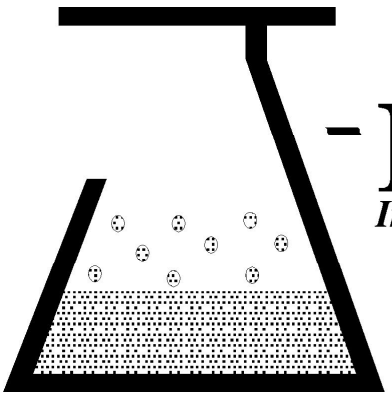
Precision Instruments for Research and Industry

Syringe Pump Manual



KEM Scientific, Inc.

Instruments for Science from Scientists

Program Index

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Software Installation

For systems supplied with the Infinity Netbook PC

The syringe pump software, KEM-Pump, is already installed on the Netbook PC.
To use your system, simply connect the USB cord from the pump to the netbook and double click on the KEM-Pump icon on the desk top.

For systems with the software supplied on a USB memory stick

Do not connect the pump to the PC before installing the KEM-Pump software and the needed drivers. To install the KEM-Pump software, open the software application folder, then double click on the file Setup.exe on the USB stick, and during the installation, accept all the default settings. After installing KEM-Pump application, open the folder titled Syringe Pump Drivers, also on the USB stick, and double click on the file titled SyringePump DriverInstaller_v130.exe.
After the drivers are installed, connect the USB cord from the pump to your PC, then start KEM-Pump by double clicking on the KEM-Pump icon installed on the desk top.

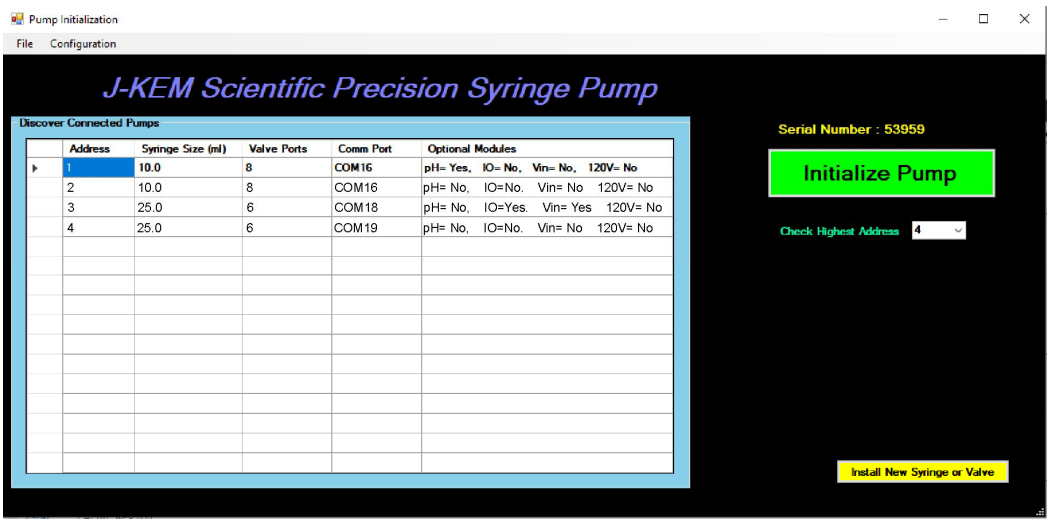
If the pump initializes and the software appears normal, then congratulations, you are ready to user your pump. If a message appears stating that the pump cannot be found, then the drives were not installed properly on your PC and you should contact you IT group.

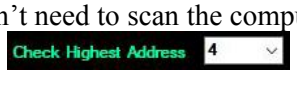
Under some installations of Windows 7, 8, and 10, the drivers will not install automatically and must be installed manually. To manually install drivers, go the computers Device Manager and manually update the drivers for the syringe pump. There are two drivers and you will need to manually update both. Please contact your IT group for PC support, or call J-KEM for assistance.

KEM-Pump Software

J-KEM offers two standard syringe pump configurations, a single pump and a dual pump module, though custom modules with up to 128 independent pumps are available. KEM-Pump software automates all of the standard, and many exotic, fluid addition programs used in research chemistry and biology. KEM-Pump includes both a run-time executable program, described below, and optionally (contact J-KEM) ,the original source code for researchers who want to extend the application to include their own syringe pump procedures or to include the pump in a larger automation system.

