VCPlus Instruction Manual

Model # ALA-VC4Plus
Model # ALA-VC8Plus

Ver. May 2024

Information in this document is subject to change without notice.

Printed: May 2024

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Safety

Do not use the device in a manner which is inconsistent with its intended function.

Do not expose the device to extreme conditions of humidity, hot or cold.

Do not use it in a wet area or allow the power supply to become wet or submerged.

Do not use it if wires are damaged or conductors are exposed.

This device has no clinical application and may not be used with human subjects at all.

1.0 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.

The VC**PLUS** 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 variety of outlet manifolds.

The VCPLUS is a four 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 VCPLUS 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.

2.0 VCPlus Controller

2.1 Controller Membrane 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. The default valve switch setting is ON-OFF.

4. **MOMENTARY** - Sets all Valve switches to “MOMENTARY ON” mode.

5. **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.

6. **SPILL DETECTED indicator-** LED will light when a spill is detected by the spill sensor cable connected to the rear of the controller, and an alarm will sound, and all open valves will close. Cycle power button to re-set after drying the sensor.

2.2 Controller Rear panel

7. **DC Power Input -** 15VDC @ 3.3A.

8. **Power Switch -** Main power switch to turns VC**PLUS** controller ON/OFF.

9. **SPILL SENSOR INPUT –** Connector for the spill sensor cable.

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

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

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

13. **USB** – port to connect controller to PC via USB cable.

14. **ANALOG IN -** BNC connector to control valves via an analog voltage input in 0.5 V steps.

15. **ANALOG OUT -** BNC connector that outputs an analog voltage in 0.5 V/ valve steps with a +/-100mv threshold.

16. **TTL SYNC OUT -** BNC connector that outputs a TTL high signal whenever a valve switches ON. (5V for 20msec)

2.3 Controller Interface

Power Buttons

The VC**PLUS** 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

Manual ON/OFF Control:

Manually each valve is controlled by an individual membrane panel switch. Each switch is numbered, 1 through 4, 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.

Latching Valves Control:

The VCPLUS4 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.

Rear Panel Connections

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 2.0 V dc in 0.5V steps will control valves 1-4, 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 represent a valve opening. An analog voltage from 0.5V to 2.0 V in 0.5V steps represents valves 1-4, respectively.

USB:

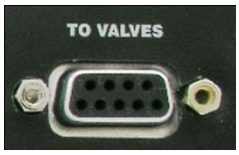
The USB connector is used to connect the VC**PLUS** controller to a computer. This port is used for software operation and firmware upgrades.

DIGITAL IN:

The digital input is used to control the valves via a TTL signal. The DB-9 male connector pins 1-4 is used to input TTL signals to valves 1-4, respectively, with pin 9 being common ground.

The ALA-BOB-8 junction box can be used to connect the VC**PLUS** to an acquisition system's digital output.

TO VALVES:



This DB-9 Female port is used to connect the controller to the valve manifold (VM-4).Pins 1-4 correspond to valves 1-4, respectively. Pin 9 is the common ground.

DC POWER:

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

POWER ON/OFF:

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

GND:

The VC**PLUS** controller can be connected to ground via a 4mm banana jack on the rear panel.

FUSE:

Internal and auto reset after power cycling.

SPILL SENSOR INPUT:

The VC**PLUS** 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**PLUS** 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**PLUS** 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:

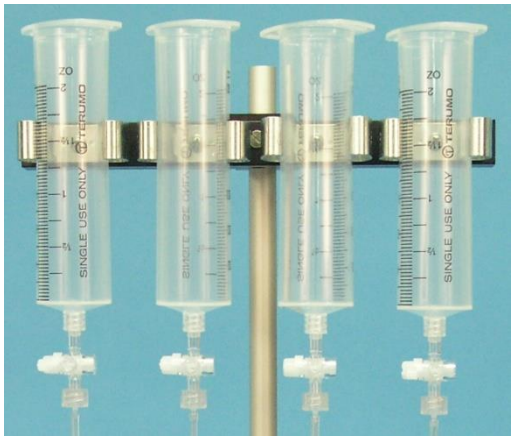
1) Press the Soft power switch on the controller panel. 

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) The system is now ready to be used again.

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

3.0 VCPlus Perfusion System components

Reservoir Bracket



A separate reservoir bracket, as shown above, is supplied for the VC**PLUS**4-PG and VC**PLUS**4-CLG gravity driven systems. This is necessary 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 VC**PLUS**4-PP and VC**PLUS**4-CLP 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 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 VCPLUS4-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 VCPLUS4 systems are also fully configurable. Compression fittings and frontend perfusion manifold are optional.

