VC^{3}8 System

INSTRUCTION MANUAL

Valve Commander

Ver. February 2014

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Introduction

ALA Scientific Instruments has been a leading manufacturer of systems for perfusion and solution exchange for many years. Our systems are designed to meet the demands of our many customers and are configured to insure maximal reliability and flexibility. Whether your experiments simply require constant application of solution to maintain the viability of your preparation or whether you require sub-millisecond solution exchanges to examine the kinetics of single-channel openings of ligand-gated channels, we have a system that will work for you.

Our VC^3 systems incorporate the following options:

a) Control of valve opening from a manual switch, a TTL signal or an analog signal.

b) Valve type options. Fast solenoid valves (custom Lee Co. valves) offer opening and closing with minimal disturbances in fluid flow. Solenoid valves also offer openings and closings at millisecond time scales. Pinch valves are essentially maintenance free and are less expensive, but open and close more slowly and introduce a small pulse into the fluid stream.

c) Low voltage circuit that will drop the valve voltage after opening. This option is for researchers who are concerned about the transmission of heat to solutions from the warming of valves).

d) Solution delivery controlled by gravity (lower cost, requiring manual manipulations to control flow) rate or gas pressure (higher cost, facilitating removal of bubbles and offering flow rate control by turning a dial).

e) A wide variety of outlet manifolds.

In addition, we manufacture other components that may be helpful in configuring your system, including temperature control systems for heating and cooling VC^3 output, chambers with gas ports for oxygenation of preparations.

If you have any questions about your system or would like further information, please do not hesitate to contact us at any time. We welcome suggestions from customers and often incorporate them into new designs.

VC³ Controller

Control Box – Front Membrane Panel
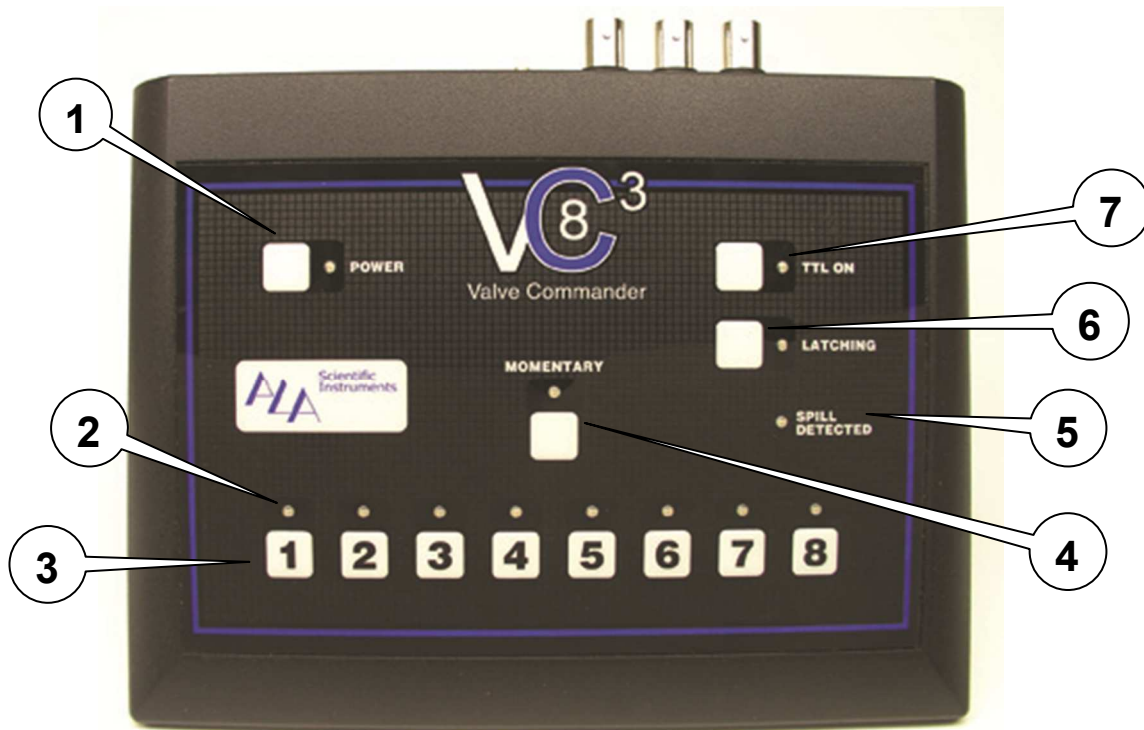
VC³8 Control Front Panel

1. **Soft Power Button with LED -** Green LED indicates when system is powered. It is also used to reset the spill sensor alarm.

2. **Channel LED -** Above each Valve button is a green LED that indicates when the power to that particular valve is ON.

3. **Valve Switches** - membrane switch (channels 1-8) for valve activation. Default valve switch setting is ON-OFF.

4. **MOMENTARY** - Sets all Valve switches to "MOMENTARY ON" switches.

5. **SPILL DETECTED indicator-** LED will light when a spill is detected by the spill sensor cable connected to the rear of the controller.

6. **LATCHING** - Sets the controller to operate in Latching mode. When active the valve that is ON will be switched OFF when any other valve is switched ON.

7. **TTL ON** - Sets the controller to accept TTL pulses to control valves via the Digital I/O port on the controller rear panel.

Control Box – Rear panel

VC³ Control Rear Panel
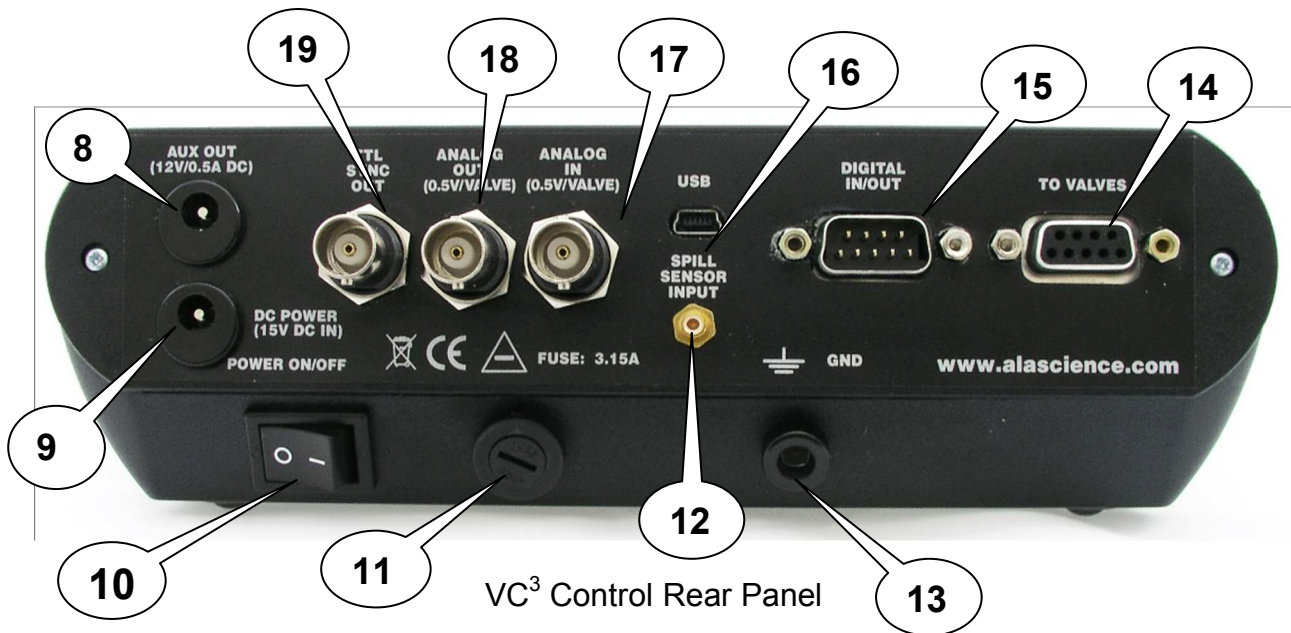
8. AUX OUT 12V DC- Port for additional 12V dc valve connection. Positive center pin.

9. DC Power Input - 15VDC @ 3.3A.

10. Power Switch - Main power switch to turns VC³ controller ON/OFF.

11. FUSE - Controller fuse. 3.15A 250 V Fast Blow 5x20mm fuse.

12. SPILL SENSOR INPUT – Connector for the spill sensor cable.

13. GND - Port (banana jack) to connect controller to ground**.**

14. TO VALVES - DB-9 FEMALE connector to connect controller to valve manifold.

15. DIGITAL INPUT - DB-9 MALE connector for TTL input control of valve channel 1-8 via DB-9 to BNC breakout cable.

16. USB – port to connect controller to PC via USB cable.

17. ANALOG IN - BNC connector to control valves via an analog voltage input in 0.5 V steps with a +/-100mv threshold.

18. ANALOG OUT - BNC connector that outputs an analog voltage in 0.5 V/ valve steps.

19. TTL SYNC OUT - BNC connector that outputs a TTL high signal whenever a valve is ON.

VC³8 Controller Instructions

Power Buttons

The VC³ valve controller has two power switches. The main power is located on the rear of the unit. This rocker switch will turn input power ON or OFF to the system.

The other power switch is a soft power button located on the membrane panel. This switch serves a dual purpose. First it is used to turn power ON or OFF to the membrane panel controls. Secondly it is used as a reset button for the spill sensor. When the spill alarm is activated, press the soft power button to reset it. Activating the soft power button will also calibrate the spill sensor to its new capacitive value. (Sensor should be cleaned and dried before calibration)

Valve Control Modes

The VC³8 is an eight-channel 12V DC valve controller. The control box has a membrane panel with pushbutton switches to control the valves and other functions. The controller is designed to control in one of three ways, Manual switch, TTL input or Analog input. The controller can also be enabled to control latching valves.

The VC³ is designed with Low voltage circuitry that will automatically drop the valve voltage after opening the valve. This option is for researchers who are concerned about the transmission of heat to solutions from the warming of valves.

Manual ON/OFF Control:

Manually each valve is controlled by an individual membrane panel switch. Each switch is numbered, 1 through 8, corresponding to each valve. Press the membrane switch once to energize "turn ON" the corresponding valve. The valve will remain on until the membrane switch is pressed again. Press the membrane switch again to de-energize, "turn OFF", the valve. A green LED will indicate when a switch is ON.

The controller is able to activate all eight valves at the same time. This aids in flushing out the reservoirs during a cleaning procedure. It is not recommended to activate more than one valve at a time during an experiment since solution mixing cannot be measured accurately.

Manual MOMENTARY Control:

To enable the membrane switches to act as momentary switches press the "MOMENTARY" button on the controller. A green LED will indicate the momentary setting is enabled. In the momentary mode you must press and hold down the membrane switch to energize, turn ON, a valve. As long as you hold down the switch the valve remains ON. Release the switch and the valve turns OFF.

TTL Mode Control:

The VC^{3}8 controller has a digital I/O port to enable valve control via TTL signals. This port allows you to control each valve using a single TTL "high" signal. To enable this feature press the TTL ON button on the front panel. A green LED will indicate the TTL mode is enabled. The digital I/O port is a DB-9 Male connector on the rear of the controller.

The optional DB-9M to BNC breakout cable, allows the VC^3 to be controlled by most acquisitions systems' digital outputs.

Multiple valve control is possible by using this port. This is useful when priming the system reservoirs and when running a cleaning procedure.

