purge Time:** Specifies the amount of time the sampler hose is evacuated after a sample is collected. The minimum value is 0 s. The maximum value for SDI-12 control is 280 s. The maximum value for PakBus®, Pulse, Modbus®, and Time control types is 800 s. The setting is only active if the **Set Final Purge Time** is toggled to *set*.

- **Sample Volume Level Set Time:** The amount of time the sample is evacuated out of the metering chamber back into the intake hose to reach the desired volume. The sample volume is determined by the level of the volume set rod. The minimum time is 3 s. The maximum time for the SDI-12 control type is 30 s. The maximum time is 800 s for PakBus®, Pulse, Modbus®, and Time control types. The Auto Deploy routine sets this to 12 s.

- **Sample Deposit Time:** The amount of time the sampler waits for the sample volume to drain into the sample bottle. Minimum time is 5 s. The maximum time for SDI-12 is 20 s. The maximum time for PakBus®, Pulse, Modbus®, and Time control types is 800 s. If the sample volume is greater than 420 mL, the deposit time must be 18 to 20 s. The Auto Deploy routine sets this to 8 s.

- **Set Vacuum Time Out:** Allows the user to choose the default (two times the Purge Time) or to independently set the time out. If the default is chosen and the Purge Time is 0 s, the time out value is 10 s. This is not set during Auto Deploy.

- **Vacuum Time Out:** The maximum time-out for SDI-12 control type is 330 s. The maximum vacuum time-out for PakBus®, Pulse, Modbus®, and Time control types is 800 s.

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- **Sample Chamber – Pressure Relief**: Enable the pressure relief option when collecting large sample volumes and/or using long hose lengths (over 50 ft) for discrete samplers. This setting should not be used with short hose lengths (less than 25 ft) since extra sample volume may be collected. This setting vacuums the sample chamber for a short time immediately after setting the sample volume level. Enabling the feature removes back pressure present in long hose lengths and reduces nozzle spray when depositing the sample to discrete bottles.

6.2.4 Pulse Settings Tab
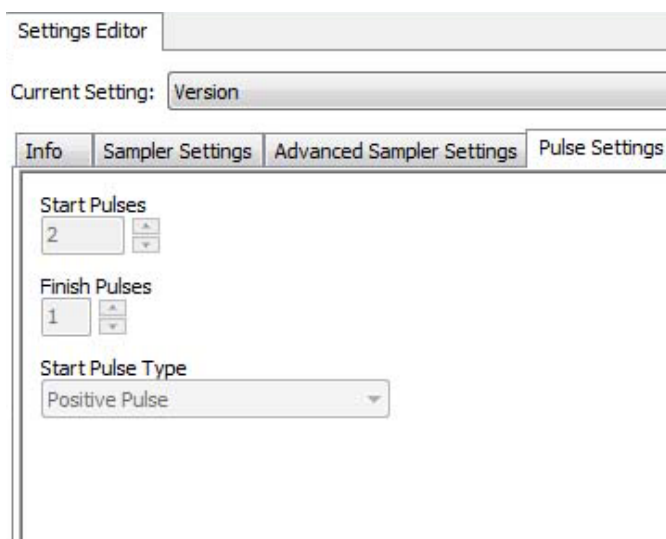
FIGURE 6-7. Pulse Settings tab

Once *Pulse* is chosen as the **Control Type** via the **Sampler Settings** tab (Section 6.2.2, *Sampler Settings Tab (p. 12)*), the options within the **Pulse Settings** tab become available.

- **Start Pulses**: The number of input pulses needed to initiate the sample process. The range is 1 to 10,000 pulses. The controller continues to accumulate pulses even when the sampler is running.

- **Finish Pulses**: The number of pulses returned by the sampler after successfully finishing a sample cycle. It is important to note that no pulses are returned if an error/fault is generated.

- **Start Pulse Type**: Specifies whether the Start Pulse is a positive pulse or a contact closure/open collector (negative pulse). See Section 8.2.6, *Pulse Control (p. 50)*, for more details.

6.2.5 Time Settings Tab

Once *Time* is chosen as the **Control Type** via the **Sampler Settings** tab (Section 6.2.2, *Sampler Settings Tab (p. 12)*), the options within the **Time Settings** tab become available (FIGURE 6-8).
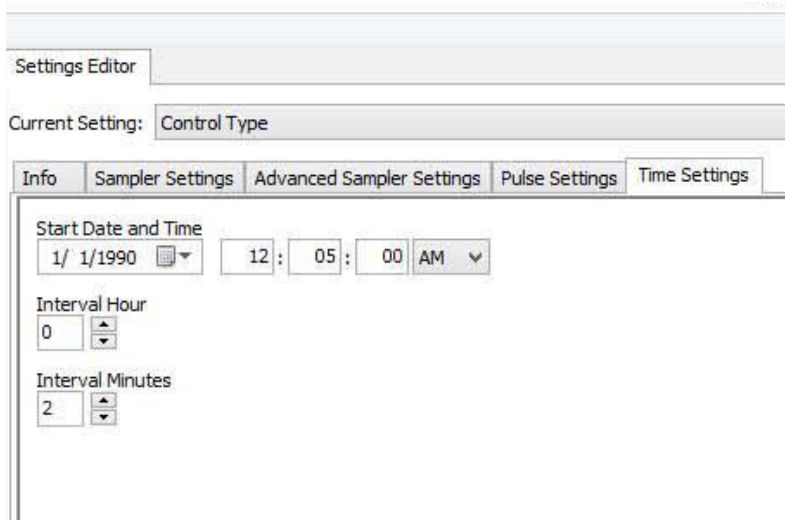
FIGURE 6-8. Time Settings tab

NOTE	If running with time-based control, the user must sync the clock of the sampler. This is described in Section 6.1.1, *Clock Tab (p. 10)*.

- **Start Date and Time**: Specifies the date and time at which sample collection begins. Following this point in time, the schedule for all future samples use the interval specified by the Interval Hour and Interval Minutes settings. This setting is ignored unless the sample **Control Type** is set to *Time*. The default start date and time are 12:05 AM on January 1, 1990. This must be changed.

CAUTION	If the default Start Date and Time is not changed, the sampler will immediately begin sampling after the configuration is applied to the VSC100. Make sure to set this start date and time far enough into the future to ensure that the sampler is in place before it starts taking samples.

- **Interval Hour**: Specifies the number of hours in the time interval between sample collections. This must be an integer value.

- **Interval Minutes**: Specifies the number of minutes in the time interval between sample collections. Must be an integer value from 0 to 59.

6.2.6 Terminal Tab

The **Terminal** tab allows the user to complete advanced troubleshooting with the help of a Campbell Scientific application engineer. This tab is no longer available once the user interacts with the **Settings Editor** tab.

7. Installation

7.1 Field Installation

7.1.1 Required Gear for Field Deployment

- Sampler (top, control section, base with bottles)
- 7/8 inch wrench (adjusting rods)
- 9/16 inch wrench (adjusting rods)
- 5/32 inch Allen wrench (adjusting rods)
- 1/4 inch nut driver (tightening hose clamp)
- Small flat head screwdriver (wiring to datalogger)
- USB cable (connecting to VSC100)
- Control cable (connects datalogger to the sampler)
- Internal or external 12 Vdc battery (Section 7.2.4, *Battery (p. 23)*)
- External power cable if using an external battery (Section 7.2.3.3, *External Battery Cable (pn 30819) (p. 22)*)
- Datalogger with its own power supply, protected in an enclosure if necessary
- 3/8 inch hose clamp to secure the intake hose to the sampler volume set rod
- Laptop computer with *DevConfig* (2.09 or higher)

7.1.2 Sampler Positioning

Place the sampler on a level surface as close as practical to the sample source (FIGURE 7-1). Appendix A, *Sample Transport Velocity (p. A-1)*, shows the maximum expected lift that can maintain an intake velocity greater than 2.5 ft/s as required by the EPA. An intake velocity greater than 2.5 ft/s prevents settling of sediment before reaching the metering chamber, and, therefore, biasing the sample to a lower suspended sediment concentration. It is better to have a shorter hose and a longer control cable connecting the sampler to the datalogger. Manhole installation may require a three-point suspension harness.

The sampler must be located above the sample source, or the liquid will flood the machine. For situations where this is not possible, contact a Campbell Scientific application engineer for solutions on pressurized sources.
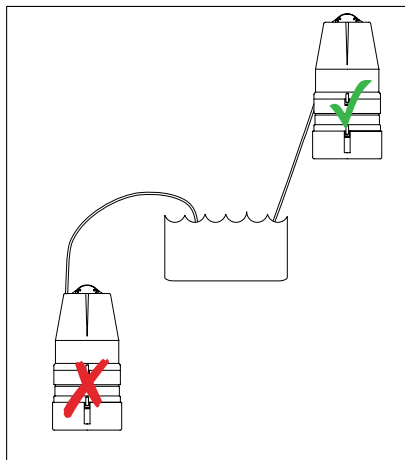
FIGURE 7-1. Sampler installation

7.1.3 Steps for Field Deployment

Once the sampler is positioned complete the following steps for deployment.

1. Loosen the brass nut to set the volume control tube to the approximate volume required for collection by aligning the base of the tube with the graduated marking on the metering chamber (FIGURE 7-2). It is best to collect this volume and measure at least once to make sure it matches expectations. If necessary, adjust the tube up or down to obtain the desired collection volume.

2. Set the height of the conductivity rod (FIGURE 7-2). The bottom of the conductivity rod must be higher in the metering chamber than the volume control tube (at least 1.3 cm (0.5 in)), but below the bottom of the float valve barrier.
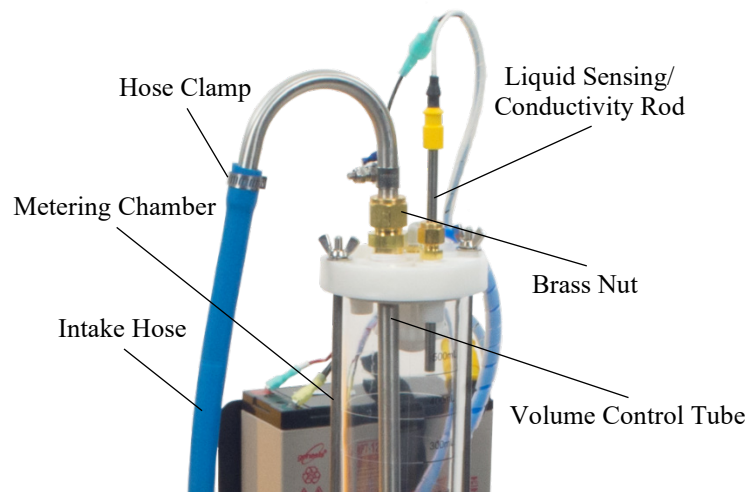
FIGURE 7-2. Conductivity rod and intake hose connection

3. Connect the positive lead (+) to the top of the conductivity rod (yellow cap).

4. Connect the battery.

    a. If using an internal battery, place it in the mount and connect the red and black leads to the matching terminals. Also connect the yellow caps with the fuse.

    b. If using an external battery, make sure the external power cable is stripped and the correct leads are in place to connect the battery. Connect the external power cable to the **Power** connector on the Control Panel (FIGURE 7-3).

5. Turn on the sampler and set the three-way switch on the control panel to the power source being used (FIGURE 7-3). If powered correctly, the green power LED lights for several seconds and starts blinking green once per second.
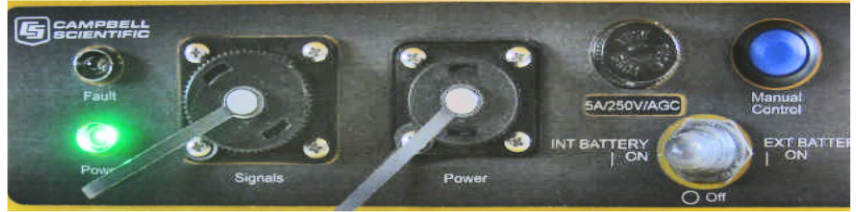
FIGURE 7-3. Control panel

6. Connect the top of the intake hose to the volume control tube and tighten the hose clamp (FIGURE 7-2).

7. Route the hose so that it has a near continuous slope from the sampler to the source liquid. This keeps the hose clear and fully drained.

8. Put the sinker end of the intake hose into the water body to be sampled, ensuring at least 3-inch depth. The sinker/strainer needs to be placed at a depth that ensures it will remain submerged regardless of the flow velocities.

9. If you do not know the necessary purge times, run the Auto Deploy routine by pushing and holding the Manual Control button until the sampler begins running (approximately 5 s (FIGURE 7-3)). The Auto Deploy routine sets the purge and the vacuum times based on the length of the hose and the change in height between the sampler and the water source. Wait for the sampler to stop before proceeding to Step 10.

10. Running the Auto Deploy routine drops a sample into one of the sample bottles. If you do not want this volume as part of your final sample count, remove the control section of the sampler and empty the sample just collected. If necessary, replace with a clean bottle.

11. Push the Manual Control button once (FIGURE 7-3) to Service the sampler and reset the sample count to 0.

12. Configure the sampler based on a chosen control type (see Section 8.2, *Deployment Procedures for Each Control Type (p. 28)*).

13. If controlling the sampler with a datalogger or another external device, connect the PVS5120CBL cable to the **Signals** connector on the Control Panel (FIGURE 7-3), and then wire the cable to the datalogger or MD485. Wiring is specific to a given control type. Please see the section on your control type for wiring directions.

14. If using a datalogger, access *LoggerNet* and do the following (assumes knowledge of using *LoggerNet* to setup the datalogger and connect either via a direct connection or remote connection):

    a. From the *LoggerNet Connect* window, click **Connect | Collect Now** to collect any data on the datalogger.

    b. From the *Connect* screen, click the **Send New** button. Browse to find the datalogger program that controls the sampler; click **Open | Send**.

7.2   Sampler Components

7.2.1   Sample Volume Adjustment
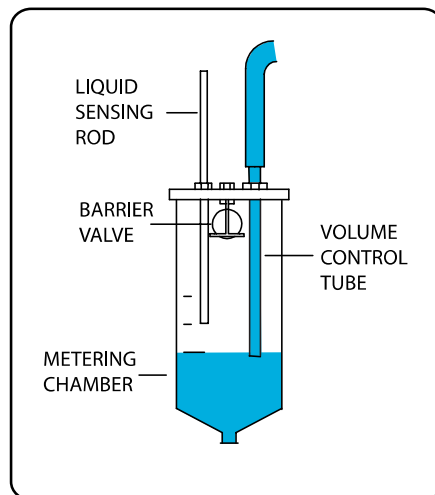
FIGURE 7-4. Metering chamber and volume control tube

Setting the desired sample volume is accomplished by adjusting the height of the volume control tube within the metering chamber (FIGURE 7-4). The tube mounts through the top of the chamber with a gland nut fixing the position. To adjust the sample volume, loosen the nut until the volume control tube moves freely. Raise or lower the bottom end of the tube to the desired volume using the lines provided on the side of the metering chamber as a guide (lines are spaced at 100 mL intervals with the exception of one at 50 mL). Tighten the gland nut to hold the volume control tube at the desired position.

The sampler has a volume accuracy/repeatability of ±2% or ±2 mL. If an exact amount of liquid is required for a sampling protocol, the user should manually collect a few samples to ensure that the rod is set at the correct location. For example, a user wants to collect 400 mL samples. The user manually collects several samples, and each of the samples has a 380 mL volume. The user adjusts the volume control tube up, and manually collects more samples. This process is repeated until the volume manually collected is ~400 mL. The volume control tube is then tightened in place. Once the liquid sensing/conductivity rod is tightened, the sample should be within ±2% or ±2 mL of the desired volume.

CAUTION	The volume control tube should always be located below the liquid sensing/conductivity rod.

NOTE	Hold the bottom nut while loosening or tightening the top nut, or it may become loosened from the metering chamber cover and create an imperceptible leak in the vacuum system.

7.2.2 Liquid Sensing/Conductivity Rod

This probe, also called the liquid sensing rod or conductivity rod, is used to stop the sample intake. Always ensure that its lower end is located above the volume control tube and below the bottom of the float valve barrier (plastic ball). Because the fluid intake is always turbulent, there must be at least a 1/2 inch difference between the rods. If you have a variable height water source that may be dry at times (like a storm water application), you may want to increase the offset to at least an inch between the volume control tube and the conductivity rod.

In applications with substantial oil or grease, the rod can become coated and lose its conductivity. This is prevented by cleaning the rod regularly. In extreme cases, extra stainless steel wire can be wrapped around the liquid sensing rod to increase its surface area.

CAUTION	The liquid sensing rod and volume control tube must be kept clean to ensure the conductivity necessary to detect the presence of the fluid.

7.2.3 Cables

7.2.3.1 PVS5120CBL-L Control Cable (pn 30432)

The PVS5120CBL-L control cable connects the sampler to a datalogger, MD485, or another external device that will control or monitor the sampler (FIGURE 7-5). The cable has a connector at one end that attaches to the **Signals** connector on the Control Panel. The other end of the cable has pigtails that connect to the external device.

FIGURE 7-5. PVS5120CBL-L Control Cable (pn 30432)

7.2.3.1.1 Wiring

When using SDI-12, the sampler connects directly to the datalogger. When using PakBus® or Modbus®, the sampler connects to an MD485 and the MD485 connects to the datalogger using an SC12 cable or 18663 null modem cable (see MD485 manual for more information). The optional water detection probe connects to the gray and yellow wires on the PVS5120CBL control cable. TABLE 7-1 is a general wiring table.

CAUTION	Only connect the wires needed for the specific control type. Cap, tape, or cut the unused wires at the shield. Connecting the unused wires to ground causes problems with the fault/red wire. Allowing the unused wires to touch can cause shorts.