The following are some of the choices available:

- Pinch or isolation 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 isolation 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 VCPLUS4-PG and VCPLUS4-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 isolation valves

The isolation valve is a solenoid-operated device that uses a flexible diaphragm to isolate the actuation mechanism from the fluid path. Media isolation valves are commonly used for a wide variety of applications, including those that require precise, repeatable dispensing of media for analytical instrumentation. All wetted areas of the valve are PTFE, making this series ideal for use with corrosive media like ACSF and salty and caustic solutions. Furthermore, all the liquid that enters the valves passes through, so there is never any trapped liquid that cannot be flushed out.

Gravity or Pressure Driven

The option to have the VC**PLUS**4 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**PLUS**4-PG (Pinch valves) and VC**PLUS**4-SG (isolation valves) are configured to be gravity driven. In a typical VC**PLUS**4 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 VCPLUS4-PP(image shown) and VCPLUS4-CLP 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.

Since there are several possible front-end manifolds and tubing choices, both the VC**PLUS**4-PP and the VC**PLUS**4-CLP 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**PLUS**4 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**PLUS**4 gravity systems include a MMF-4 (4 to 1 channel Minimanifold) and tubing . The MMF-4 has barbs for use with 1/16" id pvc tubing.

As stated earlier, the VC**PLUS**4 pressure systems are configured up to the valve input. The VC**PLUS**4 pressure systems do not include focal perfusion manifolds. This allows the systems to be more configurable to the user's needs. ALA Scientific focal perfusion manifolds include the Micromanifold® and the Millimanifold™. For more information on the manifolds, go to the optional accessories section.

4.0 System Assembly Instructions

Gravity systems

Below are the instructions for assembling the VC**PLUS**-4PG and VC**PLUS**-4CLG 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 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 cap (thumb) screws.
6. Mount the 4 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 isolation 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 the valve. This allows for easy insertion of silicone tubing. Go to step 14.
10. Remove caps from valve ports.
11. Insert pvc tubing coming from the reservoir to the input port (top) of the valve.
12. Insert pvc tubing coming from the front-end manifold to the output port (bottom) of the valve.
13. Connect the control box to valve box via the DB-9 Male serial cable.
14. Connect 15V power supply to the control box.
15. Connect 15V power supply to wall outlet using power cord.
16. Turn ON the main power on control box by flipping rocker switch on the rear of the control box.
17. Press the soft power button on the control membrane panel. Green LED will light.
18. Your system is ready for manual use. Press membrane panel switches on top of the control box to open/close valves.

Pressures systems

Below are the instructions for assembling the VC**PLUS**-4PP and VC**PLUS**-4CLP 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 (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 packed separately. Remove them from the package and snap them into the clips on the valve manifold panel. 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 isolation 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 the valve. This allows for easy insertion of silicone tubing. *Go to step 8.*
7. Remove any caps or covers from valve ports if present.
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 4 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-9 male serial cable.

Note that VCPLUS controllers can only be used with VCPLUS valve manifolds and vice versa. Systems are not backward compatible with previous systems.

11. Connect 15V power supply to the control box.
12. Connect 15V power supply to wall outlet using power cord.
13. Turn ON the 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.

5.0 Experimental Setup – Solution delivery

Four syringes are supplied as reservoirs for the application of solutions. 60ml syringes are standard on gravity systems (Other size reservoirs can easily be connected). Each reservoir is suspended by a metal clip and attached to 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 VCPLUS4 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 isolation valves can open in 5 to 20msec. The valve either releases or restricts the flow of the solution in the reservoir.

Gravity Driven System

If you receive a gravity driven VCPLUS 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 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**P**LUS4 directs the fluid through the valve to a front-end manifold. In a standard VC**P**LUS4 gravity system the fluid is directed to the MMF-4, 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 isolation valves or you may damage the valve. Pressure is mostly used with a Micromanifold® where input and output tubes are 100um ID or 200um ID and flow by gravity is very slow.