ANALOG Voltage Control:

A BNC connector is used to input an analog voltage to control the valves. An analog voltage from 0.5V to 4.0 V dc in 0.5V steps will control valves 1-8, respectively. There is a +/-100mV threshold.

To operate in this mode, the "MOMENTARY" mode switch must first be enabled. Connect the ANALOG IN port to your acquisition system analog out port via a BNC male cable to control all valves.

Latching Valves Control:

The VC^{3}4 controller can be set to latching mode. By pressing the "LATCHING" button on the controller the green led will indicate that the controller is in latching valve mode.

When active the valve that is switched ON will be switched OFF when any other valve is switched ON. Only one valve can be ON at a time in this mode. This feature allows for fast manual solution switching by eliminating the need to switch a valve OFF before switching another ON.

TTL SYNC OUT:

The sync out BNC port can be used as either a TTL marker or to sync (trigger) the controller to another device.

A TTL high (+5V) signal is output whenever a valve is turned ON (energized).

ANALOG Voltage Control:

As stated above (Control Modes section), this feature allows for the control of valves via an analog input. A BNC connector is used to input an analog voltage to control the valves. An analog voltage from 0.5V to 4.0 V dc in 0.5V steps will control valves 1-8, respectively. There is a +/-100mV threshold.

To operate in this mode, the "MOMENTARY" mode switch must first be enabled. Connect the "ANALOG IN" port to your acquisition system analog out port via a BNC male cable to control all valves.

ANALOG OUT:

BNC connector is used to output an analog voltage to representing a valve opening. An analog voltage from 0.5V to 4.0 V in 0.5V steps represents valves 1-8, respectively.

AUX OUT:

The AUX OUT port outputs 12V dc whenever any valve is turned ON. This port can be used to connect an additional 12V dc valve. Center pin on the connector is positive (+).

USB:

The USB connector is used to connect the VC^3 controller to a computer. This port is used for programming and maintenance at the factory only.

DIGITAL IN:

The digital input is used to control the valves via a TTL signal. The DB-9 male connector pins 1-8 is used to input TTL signals to valves 1-8, respectively, with pin 9 being common ground.

An optional DB-9F to 8BNC breakout cable can be used to connect the VC^3 to an acquisition systems digital output.

TO VALVES:

This DB-9 Female port is used to connect the controller to the valve manifold (VM-8).

A DB-9M/M cable is supplied with the VC^3 perfusion system. Pins 1-8 correspond to valves 1-8, respectively. Pin 9 is the common +12 V DC.

DC POWER:

The DC power jack is the main power input to connect the universal 15V DC power supply supplied with the VC^3 system.

POWER ON/OFF:

Power ON/OFF switch will turn the main power to the controller ON or OFF.

GND:

The VC^3 controller can be connected to ground via a banana jack on the rear panel.

FUSE:

The VC^3 fuse holder is located on the rear panel and uses 5x20mm fuses. The rated value for the VC^3 controller is a 250V 3.15A fuse.

Replace fuse by using a straight edge screw driver to twist off fuse holder cap. Use fuse of stated rated value only.

SPILL SENSOR INPUT:

The VC^3 has been designed with a built in spill sensor. This feature will allow for the protection against overflows from chamber or dishes onto expensive optics or electronics.

To use this feature simply connect the spill sensor cable supplied with the VC^3 system to this port. Place the sensor wire around the area you wish to protect from liquid spills and turn ON the controller

The VC^3 controller auto calibrates the spill sensor every time it is turned ON. Therefore, it is important that the spill sensor cable be connected before the controller is turned ON.

If a spill occurs the sensor will detect it and two things will happen.
1) There will be a soft power shut down. This means power to the valves will be cut off. The main power will still be ON.
2) An audible and visual alarm will be activated. The audible alarm will be a chirping sound. The visual alarm is a red LED on the controller will blink repeatedly.

To reset the system after a spill

After a spill the alarm will sound and power will be cut to the valves. Follow the procedure below to reset the controller:

1) Press the Soft power switch on the controller panel. This will turn the alarm off.
2) Turn OFF main power on rear of controller.
3) Remove spill sensor cable from controller.
4) It is important to carefully clean and dry the sensor wire after a spill. Depending on what was spilled on the sensor, use distilled water to wash off any solution on the sensor. Carefully dry the sensor with an absorbent towel (paper towel).
5) Once dry replace spill sensor cable on the controller.
6) Turn main power ON from rear of controller.
7) Turn soft power switch ON from controller membrane power.
8) Controller will calibrate itself to the spill sensor cable.
9) System is now ready to be used again.

It is sometimes necessary to turn soft power OFF and ON after following above procedure for the system to calibrate.

VC³8 Perfusion System Components
## Reservoir Bracket

A separate reservoir bracket, as shown above, is supplied for the VC³8-PG and VC³8-SG gravity driven systems. This is necessary so as to be able to adjust the height of the reservoirs to attain faster or slower flow rates. A second extension rod is also supplied to be able to place the reservoir bracket even higher. The standard reservoirs supplied for the gravity systems are 60ml. Other sizes are also available.

Standard reservoirs for the VC³8-PP and VC³8-SP pressure systems are 5ml. These are mounted directly on the valve manifold box (see valve manifold section). Unlike the reservoirs supplied with the gravity systems, these reservoirs are modified with custom plugs, which allows for the   introduction of positive pressure into the reservoir. The 8 reservoirs are inter-connected with tubing (pressure manifold) having a single input pressure port. Also available are 10ml and 60ml pressurizing reservoirs.

Valve Manifolds

All **VC³8-xx** systems come with a valve manifold. The valve manifold is a metal box that houses the valves, circuit board and all cables and connectors needed to control the valves. The manifold serves both to esthetically house the valves as well as protect the electronics from liquid spills. The type of valve manifold used depends upon the customer's needs. As with all of ALA Scientific Instruments' perfusion systems, the VC³8 systems are also fully configurable.
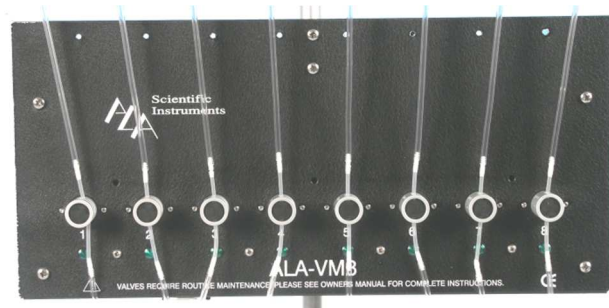
The following are some of the choices available:

- Pinch or wetted valves
- Pressure or gravity driven
- Size of reservoirs (1, 5, 10 or 60mL)
- Type of front end (MMF, MLF QMM)

Two types of valves are available for use in our valve manifolds, 12 Volt dc pinch solenoid valves and 12 Volt dc wetted solenoid valves.

Pinch Valves:

The pinch valves used are 3-way. This allows the use of either the normally open (NO) or normally closed (NC) port as the default state for the perfusion system. The advantage is for customers that perfuse for extended periods of time. Pinch valves tend to heat up when energized for extended periods of time. This heat can then be transferred to the solution passing through the silicone tubing, which in some cases can ruin the experiment. To avoid this, the VC^38-PG and VC^38-PP system valve or valves can be set to the N.O. state by inserting the silicone tubing supplied into the N.O. port. The solution will flow until the valve is energized. For applications where short bursts of perfusive are used, the N.C. state is used. In this state, solution will flow only when the valve is energized.

Note: pinch valves require silicone tubing in the N.C. port to act as a spring to help the valve pinch mechanism function properly.

2-way solenoid (*Wetted*) Valves:

The 2-way (wetted) 12 volt solenoid valves used in the VC^38-SG and the VC^38-SP systems are custom made for ALA Scientific by the Lee Co. These valves are built with as inert materials as possible inside the valve. These valves are generally used when fast applications (<10ms rise times) are required. Since the solutions are in contact with the inside of the valve, the valve requires more maintenance than the pinch valves (see Valve Maintenance section).
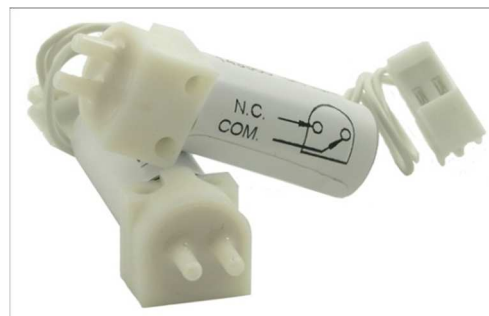
Gravity or Pressure Driven:

The option to have the VC^38 system be pressure or gravity driven depends upon the application. For perfusion of bath, recording chamber, tissue slice, or clusters of cells, the valve manifold can be configured to be gravity driven. Gravity systems use larger ID tubing to deliver the solutions over a larger area. If focal perfusion is required, such as for single cell, patch on a slice perfusion, then a pressure driven valve manifold is used. For focal delivery of solutions we need to use small ID tubing, generally 100 to 500 micron ID. This small ID tubing requires pressure to push the solutions through.

The VC^38-PG (Pinch valves) and VC^38-SG (wetted valves) are configured to be gravity driven. In a typical VC^38 gravity system the reservoirs used are 60ml. The reservoirs are mounted on the reservoir bracket above the valve manifold. This bracket is then lowered or raised a distance from the valves to create more or less of a flow rate.

The VC^{3}8-PP and VC^{3}8-SP use valve manifolds that are configured to be pressure driven. These manifolds typically come with 5ml reservoirs (10&60ml also available). The 5ml reservoirs are mounted directly on the valve manifolds' front panel (see picture on right). The reservoirs are inter-connected to a common pressure input tube. The input pressure must be regulated not to exceed 30PSI.
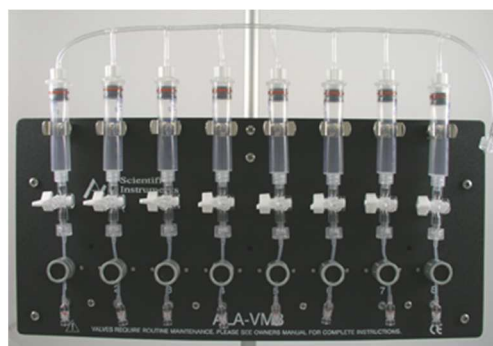
VC^{3}8-SP   **VC^{3}8-PP**

Since there are a number of possible front-end manifolds and tubing choices, both the VC^{3}8-PP and the VC^{3}8-SP systems are sold configured up to the valve inputs. This allows the user to connect the valve outputs to their choice of front-end tubing and manifold. The user also has the option to include one of our focal perfusion manifolds and accessories in their order (see the options section).
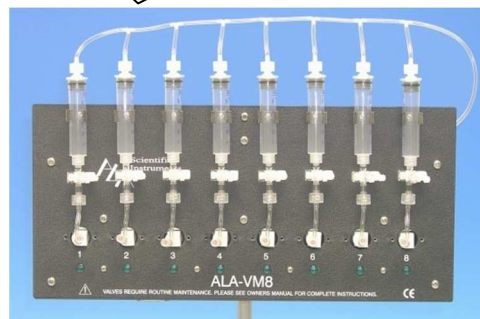
Reservoirs:

All VC^{3}8 systems can be configured to use different reservoir sizes. The default size for gravity systems is 60ml and for pressure systems 5ml. The gravity system reservoirs are standard luer lock syringes. The reservoirs for the pressure systems are syringes that are fitted with custom plugs to allow pressurization.


Front-end manifolds:

All VC^{3}8 gravity systems include a MMF-8 (8 to 1 channel Minimanifold) and tubing. The MMF-8 has barbs for use with 1/16" id pvc tubing.