TABLE 7-1. PVS5120CBL-L Cable Connections

Wire	Description	Connection
Green	SDI-12/Pulse Out	Datalogger control port (C1, C3, C5, or C7)
Blue	Pulse Start	Connect directly to pulse device such as a flow meter to trigger the sampler based on a pulse (5 V TTL)
Purple	Ground	Datalogger G terminal
Gray	Ground	Connects to one lead of the optional water detection probe
Yellow	Water Sensor	Connects to one lead of the optional water detection probe
White	RS-485 A-	MD485 RS-485 A port
Black	RS-485 B+	MD485 RS-485 B port
Red	Fault	Outputs 5 V TTL
Brown	RG	Resistive ground ($\perp$)

7.2.3.2 USB Cable (pn 17648)

This USB cable is shipped with the sampler (FIGURE 7-6). It connects the sampler to a PC, which is required for sampler configuration (see Section 6.1, *Connecting to the VSC100/Sampler via DevConfig (p. 9)*). Drivers for this cable should install automatically (no disk necessary) the first time it is plugged into a PC.

NOTE   Be sure to wait enough time for the drivers to install before opening Campbell Scientific's *DevConfig*.

FIGURE 7-6. USB Cable (pn 17648)

7.2.3.3 External Battery Cable (pn 30819)

The external battery cable (pn 30819) connects an external battery to the sampler via the **Power** port on the Control Panel (FIGURE 7-7). This cable is optional.

FIGURE 7-7. External Battery Cable (pn 30819)

7.2.4 Battery

7.2.4.1 Internal verses External Battery Options

The PVS5120 series samplers can be powered via an internal or an external power supply. The internal power supply is a 7 or 17 Ah, 12 Vdc battery (pn 27823 and pn 29785) that is mounted in the harness on the top of the control section of the sampler. This battery can be charged via the charger sold as an accessory to the sampler (pn 27825 or 29735). When charging with the approved charger the sampler can be running and charging at the same time.

| CAUTION | Do not try to operate the sampler with only the charger plugged into ac power. An internal battery needs to be present to operate with the charger. |

External power supply for the sampler must supply 12 Vdc and be connected to the **Power** connector on the Control Panel via the external power cable that ships with the sampler. This cable needs to have leads attached that are compatible with the users external power supply. If using an external power supply, the user can not charge the external battery via the sampler charger. To charge an external battery, the user must provide an independent charging system.

7.2.4.2 VSC100 Battery

The VSC100 controller contains a 3 Vdc coin cell lithium battery (pn 15598) to maintain user settings and the real-time clock of the sampler during loss of system power. The battery has an estimated 5 year life under normal operating conditions/temperatures. The battery is replaceable by the user. See Appendix E, *Lithium Battery Replacement (p. E-1)*, for a tutorial to replace the battery. Since the controller is a low-power device, this uncovering can be safely done, taking care that no conductive implement contacts sensitive circuit components.

7.2.4.3 Fuses

Every PVS5120 ships with two fuses. The first fuse is located directly on the Control Panel of the sampler and varies depending on which pump a user orders (see TABLE 7-2 for more information). The second fuse is a 10 A/32 V MDL fuse and goes into two yellow caps on the positive line to the battery. This fuse is independent of pump type.

TABLE 7-2. Fuse Part Numbers		
Pump Type	**Fuse Description**	**Part Number**
Standard pump	5A/250V/AGC	28314
Large pump	10A/32V/MDL	28315

7.3   Optional Components

7.3.1 Water Detection Probe

The 30144-L water detection probe (FIGURE 7-8) is a simple circuit constructed of two stainless steel rods wired to the control cable. It acts as a pre-check to collecting a sample by determining if water is present at the intake hose. It should be used in locations that have a variable height water source, for example stormwater monitoring. The sensor is placed in the water body at a level equal to or higher than the intake hose. When used with the controller, samples are only collected when the circuit is connected by water touching both rods. If there is not enough water to touch both rods, the sample is stopped and response code **6** (no sample liquid detected) is returned to the datalogger.

The sensor is wired directly to the end of the control cable. Connect one wire to the yellow lead of the control cable and the other wire to a ground lead on the control cable.

FIGURE 7-8. 30144-L Water Detection Probe

7.3.2 Sinker / Strainer

The intake hose includes either a lead sinker (pn 26915) or stainless steel sinker/strainer (pn 26914); see FIGURE 7-9; both are intended to keep the sample line fully submerged in the source liquid. The stainless steel sinker/strainer should be used in situations with material that clogs up a normal sinker, or where the standard sinker could stir up bottom sediment.

FIGURE 7-9. Lead sinker attached to the intake hose (left) and the sinker/strainer

7.3.3 Wall Chargers

Campbell Scientific offers a 110 Vac charger (pn 27825) and a 100 to 240 Vac charger (pn 29735) for recharging your battery via ac power (FIGURE 7-10). When purchased with the PVS5120, the 110 Vac charger is option –C1 and the 100 to 240 Vac charger is option –C2.

FIGURE 7-10. 110 Vac Charger (pn 27825)

7.4 Fault-Wiring Directions

Connect the fault wire of the control cable to the input of a programmable logic controller (PLC). It is a 5 V TTL logic level with high representing a full/fault condition (response code >0) and low = no fault (response code = 0).

7.5   Installation Checklist

Check the following items prior to use of the sampler:

1. Sampler is mounted securely and level.

2. Intake Hose:
   a. Free of kinks.
   b. Properly installed into liquid.
   c. Properly connected to volume control tube on metering chamber.

3. Discharge hose (only in the composite samplers):
   a. Free of kinks.
   b. Natural downward slope to sample container.
   c. Properly connected to (or in) sample container.

4. Power requirements:
   a. Check battery electrical condition.
   b. Recharge if necessary.

8.   Operation

8.1   Operating Sequence
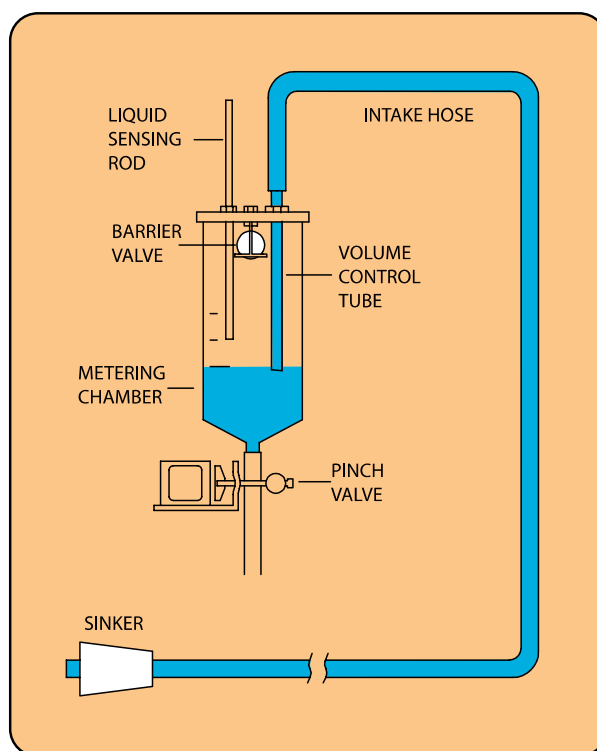
FIGURE 8-1. Diagram of operating sequence

Sampling process:

1. High pressure air purge of intake hose.

2. Liquid is drawn into the metering chamber, up to the liquid sensing rod.

3. All excess liquid is purged from the system down to the level set by the volume control tube.

4. The sample is then released into either one composite container or one of several discrete containers.

The sampling sequence begins with a high pressure air purge of the intake assembly to remove residual liquid and obstructions. Upon completion of the pre-purge cycle, the system converts to a vacuum state, drawing the sample through the intake hose into the metering chamber. The system then pressurizes, ejecting excess fluid back through the intake line until the predetermined sample volume is achieved. The sample is then deposited under pressure into the sample container while the post purge again clears the intake line of any residual liquid. Purge time is a function of hose length and head between the sampler and the sample source.

FIGURE 8-2 shows purge times for hose lengths up to 232 feet with one foot of lift. This example is based on tests completed at 4500 ft above sea level. There was only 1 foot of lift for all of the runs. Purge time was determined by running the Auto Deploy routine for each hose length.
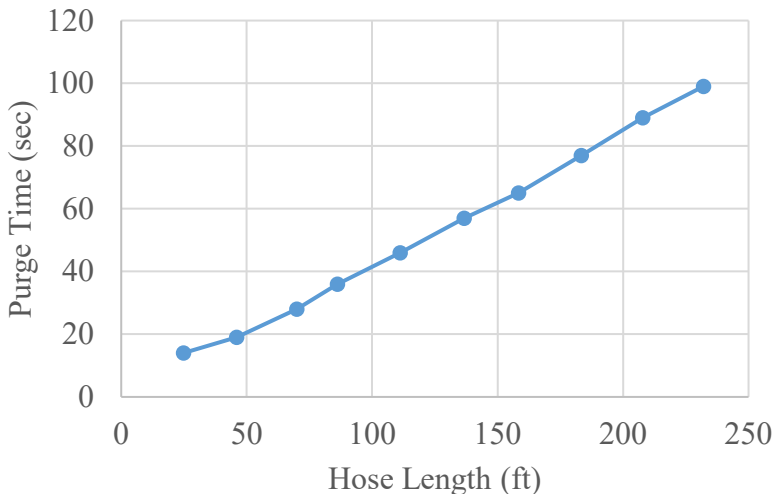
FIGURE 8-2. *Purge time as a function of hose length*

If the sampler is not able to draw a sufficient volume of fluid to complete the circuit between the volume control tube and the conductivity rod, the unit automatically initiates a second attempt. If the sample liquid still does not touch the conductivity rod, the sampler purges to the level of the volume control rod, and then drops the remaining liquid into the sample container and returns response code 4 (vacuum time out error). The sampler waits till the next initiation (**Run** command) to try to collect another sample. When a

vacuum time out error (response code 4) occurs, a sample bottle may overfill. See Appendix F, *Response Code 4 Scenarios (p. F-1)*, for some examples.

8.2 Deployment Procedures for Each Control Type

The following sections step the user through configuring the sampler, wiring the control cable, and developing the necessary datalogger program for each control type. For questions about any setting in *DevConfig*, see Section 6, *Device Configuration Utility Overview (p. 9)*, or the *DevConfig's* help provided at the bottom of the window when a setting is clicked. These control types correspond to the scenarios presented in the two *Quick Deploy Guides* shipped with the samplers.

TABLE 8-1 shows the default settings. The default settings are changed using *DevConfig* (version 2.09 or higher).

TABLE 8-1. Default Settings	
Parameter	**Setting**
Control Type	SDI-12
SDI-12 Address	0
Number of Sampler Bottles	24 Bottles – Discrete
Samples Per Bottle	1
Never Full Operation	Disable Never Full
Water Present Sensor	Not Installed

To use *DevConfig*, the sampler needs to be powered and the VSC100 controller needs to be connected to a PC via the 17648 USB cable (FIGURE 8-3).

FIGURE 8-3. VSC100 and 17648 USB cable

8.2.1 Connecting to the VSC100/Sampler via *DevConfig*

1. Connect the 17648 USB cable to the front of the sampler controller (VSC100) and the other end to the computer's USB port (FIGURE 8-3). Wait for Windows® to install the driver before opening *DevConfig*.

CAUTION User must have Admin rights on the computer to install the drivers.

2. Open *DevConfig*. Select the **VSC100 Series** under the **Sampler**. Click **Communication Port** and select the correct **COM port**. Click **Connect** (FIGURE 8-4).
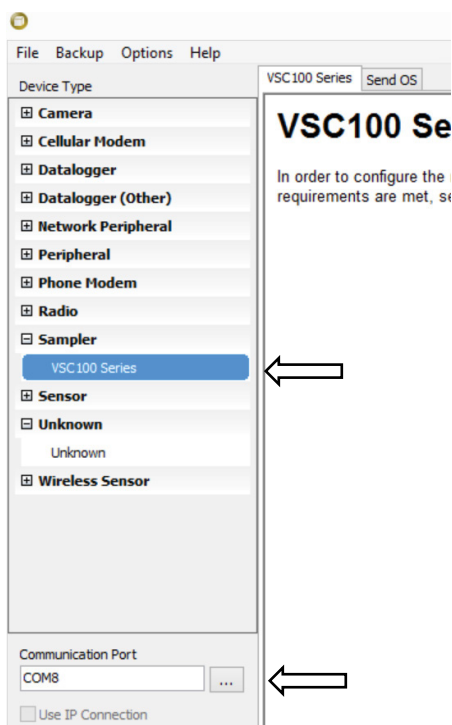
FIGURE 8-4. *Device Configuration VSC100*

3. Once connected to the VSC100, you are ready to configure your sampler.

4. Click the **Clock** tab at the top of the window (FIGURE 6-3). Next click **Set Clock,** which syncs the sampler clock with the computer clock. The sampler clock accuracy is 8.2 minutes/month over the temperature stated temperature range or roughly 1 minute/month at 25 °C. Also the VSC100's internal battery maintains the clock settings (see Section 6.1.1, *Clock Tab (p. 10)*, for more information).

CAUTION If a new operating system is loaded to the VSC100, the clock must be synced before deploying the sampler.

8.2.2 Time-Based Control

Time-based control allows the PVS5120 to run as a stand-alone sampler. Status values are not reported unless a datalogger is used for monitoring the sampler. A datalogger can be used to monitor the sampler over RS-485 and uses either the PakBus® or Modbus® protocol. An MD485 is also required (see Appendix C, *Monitoring Sampler Status via RS-485 (p. C-1)*).

CAUTION	If running with time-based control, the user must sync the clock of the sampler. This is described above in Section 6.1.1, *Clock Tab (p. 10)*.

1. Once connected to the VSC100, click the **Sampler Settings** tab (FIGURE 8-5).

   a. Set the **Control Type** to *Time*.

   b. If using PakBus® to monitor the sampler over RS-485, set the **PakBus Address**.

   c. If using Modbus® to monitor the sampler over RS-485, set the **Modbus Address**.

   d. Set the **Number of Sampler Bottles**.

   e. Set the **Samples Per Bottle**. It can range from *1* to *999*. This setting is ignored if **Never Full** is set to *On/Enable*.

   f. Typically leave the **Never Full Operation** disabled.

   g. If the Auto Deploy routine has been run, the **Purge Time** should already be set. If not using Auto Deploy, enter the amount of time the sampler hose is evacuated before and after the sample is collected.

   h. If a **Water Present Sensor** is present, click to install. This sensor is wired to the sampler control cable. See Section 7.3.1, *Water Detection Probe (p. 24)*, for more information.

FIGURE 8-5. Time-Based Sampler Settings screen

2. Click the **Advanced Sampler Settings** tab (FIGURE 6-6). In most cases, only the Enable Pressure Relief setting is changed.

   a. Set **Sample Chamber – Pressure Relief**. If collecting a sample volume >450 mL or using an intake hose longer than 50 ft, this feature must be enabled.

3. Click the **Time Settings** tab.

   a. Change the **Start Date and Time** to a time period in which the sampler will be fully installed.

CAUTION   For the **Start Date and Time,** do not use the default value of 12:05 AM on January 1, 1990. If you do not change the default setting, the sampler will immediately begin sampling after the configuration is applied to the VSC100. Additionally, the **Start Date and Time** needs to be set far enough into the future so that the sampler is fully installed before attempting to take a sample.

---

   b. For **Interval Hours**, specify the number of hours in the time interval between sample collections.

   c. **For Interval Minutes**, specify the number of minutes in the time interval between sample collections (0 to 59 minutes).

4. Click **Apply**. It is a good idea to save the configuration file for future reference. Also if you are using a datalogger to monitor the sampler over

RS-485, see Appendix C, *Monitoring Sampler Status via RS-485 (p. C-1)*, for additional deployment steps.

8.2.3 SDI-12 Control

SDI-12 control runs the sampler as an SDI-12 sensor. The sampler connects to the datalogger using the PVS5120CBL control cable. The **SDI12Sensor** instruction issues the sampler's **M!** command to a specific port on the datalogger. The SDI-12 address is assigned in *DevConfig* and referenced in the datalogger program. Four status variables are returned to the datalogger via SDI-12 once the sample is complete and in the case of the discrete sampler the arm moved to the next location.

The sampler can run in concurrent SDI-12 mode by using a **C!** command. The response time of the sampler varies depending on the purge, vacuum, and sample drop times set up in *DevConfig* (for example, the longer the hose and the greater the lift between the sampler and the water source the longer response time to the **M!** command).

1. Once connected to the VSC100 in *DevConfig*, click the **Sampler Settings** tab (FIGURE 8-6).

    a. Set the **Control Type** to *SDI-12*.

    b. Typically use the default **SDI-12 Address** of *0*.

    c. Set the **Number of Sampler Bottles.**

    d. Set the **Samples Per Bottle**. It can range from *1* to *999*. This setting is ignored if **Never Full** is set to *On/Enable*.

    e. Typically leave the **Never Full Operation** disabled.

    f. If the Auto Deploy routine has been run, the **Purge Time** is already set. If not using Auto Deploy, enter the amount of time the sampler hose is evacuated before and after the sample is collected.

    g. If a **Water Present Sensor** is present, click to install. This sensor is wired to the sampler control cable. See Section 7.3.1, *Water Detection Probe (p. 24)*, for more information.

FIGURE 8-6. SDI-12 Sampler Settings screen

2. Click the **Advanced Sampler Settings** tab (FIGURE 6-6). In most cases, only the Enable Pressure Relief setting is changed; reasons to change the other options from factory defaults are discussed in Section 6.2.3, *Advanced Sampler Settings Tab (p. 13)*.

    a. Set **Sample Chamber – Pressure Relief**. If collecting a sample volume >450 mL or using an intake hose longer than 50 ft, this feature must be enabled.