5.1 Daily Usage

Getting the VCPLUS ready for an experiment

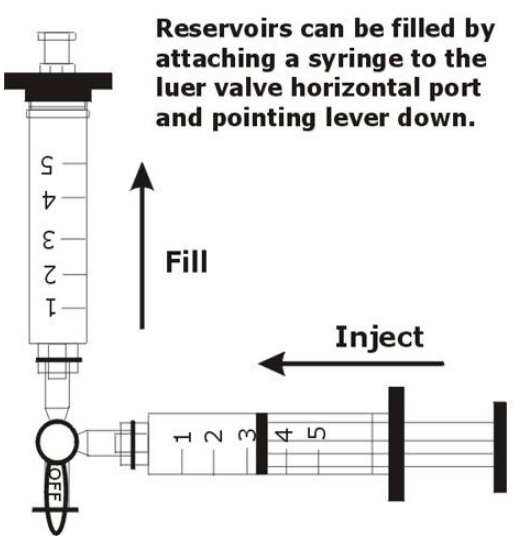
Whether your system is gravity or pressure driven the priming procedure is basically the same for both. Both systems as stated previously are comprised of 4 reservoirs and 4 valves and the tubing connecting them. When preparing to prime the system, the, start by powering up the VC**PLUS** controller.

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**PLUS**4 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**PLUS**4 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.



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 reservoirs 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 your system is gravity or pressure driven the priming procedure is basically the same for both. Both systems as stated previously are comprised of 4 reservoirs and 4 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 contracts when under pressure and expands when with no pressure resulting in leaking.
c. The system is now ready to be used 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 VCPLUS 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 (1-4) 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 the 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.

6.0 VCPlus Software Download and Installation

To control the VC**PLUS** via software you must first install the VC**PLUS** program. Software can be downloaded from the ALA website.

System requirements are to run the software:

1. OS and version: Windows 10_64 bits or higher
2. Additional programs required (.NET): dot net framework 4
3. USB C port.

Software Download

The VCPlus software can be downloaded from any of the VCPlus system product pages. It is the same software for all VCPlus systems. Go to link below to download software. The software file will be in the *Download* tab of the VCPlus web page.

https://alascience.com/product-tag/perfusion-system/

or download directly from the link below.

https://www.alascience.com/products/zip/VCPlus_software.zip

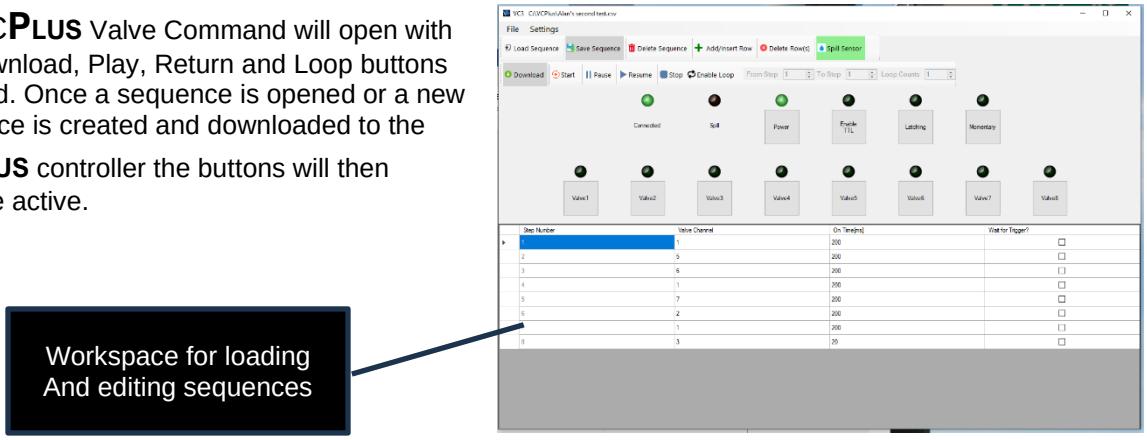
Software Installation

1. Un-zip, open and install. -Agree to install on security window
2. The software will create a folder called ***ALA Scientific Instruments*** on the C:Program Files(x86) drive and all relevant files will be placed there. This folder will be the default for Sequence files as well.

6.1 Running the VCPLUS Software

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

The VC**PLUS** 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 VC**PLUS** controller the buttons will then become active.