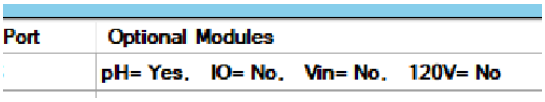
Start KEM-Pump by selecting its' icon from the Start menu or double-clicking the KEM-Pump icon on the desktop.



On startup, the software scans to detect all attached pump modules. Each detected pump is listed in the table shown. The user should make sure that the syringe size and valve port count matches what is actually installed on the pump module, if not, then the configuration of the pump must be set to the correct values using the screen that appears when the Install New Syringe and Valve button is clicked. Initialize the software and the pump by clicking on the green Initialize Pump button. KEM-Pump software supports connecting 16 pumps, but to save time when starting the software, you can specify the last pump address to search for. For example, if you have a dual pump system, the software doesn't need to scan the computer looking for 16 pumps when it only needs to scan and connect to two pump. The control 

allows the user to set the highest address to scan for thus saving time on startup.

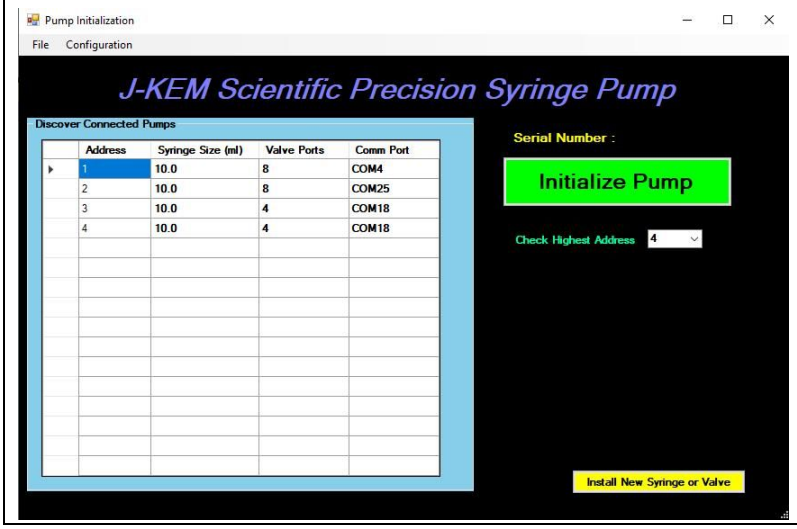
If you have installed a new syringe or distribution valve on a pump, then do not initialize the pump, but click the Configure New Syringe button and follow the instructions in the section titled Pump Configuration Form.



The initialization screen also show what optional modules are installed on each syringe pump. These modules include a pH probe input to control solution pH during a reaction, an Input/Output module that allows external control of the pump or for the pump to control external valves or other instruments, a Voltage input module that allows that modifies the pumps behavior based on an analog input from instruments line UV sensors or motor controllers, and a high power 120Vac output that allows the pump to turn On/Off 120 vac devices as part of its program. Contact J-KEM for more information.

Pump Addressing

Kem-Pump supports operating up to 16 independent pump modules, that means a system can consist of up to 16 single pump modules, 8 dual pump modules, or any combination of the two. To operate multiple pumps each pump must have a unique *address*. If your pump system consists of one single pump, then it will always have the factory programmed address of '1', or if you have a dual pump system, then the first pump module will have the address of 1 and the second the address of 2.



When the concept of pump *address* becomes important is when you begin to connect multiple pumps to the same PC. For example, if you ordered a one single position pump and one dual position pump, the single pump will have an address of '1' and the two modules in the dual pump will have the addresses of '1' and '2'. If these two systems are connected to the PC at the same time, the single pump, with an address of '1' and the first module in the dual pump, with an address of '1' will conflict with each other. In this case, KEM-Pump would display an error message and the software would not start.