As stated earlier, the VC^{3}8 pressure systems are configured up to the valve input. The VC^{3}8 pressure systems do not include focal perfusion manifolds. This allows the systems to be more configurable to the users needs. ALA Scientific focal perfusion manifolds include the Micromanifold® and the Millimanifold™. For more information on the manifolds, go to the optional accessories section.

DB-9M to BNC Breakout cable:

The TTL valve control feature uses aDB-9Female connector as its input. To facilitate connection to the digital outputs of an acquisition system the **DB9BNC8** cable can be used. **(Optional)**
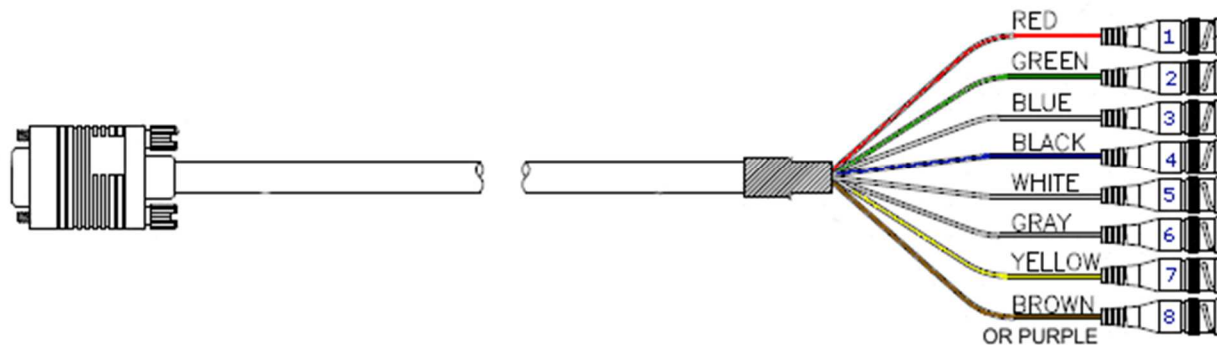
Cable is color coded according to above image. Red corresponds to valve1, green to valve 2 and so forth. Connect the DB-9Female connector to the rear of the VC^38 controller. Connect the BNC 's to the digital outputs of your acquisition system.

Assembly Instructions

Gravity systems

Below are the instructions for assembling the VC^3-8PG and VC^3-8SG systems.

1. Screw one of the aluminum rods into the magnetic base.
2. Secure the magnetic base to a plate.
3. Mount the valve manifold box. Place the valve box over the rod inserting the rod through hole in the holder that is attached to the valve box. Secure the valve box to the rod by tightening the red cap (thumb) screws.
4. Attach the second aluminum rod to the first rod.
5. Mount the reservoir bracket. Place the bracket over the rod and insert it into the holder located on the back of the bracket. Secure the bracket by tightening the red cap (thumb) screws.
6. Mount the 8 reservoirs (60 ml syringe) to the reservoir bracket by placing each syringe into a silver clip.
7. Attach tubing assembly to the reservoirs by connecting the female luer fitting on the tubing to the male fitting of the syringe.
8. Raise the reservoir bracket (loosen the red thumb screws) so that the silicone tubing on the tubing assembly is at the same height as the valves.

For pinch valves go to step 9.   For wetted solenoid valves go to step 10.

9. Place silicone tubing into N.C. port (rear port) of the pinch valve. Push the front of the valve to manually open/close valve. This allows for easy insertion of silicone tubing. Go to step 14.

10. Remove silicone tubing with white fittings from tubing assembly.
11. Remove red caps from valve ports.
12. Insert pvc tubing coming from the reservoir to the input port (top) of the valve.
13. Insert pvc tubing coming from the front-end manifold to the output port (bottom) of the valve.
14. Connect the control box to valve box via the DB-9Male serial cable.
15. Connect 15V power supply to the control box
16. Connect 15V power supply to wall outlet using power cord.
17. Turn ON main power on control box by flipping rocker switch on the rear of the control box.
18. Press the soft power button on the control membrane panel. Green LED will light.
19. Your system is ready for manual use. Press membrane panel switches on top of the control box to open/close valves.

To digitally control the valves you will need to use our DB-9F to 4/8BNC breakout cable. Connect the DB-9F to the VC^3's digital I/O port and the BNC connectors your data acquisition system TTL outputs (digital). Follow the steps on your data acquisition system to set up digital pulses.

Pressure systems

Below are the instructions for assembling the VC^3-8PP and VC^3-8SP systems.

1. Screw the aluminum rod into the magnetic base.
2. Secure the magnetic base to a metallic plate.
3. Mount the valve manifold box. Place the valve box over the rod inserting the rod through hole in the holder that is attached to the valve box. Secure the valve box to the rod by tightening the red (thumb) screws.

Systems with 5ml reservoirs go to step 4, 10 ml and 60 ml reservoirs go to step 5

4. Systems with 5ml reservoirs have the reservoirs mounted directly on the valve manifold and already connected to the valve. Go to step 6.
5. Mount the pressurized reservoir bracket on the rod above the valve manifold. Place the bracket over the rod and insert it into the holder located on the back of the bracket. Secure the bracket by tightening the red (thumb) screws.

For pinch valves go to step 6.   For wetted solenoid valves go to step 7.

6. Attach tubing assembly from each reservoir to its corresponding pinch valve. Place silicone tubing into N.C. port (rear port) of the pinch valve. Push the front of the valve to manually open/close valve. This allows for easy insertion of silicone tubing. *Go to step 8.*
7. Remove red caps from valve ports.
8. Insert pvc tubing coming from the reservoir to the input port (top) of the valve.
9. At this point you can connect your own perfusion manifold (front-end) to the output port of the valve or use the 8 channel Minimanifold™ provided. If you purchased the system with a miniaturized output (Micromanifold®/Millimanifold™ and Teflon® tubing) go to options section in this manual for instructions.
10. Connect the control box to valve box via the DB-9male serial cable.
11. Connect 15V power supply to the control box
12. Connect 15V power supply to wall outlet using power cord.
13. Turn ON main power on control box by flipping rocker switch on the rear of the control box.
14. Press the soft power button on the control membrane panel. Green LED will light.
15. Your system is ready for manual use. Press membrane panel switches on top of the control box to open/close valves.

To digitally control the valves you will need to use our DB-9F to 4/8BNC breakout cable. Connect the DB-9F to the VC^3's digital I/O port and the BNC connectors your data acquisition system TTL outputs (digital). Follow the steps on your data acquisition system to set up digital pulses.

Experimental setup - Solution Delivery
Overview

Eight syringes are supplied as reservoirs for the application of solutions. 60ml syringes are standard on the gravity systems (Other size reservoirs can easily be connected). Each reservoir is suspended by a metal clip and attached the valve manifold box or to a bracket. The height of the valve manifold and bracket can be adjusted along the shaft using the slide clamp if necessary. This valve/reservoir assembly is supported with a magnetic base, which should be locked to a ferrous steel surface.

The VC^{3}8 system utilizes valves for fluid control. Pinch valves can be expected to open in 15 to 20msec after triggering while regular two-way "wetted" solenoid valves can open in 7 to 10msec. The valve either releases or restricts flow of the solution in the reservoir.

Gravity Driven System:

If you received a gravity driven VC^3 system follow the assembly instructions above for "gravity system". In a gravity system, the flow rate is determined by the height of the reservoirs from the output. The height of the bracket can be adjusted along the shaft using the slide clamp in order to adjust the flow due to gravity. The height of the reservoirs can also be fine adjusted individually by raising or lowering each one in its metal clip. Raising the reservoirs increases flow rate while lowering decreases the flow rate.

Note: pinch valves require silicone tubing in the N.C. port to act as a spring to help the valve pinch mechanism function properly.

The VC^{3}8 directs the fluid through the valve to a front-end manifold. In a standard VC^{3}8 gravity system the fluid is directed to the MMF-8, which is comprised of two, four-way "Minimanifolds" and then is brought to a single output. The Minimanifold™ is the zone of convergence of all the fluids. In each Minimanifold™, four fluids enter a space at diametrically opposing positions and then flow out a single output. The two outputs are tied together to one localized port. All tubing leading to and from the Minimanifold™ has the same 1/16" inner diameter. The space inside this convergence zone and the additional length of tubing that the fluid must pass through to reach the output is referred to as the "dead" volume or flush space. The "dead" volume of each Minimanifold™ is about 100µl.

Pressure Driven System:

In a pressure driven system reservoirs remain at a constant height. The reservoirs are inter-connected together with tubing having a common input for positive pressure. It is this positive pressure, when the valve opens that forces the solution through the valve to the front-end manifold. To control flow rates in this type of system, it is necessary to be able to regulate the input pressure. The input pressure should not exceed 30PSI when using LFAA "wetted" solenoid valves or you may damage the valve.

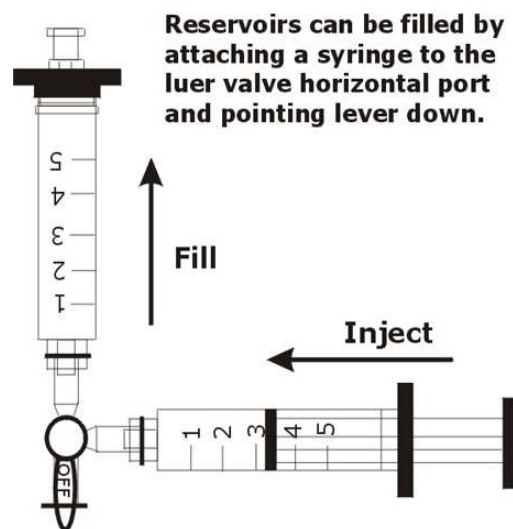# Daily Usage

Getting the VC^3 ready for an experiment

Whether you system is gravity or pressure driven the priming procedure is basically the same for both. Both systems as stated previously are comprised of 8 reservoirs and 8 valves and the tubing connecting them. When preparing to prime the system the, start by powering up the VC^3 controller.

For a pressure driven system, make certain that your source of positive pressure is working and hooked up to the valve manifold.

Once your system is fully assembled and you are ready to start perfusion do a final check. First make sure that the valve manifold is close enough to your setup to allow the front-end manifold to reach. Second, it is a good idea to ground the VC^{3}8 system to your set-up ground. The grounding connector (banana jack) on the rear of the control box can be used to secure a wire between the VC^{3}8 and your set-up ground.

Filling the Reservoirs

Fill each reservoir by using a syringe with a luer-lock tip. Lock the filling syringe onto the luer stop-cock of the particular reservoir that you want to fill. Twist the filling syringe to lock it in place. Move the lever on the stop-cock down, depress the syringe and fill the reservoir. Do not fill it to the air input port, leave a little space. When the reservoir is filled, return the lever of the stop-cock to horizontal and remove the syringe. **Never try to fill a reservoir when the valve is open and pressure is being applied!** Move onto the next solution and continue until they are all filled.

Reservoirs can be filled by attaching a syringe to the luer valve horizontal port and pointing lever down.

Fill

Inject

Important notes: **All tubes must be filled for the unit to operate properly. This means that all reservoirs must be filled and each tube primed and free of air bubbles. Tubes not being utilized can be filled with distilled water.**

When filling the the resevoirs it is best to use solutions that have been de-gassed. Warm the solutions to a few degrees above room temperature or above the temperature at which they will be applied. Solutions that are not de-gassed run the risk of releasing air bubbles during the experiment as they pass through the small tubes. Solutions should always be filtered before being added to the system.