3. Click **Apply**. It is a good idea to save the configuration file for future reference.

4. Connect the PVS5120CBL cable to the front of the sampler, and wire the cable to the datalogger (TABLE 8-2).

5. Use *LoggerNet* to connect to the datalogger. The following steps assume a knowledge of how to setup the datalogger and connect either via a direct connection or remote connection.

    a. From the *LoggerNet Connect* window, click **Connect | Collect Now** to collect any data on the datalogger.

    b. From the *Connect* screen, click the **Send New** button. Browse to find the *CRBasic* program that controls the sampler via SDI-12 (see Section 8.2.3.2, SDI-12 Programming *(p. 34)*. Click **Open | Send**.

8.2.3.1 Wiring for SDI-12 Control

Wire	Description	Connection
TABLE 8-2. SDI-12 Wiring (PVS5120CBL-L Cable)		
Green	SDI-12/Pulse Out	Datalogger control port (C1, C3, C5, or C7)
Blue	Pulse Start	Not used
Purple	Ground	Datalogger G
Gray	Ground	Connects to one lead on the optional water detection probe
Yellow	Water Sensor	Connects to one lead on the optional water detection probe
White	RS-485 A–	Not used
Black	RS-485 B+	Not used
Red	Fault	Not used
Brown	RG	Datalogger's ⏚

8.2.3.2 SDI-12 Programming

In *CRBasic*, use the **SDI12Recorder()** instruction to program the datalogger to control the sampler. This instruction sends a request to the sensor to make a measurement and then retrieves the measurement from the sensor. The sampler returns the following four status values after it has completed the sampling procedure and the distribution arm has advanced as necessary.

1. **Sample bottle number:** Bottle number that the sample is deposited in (1 to 24).

2. **Sample number:** The number of samples collected for this bottle.

3. **Response code:** Numeric code ranging from 0 to 8 that represents different conditions (TABLE 8-3).

4. **Sampler battery voltage:** Returns the battery voltage just before that sample was collected.

TABLE 8-3. Numeric Response Codes of the VSC100	
Numeric Response Code	**Definition**
0	No Error: Successful Sample
1	All samples complete
2	Low start battery (Voltage <11.0 Vdc)
3	Low run battery (Voltage <10.5 Vdc occurs after pumping has started)
4	Sampler vacuum timed out; no sample detected
5	Sample overflow detected (only if an overflow sensor is installed; only available for stationary samplers)
6	No sample liquid detected (only if water detection probe is installed and configured)
7	Arm calibration error
8	Liquid Sensing/Conductivity Rod and Volume Control Tube are shorted

For all CRBasic dataloggers, except the CR200(X) series, the **SDI12Recorder()** instruction has the following form:

SDI12Recorder(*Destination, SDIPort, SDIAddress, "SDICommand", Multiplier, Offset***)**

Where,

- *Destination* – For the sampler, the destination location should be a four value array.

- *SDIPort* – Datalogger control port to which the sampler is connected.

- *SDIAddress* – This address must match the sampler's address. The sampler's default address of 0 should be used unless more than one SDI-12 device is connected to the same port. The sampler's default address is changed using *DevConfig*.

- *SDICommand* – The only commands recognized by the sampler are "**M!**" and "**C!**". The "**C!**" command should only be used if you want to run SDI-12 sensors concurrently. The command needs to be enclosed in quotes.

NOTE	The PVS5120 does not support extended SDI-12 commands.

Use the default values of 1.0 and 0.0 for the *Multiplier* and *Offset*, respectively.

When using a CR200(X), the **SDI12Recorder()** instruction has the following form:

SDI12Recorder(*Destination*, *"OutString"*, *Multiplier*, *Offset***)**

Where,

- *OutString* – The sampler's SDI-12 address and SDI-12 command *(*must be enclosed in quotes). For example when using the default SDI-12 address of 0, enter "**0C!**".

For more information on each of the **SDIRecorder** parameters, see the *CRBasic Help*. See Appendix B.1.1, *CR1000 SDI-12 Programs (p. B-1)*, and Appendix B.1.2, *CR200X Series Programs (p. B-3)*, for complete example programs. The example programs are available for download at: *www.campbellsci.com/19_1_767*.

8.2.4 PakBus® Control

Both the PakBus® and Modbus® control types use the MD485 to communicate via RS-485. When using RS-485, connect the sampler to an MD485 using the PVS5120CBL control cable and then connect the MD485 to the datalogger using an SC12 cable. The *CRBasic* program uses either a **SendVariables()** or **GetVariables()** instruction to trigger a sample and return the status values. The PakBus® address is assigned in *DevConfig* and referenced in the datalogger program. The PakBus® address must be unique for each sampler on your network and for each datalogger. Four status variables are returned to the datalogger once the sample is complete. If using a discrete sampler, the arm moves to the next location.

The datalogger program needs to trigger a sample and then ask for the status values (see Appendix B.2, *PakBus® Example Programs (p. B-4)*). The response time of the sampler varies depending on the purge, vacuum, and sample drop times set up in *DevConfig*. The longer the hose and the greater the lift between the sampler and the water source, the longer it takes for status values to be returned.

8.2.4.1 Configuring the MD485

1. Connect a serial cable to the RS-232 port on the MD485 and to the computer.

2. Supply power (12 Vdc) to the MD485 by the power jack or through the +12 V line on the CS I/O connector. Use the SC12 serial cable to connect the MD485's CS I/O port to the datalogger's CS I/O port.

3. Open *DevConfig*. Click **Peripheral**. Select *MD485*. Select the **Communication Port**. Push the **Program** button on the MD485. Click **Connect**. The program button is located to the right of the RS-485 connectors on the modem's front panel (FIGURE 8-7).
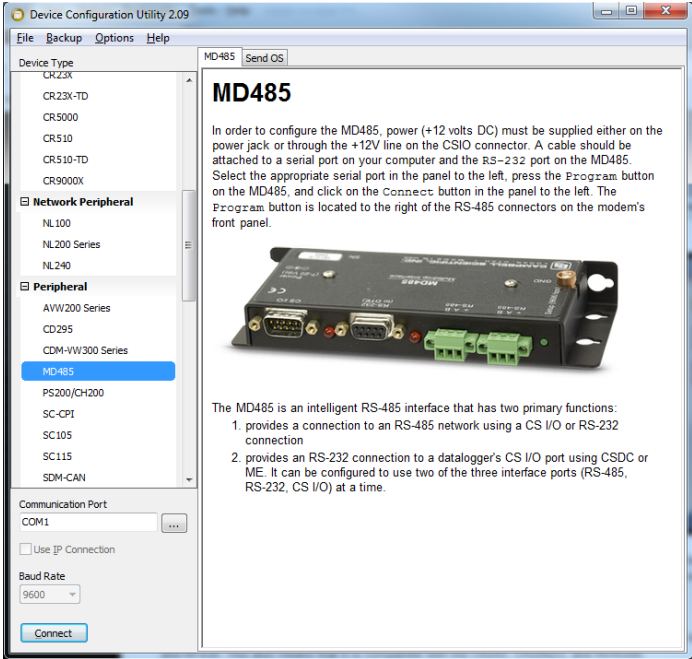
FIGURE 8-7. MD485 Device Configuration screen

4. Click the **MD485** tab. Select *CS I/O* and *RS-485* in the **Active Ports** box. Select *Transparent Communication* in the **Protocol** box (FIGURE 8-8).
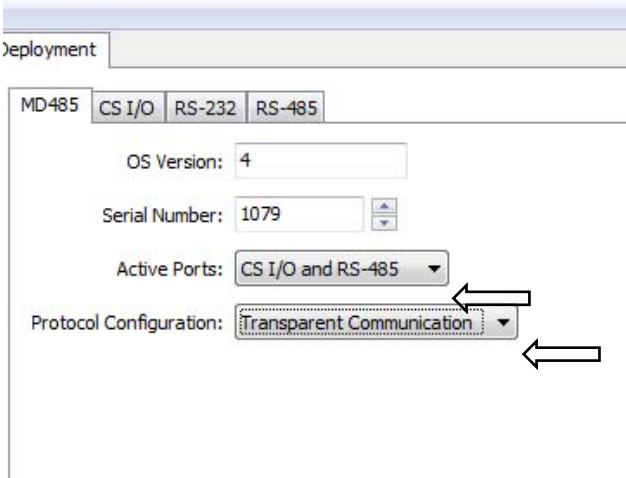
FIGURE 8-8. MD485 Deployment tab

5. Click the **CS I/O** tab. Set the mode based on the type of datalogger being used. Below shows the configuration for a CR1000 with SDC7 used for the address (FIGURE 8-9).

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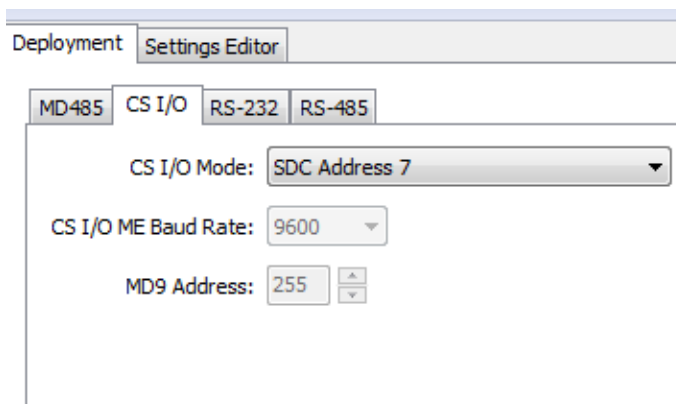
FIGURE 8-9. MD485 CS I/O tab

6.   Click the **RS-485** tab. Set **Baud Rate** to 38.4 kbps. Set **Parity** to *None*.
      Set **Character Length** to *8 bits*. Set **Stop Bits** to *1 bit* (FIGURE 8-10).
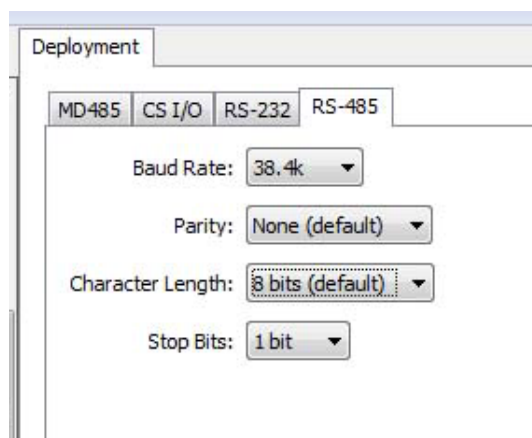
FIGURE 8-10. MD485 RS-485 tab

7.   Click **Apply**.

8.2.4.2 Configuring Sampler for PakBus® Control

1.   Once connected to the VSC100 in *DevConfig*, click the **Sampler Settings**
      tab (FIGURE 8-11).

      a.   Set the **Control Type** to *PakBus*.

      b.   Set the **PakBus Address**. This is the address of the sampler and is
            referenced in the *CRBasic* program running on the datalogger. The
            default PakBus® address for the samplers is 95. Each sampler needs
            to be uniquely addressed, as well as each datalogger on the network.

      c.   Set the **Number of Sampler Bottles**.

      d.   Set the **Samples Per Bottle**. It can range from *1* to *999*. This setting
            is ignored if **Never Full** is set to *On/Enable*.

e. Typically leave the **Never Full Operation** disabled. The **Never Full Operation** is typically enabled only when the sampler is easily accessible and containers are collected regularly, for instance at a waste water treatment facility.

f. If the Auto Deploy routine has been run, the **Purge Time** is already set. If not using Auto Deploy, enter the amount of time the sampler hose is evacuated before and after the sample is collected. The maximum value is 800 s. The final purge time can be set separately (refer to Section 6.2.3, *Advanced Sampler Settings Tab (p. 13)*).

g. If a **Water Present Sensor** is present, click to install. This sensor is wired to the sampler control cable. See Section 7.3.1, *Water Detection Probe (p. 24)*, for more information.

FIGURE 8-11. PakBus® Setting Editor screen

6. Click the **Advanced Sampler Settings** tab (FIGURE 6-6). In most cases, the only setting a user may want to change is to Enable Pressure Relief setting.

a. Set **Sample Chamber – Pressure Relief**. If collecting a sample volume >450 mL or using an intake hose longer than 50 ft, this feature must be enabled.

7. Click **Apply**. It is a good idea to save the configuration file for future reference.

8. Connect the PVS5120CBL cable to the front of the sampler and wire the cable to the MD485 (TABLE 8-4). Connect the MD485 to the datalogger using the SC12 cable or the null modem cable.

9. Use *LoggerNet* to connect to the datalogger. The following steps assume a knowledge of how to setup the datalogger and connect either via a direct connection or remote connection.

   a. From the *LoggerNet Connect* window, click **Connect | Collect Now** to collect any data on the datalogger.

   b. From the *Connect* screen, click the **Send New** button. Browse to find the *CRBasic* program that controls the sampler via PakBus® (see Section 8.2.4.4, *Programming for PakBus®* Control *(p. 40)*). Click **Open | Send**.

8.2.4.3 Wiring for PakBus® Control

<table>
<tr><td colspan="3">TABLE 8-4. PakBus® Control Connections (PVS5120CBL-L Cable)</td></tr>
<tr><td>Wire</td><td>Description</td><td>Connection</td></tr>
<tr><td>Green</td><td>SDI-12/Pulse Out</td><td>Not used</td></tr>
<tr><td>Blue</td><td>Pulse Start</td><td>Not used</td></tr>
<tr><td>Purple</td><td>Ground</td><td>Not used</td></tr>
<tr><td>Gray</td><td>Ground</td><td>Connects to one lead of the optional water detection probe</td></tr>
<tr><td>Yellow</td><td>Water Sensor</td><td>Connects to one lead on the optional water detection probe</td></tr>
<tr><td>White</td><td>RS-485 A-</td><td>MD485 RS-485 A port</td></tr>
<tr><td>Black</td><td>RS-485 B+</td><td>MD485 RS-485 B port</td></tr>
<tr><td>Red</td><td>Fault</td><td>Not used</td></tr>
<tr><td>Brown</td><td>RG</td><td>MD485 RG terminal (⏚)</td></tr>
</table>

8.2.4.4 Programming for PakBus® Control

PakBus® can be used to control the sampler and to monitor a timed-based or pulse controlled sampler. When using PakBus®, the datalogger communicates with the sampler via RS-485. An MD485 multidrop modem is required for this communication.

In *CRBasic*, the **SendVariables()** or **GetVariables()** instruction initiates the sample and collects the returned status values. These instructions access the **Public** table stored in the VSC100 controller. TABLE 8-5 provides the array value, name, and description of the VSC100 Public Table.

The sampler returns four status values regardless of control type after it has completed the sampling procedure and the distribution arm has advanced as necessary. These status values are array values 12 through 15 in TABLE 8-5.

NOTE	When getting data from the sampler, the *source datalogger* is the sampler.

The **SendVariables()** and **GetVariables()** instructions have the following structure:

SendVariables(*ResultCode, ComPort, NeighborAddr, PakBusAddr, Security, TimeOut, "TableName", "FieldName", Variable, Swath***)**

GetVariables(*ResultCode, ComPort, NeighborAddr, PakBusAddr, Security, TimeOut, "TableName", "FieldName", Variable, Swath***)**

Where,

- *ResultCode* – This is the PakBus® communications response. See *CRBasic Help* for more information.

- *ComPort* – The communications port used to communicate with the source device.

- *NeighborAddr* – A static route to the source datalogger (for example, the PakBus® address of a neighbor datalogger that the destination datalogger can go through to communicate with the source datalogger).

- *PakBusAddr* – The PakBus® address of the sampler. Typically the default address of 95 can be used unless multiple samplers are connected to the same port. This address is configured in *DevConfig*.

- *Security* – Typically enter 0000.

- *TimeOut* – Enter 0.

- *TableName* – The sampler's data table that the value(s) is retrieved from. For the *TableName,* enter "*Public" (*must be enclosed in quotes).

- *FieldName* – To retrieve status values, enter *"Bottle"* (must be enclosed in quotes). To start sample collection, enter *"Start" (*must be enclosed in quotes).

- *Variable* – The variable or variable array in which the values retrieved from the source datalogger are stored. This parameter must be dimensioned equal to or greater than the *Swath* retrieved from the source datalogger.

- *Swath* – The number of values that are retrieved from the source datalogger.

For more information on each of the **SendVariables** and **GetVariables** parameters, see the *CRBasic Help*. Section 8.2.4.5, *PakBus® Example* Instructions *(p. 43)*, provides some example **SendVariables()** and **GetVariables()** instructions for controlling the sampler. Complete program

examples for the CR1000 can be found on our website at *www.campbellsci.com/19_1_767* and in Appendix , *PakBus® Example Programs (p. B-4)*.