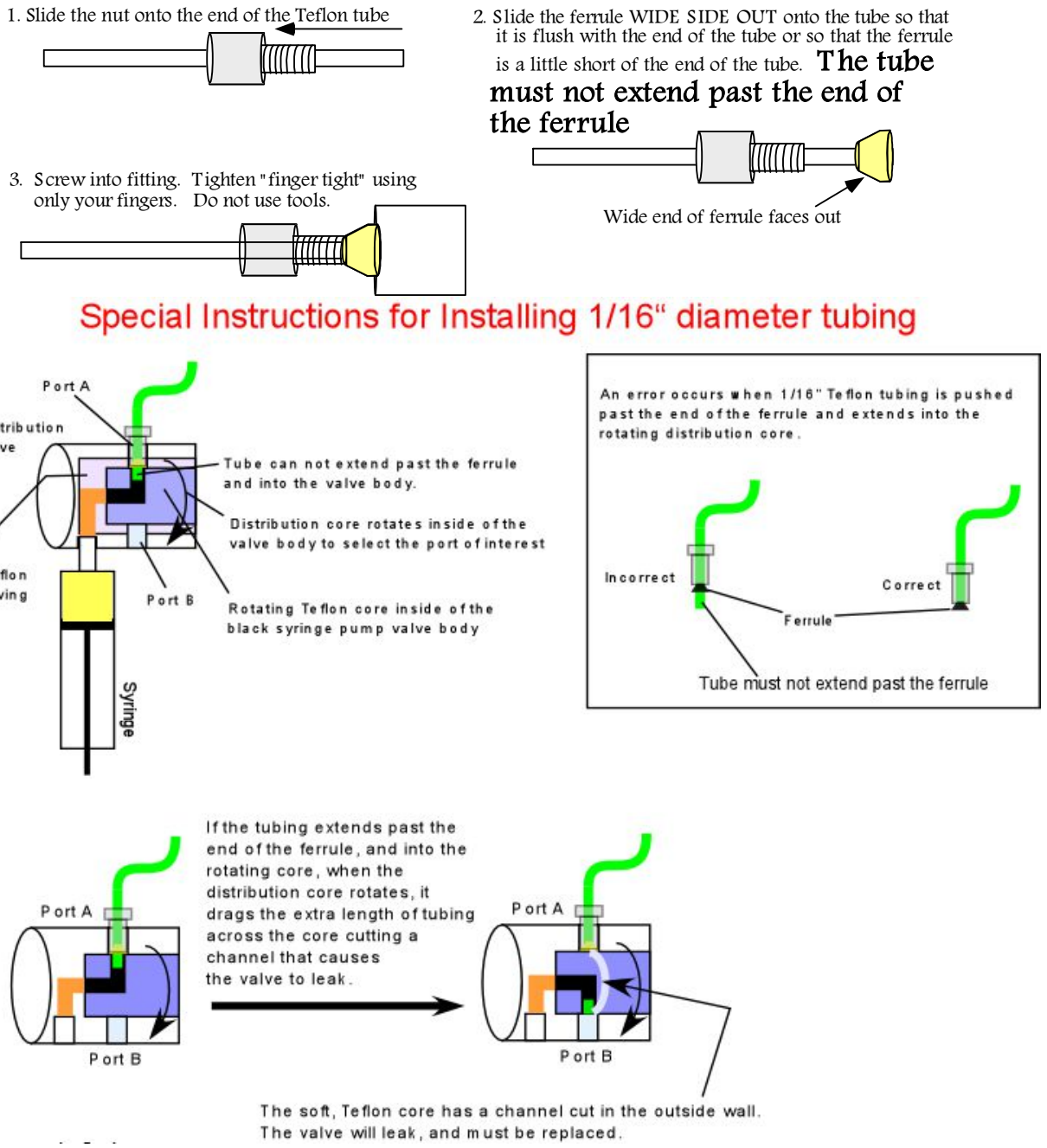
To correct this problem, either the address in the single pump must be changed to '3' or the addresses in the dual pump can be changed to '2' and '3'. Just to complete this discussion, if you have 5 single pumps and want to operate them as 5 independent pump systems on a single copy of KEM-Pump, then the address in the five modules need to be changed to 1 to 5. For information on how to change a pumps address, see the discussion titled Changing a Pumps Address in the section of this manual titled Installing a Syringe or Distribution Valve.

Hardware Installation

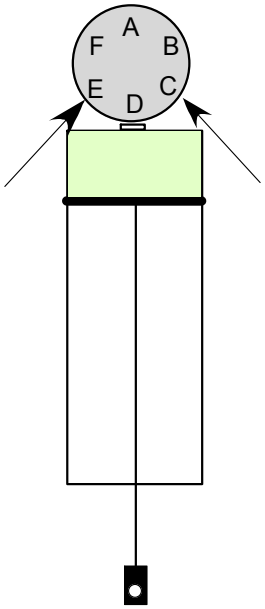
Pump and Valve Installation - If you will be installing your own syringe and/or distribution valve, see the instructions in the section titled Installing a Syringe or Distribution Valve.

Installing a syringe or valve involves two steps. 1) Physically attaching the valve and syringe to the pump module, and 2) configuring the pump software to operate the syringe size and the port type attached. Both steps are described in the section titled Installing a Syringe or Distribution Valve.