For pressure systems, check that at least 4 psi (~200mm/Hg) has been set as the pressure for each reservoir (This is the minimum pressure needed for priming the system, more pressure may be desirable.).

Priming the system

Whether you system is gravity or pressure driven the priming procedure is basically the same for both. Both systems as stated previously are comprised of 8 reservoirs and 8 valves and the tubing connecting them. When priming the system the following procedure is recommended.

1) All tubing must be the same length to be sure that all fluids flow at the same rate.
2) Fill all reservoirs with your experimental solutions. Use distilled water if necessary to fill unused reservoirs. Preheat solutions when possible to minimize air bubbles.
3) It is important to also fill all the tubing from each reservoir all the way down to the tip of the front-end manifold. Air in the system causes compliance which will degrade performance. Not filling certain channels can cause solutions to back up into these unfilled channels during an experiment.

   For Gravity systems:
   a. Open the valves below each reservoir and observe the solution flow down and fill each line. Shut valve off once line is filled.
   b. Air bubbles are generally not a concern with gravity systems since the size of the delivery tubing is of a large ID. However, if there are bubbles in the line flush out that line until bubble is out. This is most important in any unused line that has distilled water because an air bubble contract when under pressure and expand when with no pressure resulting in leaking.
   c. The system is now ready to be use for perfusion.

   For Pressure systems:

   a. Connect pressure source to valve manifold.
   b. Set pressure regulator to approximately 3-5 PSI. This is only for priming. Higher pressure may be used to fill lines faster.
   c. Open the valves below each reservoir and observe the solution flow down and fill each line. Take care to catch solution when it comes out the front end manifold. Use paper towel to absorb solution.
   d. Shut valve off once line is filled.
   e. Check lines for air bubbles in flow path.
   f. If bubbles are present open the line until all air bubbles are out.
   g. When all lines are filled and bubble free, the system is ready to use.

4) Attach the front end manifold to your holder (manipulator) and set it to point to the target of the perfusion solutions.
5) The system is ready.

Running the VC^3 perfusion system

Depending on which mode of valve control you chose to use, solutions will be delivered to the target whenever a valve is energized. By pressing any of the valve switches on the membrane panel (1-8) solution can be delivered to your target and stopped again manually. TTL and analog voltage protocols can be written in your acquisition system software for automated valve control.

It is very important that maintenance is performed on all parts that are exposed to solutions. Flush out entire system when experiment is done (see Maintenance section). When using focal front-ends that have µm ID openings, proper cleaning will increase life span and minimize clogging.

VC³ Software
Software Installation

The VC³ perfusion system can be controlled manually, by an analog signal, TTL signal or via the USB port from a PC. To control the VC³ via software you must first install the VC³ program provided with the system on a CD. The following steps should be followed:

1. Place the VC³ CD supplied into the PC CD/DVD player.
2. Go to the 'My Computer' and open the CD/DVD device. The VC³ files will be displayed. Select the operating system folder for your PC.
3. Run the Setup.exe file to load the VC³ program. Follow the instructions provided.

     a. A window will appear informing you that the VC³ software is preparing to be installed. You can now cancel the installation or proceed with the installation.

        Press **Next**
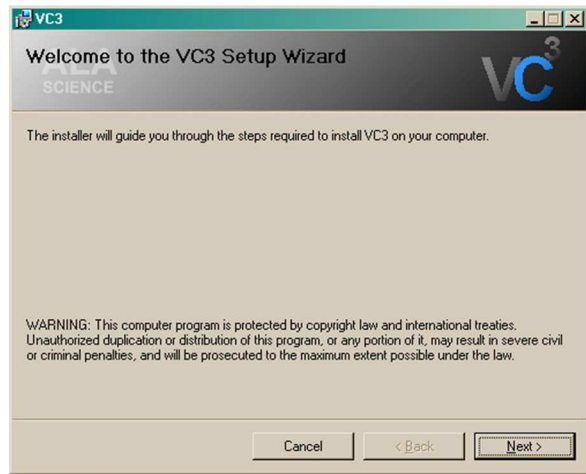
     b. Select the shortcuts wanted by checking the box in front of the option.

        Press **Next**
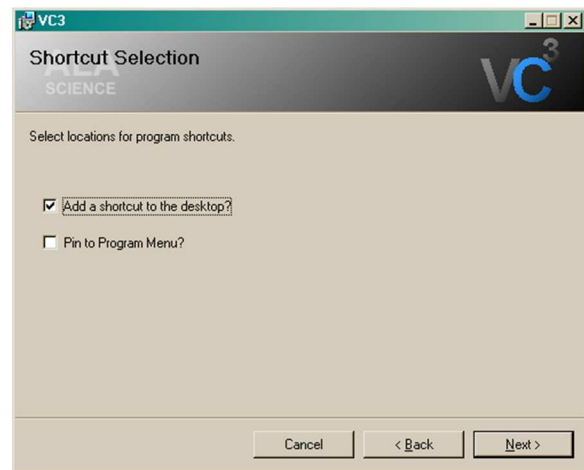
c. Select the installation folder where the VC^3 software will be installed to by using the browse button.The default folder is , **C:\Program Files\ALA Science\VC3**

Assign who can use the VC^3 program on this PC by selecting **Everyone** or **Just me**.

Press **Next**
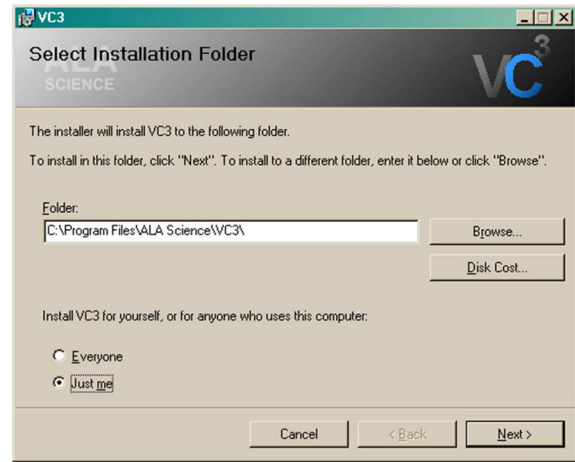
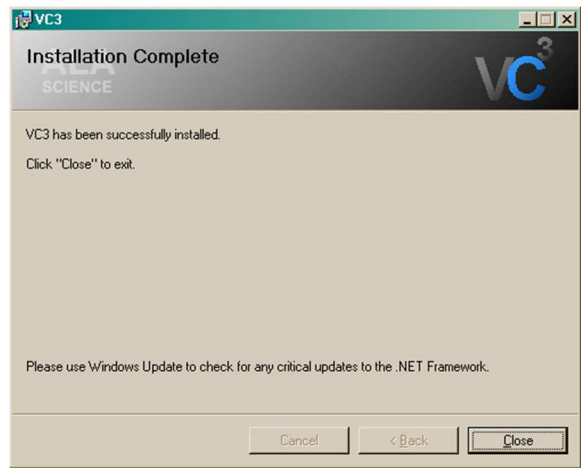d. The VC^3 software is now ready to be installed.

Press **Next**
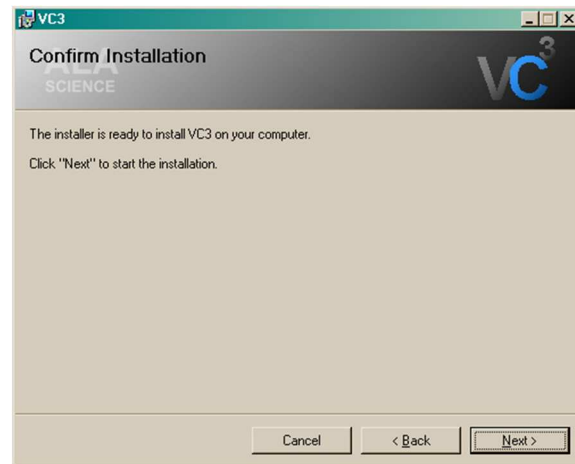
e. The VC^3 software is being installed to the computer.
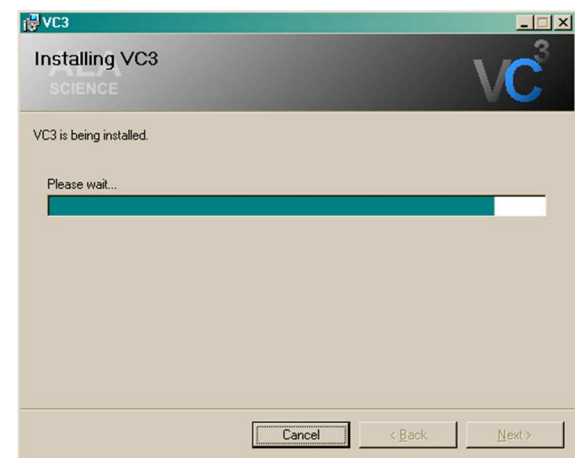
f. The VC^3 software installation is complete.

Press **Close**

The VC^3 program is now ready to be used.

g. Before proceeding any further, the VC^3 controller must be connected to the PC via the USB cable supplied. The VC^3 system should be ready for use after following the instructions in the System Assembly section of this manual.

Turn on the VC^3 controller main power on the rear of the unit.

If this is the first time installing the VC^3 software the computer will detect new hardware connected to it.

Go to the **USB Driver Installation** section and follow the instructions to install the new hardware drivers.

h. After the USB driver is installed the VC^3 system is ready to be controlled via the computer software. Go to the **Running the VC^3 Software** section for instructions.

VC³ USB Driver Installation

1. When you turn ON the VC³ controller a message will appear at the bottom right corner of your screen. This message indicates that the PC has detected a new piece of hardware.

2. The Windows Hardware wizard will appear. It gives several options to detect the software drivers for the new hardware detected.

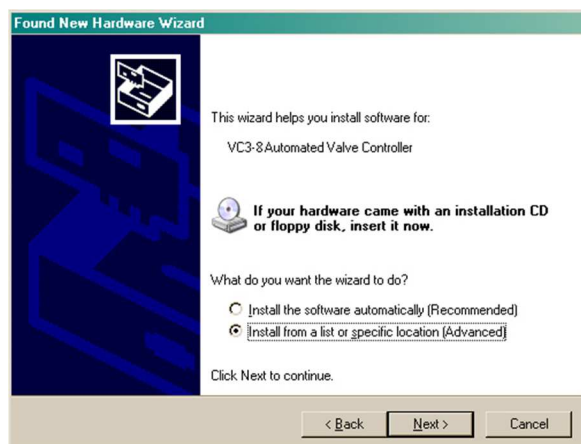   Select the last option.
   No, not at this time

   Press *Next*

3. The Hardware Wizard will identify the new hardware; VC3-4 automated Valve Controller, and will install the drivers for it.