<table>
<tr><th colspan="3">TABLE 8-5. VSC100 Public Table for PakBus® Control</th></tr>
<tr><th>Array Value</th><th>Name</th><th>Description</th></tr>
<tr><td>1</td><td>Bottles</td><td>Number of bottles in sampler.</td></tr>
<tr><td>2</td><td>SampPerBottle</td><td>Number of samples to be put in each bottle(s).</td></tr>
<tr><td>3</td><td>NeverFull</td><td>Determines if the sampler loops without stopping (must be manually serviced before the sampler is full to prevent overflow).</td></tr>
<tr><td>4</td><td>PurgeTime1</td><td>Initial purge time, in seconds, that the sampler hose is purged before collecting sample.</td></tr>
<tr><td>5</td><td>LevelSetTime</td><td>Time, in seconds, to evacuate sample chamber to desired sample volume.</td></tr>
<tr><td>6</td><td>DepositTime</td><td>Time in seconds to hold pinch valve open to allow sample to be deposited in bottle.</td></tr>
<tr><td>7</td><td>PurgeTime2</td><td>Final purge time, in seconds, that the sampler hose is evacuated after collecting sample.</td></tr>
<tr><td>8</td><td>UsePurgeTime</td><td>A true/false variable which indicates if PurgeTime2 is set independently of PurgeTime1 or is set to same value as PurgeTime1.</td></tr>
<tr><td>9</td><td>SetTimeOut</td><td>True/false value that indicates whether the vacuum time is set by the user or automatically set (2 x PurgeTime1).</td></tr>
<tr><td>10</td><td>TimeOut</td><td>Vacuum timeout, in seconds, to determine how long sampler should attempt to collect a sample before triggering an error.</td></tr>
<tr><td>11</td><td>SamplerType</td><td>The sampler type determined by the corresponding integer value:
0 = PakBus, 1 = Pulse, 2 = Modbus,
3 = SDI-12, 4 = Time</td></tr>
<tr><td>12</td><td>Bottle</td><td>Indicates bottle number that the sample is deposited in (1 to 24). Value is always 1 for composite sampler. (Read only.)</td></tr>
<tr><td>13</td><td>SampleCount</td><td>Displays the number of samples deposited in to this bottle. Value is always 1 for never full option. (Read only.)</td></tr>
<tr><td>14</td><td>Response</td><td>Displays numeric code ranging from 0 to 8 that represents a different condition (TABLE 8-3). 0 indicates no errors. (Read only.)</td></tr>
<tr><td>15</td><td>Batt</td><td>Returns the sampler's battery voltage just before that sample was collected. (Read only.)</td></tr>
</table>

8.2.4.5 *PakBus® Example Instructions*

Below shows example *CRBasic* instructions for using PakBus® to control the sampler.

This instruction initiates a sample:

SendVariables(Result(2),ComSDC7,0,sampler_PakBus_address,0000,0, "Public","Start",Start_sample,1**)**

This instruction collects the status values:

GetVariables(Result(3),ComSDC7,0,sampler_PakBus_address,0000,0, "Public","Bottle",Sampler_status(1),4**)**

8.2.5 Modbus® Control

Both PakBus® and Modbus® control types use the MD485 to communicate with a Campbell Scientific datalogger via RS-485. When using RS-485, connect the sampler to an MD485 using the PVS5120CBL control cable and connect the MD485 to the datalogger using an SC12 cable. The *CRBasic* program uses the **ModbusMaster()** instruction. The Modbus® address is assigned in *DevConfig* and referenced in the datalogger program. The Modbus® address must be unique for each sampler on your network and for each datalogger.

Four status variables are returned to the datalogger once the sample is complete and in the case of the discrete sampler the arm moved to the next location. The program running on the datalogger needs to monitor the sampler for the sample to complete and then asks for the status values (see Appendix B.3, *Modbus® Example Programs (p. B-6)*). The response time of the sampler varies depending on the purge, vacuum, and sample drop times set up in *DevConfig*. The longer the hose and the greater the lift between the sampler and the water source, the longer it takes for status values to be returned.

It is also possible to use a third party's PLC to control the sampler via RS-485.

8.2.5.1 *Configuring the MD485*

1. Connect a serial cable to the RS-232 port on the MD485 and to the computer.

2. Supply power (12 Vdc) to the MD485 by the power jack or through the +12 V line on the CS I/O connector. The SC12 serial cable connects the MD485's CS I/O port to the datalogger's CS I/O port; an SC12 cable is shipped with the MD485.

3. Open *DevConfig*. Click **Peripheral**. Select *MD485*. Select the **Communication Port**. Push the **Program** button on the MD485. Click **Connect**. The program button is located to the right of the RS-485 connectors on the modem's front panel (FIGURE 8-12).
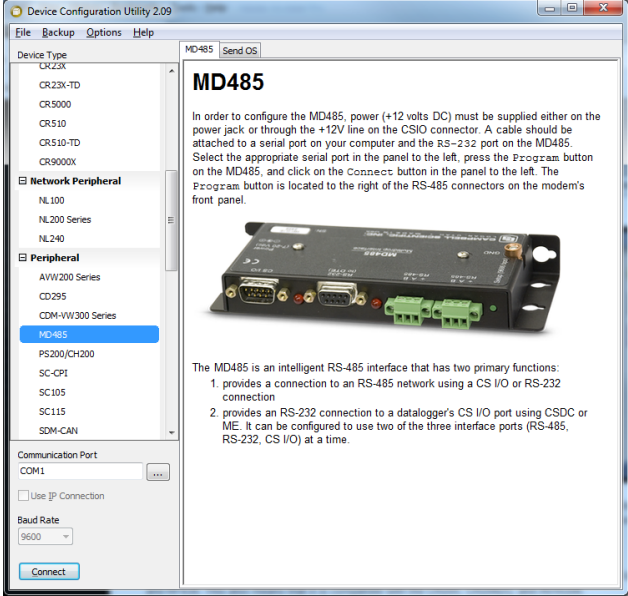
FIGURE 8-12. MD485 Device Configuration screen

4. Click the **MD485** tab. Select *CS I/O* and *RS-485* in the **Active Ports** box. Select *Transparent Communication* in the **Protocol** box (FIGURE 8-13).
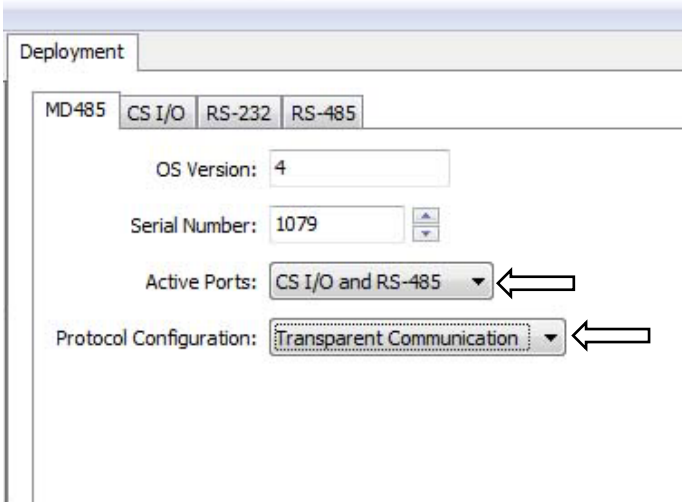
FIGURE 8-13. MD485 Deployment tab

5. Click the **CS I/O** port tab. Set the mode based on the type of datalogger being used. Below shows the configuration for a CR1000 with SDC7 for the address (FIGURE 8-14).
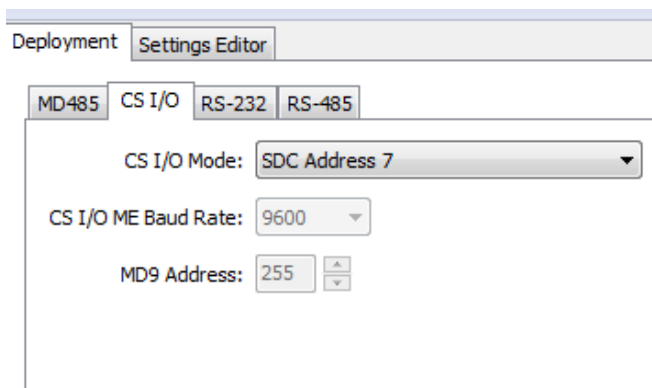
FIGURE 8-14. MD485 CS I/O tab

6. Click the **RS-485** tab. Set Baud **Rate** to *38.4k*. Set **Parity** to *None*. Set **Character Length** to *8 bits*. Set **Stop Bits** to *1 bit* (FIGURE 8-15).
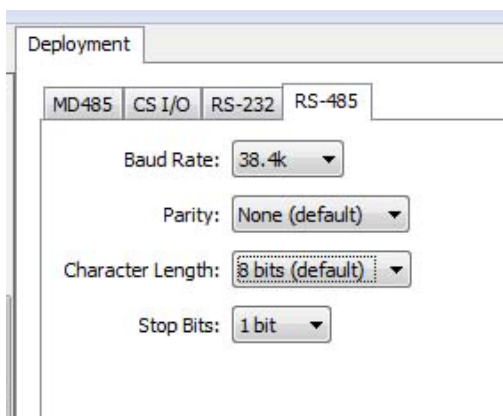
FIGURE 8-15. MD485 RS-485 tab

7. Click **Apply**.

8.2.5.2 Configuring Sampler for Modbus® Control

1. Click the **Sampler Settings** tab (FIGURE 8-16).

   a. Set the **Control Type** to *Modbus*.

   b. Set the **Modbus Address**. This is the address of the sampler and is referenced in the *CRBasic* program running on the datalogger. The default Modbus® address for the samplers is 1. Possible values are 1–127.

   c. Set the **Number of Sampler Bottles**.

   d. Set the **Samples Per Bottle**. It can range from *1* to *999*. This setting is ignored if **Never Full** is set to *On/Enable*.

   e. Typically leave the **Never Full Operation** disabled.

f. If the Auto Deploy routine has been run, the **Purge Time** will already be set. If not using Auto Deploy, enter the amount of time the sampler hose is evacuated before and after the sample is collected. The maximum value is 800 s.

h. If a **Water Present Sensor** is present, click to install. This sensor is wired to the sampler control cable. See Section 7.3.1, *Water Detection Probe (p. 24),* for more information.
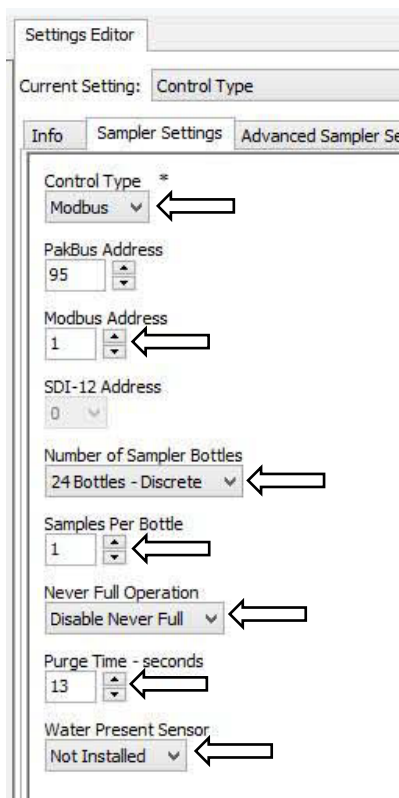
FIGURE 8-16. Modbus® Setting Editor screen

2. Click the **Advanced Sampler Settings** tab (FIGURE 6-6). In most cases, the only thing a user will want to change is to Enable Pressure Relief setting.

a. Set **Sample Chamber – Pressure Relief**. If collecting a sample volume >450 mL or using an intake hose longer than 50 ft, this feature must be enabled.

3. Click **Apply**. It is a good idea to save the configuration file for future reference.

4. Connect the PVS5120CBL cable to the front of the sampler and wire the cable to the MD485 (TABLE 8-6). Connect the MD485 to the datalogger using the SC12 cable or the null modem cable.

5. Use *LoggerNet* to connect to the datalogger. The following steps assume a knowledge of how to setup the datalogger and connect either via a direct connection or remote connection.

    a. From the *LoggerNet Connect* window, click **Connect** and then **Collect Now** to collect any data on the datalogger.

    b. From the *Connect* screen, click the **Send New** button. Browse to find the *CRBasic* program that controls the sampler via Modbus® (see Section 8.2.5.4, *Programming for Modbus® Control with Campbell Scientific Datalogger (p. 47)*. Click **Open | Send**.

8.2.5.3 Wiring for Modbus® Control

TABLE 8-6. Modbus® Control Connections (PVS5120CBL-L Cable)

Wire	Description	Connection
Green	SDI-12/Pulse Out	Not used
Blue	Pulse Start	Not used
Purple	Ground	Not used
Gray	Ground	Connects to one port on the optional water detection probe
Yellow	Water Sensor	Connects to one port on the optional water detection probe
White	RS-485 A-	MD485 RS-485 A port
Black	RS-485 B+	MD485 RS-485 B port
Red	Fault	Not used
Brown	RG	MD485 RG port (⎓)

8.2.5.4 Programming for Modbus® Control with Campbell Scientific Datalogger

Modbus® can be used to control the sampler and to monitor a timed-based or pulse controlled sampler. When using Modbus®, the datalogger communicates with the sampler via RS-485. An MD485 multidrop modem is required for this communication.

The **ModbusMaster()** instruction initiates a sample and collects the returned status values. This instruction accesses the **Public** table stored in the VSC100 controller. TABLE 8-7 provides a description of the Modbus® coils and input registers stored in the VSC100 Public Table.

The sampler returns four status values regardless of control type after it has completed the sampling procedure and the distribution arm as advanced as necessary. These status values are registers 23 through 29 in TABLE 8-7.

Running the sampler as a Modbus® slave while the datalogger acts as the Modbus® master device requires issuing the **ModbusMaster()** instruction multiple times. The settings/options chosen within the instruction depend on whether you are triggering a sample, checking to see if it is done sampling, or asking for the status values.

TABLE 8-7. Generic Modbus® Control and Monitoring of the Sampler					
CRBasic **ModbusMaster()**					
Function	**Start**	**Length**	**Coil**	**Name**	**Description**
1 or 15	1	1	00001	Start	Start
1 or 15	2	1	00002	Serviced	Serviced
1 or 15	3	1	00003	Auto Deploy	Auto Deploy
			Register*		
3 or 16	1	1	40001 & 40002	Bottles	Number of bottles in sampler.
3 or 16	3	1	40003 & 40004	SampPerBottle	Number of samples to be put in each bottle(s).
3 or 16	5	1	40005 & 40006	NeverFull	Determines if the sampler loops without stopping (must be manually serviced before the sampler is full to prevent overflow).
3 or 16	7	1	40007 & 40008	PurgeTime1	Initial purge time, in seconds, that the sampler hose is purged before collecting sample.
3 or 16	9	1	40009 & 40010	LevelSetTime	Time, in seconds, to evacuate sample chamber to desired sample volume.
3 or 16	11	1	40011 & 40012	DepositTime	Time, in seconds, to hold pinch valve open to allow sample to be deposited in bottle.
3 or 16	13	1	40013 & 40014	PurgeTime2	Final purge time, in seconds, that the sampler hose is evacuated after collecting sample.
3 or 16	15	1	40015 & 40016	UsePurgeTime	A true/false variable which indicates if PurgeTime2 is set independently of PurgeTime1 or is set to same value as PurgeTime1.
3 or 16	17	1	40017 & 40018	SetTimeOut	True/false value that indicates whether the vacuum time is set by the user or automatically set (2 x PurgeTime1).
3 or 16	19	1	40019 & 40020	TimeOut	Vacuum timeout, in seconds, to determine how long sampler should attempt to collect a sample before triggering an error.
3 or 16	21	1	40021 & 40022	SamplerType	The sampler type determined by the corresponding integer value: 0 = PakBus, 1 = Pulse, 2 = Modbus, 3 = SDI-12
3	23	1	40023 & 40024	Bottle	Indicates bottle number that the sample is deposited in (1 to 24). Value is always 1 for composite sampler. (Read only.)
3	25	1	40025 & 40026	SampleCount	Displays the number of samples deposited in to this bottle. Value is always 1 for never full option. (Read only.)
3	27	1	40027 & 40028	Response	Displays numeric code ranging from 0 to 8 that represents a different condition (TABLE 8-3). 0 indicates no errors. (Read only.)
3	29	1	40029 & 40030	Batt	Returns the sampler's battery voltage just before that sample was collected. (Read only.)

*The Registers contain 15 values encoded as IEEE 754, 4-byte floating point (CDAB)

The **ModbusMaster()** instruction has the following form:

ModbusMaster(*ResultCode, ComPort, BaudRate, ModbusAddr, Function, Variable, Start, Length, Tries, TimeOut, [ModbusOption]***)**

Where,

- *ResultCode* – The ResultCode parameter is a variable that holds the results of the communication attempt.

- *ComPort* – The ComPort parameter specifies the communication port and mode that are used for this instruction.

- *BaudRate* – Use 38400 bps.

- *ModbusAddr* – Enter the Modbus® address set in *DevConfig*.

- *Function* – Enter the appropriate code (TABLE 8-8) to define what data is being sent to or received from the **ModbusSlave**. For example, use function code 1 to see if the sampler is still running. Use function code 3 to return the status values. Use function code 15 to set the start sample flags high.

TABLE 8-8. Modbus® Function Codes		
Code	**Name**	**Description**
01	Read Coil/Port Status	Reads the On/Off status of discrete output(s) in the ModbusSlave
03	Read Holding Registers	Reads the binary contents of holding register(s) in the ModbusSlave
15	Force Multiple Coils/Ports	Forces multiple Coils/Ports in the ModbusSlave to either On or Off
16	Write Multiple Registers	Writes values into a series of holding registers in the ModbusSlave

- *Variable* – The *Variable* parameter is used to specify the variable array that is used as the source of data to send, or the variable array that is used as the destination for data received.

- *Start* – The *Start* parameter is used to specify the first number of the register or coil that is acted upon with this instruction. TABLE 8-7 shows the descriptions of the registers and coils for the sampler. When initiating a sample, enter 1 for this parameter. When collecting all of the status values, enter 23 for this parameter.

- *Length* – The *Length* parameter is used to specify the number of variables to act upon with this instruction. The *Length* for initiating a sample is *1*. The *Length* for collecting status values is 4.

- *Tries* – The *Tries* parameter is used to specify the number of times the **ModbusMaster** datalogger should attempt to communicate with the **SlaveModbus** datalogger before moving on to the next instruction.