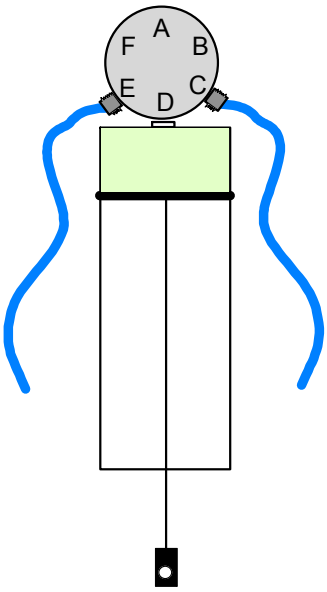
Tubing Installation – The fittings that secure tubing to the black distribution valve are ¼-28 finger tight fittings. The ferrule must be placed on the tubing properly for a fluid tight connection.



When a large diameter syringe is used, like a 25 or 50 ml syringe, connection to the ports at the bottom of the valve often become obstructed by the syringe. For example, on the 6-port valve at the right, port D is behind the syringe and is complexly inaccessible (which often is acceptable, since this port can be used to fill the syringe with air which is used to push other fluids through the remaining solvent lines).
Ports C and E are inaccessible to standard fittings and require a “Headless Nut” to make a fluid connection to these ports. Headless nuts screw almost all the way into the valve avoiding contact with the syringe.
Headless nuts can be ordered from J-KEM (see below).
To install headless nuts to a distribution valve the syringe must be removed from the pump to make the ports accessible, once the tubing is attached to the valve (using the headless nut), the syringe can be reinstalled.



To make tubing connections to a distribution valve using a headless nut:
1) Remove the syringe from the pump by first removing the screw at the end of the syringe plunger, then unscrew the syringe from the valve.
2) Attached tubing to the desired port using the headless nut and ferrule.
3) Screw the syringe into the valve, but don‘t over-tighten it.
4) Reattaching the screw through the bottom of the syringe plunger is a very critical step. Follow the instructions in the section titled Installing a Syringe or Distribution Valve in our User Manual EXACTLY.

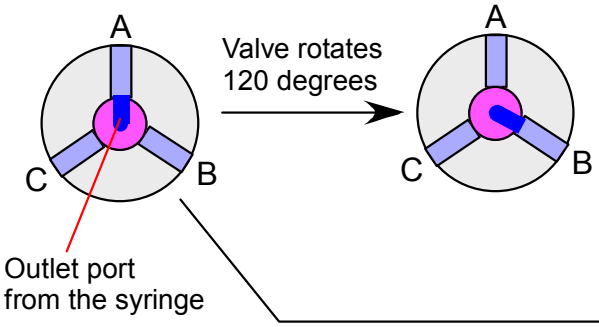


Headless nut for 1/8“ OD tubing -
Cat# JXF-368-18, Price $ 12.72 each.
Headless nut for 1/16” OD tubing -
Cat# JXF-368-16, Price $ 12.72 each.

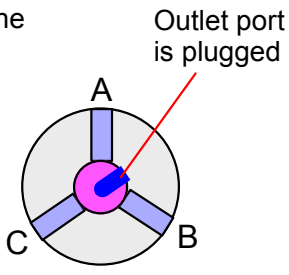
Valve Port Configuration

When a new distribution valve is placed on the pump, the configuration of the system (stored in pump memory) MUST be changed to reflect the actual syringe size in use and the number of ports on the distribution valve. If an incorrect valve configuration is stored, damage will occur to the valve.

For example, if the pump has a 3-port valve and the pump’s configuration is set to a 3-port valve, when the valve is commanded to go from Port A to Port B, the valve correctly rotates 120 degrees.

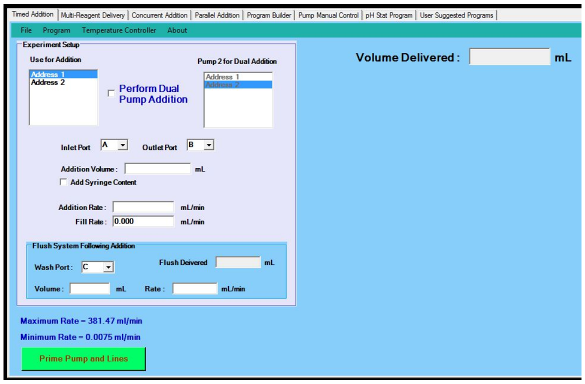


But if a 6-port valve is stored in the pump’s configuration, when in reality it has a 3-port valve on the pump, when the pump is commanded to move to Port B, the valve rotates 60 degrees which blocks the outlet of the valve. If the syringe attempts a dispense in this valve position, the Teflon inside of the valve will distort due to excess pressure and the valve must be replaced.