   Select the second option,
   Install from a list or specific location (Advanced)

   Press *Next*

4. The Wizard will now search for the drive at a specific location on your PC hard drive.

   Select the first option,
   Search for the best driver in these locations
   Then check **Include this location in the search**

   Press **Browse** and go to the following location on the computer;
   C:\Program Files\ALA Science\VC3\Application Drivers
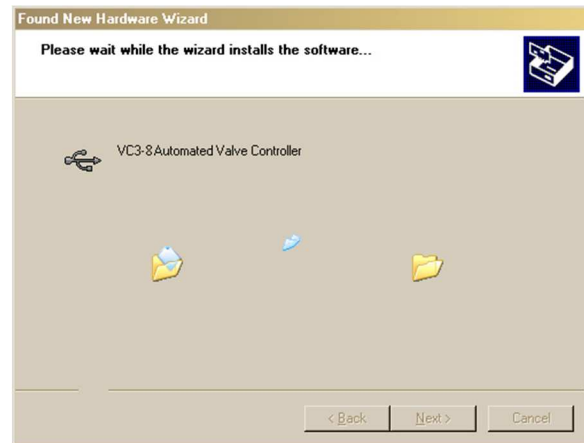
   Press **Next**
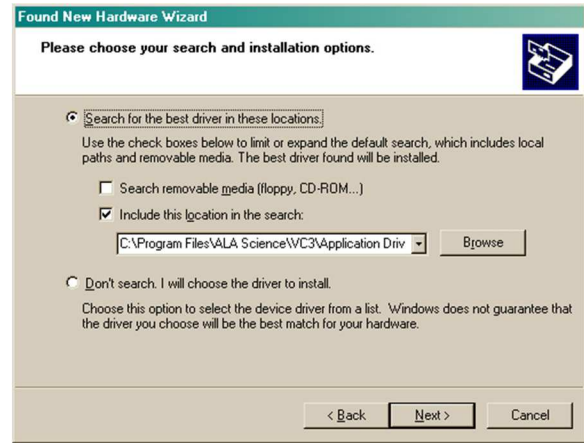
5. A Windows warning will appear.
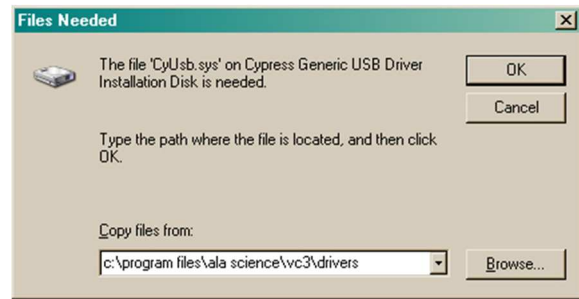
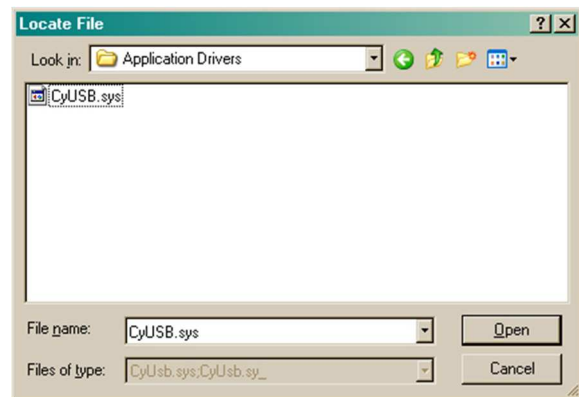   Press **Continue Anyway**

6. The VC^3 driver will now attempt to install.

7. A window asking for the path of the USB driver will appear if the system cannot find the file itself.

   Press **Browse...** and go to location **C:\Program Files\ALA Science\VC3\Application Drivers**
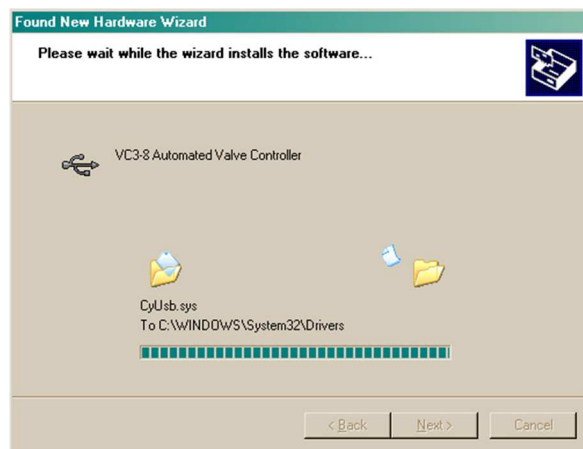
8. Select the following file, **CyUSB.sys**

   Press **Open**

9. The USB driver for the VC^3 will now be installed on the PC.

10. The Hardware Wizard will indicate when the installation is complete.

    Press **Finish**

Firmware Upgrade Installation

First time upgrade

To upgrade the VC^3 firmware to a new version for the first time, follow the steps below. If this is not the first time the firmware has been upgraded via this computer, then follow the steps

1. Run the VC^3 software. On the computer desktop double click the VC^3 icon named **VC^3 Desktop**. This will open the screen shown.
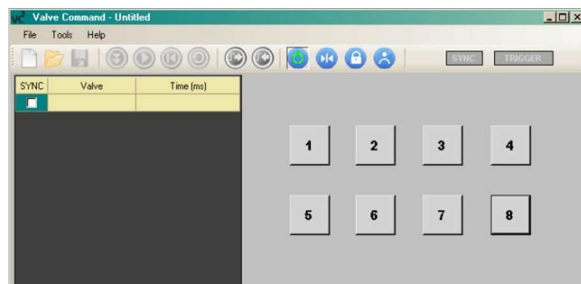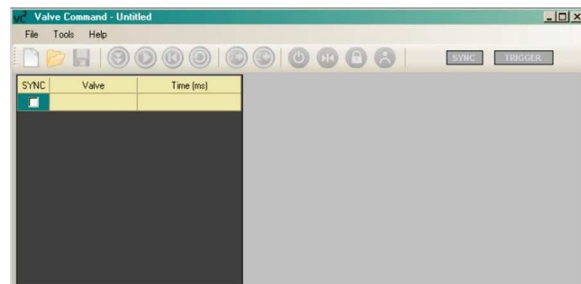

2. Select the **Help** drop down menu on the top toolbar. Scroll down to **Upgrade Firmware** select it.

3. A warning window will pop up before the proceeding with the firmware upgrade.
   Press **OK**

4. All the buttons on the VC^3 Valve Control GUI will be disabled during the firmware upgrade.
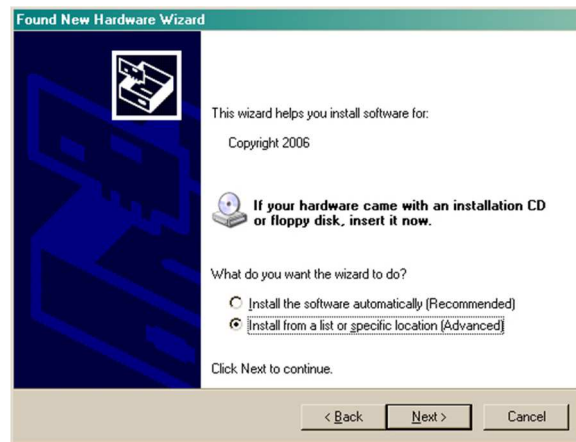

5. The Hardware Wizard gives several options to search for the software for the hardware.

   Select the last option
   No, not at this time

6. The Hardware Wizard identifies the hardware and gives options to install the firmware. Select the second option,

   Install from a list or specific location

7. Select *Search for the best driver in these locations* option. Check *include this location in the search*.

   Browse to *C:\Program Files\ALA Science\VC3\Firmware Upgrade Tools\USB Driver* for the files required.
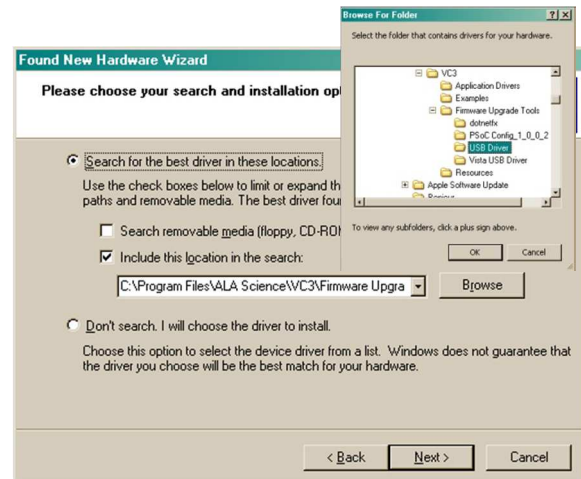
8. Since this is the first time this computer will upgrade the VC^3 firmware, it must install the driver that will communiate with the VC^3 processor. The *USB Bootloader* driver is loaded to the computer. This will allow for future firmware updates.
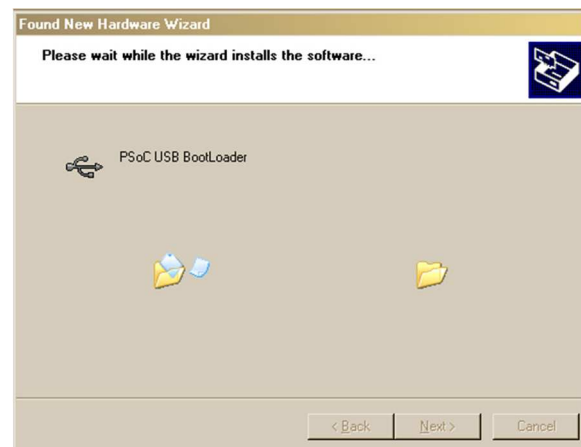
9. A Windows warning about the software being installed will appear.

   Press *Continue Anyway*

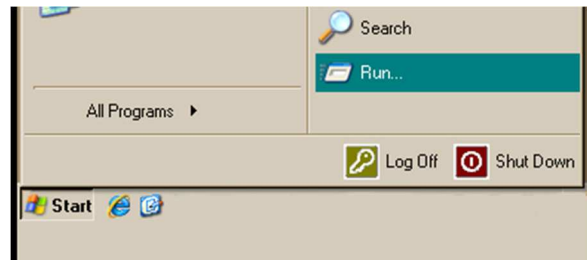10. The wizard has completed installing the USB Bootloader.

    Press *Finish*

11. Once the Bootloader driver is installed, the computer will state that the new hardware is ready to use.

12. Now that all the drivers are installed on this computer we can proceed with the firmware upgrade.
    Go to the *Start* and then *Run* on the Windows taskbar.
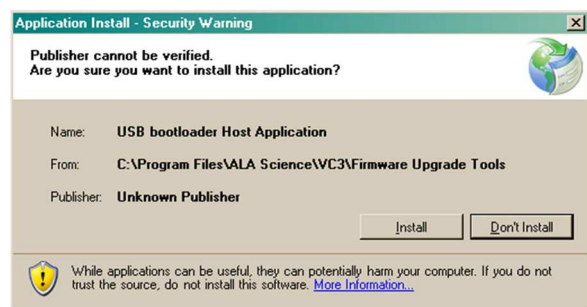
13. Browse to and open the following file;

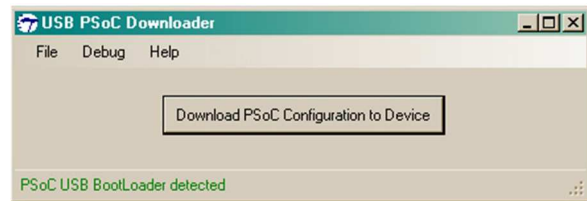   *C:\Program Files\ALA Science\VC3\Firmware Upgrade Tools\setup.exe*

    Press *OK*

14. The USB Bootloader Host Application will be installed.

    Press *Install*

15. Once installed the **USB PSoC Downloader** will detect the *USB Bootloader*.

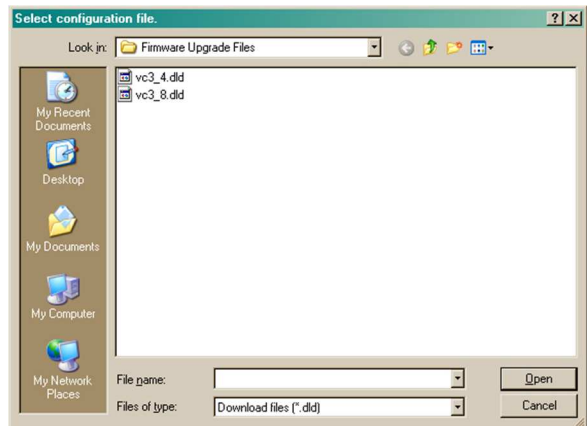   Press ***Download PScO Configuration to Device*** button.