- *TimeOut* – The *TimeOut* parameter specifies the amount of time, in 0.01 seconds, that the ModbusMaster datalogger should wait for a response from the ModbusSlave before considering the attempt a failure.

For more information on each of the **ModbusMaster()** parameters, see *CRBasic Help*. Section 8.2.5.5, *Modbus® Example Instructions (p. 50)*, provides some example **ModbusMaster()** instructions. Complete program examples for the CR1000 can be found on our website at *www.campbellsci.com/19_1_767* and in Appendix B.3, *Modbus® Example Programs (p. B-6)*.

8.2.5.5 Modbus® Example Instructions

This instruction initiates a sample and uses *Function 15* to set the flag in the sampler:

ModbusMaster(*MbResult(2),ComSDC7,38400,MBAddress,15,Start_sample,1, 1,3,100,0***)**

This instruction checks to see if the sampler is still running:

ModbusMaster(*MbResult(1),ComSDC7,38400,MBAddress,1,Start_sample,1,1 ,3,100,0***)**

This instruction collects the status values:

ModbusMaster(*MbResult(3),ComSDC7,38400,MBAddress,3,Sampler_status(), 23,4,3,100,0***)**

8.2.6 Pulse Control

The sampler can be directly connected to a 0 to 5 V TTL pulse outputting device via the PVS5120CBL control cable. The sampler counts the accumulating pulses from the external device, for example a flow meter, to trigger a sample.

The sampler monitors either a 5 V contact closure or a positive pulse waveform. Either type of pulse needs to generate at least a 50 ms pulse width. When running the sampler via pulse control the four status values will not be returned to the user unless monitoring the sampler via RS-485 (similar to time-based control). See Appendix C, *Monitoring Sampler Status via RS-485 (p. C-1)* to learn how to configure for RS-485 monitoring.

NOTE   If using a datalogger, it may be easier to wire the pulse output device (flow meter or rain gage) to the datalogger, and then have the datalogger monitor and record the pulses. The datalogger can control the sampler via SDI-12 or RS-485 and return the four status values to the user.

---

1. Once connected to the VSC100, click the **Sampler Settings** tab (FIGURE 8-17).

    a. Set the **Control Type** to *Pulse*.

    b. Set the **Number of Sampler Bottles**.

    c. Set the **Samples Per Bottle**. It can range from *1* to *999*. This setting is ignored if **Never Full** is set to *On/Enable*.

    d. Typically leave the **Never Full Operation** disabled.

    e. If the Auto Deploy routine has been run, the **Purge Time** will already be set. If not using Auto Deploy, enter the amount of time the sampler hose is evacuated before and after the sample is collected. The maximum value is 800 s.

    f. If a **Water Present Sensor** is present, click to install. This sensor is wired to the sampler control cable. See Section 7.3.1, *Water Detection Probe (p. 24)*, for more information.
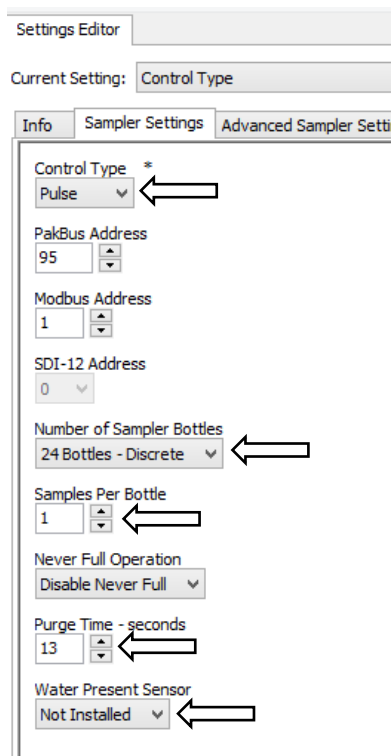
FIGURE 8-17. Pulse Control settings

2. Click the **Advanced Sampler Settings** tab (FIGURE 6-6). In most cases, the only thing a user will want to change is to Enable Pressure Relief setting; however, if you are interested in why the other options should be changed from factory defaults, see Section 6.2.3, *Advanced Sampler Settings Tab (p. 13)*.

      a.   Set **Sample Chamber – Pressure Relief**. If collecting a sample volume >450 mL or using an intake hose longer than 50 ft, this feature must be enabled.

3.   Click the **Pulse Settings** tab (FIGURE 8-18).

      a.   Set **Start Pulses**. This is number of input pulses needed to initiate the sample process.

      b.   Set the number of **Finish Pulses** that the sampler will return to the datalogger when a successful sample is collected.

NOTE	No pulses are returned if an error/fault is generated.

      c.   Set **Start Pulse Type** to either *Positive Pulse* in the case of a flow meter (positive pulse type takes a 0 V signal and raises it up to 5 V) or *Contact Closure* in the case of a tipping bucket rain gage (contact closure drives a line from 5 V/normally open line down to 0 V/closed).
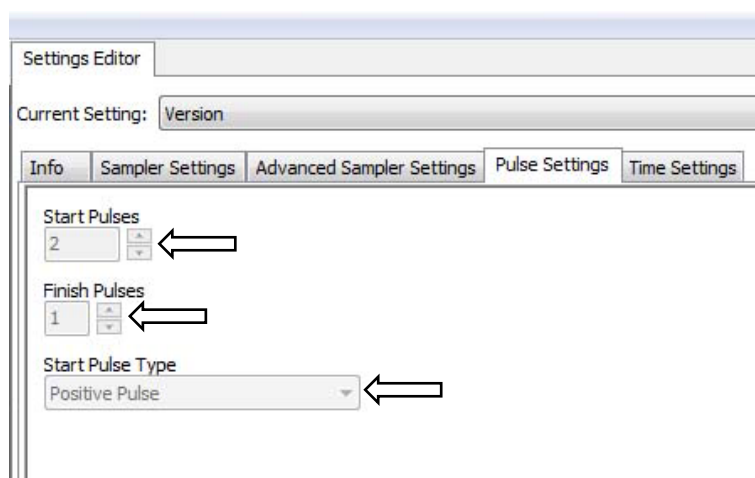
FIGURE 8-18. Pulse Settings tab

4.   Click **Apply**. It is a good idea to save the configuration file for future reference.

5.   Connect the sampler cable to the front of the sampler and wire the cable to the controlling device that is providing pulses.

6.   If a datalogger provides the pulses or is used to monitor the sampler, use *LoggerNet* to connect to the datalogger. The following steps assume a knowledge of how to setup the datalogger and connect either via a direct connection or remote connection.

      a.   From the *LoggerNet Connect* window, click **Connect | Collect Now** to collect any data on the datalogger.

b. From the *Connect* screen, click the **Send New** button. Browse to find the *CRBasic* program that controls or monitors the sampler. Click **Open | Send**.

8.2.6.1 Wiring for Pulse Control

Wire	Description	Connection
TABLE 8-9. Pulse Control Wiring (PVS5120CBL-L Cable)		
Green	SDI-12/Pulse Out	PLC or datalogger control port*
Blue	Pulse Start	External device 0 to 5 V TTL
Purple	Ground	External device ground
Gray	Ground	Optional water detection probe
Yellow	Water Sensor	Optional water detection probe
White	RS-485 A–	MD485 RS-485 A port**
Black	RS-485 B+	MD485 RS-485 B port**
Red	Fault	Not used
Brown	RG	MD485 RG port**

*Connect only if producing a pulse after a successful sample
**Only use if monitoring the sampler over RS-485 for status feedback

9. Maintenance and Troubleshooting

The PVS5120 is designed to give years of trouble-free service with reasonable care. However, if factory repair is needed, first contact a Campbell Scientific application engineer to obtain an RMA (Return Materials Authorization) number. An RMA number and product-safety documents (forms are provided) are required prior to any repair shipments being accepted at Campbell Scientific. See the *Assistance* statement at the back of this manual for more information.

9.1 Maintenance

The following procedures should be performed periodically based on use of sampler.

9.1.1 Meter Chamber Assembly

1. Disconnect power.

2. Open metering chamber by removing wing nuts and chamber cover.

3. Clean volume control tube and level sensing probe with mild detergent. Alternatively, exchange tube and probe with clean set. Do not use any cleaner which may be harmful to the metering chamber cover. Do not use solvents such as acetone, benzene, carbon tetrachloride or lacquer thinners. Grease and oil may be removed with kerosene or aliphatic naphtha (nonaromatic).

4. Check and clean O-rings in metering chamber cover. Replace if damaged, worn or brittle.

5. Clean metering chamber using mild detergent.

CAUTION	Do not use any cleaner which may be harmful to the clear acrylic (for example, petrochemical solvents, as noted above). Do not use abrasives or "scouring" compounds.

6. For composite systems, check discharge tubing for wear and replace as necessary.

7. Check pinch valve to ensure free movement.

8. If possible, run sampler through several sampling sequences in clean water.

9.1.2 Internal Battery (when included)

1. Charge battery to full capacity when being stored for long periods and disconnect fuse at battery.

2. Recharge battery to full capacity before being deployed.

3. Monitor battery voltage and recharge or swap out, at or before, 11.6 Vdc.

9.1.3 Intake Hose

1. Check for any obstructions at intake end and clean.

2. Inspect for breaks, cracks, or any point where leakage may be suspected by submerging in a bucket of water and run through a complete sampling cycle. Watch for air bubbles during the purge cycle.

3. Clean by completing several sampling sequences using mild detergent.

CAUTION	Do not use any cleaner that may be harmful to the intake hose material.

9.1.4 Testing System Vacuum

Using a pressure / vacuum gage, take a reading to ensure system has no leaks. Optimal pressure is above 28 psi. Optimal vacuum should be 12 mm Hg or higher. If the system is not performing at its peak, try the following:

1. Check intake hose for leaks/kinks.

2. Check discharge tube, ensure it has no leaks and is in good shape.

3. Check all fittings to ensure they are tight.

4. Make sure when tightening and loosening the brass gland nuts on the top of the metering chamber cover that the bottom nut is held secure and does

not move on the cover. Ensure the top nut is securely tightened, by using correct wrenches.

5. If system is still not performing at its peak, inspect pump and all pump tubing.

9.1.5 VSC100 Maintenance

The only maintenance for the controller is to replace its battery (see Appendix E, *Lithium Battery Replacement (p. E-1)*).

9.2   Troubleshooting

9.2.1 Common Troubleshooting Scenarios

Symptom #1: Sampler does not pull a sample or purge while running:

- Check all connections and intake line for loose fittings or plugged intake hose. Tighten loose fittings and replace plugged intake hoses.

- Verify that wing nuts and brass gland nuts on the meter chamber cover are tightened and the cover is on correctly.

- Spray dish soap/water mixture on metering chamber cover, blue intake hose connection, 1/4 inch air tubing and then check for bubbles during the purge cycle. Fix leaks by replacing hoses, tightening connections, and replacing chamber cover.

- Remove blue intake hose to metering chamber and place your thumb on stainless steel intake tube; is there pressure or suction on it at any time during the sampling process?

- Check the pump and vacuum pressure. The maximum pump pressure should be above 28 psi (on new pumps); vacuum pressure typically is around 12 to 22 psi (on new pumps). The sampler only tries twice before shutting down if a successful sample is not taken. Pump may need to be rebuilt or replaced. This requires the following parts:

  o   pn 28333 Sampler Replacement 12 Vdc Vacuum Pump

  o   pn 28620 Service Repair Kit for sampler vacuum pump

  o   pn 26895 brush and lead wire repair kit for sampler vacuum pump

Symptom #2: Sampler does not switch from vacuum to purge when contact is made with the conductivity rod:

- Clean volume control tube and conductivity rod.

- Push and release the Manual Control button twice to induce a Manual Sample. Short across the volume control tube and liquid sensing/conductivity rod with screwdriver to switch sampler from vacuum to purge simulating a successful sample. If it does not switch,

o   Check that the positive wire lead (yellow connector) is securely attached to the top of the conductivity rod. Check for corrosion inside of the yellow connector and on top of the conductivity rod. Clean if needed.

o   If the yellow connector is securely attached, use a multimeter to see if 3.3 Vdc is present.

o   If 3.3 Vdc is not present, check for a broken wire and recheck the yellow connector to ensure that it is not loose or broken.

Symptom #3: Sampler clock drifts outside of specification:

- Connect to the computer and sync the clock by using the **Clock** tab in *DevConfig*.

- Apply setting and disconnect.

- Power cycle the sampler.

- Connect the sampler to the computer and check the clock to see if it has drifted. If it has drifted, replace the coin cell battery (see Appendix E, *Lithium Battery Replacement (p. E-1)*).

9.2.2 Information Needed for Help in Troubleshooting a Problem

Campbell Scientific application engineers need the following information to help troubleshoot a problem:

- Serial and model numbers (serial number indicates whether the sampler is still under warranty)

- Your PVS5120 sampler program

- Symptoms: What is the sampler doing or not doing?

- Whether the red LED on the front panel is lit

- Whether the green LED on the front panel is lit

- Equipment connected to the front panel (for example, external battery, control cable, 12 Vdc charger)

- Voltage of the battery supplying power to the sampler

9.3   Storage

If the sampler is not to be used for an extended period of time, store the unit in an upright position in a warm, dry location. If the unit has an internal battery, recharge the unit prior to storage and disconnect the yellow fuse caps on the control section.

Appendix A. Sample Transport Velocity

TABLE A-1. Vertical Velocity at Sea Level									
System Size	**Height**								
	0 m (0 ft)	**1.5 m (5 ft)**	**3.1 m (10 ft)**	**4.6 m (15 ft)**	**5.5 m (18 ft)**	**6.1 m (20 ft)**	**6.7 m (22 ft)**	**7.6 m (25 ft)**	**8.2 m (27 ft)**
large pump	2.16 m/s (7.1 ft/s)	2.16 m/s (7.1 ft/s)	1.83 m/s (6 ft/s)	1.52 m/s (5 ft/s)	1.34 m/s (4.4 ft/s)	1.25 m/s (4.1 ft/s)	1.10 m/s (3.6 ft/s)	0.91 m/s (3 ft/s)	0.79 m/s (2.6 ft/s)
standard pump	1.55 m/s (5.1 ft/s)	1.43 m/s (4.7 ft/s)	1.10 m/s (3.6 ft/s)	0.82 m/s (2.7 ft/s)	0.49 m/s (1.6 ft/s)	0 m/s (0 ft/s)			

TABLE A-2. Horizontal Lift							
System Size	**Distance**						
	7.6 m (25 ft)	**15.2 m (50 ft)**	**22.9 m (75 ft)**	**30.5 m (100 ft)**	**53.3 m (175 ft)**	**61 m (200 ft)**	**76.2 m (250 ft)**
large pump	2.2 m/s (7.1 ft/s)	1.9 m/s (6.2 ft/s)	1.7 m/s (5.6 ft/s)	1.5 m/s (5 ft/s)	1.2 m/s (4 ft/s)	1.1 m/s (3.7 ft/s)	0.8 m/s (2.6 ft/s)
standard pump	1.6 m/s (5.1 ft/s)	1.4 m/s (4.7 ft/s)	1.28 m/s (4.2 ft/s)	1.25 m/s (4.1 ft/s)	1 m/s (3.4 ft/s)	0.9 m/s (3.1 ft/s)	0.7 m/s (2.3 ft/s)

[1]Samples were collected at sea level
[2] Vertical head <2 ft

Standard Pump   Large Pump

Appendix B. Example Programs

B.1 SDI-12 Example Programs

B.1.1 CR1000 SDI-12 Programs

B.1.1.1 CR1000 Program Controlling One Sampler

NOTE   During testing, it was helpful to include an *Autoru*n parameter as a Boolean variable. It allows the user to set the *Autorun* variable to false in the **Public** table before opening up the sampler for servicing without having to cut power to either the datalogger or the sampler. Also the list of *Responses* includes a string message for numeric response code (TABLE 8-3). This will allow a text message to be returned to the user in the data table. The following program is available for download from the PVS5120 webpages.

```
'VSC100 program with SDI-12 communication
'date: 2014/05/13

PreserveVariables

'Declare Public Variables
Public sdi12(4)    'This is the destination array for the output values from the sampler
Alias sdi12(1)= Bottle
Alias sdi12(2)= Smpl_count
Alias sdi12(3) = Response_Code
Alias sdi12(4) = Sampler_Volt 'this is the voltage of the sampler battery

Public SamplerAddr As String *1 'This is the sdi-12 address assigned to the sampler in DevConfig
Public Run As Boolean
Public Autorun As Boolean 'This variable allows the user to prevent the logger from triggering
'the sampler.  It is helpful when servicing the sampler or testing in the lab.  Just set the variable
'to false in the public table and sampling is stopped until the user sets the variable true.
'The following two variables are used to convert the numeric response code value from the sampler
'to a text message.
Dim Response_List(9) As String
Public response_code_message As String

'Define Data Tables
'Sdi-12 output from the sampler including bottle number, sample number in a given bottle,
'response code, and sampler voltage at the time of the sample)
DataTable (SamplerStat,1,1000)
  Sample (1,Bottle,FP2)
  Sample (1,Smpl_count,FP2)
  Sample (1,Response_Code,FP2)
  Sample (1,response_code_message, String)
  Sample (1,Sampler_Volt,FP2)
EndTable

'Main Program
BeginProg
  'Program startup values
  SamplerAddr = "0" 'This is the sdi12 address assigned to the sampler.  It is set in DevConfig.

  Response_List(1) = "No error"
  Response_List(2) = "All samples complete"
  Response_List(3) = "Low start battery (V<11.0 V)"
  Response_List(4) = "Low run battery (V<10.5V)"
  Response_List(5) = "Sampler vacuum timed out, no sample detected"
  Response_List(6) = "Sample overflow detected"
  Response_List(7) = "No sample liquid detected"
  Response_List(8) = "Arm calibration error"
  Response_List(9) = "Conductivity rod and Sample tube are shorted"

  Autorun=true
```

```
  'In this program the sampler is triggering via sdi12 once every 15 minutes. But the scan interval is set at
every 10 'sec assuming the logger is doing more than just triggering the sampler.  This can be changed very
easily.
  Scan (10,Sec,0,0)
    If IfTime(0,15,Min)AND Autorun Then
      Run=true
      End If

      If Run Then
        'Values initialized to 999 to make communication errors easier to identify.
        'For example if the logger is powered up but the sampler is turned off, NAN is returned for the
        'first array location and 999s will remain in the remaining 3 array locations.  This is repeated
        'each time the logger tells the sampler to run.

        sdi12(1) = 999
        sdi12(2) = 999
        sdi12(3) = 999
        sdi12(4) = 999

        SDI12Recorder (sdi12(),1,SamplerAddr,"M!",1.0,0) 'Run the Sampler
        'In this example the sampler is wired into com port 1
        response_code_message=Response_List(Response_Code+1)

        Run=false
        CallTable SamplerStat
      EndIf
    NextScan
  EndProg
```