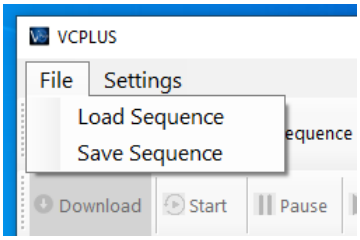


(Main Screen, 8 Channel system selected)

Control Buttons - Overview

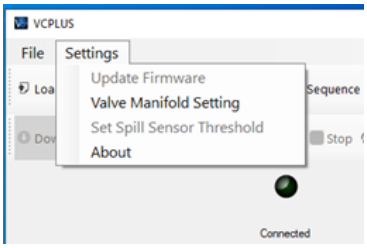
File

Open file dialogue to retrieve a previously saved sequence by loading it or saves the sequence you have. Sequences will be saved to the ALA Scientific Instruments folder on the C drive by default. You can select another folder to save to. Sample sequences of four and eight valves are pre-loaded into the folder as an example.



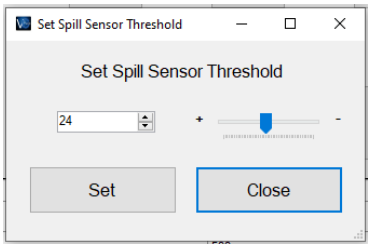
Settings

Firmware Update—used when updating firmware only. Valve Manifold Setting—select 4 or 8 channel system. Set Spill Sensor Threshold—adjust spill sensor to best performance. About---gives software version.

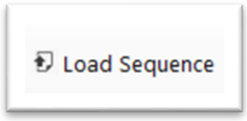


Set Spill Sensor Threshold

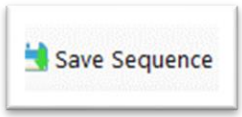
Adjust the sensitivity of the spill sensor. 1-50, 1 is most sensitive.



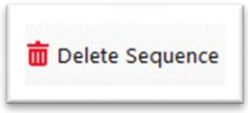
Toolbar



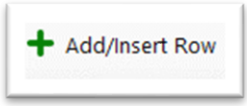
Loads a sequence file from the storage location into the workspace.



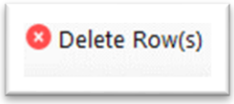
Saves the sequence from the workspace to the designated file location.



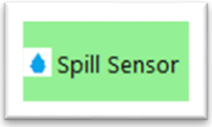
Deletes the sequence in the workspace.



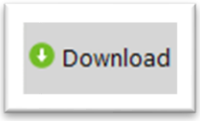
Allows a row to be inserted at the cursor position in the sequence.
Use Add/Insert Row to create a multiple step sequence.



Deletes the highlighted row from a sequence.

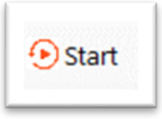


Allows the spill sensor to be turned on and off from the computer Interface.



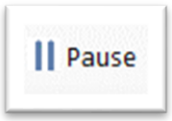
This button will download a sequence loaded in the VC**PLUS** Valve Command program to the VC**PLUS** controller. You must download the sequence each time it is edited.

Start running a Sequence



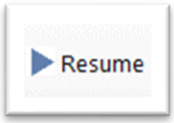
This button will start running the loaded sequence from the first line.

Pause



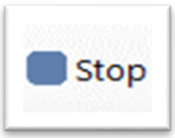
Pause the sequence at the current step.

Resume



This button resumes running the sequence from the pause point.

Stop

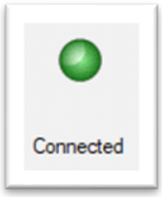


Stops the sequence at the line selected.

Enable Loop

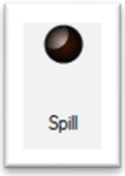
This button will enable or disable a loop created in a sequence. Only one loop can be created in a sequence. A loop will not be saved, so it is best to note where the loop is in case you need to add it again.

Connected



Green indicates that the computer is connected to a VCPlus controller

Spill



Lights up when a spill is detected. An alarm will sound as well.

Power

Cycles the power on and off—the same as the power button on the membrane.

Use this button to re-cycle the power to reset the spill sensor.

Trigger

Enables/disables the trigger in function. The trigger function is utilized via the 8 pin Digital In on the back of the VC**PLUS** controller. You must input a trigger at the pin corresponding to the valve selected in the row. Check the box "Wait for Trigger" and the program will pause until a TTL is sensed at the pin corresponding to the valve number. Then the sequence will continue. ALA BOB-8 breakout box can be used.

Latching

Enables/disables the latching mode of the VC**PLUS** 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.

Momentary

This button will switch the valve buttons from being toggled to momentary. When the button is gray, the toggle mode is enabled. When green, the valve stays ON while the mouse button is held down over its valve button, release the mouse button and the valve turns off.