The Timed Addition Program

The timed addition program allows the pump to add any volume of a single reagent at a user specified rate. The pump has two addition modes depending on the rate of addition. The maximum rate is listed on the bottom of the screen. Rates above the Minimum Continuous Rate, also at the bottom of the screen, are added as a smooth, continuous stream of fluid. Flow rates below the Continuous Rate are added as discrete injections in one second increments.



To set up a Timed Addition experiment, you must enter the following information.

Inlet Port – Select the port on the distribution valve reservoir of reagent is connected to.
Outlet Port – Select the port on the distribution valve that you want the reagent to be delivered out of.
Addition Volume – Enter the volume of reagent to deliver. This program will delivery any volume from any syringe since it handles refilling the syringe automatically. For example, this program can use a 5 ml syringe to delivery 35 mls of reagent.

Add Syringe Content – The function of this check box is explained at the end of this section.
Fill Rate – This is the infusion rate that the program uses when filling the syringe. The program automatically enters a fill rate that is just slightly faster than the dispense rate. The fill rate can be changed by the user to any flow rate allowed for the syringe size in use as long as the fill rate is faster than the dispense rate.

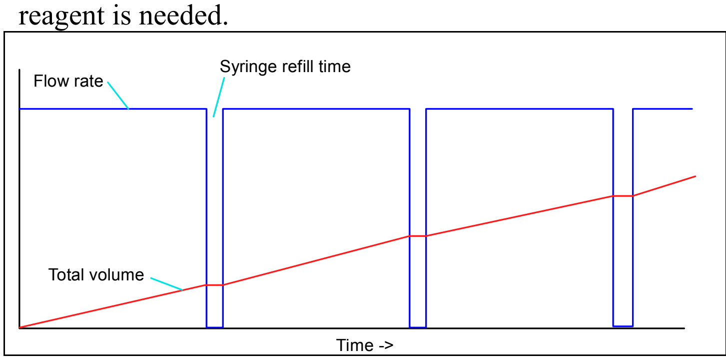
Flush Delivery Line

After the addition of the reagent is complete, it's often desirable to flush the reagent that remains in the delivery line into the reactor using a wash solvent. Depending on whether the outlet line is primed (see later), the reagent remaining in the delivery line is part of the reagent volume that was requested to be delivered, so normally, this reagent is flushed into the reaction system. The delivery line is flushed using the settings in the "Flush System Following Addition" box immediately after the addition of the reagent is complete. If you do not want to flush the reagent line, these boxes should be left empty.

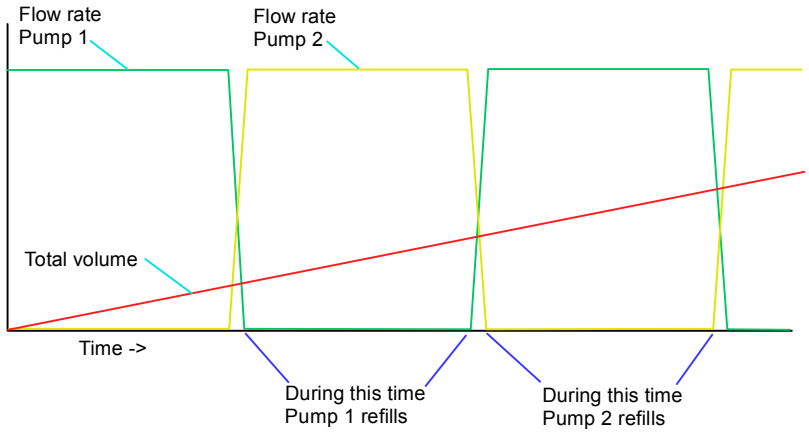
Wash Port – Select the port on the distribution valve that the flush solvent is attached to. This port can be open to the air (to flush with air) or it can be a reaction or wash solvent.
Volume – Enter the volume of the flush solvent used to purge the delivery line..
Rate – Enter the flow rate for the addition of the flush solvent.