.

16. Open configuration file located in **c:\Program Files\ALA Science\VC3\Firmware Upgrade Files**

    For VC3-4, the file is VC3-4_USB_REVx.dld

    For VC3-8, the file is VC3-8_USB_REVx.dld

    Where x is the latest revision desigantion.

17. Configuration file sis downloaded to the VC^3 controller.
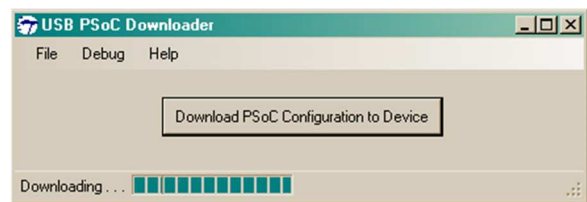
18. When complete the Downloader will show that no device is detected.
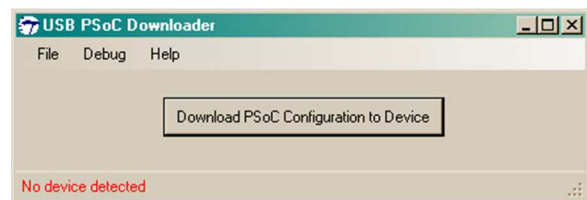
19. The VC^3 program will become active once again. All buttons will return to active status.

    The VC^3 software is now ready to be used.
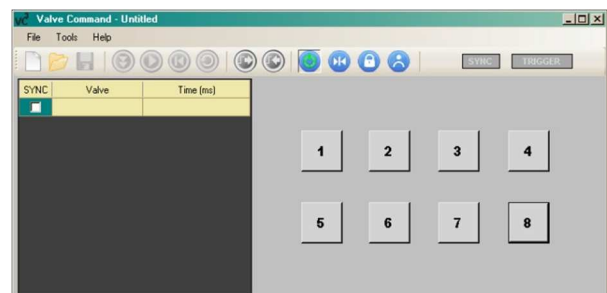
If you previously upgraded the firmware of the VC^3 on this computer, then all the drivers and software required to perform the upgrade are already installed. Follow the steps below to upgrade the firmware.

1. Run the VC^3 software. On the computer desktop double click the VC^3 icon named **VC3 Desktop**. This will open the screen shown.
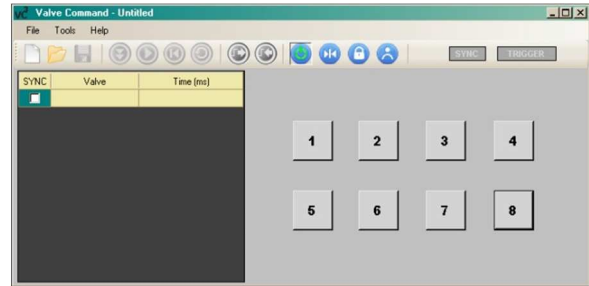
2. Select the **Help** drop down menu on the top toolbar. Scroll down to **Upgrade Firmware** select it.

3. A warning window will pop up before the proceeding with the firmware upgrade.
   Press **OK**

4. All the buttons on the VC^3 Valve Control GUI will be disabled during the firmware upgrade.
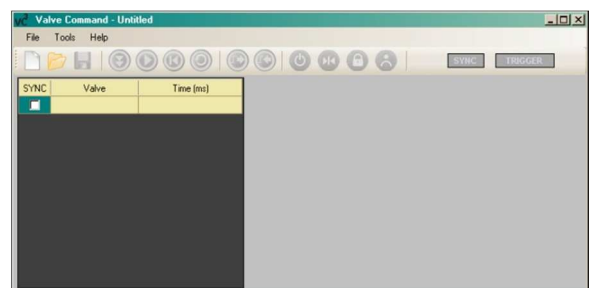
5. Go to **Start** and then **All Programs** on the Windows taskbar. Find the **Cypress Microsystems** tag and then click on **the USB Bootloader Host Application**.

6. The USB PSoC Downloader will appear. It will detect the the USB Bootloader of the VC^3 controller.

   Press ***Download PScO Configuration to Device*** button.
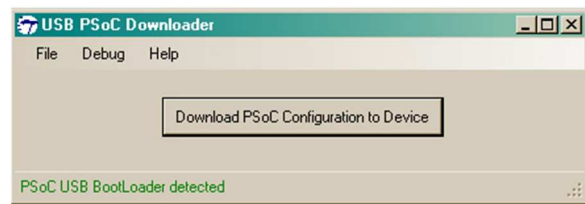
7. Open configuration file located in **c:\Program Files\ALA Science\VC3\Firmware Upgrade Files**

   For VC3-4, the file is VC3-4_USB_REVx.dld

   For VC3-8, the file is VC3-8_USB_REVx.dld

   Where x is the latest revision designation.
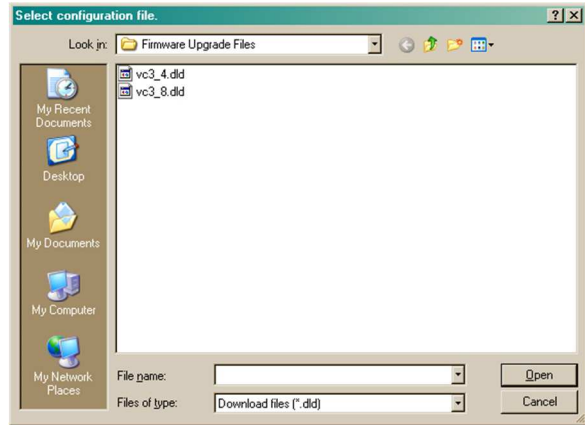
8. Configuration file sis downloaded to the VC^3 controller.
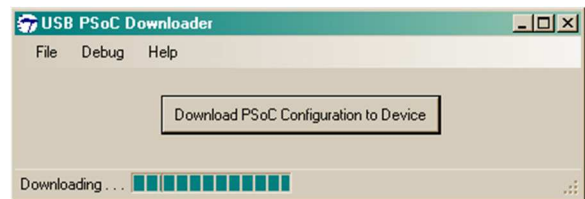
9. When complete the Downloader will show that no device is detected.
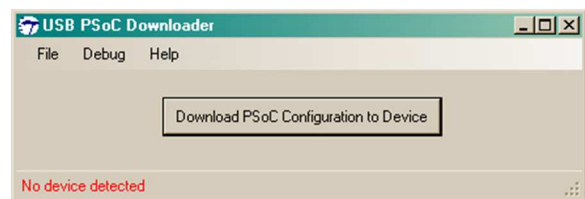
10. The VC^3 program will become active once again. All buttons will return to active status.

    The VC^3 is now ready to be used.
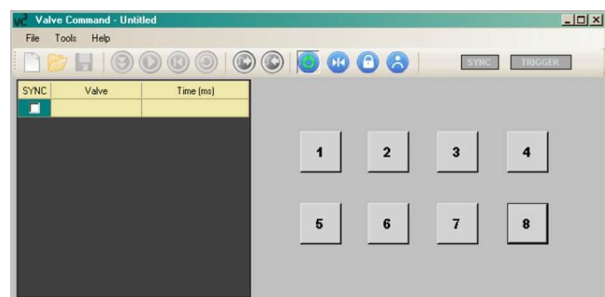
Running the VC³ Software

To run the VC³ program double click on the VC³ icon on the desktop named **VC3 Desktop**. This will open the VC3 Valve Command GUI shown below.

The VC³ Valve Command will open with the Download, Play, Return and Loop buttons disabled. Once a sequence is opened or a new sequence is created and downloaded to the VC³ controller the buttons will then become active.
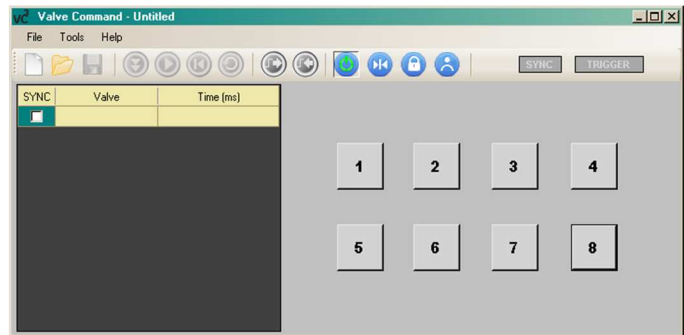
Control Buttons - Overview

- **New**

    This button will start a new sequence file. Make sure you the old sequence file before pressing this button.

- **Open**

    This button is used to open a saved sequence file on the computer. The sequence fiel will have a *.VC3 extension.

- **Save**

    This button will save the current sequence file being used.

- **Download**

    This button will download a sequence loaded in the VC³ Valve Command program to the VC3 controller.

- **Play**

    This button will start running the sequence loaded.

- **Return to Start**

    This button stops and returns the sequence to the first step.

- **Loop**

    This button will enable or disable a loop created in a sequence.

- **Sync**

  This button will enable/Disable the TTL/Sync Out port on the back of the VC^3 controller. When any valve is opened the port will output 5v DC when the sync is enabled. This will be indicated by the button changing color to green.

- **Trigger**

  This button enables/disables the trigger function. The trigger function is utilized via the analog input port on the back of the VC^3 controller. Therefore the analog function will be disabled if an output trigger is used. When the trigger function is enabled the button will be green.

- **Power**

  This button turns ON or OFF the VC^3 controller.

- **TTL In/Out**

  This button enables/disables the TTL function of the VC^3 controller. When enable the green lamp on the controller panel will be ON. The VC^3 can then be controlled via the Digital In/Out port on the back of the VC^3 controller using the provided DB9 to BNC cable and sending TTL signals from the acquisition system.

- **Latching**

  This button enables/disables the latching mode of the VC^3 controller. The button will go green when enabled. The Latching lamp on the controller will also turn ON. When enabled the valve that is switched ON will be switched OFF when any other valve is switched ON. Only one valve can be ON at a time in this mode. This feature allows for fast manual solution switching by eliminating the need to switch a valve OFF before switching another ON.

- **Toggle/Momentary**

  This button will switch the valve buttons from being toggle or momentary. When the button is gray, the toggle mode is enabled. In this mode the valve stays ON until the button is pressed a second time. Multiple valves can be ON in this mode.

  When the button is green the momentary mode is enabled. The green lamp on the controller will turn ON. In momentary mode you must left click and hold down button down switch to energize, turn ON, a valve. As long as you hold down the switch the valve remains ON. Release the switch and the valve turns OFF.
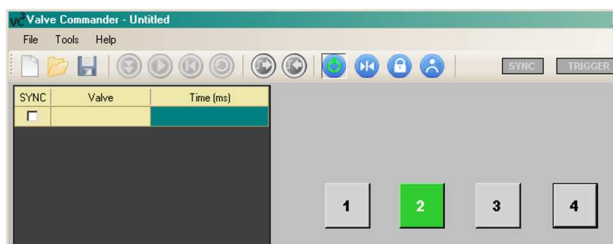
- **Valve Buttons**

  These buttons turn ON/OFF the corresponding valves.