B.1.1.2 CR1000 Program for Running Three Samplers Concurrently

```
'VSC100 program for running 3 samplers concurrently via SDI-12.
'Once a C! command is issued the returned status values will not be available to the logger until the logger
tells the 'samplers to run the next time.  This is because a service command is not issued by the sensor with
a C! like in an 'M! If you need data back sooner than the next sample follow the steps below.
'date 2014/10/17

Public PTemp, batt_volt

Public SamplerOne(4), SamplerTwo(4), SamplerThree(4) 'Returned Sampler status values for each sampler
Public CmdOne As String, CmdTwo As String, CmdThree As String
DataTable (SamplerStat,1,1000)
  Sample (4,SamplerOne(),FP2)
  Sample (4,SamplerTwo(),FP2)
  Sample (4,SamplerThree(),FP2)
EndTable

BeginProg
  Scan (5,Sec,0,0) 'scan interval every 5 seconds
    PanelTemp (PTemp,250)
    Battery (batt_volt)

    If IfTime (0,2,Min) Then  'This example tells the samplers to run every 2 minutes
      CmdOne = "C!"
      CmdTwo = "C!"
      CmdThree = "C!"
    Else  'Else issue the "C" command every 5 seconds to get the status values when available
      CmdOne = "C"
      CmdTwo = "C"
      CmdThree = "C"
    EndIf

    SDI12Recorder (SamplerOne,1,0,CmdOne,1.0,0) 'sampler address 0
    SDI12Recorder (SamplerTwo,1,1,CmdTwo,1.0,0) 'sampler address 1
    SDI12Recorder (SamplerThree,1,2,CmdThree,1.0,0) 'sampler address 2

    'The following logic sets all 4 status values to NAN if the first one comes back as NAN when
    'communication between the logger and sampler is interrupted.
    If SamplerOne(1) >= 1E9 OR SamplerOne(1) = NAN Then Move (SamplerOne,4,NAN,1)
    If SamplerTwo(1) >= 1E9 OR SamplerTwo(1) = NAN Then Move (SamplerTwo,4,NAN,1)
    If SamplerThree(1) >= 1E9 OR SamplerThree(1) = NAN Then Move (SamplerThree,4,NAN,1)

    CallTable SamplerStat
  NextScan
EndProg
```

B.1.2 CR200X Series Programs

```
'This generic program for the CR200X triggers the PVS5120 based on a user-defined time interval.
'The VSC100 must be configured for SDI-12 control type and have an SDI-12 address of 0

'*** Change this value to the desired sample interval.
'Sample interval must be greater than or equal to two minutes unless you are using a very short hose.**
Const Sample_Interval = 2 ' Minutes.  This is the sample interval

Public Run 'Set as a non-zero value in the public table for the sampler to begin sampling on the next scan
'interval. For example 0=Stop 1=sample.

Public BVolt 'This is the voltage of the CR200's power supply
Units BVolt = VDC
Public VSC100(4)'This is the destintation array for the output values from the VSC100
Alias VSC100(1) = Bottle_Number 'This is the bottle number that the last sample was deposited into
Alias VSC100(2) = Sample_Number 'This is the number of the last sample that was deposited into the current
bottle
Alias VSC100(3) = Response_Code 'This is the result code returned by the VSC100
'Possible response codes returned from VSC100
'  0 - No Error
'  1 - Sampler Full
'  2 - Low Sampler Start Battery
'  3 - Low Sampler Run Battery
'  4 - Vacuum Timeout
'  5 - Bottle Overflow (if detection probe installed)
'  6 - No Water Present (if water detection probe installed)
'  7 - Distributor Arm Calibration Failure
'  8 - Sample Sense Rod Shorted
Alias VSC100(4) = Sampler_Volt 'this is the voltage of the sampler battery
Units Sampler_Volt = VDC
Dim I 'This is a hidden variable used as an index counter

DataTable (Sampler_Data,True,-1)
    DataInterval (0,Sample_Interval,min)
    Sample (1,BVolt)
    Sample (4,VSC100())
EndTable

BeginProg

    Scan (Sample_Interval ,min)
        Battery (BVolt) 'Measure the CR200's power supply
        If Run <> 0 Then 'If the system has been enabled to run then
            For I = 1 To 4'This loop sets all the elements in the VSC100 array to NAN.  This will make it
easier to recognize errors.
                VSC100(I) = NaN
            Next I
            SDI12Recorder (VSC100(),"0M!",1.0,0) 'Trigger the VSC100 to take a sample

            CallTable Sampler_Data

        EndIf
    NextScan
EndProg
```

B.2 PakBus® Example Programs

B.2.1 PakBus® Control CR1000 Program

NOTE   During testing, it was helpful to include an *Autorun* parameter as a Boolean variable. It allows the user to set the *Autorun* variable to false in the **Public** table before opening up the sampler for servicing without having to cut power to either the datalogger or the sampler. Also the list of *Responses* includes a string message for numeric response code. This will allow a text message to be returned to the user in the data table. The following program is available for download from the PVS5120 webpages.

```
'PVS5120/VSC100 program communicating via PakBus
'hardware includes MD485
'this program also contains a Autorun variable that has to be true for the sampler to sample.
'If it is set to false it will disable the sampler until (for servicing...) it is set true again
'date: 2014-05-23

PreserveVariables

'Declare Public Variables
Public batt_volt 'storing datalogger battery voltage for quality control
Public sampler_PakBus_address  'The PakBus address is set or designated
'in DevConfig.  The default value for the sampler is 95.  If you have multiple samplers on the network they
each 'need a unique PakBus address.

'The following two variables are used to convert the numeric response code value from the sampler to a text
'message.
Dim Response_List(9) As String
Public response_code_message As String

Public AutoRun As Boolean 'allows user to prevent the sampler from running on schedule via the connect screen
'without removing power to the sampler or the logger
Public GetStatus As Boolean
Public Run_sampler As Boolean
Public Start_sample 'control variable ***Warning this CAN NOT be declared as a boolean even though you are
'setting it true/false

Public Sampler_status(4)
'*** Status Values returned by the sampler once a sample is collected ****
Alias Sampler_status(1) = CurrentBottle 'Discrete distributor arm position
Alias Sampler_status(2) = SampleCount   'How many samples are currently in bottle
Alias Sampler_status(3) = ResponseCode 'Numeric Response Code
Alias Sampler_status(4) = SamplerBatt 'Sampler battery voltage (V)

'***Results returned for each communication instruction***
Public Result(3)   'does not have to be an array

'Define tables
DataTable (SamplerStat,True,1000) 'stores sampler status values
  Sample (1,CurrentBottle,FP2)
  Sample (1,SampleCount,FP2)
  Sample (1,ResponseCode,FP2)
  Sample (1,response_code_message,String)
  Sample (1,SamplerBatt,FP2)
EndTable

DataTable (Errors,true,1000) 'stores the communication errors
  Sample (3,Result(),FP2)
EndTable

DataTable (logger_battery,1,1000) 'stores the logger battery voltage for quality control in the case of
'communication errors.  It is only storing the 5 minute minimum reading but is measured on the scan interval
'in this case 10 seconds.
  DataInterval (0,5,Min,10)
  Minimum (1,batt_volt,FP2,0,False)
EndTable
```

```
'Main Program
BeginProg
  'The following text is associated with the numeric response codes provided from the sampler after each
attempted 'sample.
  Response_List(1) = "No error"
  Response_List(2) = "All samples complete"
  Response_List(3) = "Low start battery (V<11.0 V)"
  Response_List(4) = "Low run battery (V<10.5V)"
  Response_List(5) = "Sampler vacuum timed out, no sample detected"
  Response_List(6) = "Sample overflow detected"
  Response_List(7) = "No sample liquid detected"
  Response_List(8) = "Arm calibration error"
  Response_List(9) = "Conductivity rod and Sample tube are shorted"

  AutoRun=true 'initialize to True but the user can stop the sampler from sampling by changing it to false in
the 'public table.

sampler_PakBus_address = 95 'This address must match the address assigned to the sampler in DevConfig

  'Right now this sample program scans every 10 seconds and triggers the sampler once every 15 minutes
  'Both the scan interval and the sampler time can be adjusted as needed.
  Scan (10,Sec,0,0)
    Battery (batt_volt)
    CallTable logger_battery

    If IfTime(0,15,Min) AND AutoRun Then 'If you are 0 seconds into the 15 minute and autorun is true
      Run_sampler = true 'Then set "Run_sampler" flag to True
    EndIf

    If GetStatus Then 'if GetStatus is true then get variables from the sampler. If the communication fails
return
      'the results to Result(1). "Public" is the sampler table name.  "Start" is the field name on the
sampler.
      GetVariables (Result(1),ComSDC7,0,sampler_PakBus_address,0000,0,"Public","Start",Start_sample,1)

      If Start_sample <> True AND Result(1)=0 Then 'If Start_sample is not True and Result(1)=0 then get
sampler 'status
        GetVariables
(Result(3),ComSDC7,0,sampler_PakBus_address,0000,0,"Public","Bottle",Sampler_status(1),4)
        response_code_message = Response_List(ResponseCode+1)
        CallTable SamplerStat 'send the current status values to the SamplerStatus table
        GetStatus=false
      ElseIf Result(1)<> 0 OR Result(3) <> 0 Then 'Else if there either result(1) or result(3) does not equal
zero than
        'call the communcation error table.
        CallTable Errors
      EndIf
    EndIf

    If Run_sampler Then 'If Run_sampler is true send the start instruction to the sampler
      Start_sample = true
      SendVariables (Result(2),ComSDC7,0,sampler_PakBus_address,0000,0,"Public","Start",Start_sample,1)
      If Result(2)<>0 Then 'If result(2) does not equal 0 call the communication error table.
        CallTable Errors
      Else 'set GetStatus to true so on the next scan the logger knows to ask for the updated sampler_status
        GetStatus = true
      EndIf 'reset run_sampler to false so the logger waits until the top of the next sample interval
      'in this case 0 seconds into the next 15 minute interval to sample.
      Run_sampler = false
    EndIf

  NextScan
EndProg
```

B.3 Modbus® Example Programs

B.3.1 CR1000 Modbus® Control Program

```
'PVS5120/VSC100 program communicating via ModBus
'hardware includes MD485
'Important to remember to first configure the MD485
'then configure the sampler via devconfig
'then service the sampler so the arm is in the correct location and bottles are empty
'then load the program to the datalogger.
'this program also contains a Autorun variable that has to be true for the sampler to sample.
'If it is set to false it will disable the sampler until (for servicing...) it is set true again
'date: 2015-05-04

PreserveVariables

'Declare Public Variables
Public batt_volt 'storing datalogger battery voltage for quality control
Public MBAddress 'Modbus Address of the sampler as set in devconfig.


'The following two variables are used to convert the numeric response code value from the sampler
'to a text message.
Dim Response_List(9) As String
Public response_code_message As String

Public AutoRun As Boolean 'allows the user to prevent the sampler from running on schedule
'via the connect screen without removing power to the sampler or the logger

Public GetStatus As Boolean
Public Run_sampler As Boolean
Public Start_sample As Boolean 'control variable

Public Sampler_status(4)
'*** Status Values returned by the sampler once a sample is collected ****
Alias Sampler_status(1) = CurrentBottle 'Discrete distributor arm position
Alias Sampler_status(2) = SampleCount  'How many samples are currently in bottle
Alias Sampler_status(3) = ResponseCode 'Numeric response code
Alias Sampler_status(4) = SamplerBatt 'Sampler battery voltage (V)

Public MbResult(3)'need a result variable for every modbus instruction
'does not need to be an array
'will increment greater than zero to let you know if a communication does not occur
'in this program MbResult1 error code occurs when communication is lost during any scan interval
'in this program it will increment every 10 secs that communcation is lost.
'MbResult2 error code occurs when the initiate sample command can not be sent to the sampler because
'communications are down.  It will increment every 15 minutes.

'Define tables
DataTable (SamplerStat,True,-1) 'stores sampler status values
  Sample (1,CurrentBottle,FP2)
  Sample (1,SampleCount,FP2)
  Sample (1,ResponseCode,FP2)
  Sample (1,response_code_message,String)
  Sample (1,SamplerBatt,FP2)
EndTable

DataTable (ModbusErrors,true,-1) 'stores the modbus errors
  Sample (3,MbResult(),FP2)
EndTable
```

```
DataTable (logger_battery,1,1000) 'stores the logger battery voltage for
  'quality control in the case of communication errors.  It is only storing
  'the 5 minute minumim reading but will be measured on the scan interval
  'in this case 10 seconds.
  DataInterval (0,15,Min,10)
  Minimum (1,batt_volt,FP2,0,False)
EndTable

'Main Program
BeginProg
  'The following text is associated with the numeric response codes provided
  'from the sampler after each attempted sample.
  Response_List(1) = "No error"
  Response_List(2) = "All samples complete"
  Response_List(3) = "Low start battery (V<11.0 V)"
  Response_List(4) = "Low run battery (V<10.5V)"
  Response_List(5) = "Sampler vaccuum timed out, no sample detected"
  Response_List(6) = "Sample overflow detected"
  Response_List(7) = "No sample liquid detected"
  Response_List(8) = "Arm calibration error"
  Response_List(9) = "Conductivity rod and Sample tube are shorted"

  MBAddress = 0 'This must also be set in Devconfig for each sampler.  The address
  'must be unique if you are using multiple samplers.
  AutoRun=true 'initialize to True but the user can stop the sampler from sampling
  'by changing it to false in the public table.

  'Right now this sample program scans every 10 seconds and triggers the sampler once every 15 minutes
  'Both the scan interval and the sampler time can be adjusted as needed.
  Scan (10,Sec,0,0)
    Battery (batt_volt)
    CallTable logger_battery

    If IfTime(0,15,Min) AND AutoRun=true Then 'If you are 0 seconds into the 15 minute interval and autorun is true
      Run_sampler = true 'Then set "Run_sampler" flag to True
    EndIf

    If GetStatus=true Then 'if GetStatus is true then read control variable from the sampler (modbus device)
      ModbusMaster (MbResult(1),ComSDC7,38400,MBAddress,1,Start_sample,1,1,3,100,0)
      If Start_sample <> True AND MbResult(1)=0 Then 'if start_sample is NOT true and MbResult(1) = 0 then
                                                     'get the sampler status values
        ModbusMaster (MbResult(3),ComSDC7,38400,MBAddress,3,Sampler_status(),23,4,3,100,0)'reading actual status values
        response_code_message = Response_List(ResponseCode+1)'adjust the numeric response code the to assigned message
        CallTable SamplerStat 'send the sampler status to the table
        GetStatus=false
      ElseIf MbResult(1)<> 0 OR MbResult(3) <> 0 Then 'else if MbResult (1) or (3) does NOT = 0 then write to
                                                      'the error table
        CallTable ModbusErrors
      EndIf
    EndIf

    If Run_sampler Then 'if Run_sampler is True then set the control variable true and set the start flag in the sampler
      Start_sample = true
      ModbusMaster (MbResult(2),ComSDC7,38400,MBAddress,15,Start_sample,1,1,3,100,0) 'Function 15 is setting
                                                                                    'the flag in the sampler
      If MbResult(2)<>0 Then 'if there was an error in communicating with the sampler write to the error table
        CallTable ModbusErrors
      Else
        GetStatus = true 'set getstatus true so on the next scan the logger knows to ask for the
                         'sampler_status values of the new sample.
      EndIf
      Run_sampler = false
    EndIf

  NextScan
EndProg
```

Appendix C. Monitoring Sampler Status via RS-485

When controlling a sampler via time-based/stand-alone or pulse control, it is possible to still collect the sampler status values over RS-485 (PakBus® or Modbus®). The following sections walk through configuring the MD485 to talk with a CR1000 and then programming examples for Modbus® and PakBus® in *CRBasic*.

C.1 Configuring an MD485

1. Connect a serial cable to the RS-232 port on the MD485 and to the computer.

2. Supply power (12 Vdc) to the MD485 by the power jack or through the +12 V line on the CS I/O connector. You will need a SC12 serial cable to connect the CS I/O port of the MD485 to the CS I/O port on the datalogger.