SYR-2400, Dual Position Syringe Pump, Only

Since the SYR-2400 is a two pump system, the user has the option of selecting which pump to use for the delivery. The options are to use a single pump, either Pump 1 or Pump 2, or to use both pumps reciprocating delivery, which results in a continuous, delivery of reagent.
Select the pump to use in the selection box titled "For Addition Use Pump". The main difference between using a single pump (either Pump 1 or Pump 2) and using both pumps is the way the pump refills when additional reagent is needed.



During a single pump addition, the syringe fills with reagent, delivers its content, and then pauses delivery, for about 5-8 seconds while it refills. If this break in the continuous delivery of solvent is undesirable, the dual pump addition should be selected.



Dual pump delivery uses both pumps in a reciprocating manor which results in a continuous delivery of reagent. First, pump 1 delivers reagent, then just at the moment when pump 1 is about to empty it decelerates its delivery and pump 2 concurrently accelerates its delivery. A very small perturbation of delivery can result at the moment when the system is transitioning from one to the other pump. To minimize, or eliminate, this perturbation, the user can adjust the acceleration/deceleration timing using the menu option Programs -> Syringe Transition Time. The default value is 400 ms.

If a single pump was used for the dispense and the option to flush the delivery line was selected, then only that pump is used for flushing. If both pumps were used, then the volume of the flush solvent is split between the two pumps and both pumps flush the delivery line.

Prior to starting a run, it's often desirable to prime the systems inlet and outlet lines. Priming is the process of replacing the air in the lines with solvent or reagent. To accomplish this, click the green button titled Prime Pump and Lines and the screen below appears. This screen present controls that all you to manually withdraw or dispense solvent through any port on the syringe pump valve. When the system is primed to your satisfaction, click the button titled Close Prime Screen.

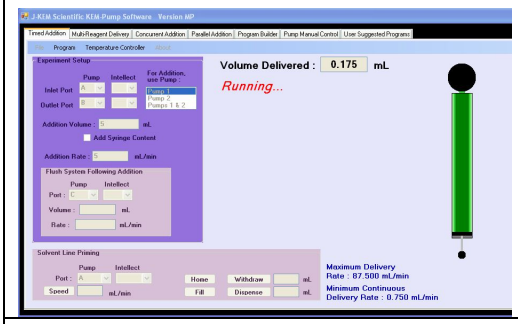
Pump – In multi-pump systems, selects the pump to operate on
Port – Selects the port on the distribution valve that the pump is connected to.
Speed – Sets the flow rate for the syringe.
Home – Empties the syringe from to selected syringe pump port.
Dispense – Dispenses the specified volume from the syringe
Fill – Fills the syringe from the selected syringe pump port.
Withdraw – Withdraws the specified volume into the syringe

Stop – This is only visible while the pump is dispensing fluid, but clicking this button immediately stops the flow of fluid from the syringe pump.

A reasonable sequence of events to prime the outlet line would be:
1. Select the PORT that the reagent is attached to.
2. Click the FILL button to fill the syringe with reagent.
3. Click the HOME button to purge air from the inlet line.
4. Click the FILL button again to fill the syringe with reagent.
5. Select the port that the reactor is attached to.
6. Enter a slow flow rate (5 ml/min)
7. If the volume of the delivery line is guessed to be 3 ml, enter 4 ml into the text box associated with the Dispense button, then click the dispense button. The pump starts to dispense reagent into the delivery line. Visually follow the reagent through the line and when air is flushed from the line and the first drop of reagent is about to exit, click the Stop button to halt reagent delivery.
8. The reagent remaining in the syringe can either be left in the syringe (since the program is about to use it), or it can manually be placed back into the reagent reservoir using the controls in the Prime group box.