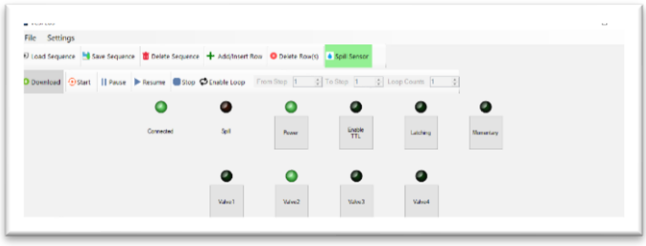
Valve Buttons

These buttons turn ON/OFF the corresponding valves.

The buttons turn green when a valve is ON. Select with the mouse left button.

6.2 Manual software Control

The VC**PLUS** can be controlled manually via the software. With the VC**PLUS** 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. Momentary and Latching 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. 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.

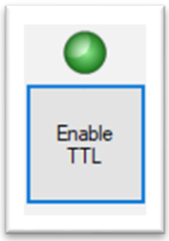
Keyboard Shortcut F-Keys

The valves can also be controlled via the computer keyboard. Using the F1 to F4 keys, control valves 1 to 4 respectively, F1 to F8 for 8 channel systems.

I/O Functions

TTL mode

There are two modes for the TTL In setting.



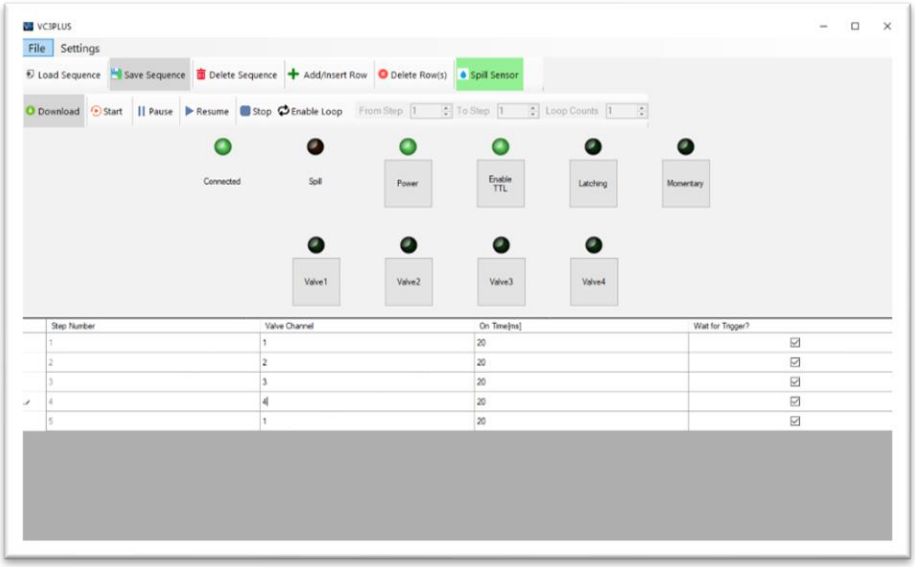
In the **TTL IN** mode the VC**PLUS** system is controlled via the TTL I/O port on the back of the VC**PLUS** controller. In software control mode, the TTL button must be enabled displayed in green.
Using the optional DB-9 to BNC cable TTL signal from an acquisition signal will turn valves ON and OFF. No setting is required if using just the controller without software, simply plug in to the input and send the signals, they will command over the manual buttons.

Sync Out Function

The Sync function outputs 5v DC for 20msec from the Sync port on the back of the VC**PLUS** controller. This can be used to sync/trigger other devices whenever a valve opens.

Trigger Functions

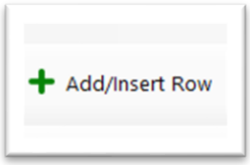
To run a sequence or individual steps via TTL trigger you must input a TTL Trigger on the appropriate channel of the TTL in DB-9 connector for the valve that is waiting for a trigger. A valve, or line in the sequence, will wait for a trigger when the Trigger box is checked in the right-hand column of the sequence file. For example, line 1 is set to wait for a trigger, when a trigger signal is sent to pin 1 on the DB-9 input, line one will execute and keep going until the next line where a trigger is requested.



Working with a Sequence

Load a Sequence

There are two ways to load a sequence on the VC**PLUS** software.