3. Open *DevConfig*. Click **Peripheral**. Select *MD485*. Select the **Communication Port**. Push the **Program** button on the MD485. Click **Connect**. The program button is located to the right of the RS-485 connectors on the modem's front panel.
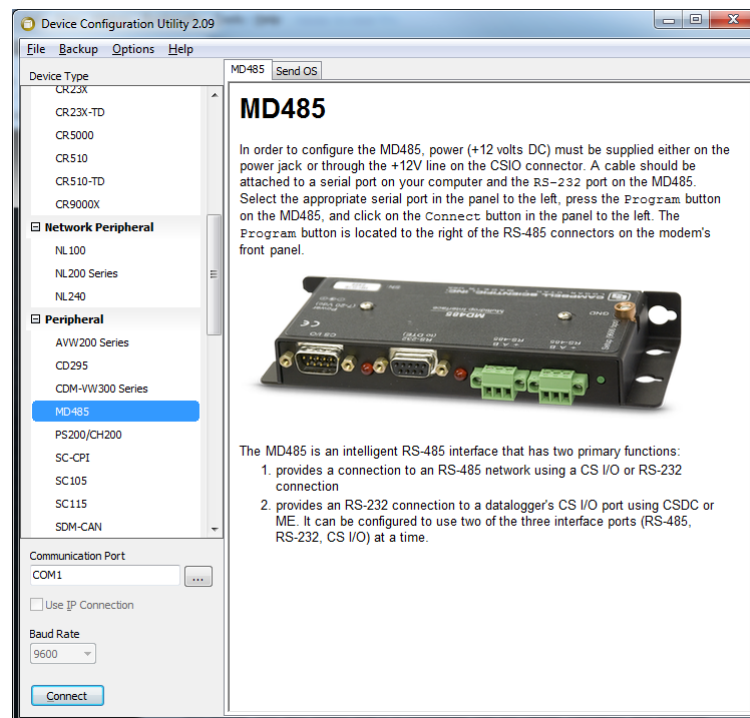
FIGURE C-1. MD485 Device Configuration screen

4. Click the **MD485** tab. Select *CS I/O* and *RS-485* in the **Active Ports** box. Select *Transparent Communication* in the **Protocol Configuration** box (FIGURE C-2).
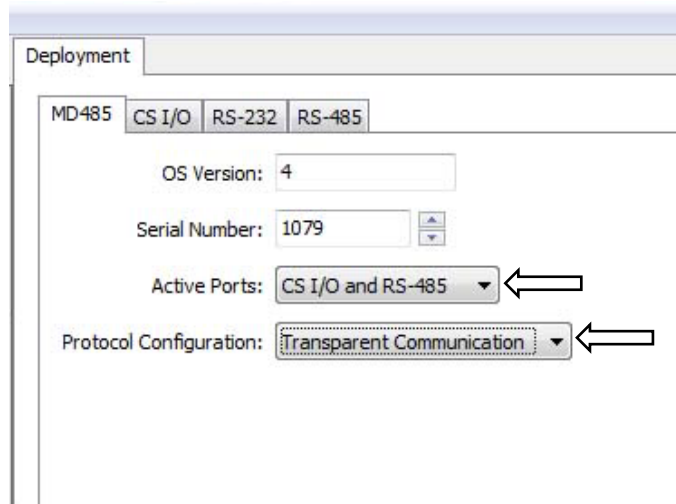
FIGURE C-2. MD485 Deployment tab

5. Click the **CS I/O** tab. Set the mode based on the type of datalogger being used.

    a. The shown configuration is for a CR1000. We used SDC7 for the address.

6. Click the **RS-485** tab. Set **Baud Rate** to *38.4k*. Set **Parity** to *None*. Set **Character Length** to *8 bits*. Set **Stop Bits** to *1 bit* (FIGURE C-3).
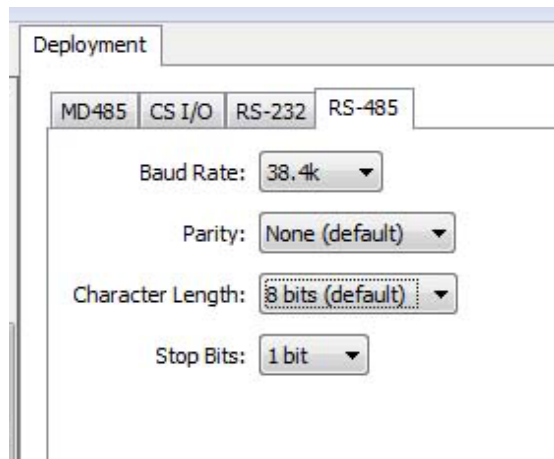
FIGURE C-3. MD485 RS-485 tab

7. Click **Apply**.

C.2 Wiring for Status Monitoring via RS-485

TABLE C-1. Status Monitoring Connections (PVS5120CBL-L Cable)		
Wire	**Description**	**Connection**
Green	SDI-12/Pulse Out	PLC or datalogger control port
Blue	Pulse Start	External device 0 to 5 V TTL
Purple	Ground	External device ground
Gray	Ground	Optional water detection probe
Yellow	Water Sensor	Optional water detection probe
White	RS-485 A-	MD485 RS-485 A port
Black	RS-485 B+	MD485 RS-485 B port
Red	Fault	Not used
Brown	RG	MD485 RG port

C.3 Configure the VSC100

Reconnect to the VSC100 to add/adjust either the PakBus® or Modbus® address depending on how you want to monitor the sampler status.

C.3.1 Connecting to the VSC100/Sampler via *DevConfig*

1. Connect the 17648 USB cable to the front of the sampler controller (VSC100) and the other end to the computer's USB port (FIGURE 8-3). Wait for Windows® to install the driver before opening *DevConfig*.

2. Open *DevConfig*. Select **VSC100 Series** under the **Sampler**. Click **Communication Port** and select the correct **COM** port. Click **Connect** (FIGURE C-4).
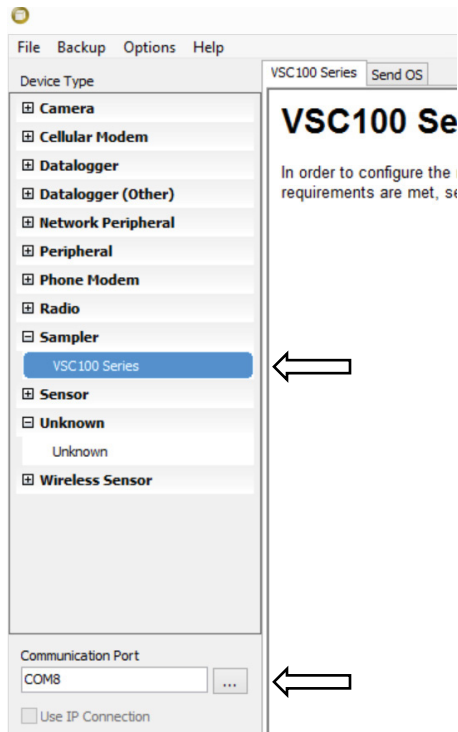
FIGURE C-4. Device Configuration VSC100

3. Once connected to the VSC100, you are ready to configure your sampler.

4. Click the **Sampler Settings** tab.

    a. Set the PakBus® address or the Modbus® Address

        i. The default PakBus® address for the sampler is 95. This value needs to be unique for each sampler and datalogger on your network.

        ii. The default Modbus® address is 1. The value can range from 1 to 127. Each sampler on your network will need a unique address.

5. You do not need to change any of your time-based or pulse control settings.

6. Click **Apply**. It is a good idea to save the configuration file for troubleshooting.

C.4 Programming for RS-485 Monitoring

C.4.1 Monitoring via PakBus®

When monitoring via PakBus® you will need to issue the **GetVariables()** instruction and save the returned values to variable array. Below is the instruction's structure and an example instruction. Also a CR1000 program is available.

GetVariables(*ResultCode, ComPort, NeighborAddr, PakBusAddr, Security, TimeOut, "TableName", "FieldName", Variable, Swath***)**

GetVariables(*Result(3),ComSDC7,0,sampler_PakBus_address,0000,0, "Public","Bottle",Sampler_status(1),4***)**

See Section 8.2.4, *PakBus®* Control *(p. 36)*, for more explanation of the **GetVariables** instruction or the *CRBasic Help*.

C.4.1.1 CR1000 Program for PakBus® Monitoring with Time-Based Configuration

```
'PVS5120/VSC100 program communicating via PakBus
'hardware includes MD485
'program monitors the status of a sampler running on a time-based configuration via PakBus.
'date: 2014-10-21

PreserveVariables

'Declare Public Variables
Public sampler_PakBus_address 'The PakBus address is set or designated
'in DevConfig.  The default value for the sampler is 95.  If you have
'multiple samplers on the network they each need a unique PakBus address.

'The following two variables are used to convert the numeric response code value from the sampler
'to a text message.
Dim Response_List(9) As String
Public response_code_message As String

Public Sampler_status(4)
'*** Status Values returned by the sampler once a sample is collected ****
Alias Sampler_status(1) = CurrentBottle 'Discrete distrubitor arm position
Alias Sampler_status(2) = SampleCount   'How many samples are currently in bottle
Alias Sampler_status(3) = ResponseCode 'Numeric Response Code
Alias Sampler_status(4) = SamplerBatt 'Sampler battery voltage (V)

'***Results returned for each communication instruction***
Public Result

'Define tables
DataTable (SamplerStat,True,1000) 'stores sampler status values
  Sample (1,CurrentBottle,FP2)
  Sample (1,SampleCount,FP2)
  Sample (1,ResponseCode,FP2)
  Sample (1,response_code_message,String)
  Sample (1,SamplerBatt,FP2)
EndTable

DataTable (Errors,true,1000) 'stores the communication errors
  Sample (1,Result,FP2)
EndTable

'Main Program
BeginProg
  'The following text is associated with the numeric response codes provided
  'from the sampler after each attempted sample.
  Response_List(1) = "No error"
  Response_List(2) = "All samples complete"
  Response_List(3) = "Low start battery (V<11.0 V)"
  Response_List(4) = "Low run battery (V<10.5V)"
```

```
Response_List(5) = "Sampler vacuum timed out, no sample detected"
Response_List(6) = "Sample overflow detected"
Response_List(7) = "No sample liquid detected"
Response_List(8) = "Arm calibration error"
Response_List(9) = "Conductivity rod and Sample tube are shorted"

sampler_PakBus_address = 95

'Right now this sample program scans every 10 seconds and triggers the sampler once a minute
'zero seconds into the minute.  Both the scan interval and the sampler time can be adjusted as needed.
Scan (30,Sec,0,0)
  GetVariables (Result,ComSDC7,0,sampler_PakBus_address,0000,0,"Public","Bottle",Sampler_status(1),4)
  response_code_message = Response_List(ResponseCode+1)
  CallTable SamplerStat 'send the current status values to the SamplerStatus table

  If Result<> 0 Then
    'call the communcation error table.
    CallTable Errors
  EndIf

NextScanEndProg
```

C.4.2 Monitoring via Modbus®

When monitoring via Modbus®, you need to issue the **ModbusMaster()** instruction and save the returned values to variable array. These status values are array values 23 through 29 in TABLE 8-7. Below is the instruction's structure and an example instruction. Also a CR1000 program is available.

The **ModbusMaster()** instruction initiates a sample and collects the returned status values. This instruction accesses the Coils and Input Registers stored in the VSC100 controller. TABLE 8-7 provides the name and description of the RS-485 coils or registers stored in the VSC100 Public Table.

The settings/options chosen within the instruction depend on whether you are triggering a sample, checking to see if it is done sampling, or asking for the status values.

ModbusMaster(*ResultCode, ComPort, BaudRate, ModbusAddr, Function, Variable, Start, Length, Tries, TimeOut, [ModbusOption]***)**

This instruction collects the status values:

ModbusMaster(*MbResult(3),ComSDC7,38400,MBAddress,3,Sampler_status(), 23,4,3,100,0***)**

C.4.2.1 Modbus® Monitoring with Time-Based Configuration

```
'PVS5120/VSC100 program communicating via Modbus
'hardware includes MD485
'date: 2014-10-21

PreserveVariables

'Declare Public Variables
'The following two variables are used to convert the numeric error code value from the sampler
'to a text message.
Dim Response_List(9) As String
Public response_code_message As String
Public GetStatus As Boolean
Public MBAddress
Public Sampler_status(4)
'*** Status Values returned by the sampler once a sample is collected ****
Alias Sampler_status(1) = CurrentBottle 'Discrete distrubitor arm position
Alias Sampler_status(2) = SampleCount  'How many samples are currently in bottle
Alias Sampler_status(3) = ResponseCode 'Numeric response code
Alias Sampler_status(4) = SamplerBatt 'Sampler battery voltage (V)

Public MbResult'need a result variable for every Modbus instruction
'increment greater than zero to let you know if a communication does not occur

'Define tables
DataTable (SamplerStatus,True,-1) 'stores sampler status values
  Sample (1,CurrentBottle,FP2)
  Sample (1,SampleCount,FP2)
  Sample (1,ResponseCode,FP2)
  Sample (1,response_code_message,String)
  Sample (1,SamplerBatt,FP2)
EndTable

DataTable (ModbusErrors,true,-1) 'stores the Modbus errors
Sample (1,MbResult,FP2)
EndTable

'Main Program
BeginProg
  'The following text is associated with the numeric response codes provided
  'from the sampler after each attempted sample.
  Response_List(1) = "No error"
  Response_List(2) = "All samples complete"
  Response_List(3) = "Low start battery (V<11.0 V)"
  Response_List(4) = "Low run battery (V<10.5V)"
  Response_List(5) = "Sampler vacuum timed out, no sample detected"
  Response_List(6) = "Sample overflow detected"
  Response_List(7) = "No sample liquid detected"
  Response_List(8) = "Arm calibration error"
  Response_List(9) = "Conductivity rod and Sample tube are shorted"

  MBAddress = 1'This must also be set in DevConfig for each sampler.  The address must be unique if you are
'using multiple samplers.

  Scan (30,Sec,0,0)

    ModbusMaster (MbResult,ComSDC7,38400,MBAddress,3,Sampler_status(),23,4,3,100,0)
'reading actual status values
    response_code_message = Response_List(ResponseCode+1)
'adjust the numeric response code the to assigned message
    CallTable SamplerStatus
'send the sampler status to the table

  NextScan
EndProg
```

Appendix D. Replacement Parts

TABLE D-1. Replacement Parts	
Part Number	**Description**
15598	3V coin cell lithium battery CR2025
26895	Pump brush and wire repair kit
26896	9L nalgene bottle w.center plug
26898	3/8 in ID 3ft latex discharge tube
26899	3/8 in ID 3 ft silicone dischrge tube
26905	0.5 L pyrex meter chamber, 3/8 in system
32808	0.5 L acrylic meter chanber, 3/8 in system
26914	3/8 in system stainless steel sinker/strainer
26915	3/8 in system lead sinker
26925-L-	Sampler 3/8 inch PVC intake hose
27166	3/8 in ID PVC blue intake hose
27954	9 L bottle
6053	7 Ah battery
27825	External 12 Vdc charger, 4 pin
27891	Pinch valve solenoid 12 Vdc
27949	3/8 in system 25 ft intake tubing w/lead sinker
27952	0.5 L polypropylene wedge bottle
27953	1 L polypropylene wedge bottle
27954	9 L bottle, Nalgene HDPE
27955	20 L bottle, Nalgene HDPE
27956	10 L (2.5 G) glass bottle w/Teflon® cap
27957	1 L glass bottle w/Teflon® cap
27969	Hose clamp (for sampler end)
27997	Quick connect stainless steel body
27998	1/2 in quick connect stainless steel stem
28009	Large pump
28251	5/8 in silicone discharge tubing 1/16 in wall
28258	20 L (5.3 gal) Nalgene PP bottle

28287	Sampler 3/8 inch Teflon® distributor assembly
28296	Sampler 3/8 inch PVC distributor assembly
28333	12 Vdc, 1.4 CFM vacuum pump w/label
30641	24-position stepper motor
29735	100 to 240 Vac charger
29786	Standard pump
30144-L	PVS5120C/D water detection probe
30819	PVS5120 external battery cable, 6ft
30991	PVS5120 short volume control tube
PVS5120CBL-L	PVS5120 control cable
VSC100	Sampler controller

E-1

Appendix E. Lithium Battery Replacement

1. Remove the four Phillips screws from the VSC100 and separate top from bottom.

Phillips screws

2. Disconnect the 16-pin connector from bottom of the VSC100.

16 pin connector

3. Remove the eight Phillips screws from the bottom of the VSC100 and separate top from bottom. Use Loctite on the four outer screws on reassembly. (Phillips screws are circled below).

E-1

4. Remove these four Phillips screws from inside the VSC100.
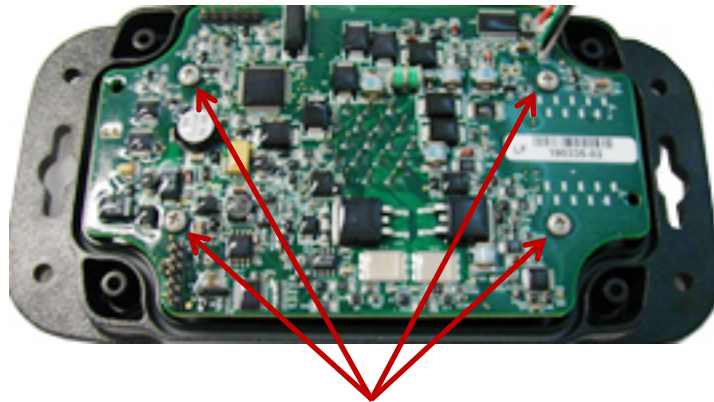
Phillips screws

5. Lift board out carefully and turn over. Be careful not to tear the wires connecting the board to the USB connector.

CAUTION When lifting the board, do not tear the wires that connect the board to the USB connector.

Wires connecting
USB connector
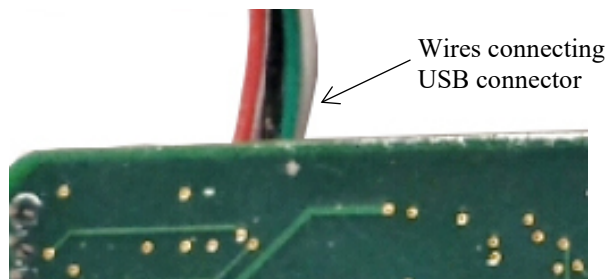
6. Replace with lithium battery, pn 15598 Lithium battery 3 V Coin Cell (CR2025).