  The buttons turn green when a valve is ON.

Manual software Control

The VC^3 can be controlled manually via the software. With the VC^3 fully assembled, the valves can be controlled by clicking the corresponding valve button to open or close the valve.

There are several modes that can be used to control the valves without using a sequence file.

Toggle Mode: The valve buttons function like toggle switches. The Toggle/Momentary button must be gray for toggle mode. Press once to turn ON, press again to turn OFF the valve. Multiple valves can be ON at the same time.

Momentary: The valve buttons function like momentary toggle switches. The Toggle/Momentary button must be green for momentary mode. Press and hold to keep the valve ON. Release the button and it will turn OFF. Only one valve at a time can be ON.

Latching: The valves act like toggle switches. The Latching button must be displayed in green to enable this mode. Press once to turn valve ON, Press again to turn OFF. The difference is that in this mode pressing a different valve the second time will turn ON that valve and turn OFF the previous valve. Only one valve can be ON at a time.

Keyboard Shortcut F-Keys

The valves can also be controlled via the computer keyboard. Using the F1 to F8 keys, control valves 1 to 8 respectively.

I/O Functions

TTL mode

There are two modes for the TTL In/Out setting.

In the **TTL IN** mode the VC^3 system is controlled via the TTL I/O port on the back of the VC^3 controller. The TTL button must be enabled displayed in green. Using the optional DB-9 to BNC cable TTL signal from an acquisition signal will turn valves ON and OFF.

In the TTL OUT mode the TTL I/O port on the back of the controller will output 5v DC when a valve is turned ON to its corresponding pin. The TTL button must be in the up position displayed in gray.

Sync Function

The Sync function outputs 5v DC from the Sync port on the back of the VC^3 controller. To enable this function, press the Sync button so it displays in green.

When a sync signal is sent the SYNC indicator box will turn red as long as the signal lasts.
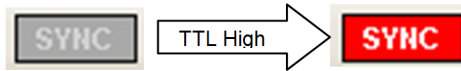
To add a Sync signal during a sequence, check the box under the SYNC label column of the sequence.

Trigger Functions

The VC^3 system can be triggered from an external source by enabling this function. The way this function can be used is to use the same port on the VC^3 controller that is used for the analog control. This means that the analog input port is disabled and cannot be used while the trigger function is used.

A message is displayed warning of this. Press **OK** to continue.
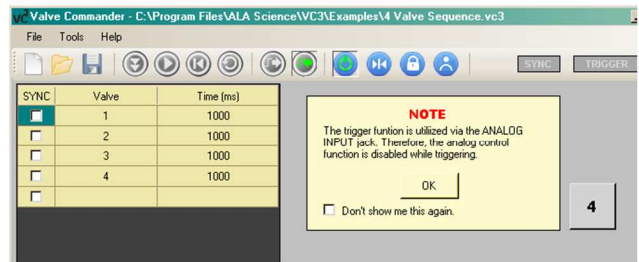
When running a sequence it will now be necessary to trigger the VC^3 controller when the sequence is started. After pressing the Play button, a message will appear informing that a rigger is required for the sequence to begin.
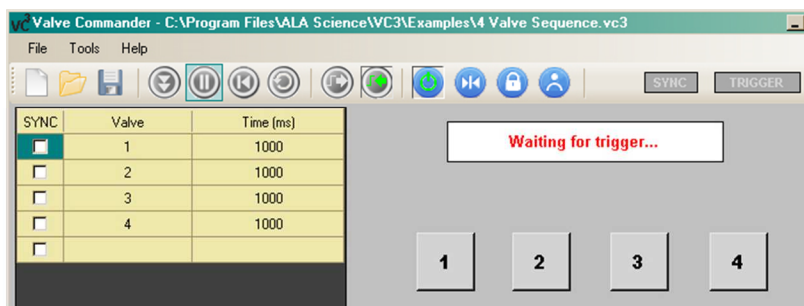
Send a TTL high signal to the Trigger IN port (Analog IN port) of the VC^3 controller to trigger the system to begin the sequence.

Working with a Sequence

Load a Sequence

There are two ways to load a sequence on the VC^3 software.

1. The first is to manually insert each step into the sequence. This is done by filling in the cells under *Valve* and *Time* appropriately.

   The valve number to be turned ON is written into the cell below the *Valve* column.

   The time the valve is to remain **ON** is written into the cell below the *Time* column. The default time units is in millisecond(ms).

   The time units can be changed by placing the cursor on the *Time* label and left clicking.

   The units available are ms, s, MM:SS , HH:MM:SS
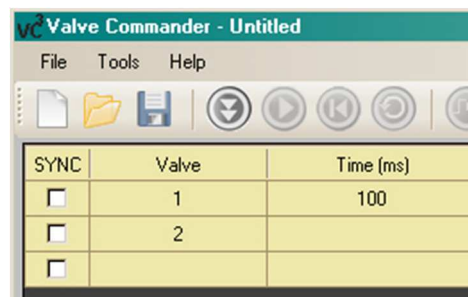
2. The second is to load a saved sequence file from the computer by pressing the Open button. Navigate to the folder where the saves sequence files are stored and open one. The default folder for saved sequence sample files is *c:\Program Files\ALA Science\VC3\Examples* .

   The loaded sequence must be downloaded to the VC^3 controller by pressing the Download button.

Run a Sequence

Once a sequence is loaded and downloaded, the sequence can be executed. Press the *Play* button to start the sequence.

The *Start* button will change into a *Pause* button. The sequence can be paused at any time while the sequence is running.

Press the *Play* button again to continue running the sequence.
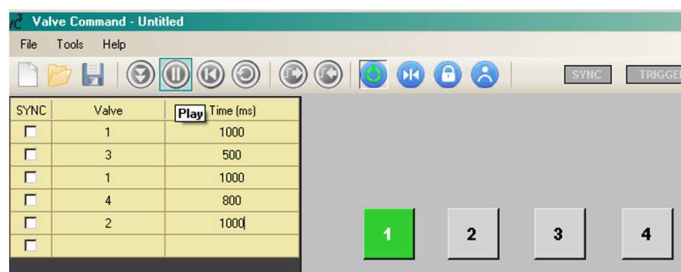
Sequence Loops

Sequence loops can be inserted into a sequence at any step. This allows for certain steps to be executed a multiple of times before the sequence moves to the next step outside of the loop.

Insert a Loop

1. Place the mouse cursor at the step you wish the loop to start. Press and hold the left mouse button and drag to the step you wish the loop to end.

2. The Loop window will open. Here you can specify the number of times the loop will run for.
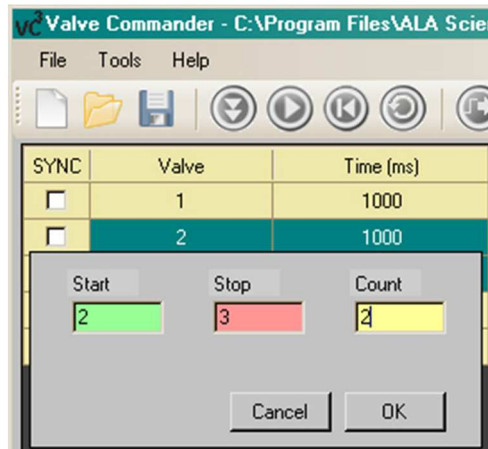
3. When a loop is inserted in the sequence the steps in the loop will be displayed as blue and dark green.
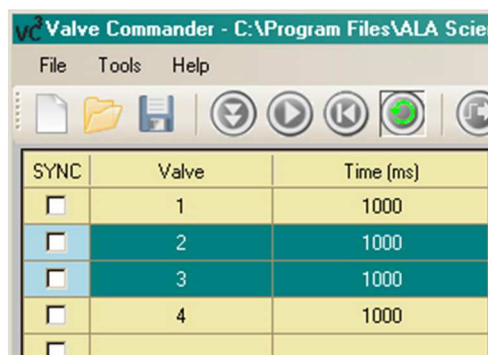
After inserting the loop, download the sequence to the VC^3 controller by pressing the download button.

The loop will now run when the Loop button is enabled.

Remove a Loop

To remove a loop function, place the cursor on the steps in the loop and right click with the mouse.

This will bring up a window asking to remove the loop.

Press **OK** to remove the loop.

Press **Cancel** to leave the loop as is.
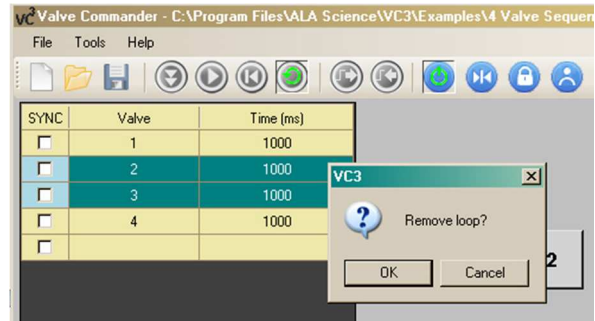
Optional accessories

As stated earlier in the manual, the VC^{3}8 systems are highly configurable to the users needs. Apart from having the options to build the VC^{3}8 system that best fits your needs, ALA Scientific Instruments also supplies products that can complement your system.

Pressure Regulator:

For pressure driven systems that require manual control of input pressure, we have the **PR-10** pressure regulator. The PR-10 allows you to adjust flow rates by dialing the desired pressure. The pressure range is 0 to 10 PSI. When the system is idle the PR-10 has an atmospheric bleed option. This prevents the solutions from in gassing.

Focal Perfusion Manifolds:

For more focal applications, the output on the VC^{3}8 systems can be configured to use a **Millimanifold**™ or **a Micromanifold**®.

The Millimanifold™ is made up of Polyimide tubes bonded together and attached to a single output. The MLF-8 has 8, 500µ ID channels, to a single, 500µ ID, output. The volume at the common area in the 8 channel Millimanifold™ is about 6 µl. The connectors at the input of the manifold are 1/16" barbs.


The Micromanifold® is made up of quartz capillaries bonded together to form 8 channels into a single output. The Micromanifold® is available in different ID sizes (100,200,350 and 500 micron). The tips are removable to ease cleaning as well as replacing. Due to the small ID's of the Micromanifold®, it is recommended that they be used with pressure systems. The Micromanifold® connects to the valve output via small "spaghetti type" tubing. We can supply either Teflon or PE tubing already attached to the Micromanifold®. When using this tubing, it is necessary to also use a compression fitting (CF-1 or CF-2) of the correct size.

Compression Fittings:

These fittings are used to reduce the valve output from 1/16" ID tubing to micrometer size ID tubing. There are 2 sizes available **CF-1** (for OD up to 470µm) and **CF-2** (for tubing with OD up to 800µm)

<u>Teflon/Polyethylene Tubing:</u>

There are a variety of sizes of tubing that can used to connect the perfusion front-end and the valve. The tubing we use is Teflon or PE. There are 2 sizes that are available that will mate up with the compression fittings we supply. For Teflon it is **FEP-1** and **FEP-2** and for Polyethylene it is **PE-10** and **PE-20**.

VC^{3}8 System Maintenance

The VC^{3}8 does not require any regular maintenance other than routine flushing of the valve/tubing system to prevent microbial growth. All VC^{3}8 parts can be externally cleaned with a damp cloth and mild soap or alcohol and water. The system can be cleaned internally with any disinfectant. Flush system thoroughly with water after doing so. Strong Clorox solutions are not recommended and no CFCs, acetone or high-grade alcohols are to be used.