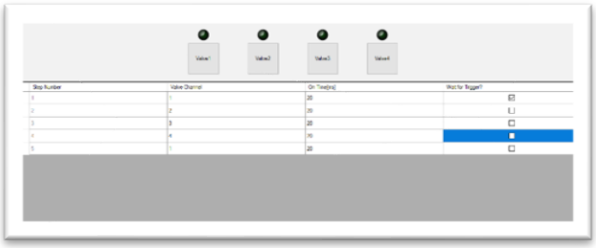


The first is to manually insert each step into the sequence. This is done by clicking the

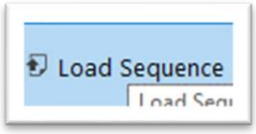
Add/Insert row button which will add a row in the workspace area. You will then need to update the valve number and the on-time in msec. On the right side you can check the box if you want the software to wait for a trigger to execute that step.

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

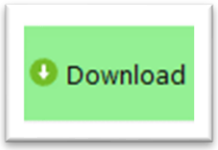
The time the valve is to remain **ON** is written into the cell below the On ***Time*** column. The default time units is in millisecond(msec).



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***\VC**PLUS*****Examples***\ .

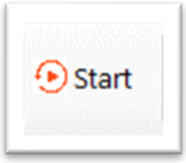


The loaded sequence must be downloaded to the VC**PLUS** controller by pressing the Download button.



Run a Sequence

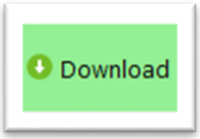
Once a sequence is loaded and downloaded, the sequence can be executed. Press the ***Start*** button to start the sequence.



The ***Start*** button will start the sequence from step 1. The sequence can be paused at any time while the sequence is running by pressing Pause. Press Resume to continue from the paused step. If you press Stop. The sequence will reset to step1.

Press the ***Start*** button again to continue running the sequence.

REMBER THAT IF YOU MAKE ANY CHANAGES TO THE SEQUENCE YOU MUST PRESS



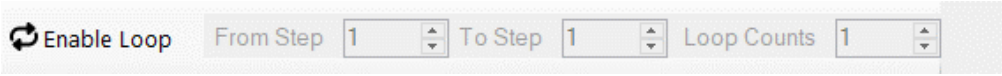
AGAIN, TO LOAD YOUR CHANGES INTO THE CONTROLLER.

Sequence Loops

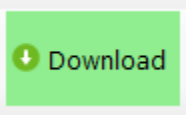
A Sequence loop can be inserted into a sequence at any step. This allows for certain steps to be executed a multiple of times before the sequence moves to the next step outside of the loop**. *Please note that a loop cannot be saved with the file so it will be necessary to note down the loop details so that they can be re-entered in that sequence when it is recalled.***

Insert a Loop

1. Click the Enable Loop button.

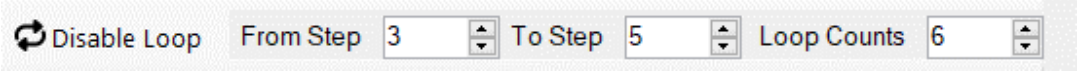


2. The Loop window will open. Here you can specify what step to start from, what step to end at and how many times to repeat before moving on. Click disable loop to stop it from running in the sequence. The sequence will run through and ignore the loop. Remember, that you must



for the change to take effect in your sequence.

A loop that is set to run will look like this:



6.0 Optional Accessories

As stated earlier in the manual, the VCPLUS4 systems are highly configurable to the user's needs. Apart from having the options to build the VCPLUS4 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 VCPLUS4 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-4 has 4, 500µ ID channels, to a single, 500µ ID, output. The volume at the common area in the 4 channel Millimanifold™ is about 5 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 4 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)

Teflon/Polyethylene Tubing

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 match the compression fittings we supply. For Teflon it is **FEP-1** and **FEP-2** and for Polyethylene it is **PE-10** and **PE-20**.

7.0 System Maintenance

The VCPLUS4 does not require any regular maintenance other than routine flushing of the valve/tubing system to prevent microbial growth. All VCPLUS4 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 the 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 Isolation Valves

It is recommended to clean the isolation valves after each use. Do not let solution dry inside the valve. This will cause the valve to leak or damage it completely.
The best preventative is to clean the valve thoroughly whenever an experiment is concluded. 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. Diluted white vinegar: To loosen any buildup of minerals in the valve.

10.0 Specifications

VCPLUS 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 @ 0.08A
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

11.0 Warranty

LIMITED WARRANTY for Valves

ALA Scientific Instruments agrees to warranty Valves for 30 days from the date of invoice. The valves are 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.

The 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 VC**PLUS** 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 using this product. It is intended only for research purposes. Your rights under this warranty may vary from state to state and country to country.

System 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.**