Replacement 3 V
lithium battery
(pn 15598)
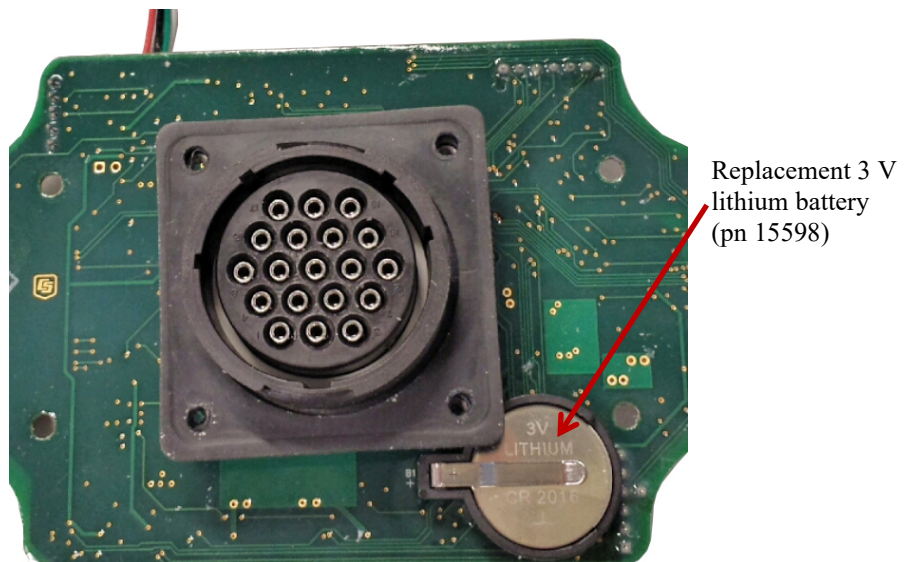
Appendix F. Response Code 4 Scenarios

A vacuum time out error (response code 4) is returned to the user as part of the sampler status values when the necessary volume of water does not enter the metering chamber and complete the circuit between the volume control tube and liquid sensing/conductivity rod. In other words, there is not enough water to complete the sample as the sampler is configured (volume depends on the setting of the volume control tube and conductivity rods).

As discussed in earlier sections, it is important to have at least half an inch height separation between the bottom of the volume control tube and the bottom of the conductivity rod. This offset is necessary because of the turbulent flow conditions as the sample enters the metering chamber. If the water supply's level varies and the water supply could dry up, we highly recommend using a water detection probe to check if enough water is available for the sample. Also, it may be necessary to increase the height difference between the bottoms of the two tubes in the metering chamber to more than an inch. The increased offset is necessary because the water is shot into the chamber under pressure as the sampler tries to vacuum up enough water to complete the circuit causing the water surface to jump.

Also, it is possible to overfill a bottle when a vacuum time out error occurs. See the scenario below.

Example 1: PVS5120D with 24 bottles and 25 ft of intake hose. It keeps 150 mL for each sample (bottom of the volume control tube is set at 150 mL within the metering chamber). Three samples are stored in each sample bottle for a total volume of 450 mL. The conductivity rod is set at 500 mL.

In this example, the sampler purges for 15 s. It then starts vacuuming the sample into the hose and metering chamber until it touches the conductivity rod (at the 500 mL line). Next the sampler purges the volume from 500 mL down to 150 mL, drops the 150 mL into the sample bottle and then purges the rest of the hose for 15 s.

The following status values are returned to the user in sampler attempt 1.

TABLE F-1. Status Value				
	Sample Attempt			
Status Value	1	2	3	4
Bottle #	1	1	1	1
Sample #	1	1	2	3
Response Code	0	4	0	0
Volume stored (mL)	150	$\leq$150	150	150

Response Code 0 = Successful Sample; Response Code 4 = Vacuum Time Out Error

On Sample Attempt 2, the sampler attempts to collect the 500 mL to close the circuit for two times the purge time. The sampler tries to collect 500 mL for 30 s. If enough liquid is still not available, the sampler purges to the level of the volume control tube (in this case 150 mL), and drops the sample into the bottle and returns a response code 4. The sample count does not increment because the sampler does not believe enough water entered the chamber to count as a successful sample. So the volume stored in the bottle for attempt #2 could be anywhere between 0 to 150 mL.

Sample Attempt 3 occurs whenever the next run condition is met (time interval or flow interval). Water enters the chamber, completes the circuit, and 150 mL are dropped into bottle one. A response code 0 is returned the sample count is incremented. Sample Attempt 4 is completed and the distributor arm will then advance to bottle 2.

When you go to the field and open up the sampler, bottle 1 can be between 450 to 600 mL; therefore, up to 100 mL are in the base of the sampler. Notice the total volume that was collected during the successful samples compared to what was actually deposited in the sample bottle. Since the conductivity rod is set at 500 mL, a total of 1500 mL was collected when the desired total amount was only 450 mL.

Example 2: Everything stays the same, but we lower the conductivity rod to just below the 300 mL line of the metering chamber. This lowers the bottom of the rod by roughly 3 inches. By lowering the rod, we may be able to completely prevent the vacuum time out errors because less water is necessary to complete the circuit.

Conclusion: It is important to balance the difference in rod height between turbulent flow and amount of volume collected. If you know your water source could go dry, the best plan is to use the water detection probe to check for enough water to collect a sample. Also, in the case of low water supply, consider how low the conductivity rod can be set and the length of your intake hose. Because the longer the hose and the higher the conductivity rod is set, a larger water volume is necessary for a successful sample regardless of how much water is actually deposited in a sample bottle.

Appendix G. Generic Modbus® Control

TABLE G-1 provides detailed Modbus® control information.

TABLE G-1. Detailed Modbus® Control Information

COILS

Item	Description	Read / Write	Function Code	Register Number	Modicon-Style Register Number
Start	Trigger sampler to take 1 sample	Read / Write	0x01,0x02,0x05	1	1 or 10001
Serviced	Reset sampler, resets distributor arm, sets Bottle=1 and Samples = 0	Read / Write	0x01,0x02,0x05	2	2 or 10002
AutoDeploy	Trigger sampler to initiate auto-deploy routine	Read / Write	0x01,0x02,0x05	3	3 or 10003

REGISTERS

Item	Description	Read / Write	Function Code	Register Numbers	Modicon Style Register Number Start	Data Format	Word Order
Bottles	Number of bottles in sampler	Read / Write	0x03,0x04,0x16	1 & 2	30001 & 30002	IEEE 754, 4-byte Floating Point	Low Order First (CDAB)
SampPerBottle	Number of samples to be put in each bottle	Read / Write	0x03,0x04,0x16	3 & 4	30003 & 30004	IEEE 754, 4-byte Floating Point	Low Order First (CDAB)
NeverFull		Read / Write	0x03,0x04,0x16	5 & 6	30005 & 30006	IEEE 754, 4-byte Floating Point	Low Order First (CDAB)
PurgeTime1		Read / Write	0x03,0x04,0x16	7 & 8	30007 & 30008	IEEE 754, 4-byte Floating Point	Low Order First (CDAB)
LevelSetTime	Time to purge sample down to level setting	Read / Write	0x03,0x04,0x16	9 & 10	30009 & 30010	IEEE 754, 4-byte Floating Point	Low Order First (CDAB)
DepositTime	Time to hold pinch value open	Read / Write	0x03,0x04,0x16	11 & 12	30011 & 30012	IEEE 754, 4-byte Floating Point	Low Order First (CDAB)
PurgeTime2		Read / Write	0x03,0x04,0x16	13 & 14	30013 & 30014	IEEE 754, 4-byte Floating Point	Low Order First (CDAB)
UsePurgeTime2		Read / Write	0x03,0x04,0x16	15 & 16	30015 & 30016	IEEE 754, 4-byte Floating Point	Low Order First (CDAB)
SetTimeOut		Read / Write	0x03,0x04,0x16	17 & 18	30017 & 30018	IEEE 754, 4-byte Floating Point	Low Order First (CDAB)
TimeOut		Read / Write	0x03,0x04,0x16	19 & 20	30019 & 30020	IEEE 754, 4-byte Floating Point	Low Order First (CDAB)
SamplerType		Read / Write	0x03,0x04,0x16	21 & 22	30021 & 30022	IEEE 754, 4-byte Floating Point	Low Order First (CDAB)
Bottle	Discrete sampler distributor arm position	Read Only	0x03,0x04	23 & 24	30023 & 30024	IEEE 754, 4-byte Floating Point	Low Order First (CDAB)
Samples	Number of samples in current bottle	Read Only	0x03,0x04	25 & 26	30025 & 30026	IEEE 754, 4-byte Floating Point	Low Order First (CDAB)
Response	Error Code	Read Only	0x03,0x04	27 & 28	30027 & 30028	IEEE 754, 4-byte Floating Point	Low Order First (CDAB)
Batt	Battery / supply voltage	Read Only	0x03,0x04	29 & 30	30029 & 30030	IEEE 754, 4-byte Floating Point	Low Order First (CDAB)

TABLE G-2. Simplified Modbus® Control						
				CRBasic ModbusMaster()		
Modbus Ctl	**Timed Ctl**	**Pulse Ctl**	**Coil**	**Function**	**Start**	**Length**
Start	Start	Start	00001	1 or 15	1	1
Serviced	Serviced	Serviced	00002	1 or 15	2	1
Auto Deploy	Auto Deploy	Auto Deploy	00003	1 or 15	3	1
			Register			
Bottles	Bottles	Bottles	40001 & 40002	3 or 16	1	1
SampPerBottle	SampPerBottle	SampPerBottle	40003 & 40004	3 or 16	3	1
NeverFull	NeverFull	NeverFull	40005 & 40006	3 or 16	5	1
PurgeTime1	StartHours	PurgeTime1	40007 & 40008	3 or 16	7	1
LevelSetTime	StartMins	LevelSetTime	40009 & 40010	3 or 16	9	1
DepositTime	StartSecs	DepositTime	40011 & 40012	3 or 16	11	1
PurgeTime2	StartDay	PurgeTime2	40013 & 40014	3 or 16	13	1
UsePurgeTime2	StartMonth	UsePurgeTime2	40015 & 40016	3 or 16	15	1
SetTimeOut	StartYear	StartPulses	40017 & 40018	3 or 16	17	1
TimeOut	IntHrs	UseNegPulse	40019 & 40020	3 or 16	19	1
SamplerType	IntMins	TotalPulses	40021 & 40022	3 or 16	21	1
Bottle	Bottle	Bottle	40023 & 40024	3	23	1
Samples	Samples	Samples	40025 & 40026	3	25	1
Response	Response	Response	40027 & 40028	3	27	1
Batt	Batt	Batt	40029 & 40030	3	29	1
*Registers 40001 to 40030 contain 15 values encoded as IEEE 754, 4-byte floating point (CDAB)						

Some Modbus® clients (masters) require the start address to be specified as base 1 while others require as base 0. For base 1 devices, set your starting address to the Register Number; for example, use a start of **23** when querying **Bottle**. For base 0 devices, set your starting address to the Register Address; for example, use a start of **22** when querying **Bottle**. Campbell Scientific dataloggers require the start to be specified as the **Register Number**.

All values contained in the registers are IEEE 754, 4-byte floating point numbers. This means that the values occupy two registers each, with each register holding 2 bytes. Data is transmitted with a swapped word order. This means that the low order word is transmitted on the wire first, followed by the high order word. The words (**registers**) use a big endian architecture. A common notation for this byte arrangement is "CDAB" where "CD" is the low-order word and "AB" is the high-order word.

Modbus Packet Example 1: Set "Start" Coil = ON
TX: 01 05 00 00 FF 00 {CRC}
RX: 01 05 00 00 FF 00 {CRC}

Modbus Packet Example 2: Read "Start" Coil
TX: 01 01 00 00 00 01 {CRC}
RX: 01 01 01 01 {CRC}, if "Start" coil is true, bit 0 = 1
or
RX: 01 01 01 00 {CRC}, if "Start" coil is false, bit 0 = 0

Modbus Packet Example 3: Set "SampPerBottle" Registers = 24.0 (0x 41 C0 00 00)
TX: 01 10 00 02 00 00 41 C0 {CRC}
RX: 01 10 00 02 00 02 {CRC}

Modbus Packet Example 4: Get "Bottle", "Sample", "Response", and "Batt" Registers
TX: 01 04 00 16 00 08 {CRC}
RX: 01 04 10 00003F80 00003F80 00000000 00004148 {CRC}

Appendix H. ISO5667 Conformity

The Campbell Scientific, Inc. Portable Vacuum Sampler 5120 (PVS5120) complies with the relevant sections of the ISO 5667-10 standard applicable to unrefrigerated portable water samplers. Individual statements from section 4.2.2 – Automatic Sampling Equipment are addressed below.

a. "Time-weighted composite samples"

   Possible with the PVS5120C.

b. "Discrete samples taken at fixed intervals, held in individual containers"

c. "Succession of short period composite samples being held in individual containers"

   Both of these are possible with the PVS5120D.

d. "Flow-weighted composite samples, i.e. taking variable volumes of sample depending on stream flow for a fixed period of time"

   This can NOT be done. The CSI sampler collects the same volume every time it samples.

e. "Flow-weighted samples held in individual bottles"

   PVS5120 can do this if a flow meter is connected to the sampler or the datalogger. You would collect a sample every X volume of water that passes the sampler. The sample will be the same volume every time.

f. "Ability of the sampler to lift samples through the required height for any chosen situation"

Pump	Maximum lift in meters at sea level (ft)
Standard	4.9 (16)
Large	8.2 (27)

   These values are dependent on age of the pump, vacuum seals, and battery condition. But for a new sampler/pump, the standards should be met.

k. "The sampling line from intake point to sample delivery point should have a minimum internal diameter of 9 mm to minimize clogging of the uptake line."

   Both the PVS5120C and D have an intake tube with an inner diameter of 9.5 mm (0.375 in). The volume control tube has an inner diameter of 10.9 mm (0.430 in).

l. "The intake liquid velocity should be a minimum of 0.5 m/s in order to prevent phase separation in the sampling line and measuring chamber."

TABLE A-1. Vertical Velocity at Sea Level									
System Size	**Height**								
	0 m (0 ft)	**1.5 m (5 ft)**	**3.1 m (10 ft)**	**4.6 m (15 ft)**	**5.5 m (18 ft)**	**6.1 m (20 ft)**	**6.7 m (22 ft)**	**7.6 m (25 ft)**	**8.2 m (27 ft)**
large pump	2.16 m/s (7.1 ft/s)	2.16 m/s (7.1 ft/s)	1.83 m/s (6 ft/s)	1.52 m/s (5 ft/s)	1.34 m/s (4.4 ft/s)	1.25 m/s (4.1 ft/s)	1.10 m/s (3.6 ft/s)	0.91 m/s (3 ft/s)	0.79 m/s (2.6 ft/s)
standard pump	1.55 m/s (5.1 ft/s)	1.43 m/s (4.7 ft/s)	1.10 m/s (3.6 ft/s)	0.82 m/s (2.7 ft/s)	0.49 m/s (1.6 ft/s)	0 m/s (0 ft/s)			

TABLE A-2. Horizontal Lift							
System Size	**Distance**						
	7.6 m (25 ft)	**15.2 m (50 ft)**	**22.9 m (75 ft)**	**30.5 m (100 ft)**	**53.3 m (175 ft)**	**61 m (200 ft)**	**76.2 m (250 ft)**
large pump	2.2 m/s (7.1 ft/s)	1.9 m/s (6.2 ft/s)	1.7 m/s (5.6 ft/s)	1.5 m/s (5 ft/s)	1.2 m/s (4 ft/s)	1.1 m/s (3.7 ft/s)	0.8 m/s (2.6 ft/s)
standard pump	1.6 m/s (5.1 ft/s)	1.4 m/s (4.7 ft/s)	1.28 m/s (4.2 ft/s)	1.25 m/s (4.1 ft/s)	1 m/s (3.4 ft/s)	0.9 m/s (3.1 ft/s)	0.7 m/s (2.3 ft/s)

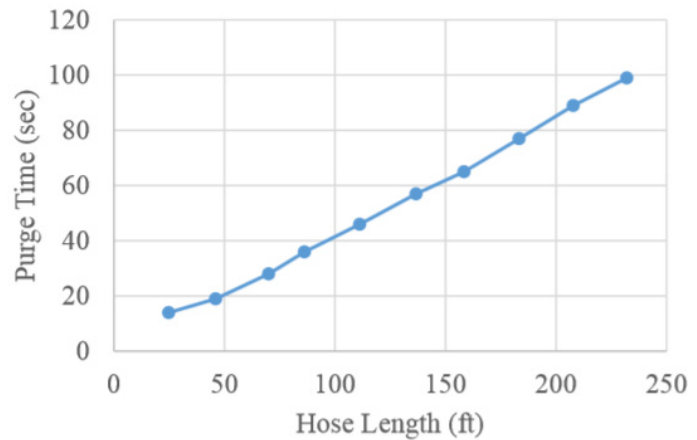m. "Ability to purge sampling lines to receive fresh sample."

FIGURE 8-2. Purge time as a function of hose length

n. "The precision and accuracy of delivered volumes should be at least 5% of the intended volume."

> *The amount of water taken is set mechanically using the liquid sensing rod and the volume control tube, which means sample accuracy is precise every time, usually within ±2% or ±2 mL. Sample accuracy increases when you have set the volume control rod and tested the collected sample at setup.*

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.

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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.

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