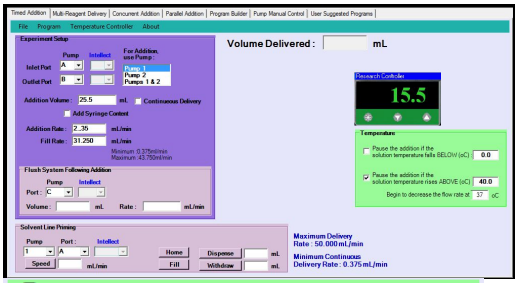
Add Syringe Content Feature

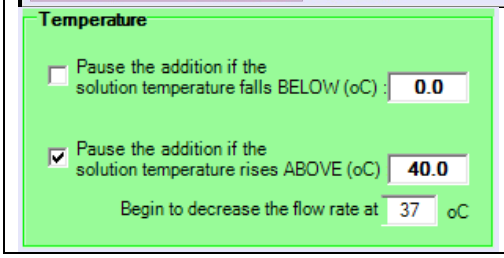
A special case for the Timed Addition Program occurs when you want to add the entire volume of a reagent, but you don't know what that volume is. For example, let's say you just worked up a reaction and the product of that reaction is in a flask. You don't know the exact volume of the reaction product, you simply want to "add it all, whatever the volume is". In this case, you can use the controls in the Prime group box to withdraw all the product into the syringe, then rather than entering a specific volume of reagent to add, click the check box titled "Add Syringe Content". The program will calculate the volume in the syringe and enter it into the Addition Volume text box automatically. The syringe can be washed, and the reagent left in the delivery line added to the reactor by using the feature of a Flush Step.



Once the appropriate addition data is entered into the Experiment Setup screen, to start the addition, select 'Start' from the Program menu on the Timed Addition tab. While a program is running, all other controls of the KEM-Pump application are disabled.

A Timed Addition program can be aborted by selecting Abort from the Program menu on the Timed Addition tab.

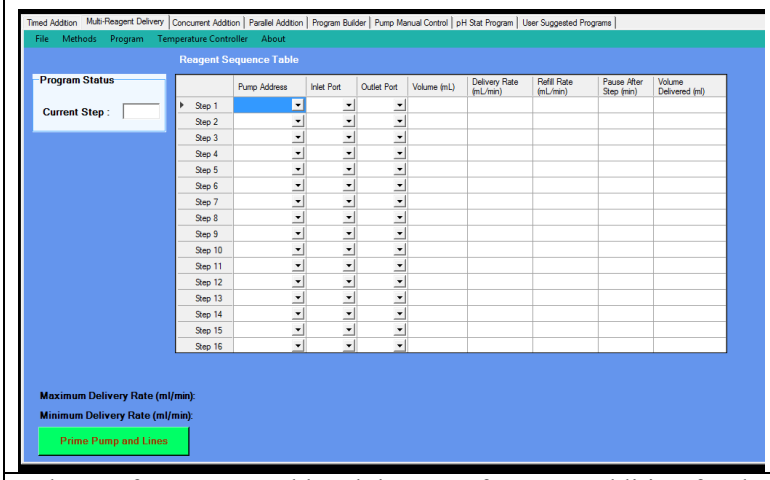




The function of a J-KEM temperature controller can be added to the software interface of the syringe pump. This provides a single interface for processes requiring temperature control during the pumping sequence. The form adds a new control that allows the user to select if the addition of reagent pauses if the reaction temperature goes below or above a user set value.
In the case on the left, the addition of reagent will proceed at the user specified rate until the solution temperature reaches 37C, between the temperatures of 37 to 40C, the rate of addition slows, then when the solution temperature reaches 40C, the addition completely stops. When the solution temperature decreases to below 40C, the addition resumes.
For a full description of the temperature control function, see the section titled "Temperature Controller Functionality".

The Multi-Reagent Delivery Program

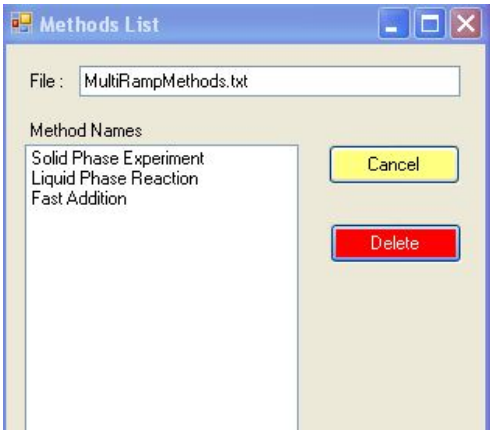
The Multi-Reagent Delivery program is selected by clicking on the tab of the same name. This program sequentially adds up to 16 reagents, at independent rates and volumes. For each step the user can specify the inlet and outlet ports, allowing multiple reagents to be added to multiple reactors.



Reagent Sequence Table – The user can program up to 16 reagents to sequentially dispense and requires that the user fill in only the number of steps desired. The options, and the number of columns in the table changes depending on whether a temperature controller is part of the syringe pump system. When a temperature controller is not part of the pump system, the Multi-Reagent table has the appearance shown at the left To create an addition step, start at Step 1 and select the port on the distribution valve that the first reagent is attached to. Enter the volume of reagent to add and the rate of reagent addition for the step. After the reagent addition is complete, the program can pause for a period of time by entering a Pause time in this column of the table. If the pause time is 0, the program immediately proceeds to the next addition step. Select the port to dispense the reagent out of, this is the Outlet Port. The rate to fill the syringe can be optionally set, which is useful when filling the syringe with viscose reagents. The program continues until all of the additions defined in the table are complete.
To reset the table for a new experiment, select Clear Sequence Table from the Program menu.