Spill Sensor

The spill sensor is a capacitive element that when wet causes the controller to sound an audible alarm and shuts off power to the valves. If the sensor wire gets wet, it must be completely dry before it can be used in the system again. To dry the sensor wire, use an absorbent towel (paper towel) to carefully remove all liquid from the wire. The system will calibrate itself to the new humidity level of its environment when it is reset. Therefore it is very important that the wire be as dry as possible so it functions properly when a spill occurs.

Maintenance of Pinch Solenoid Valves

The silicone tubes that are supplied with the pinch valves will wear out after a while and lose their elasticity. If you notice degradation in flow, these should be replaced. It is important to replace the silicone tubing with the correct size. A trick you can use to prolong the life of the silicone tubing is just to move the tubing slightly up or down in the valve so that a fresh area of tubing is compressed in the valve. Replace tubing from your supplier or use 1.02mm ID, 2.16mm OD Pt cured medium density Silicone tubing. Other tubing is 1.6mm ID PVC or Tygon tubing.

Maintenance of LFAA "wetted" Solenoid Valves

The solenoid valves made by the Lee Company can fail. Either they will not open, or not close completely if dirt or gummy materials collect inside the valve. These materials can be introduced into the valve by the fluid that is flowing through it, or by bacteria and fungi that can grow in a valve that is not well cleaned.

Particulate and gummy material have been found to damage the valve in two ways, one is where the armature of the valve passes through the solenoid, and the other is where the plunger impacts against the internal side of the output port at the "Normally Closed" side. Particulate and gummy materials can cause the armature to stick to the inside of

the solenoid. This will either cause the valve not to open or not to close. Particulate and gummy materials can also stick to the plunger in the valve and cause it not to seal when the valve is closed and thus the valve will leak.

Diagnosing the problem:
In systems where small tubes are used it is possible to mistake the expansion of dissolved gasses in the liquid being used as a leak. Quite simply as the gasses come out of solution, they displace the liquid in the tubes and the system will appear to have a leak. This is especially common in pressure driven systems where many tubes come together to one output. The user must be certain that fluid leaving the system when it is not supposed to is indeed a leak from a valve.

The first test to be performed is to determine which valve in the system is the leaky valve. The best way to do that is to remove the output tubes from the valve and apply liquid with mild pressure to the input of the valve. (See Diagrams below) If, under mild pressure, liquid emerges from the valve, then the valve is not seating. Be careful not to use too much pressure since that can cause the valve to seal and mask the problem. Once you have isolated the affected valve, follow the procedure below to clean it.

If, after following the procedures outlined, you cannot return the valve to function, you should contact your representative or the factory. Special warranty restrictions apply to valves. Should the research substances you are using prove to consistently foul the Lee solenoid valve, please check with ALA about the possibility of switching some or all of your valves to pinch valves that can be cleaned by simply changing the tubing that passes through them. Please note that the Lee solenoid valves were selected after numerous tests of virtually every similar valve available. The Lee valve proved to be the fastest and to produce the smallest shock pulse upon opening and closing. The valves provided are amongst the most inert ones fabricated by Lee, specially for ALA Scientific based on ALA Scientifics' own specifications.

2-Way Solenoid Valve Maintenance Instructions
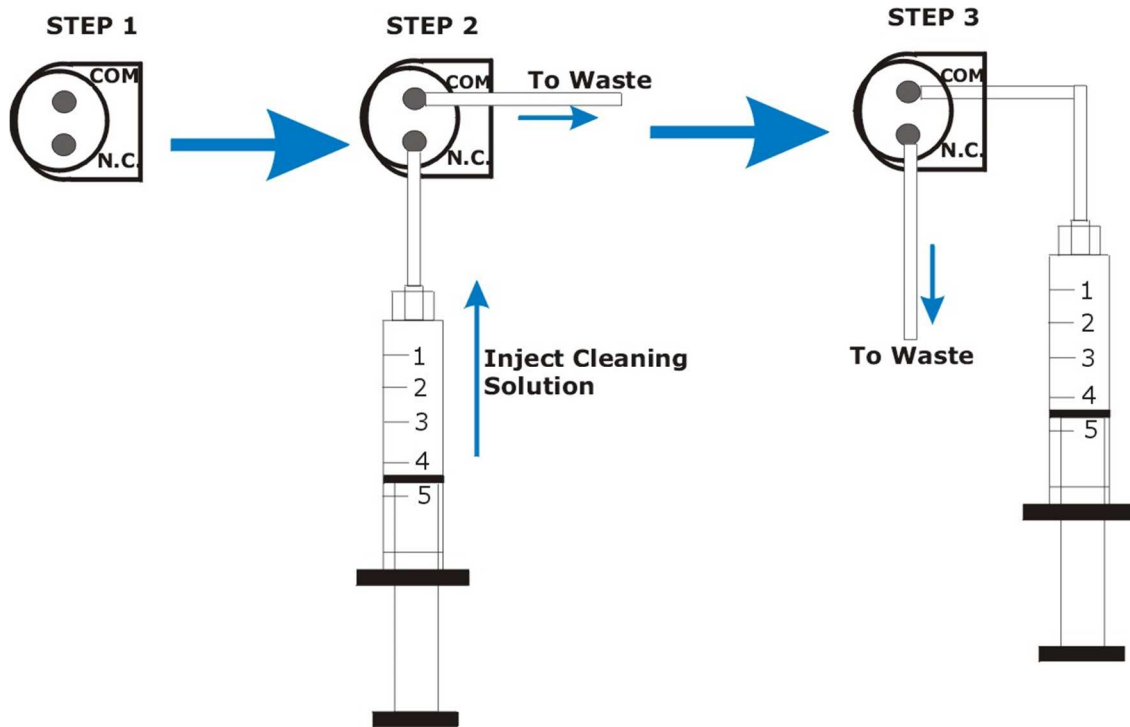
STEP 1:

    a) Disconnect Valve from system.

STEP 2:

    a) Connect 5 or 10 cc syringe to the output (N.C. port) and tubing (1/16 ID) from input (COM port) to waste.

    b) Inject Cleaning solution. This will force the port to open and allow the outside part of the seal membrane to be cleaned. (See next section for recommended cleaning solutions)

    c) Repeat approximately 3 times.

    d) Use an empty syringe to blow air through valve to remove cleaning solution from inside valve.

STEP 3:

    a) Connect 5 or 10 cc syringe to the input (COM Port) and tubing (1/16 ID) from output (N.C. port) to waste

    b) Energize valve to open port

    c) Inject Cleaning solution. This will allow the inside part of the seal membrane to be cleaned. (See next section for recommended cleaning solutions)

    d) Repeat approximately 3 times.

    e) Use an empty syringe to blow air through valve to remove cleaning solution from inside valve.

NOTE: If valve continues to leak after the cleaning procedure above, repeat procedure. If this still does not help then the valve should be replaced.

Recommended Cleaning Solutions for Lee Co. Solenoid Valves

After using a system that uses solenoid valves, you might experience mixing of your solutions. This occurs when the solenoid does not seal properly. There are many causes for a solenoid valve to leak.

The best preventative is to clean the valve thoroughly whenever an experiment is concluded or when there will be a break of longer than 1 day before the valve is used again. In the previous page there are instructions on how to clean the solenoid valves thoroughly. The type of cleaning solution will depend on the type of solutions that are used in the experiment. Below are some recommended solutions that can be used for cleaning solenoid valves.

1. Distilled water: For general flushing of valves.
2. Isopropyl Alcohol: For loosening particles that are stuck (due to use of "sticky" solutions) in valve
3. Diluted white vinegar: To loosen any build up of minerals in the valve mechanism.

Technical Specifications

VC^3 Controller

Power	110/220VAC to 15VDC @ 3.3 A - CE Compliant
Fuse	5 x 20 mm 3.15A Fuse
Switching	Manual / TTL logic /Analog voltage
Event Marker	TTL Pulse / analog voltage
Spill Sensor	Audible alarm/ power shut off
Dimensions	7.874" x 5.906" x 2.472"
Weight	1.8 lbs./0.816 kg
Connector to valve manifold	9 pin D-sub female

Valve manifold

Valves Type	Pinch Valve: 3-way 12V DC @ 0.33A "Wetted" Solenoid: 2 way 12V DC @ 0.25A
Reservoirs type	Luer Lock type
Dimensions	13.5" x 2.1" x 6.5" / 34.29 x 5.334 x 16.51 cm
Weight	
Connector to controller	9 pin D-sub female

Front-end Manifolds

Minimanifold – MMF-8	Material	ABS plastic
	Dimension	-------
	Weight	
	"dead" volume	~50µl
Millimanifold – MLF-8	Material	Polyimide
	Dimension	4" length , 500 micron ID
	Weight	
	"dead" volume	~6µl
Micromanifold – QMM-8	Material	Polyimide coated quartz capillaries
	Dimension	3.25"/82.5mm
	Weight	Varies *
	"dead" volume	< 90nl

* The Micromanifold comes in a variety of sizes and configurations.

LIMITED WARRANTY for Valves

ALA Scientific Instruments agrees to warranty Lee Company Valves for 30 days from date of invoice. The Lee Company Certifies the functionality of each valve shipped to ALA Scientific Instruments. The valves are again tested at ALA Scientific when they are incorporated into the different systems that use them. It is recommended that the valves be checked upon receipt to determine any malfunctions. The following are the only agents approved to check valves: distilled water, Nitrogen or purified air. Any other agents used will void the warranty.

Valves that have been used in actual experiments cannot be returned. Individual valves that malfunction within 30 days of invoice date will be replaced on a per case basis. ALA Scientific Instruments limits coverage to include repair or replacement of defective materials at our discretion.

Buyer is responsible for the cost of return shipment. Inspection upon receipt is essential to receiving coverage should the instrument be damaged in shipment. Generally three days after receipt is the limit for such claims with the shipping company.

ALA Scientific Instruments, Inc. is not responsible for damage occurring to, or from the use of this product that is inconsistent with its intended usage or this manual. It is the buyers' responsibility to make sure that DC valves used with this instrument are run at the proper voltage and to use common sense in the operation of this product. This instrument, or any of its parts, is not approved for clinical use and has not been produced to such standards. Under the law, the VC3 system cannot be used on human subjects in any way. It has no clinical applications and is intended as a research instrument only. No guaranty of results is offered or implied by the use of this product. It is intended only for research purposes. Your rights under this warranty may vary from state to state and country to country.

Warranty

ALA Scientific Instruments, agrees to warranty this product for a period of one year from the date of delivery against any and all manufacturer's defects in material and/or workmanship. Remedy will consist of repair or replacement at ALA's discretion. All problems should be reported immediately so as not to jeopardize warranty coverage. ALA Scientific Instruments does not assume any liability based on the use of this product, whether correct or incorrect, except as specified under law. Warranty rights may vary from state to state.

ALA Scientific Instruments will not warranty any of the plastic parts including 60cc reservoirs, all tubing and connectors, and magnetic stand parts.

If the product does need repair, it must be returned to the factory freight prepaid (freight collect will be refused) and in clean condition. If returned parts have been in contact with any liquid substance, documentation must accompany those parts, regarding what substances were used.

This product is intended for use in cellular and tissue research only. **THIS EQUIPMENT IS NOT INTENDED NOR APPROVED FOR CLINICAL USE IN ANY WAY AT ALL.**

Micromanifold™ is a trademark of ALA Scientific Instruments Inc.