Before starting an experiment, inlet and outlet lines can be manually primed by using the controls on the Manual Control tab. Once the system is in an appropriate starting condition, reselect the Multi-Reagent Delivery tab.
Once the desired addition sequence is defined in the Reagent Sequence Table, the experiment is started by selecting Start from the Program menu on the Multi-Reagent Delivery tab.
A running program can be terminated by selecting Abort from the Program menu.

SYR-2400, Dual Position Syringe Pump, Only
If the SYR-2400 (dual pump) system is in use, the table adds an additional column titled Pump Address. In this column, the user can select which pump to use for each step, Pump 1 or 2.

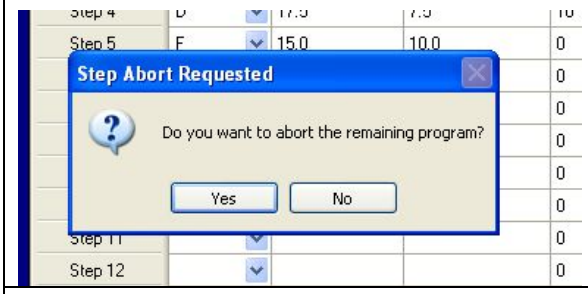


Once an experimental method if fully defined (by entering all the required information in the Reagent Sequence Table), you have 2 options. You can either start the experiment, or you can first save the method for future recall. The Methods menu contains three options:

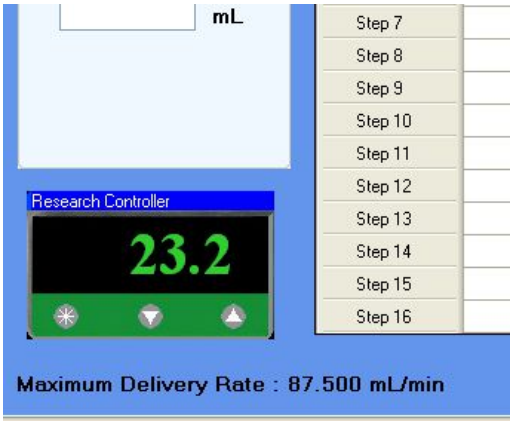
Save Method – To save the method currently defined on the screens, choose this option. When selected, a pop-up window appears prompting for a method name. Enter the name, then click OK.

Recall Method – Selecting this option brings up a list of all saved methods. Double clicking on the desired method will recall and populate the Multi-Reagent table with the saved method.

Delete Method – Selecting this option brings up a list of all saved methods. Select the method to delete by clicking on the method name, then click the Delete button.



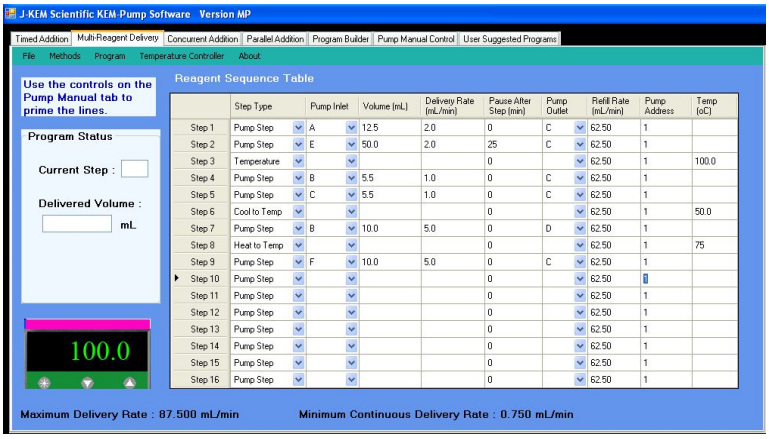
A running program can be terminated by selecting Abort from the Programs menu. When Abort is selected a popup window offers the option of aborting all remaining steps or just the current step. If you select Yes, the running program with any remaining addition steps are aborted. If you select No, the current step is aborted and the program continues at the next step in the sequence. When No is selected, any reagent remaining in the syringe is returned to the appropriate reagent reservoir before starting the next step.



The function of a J-KEM temperature controller can be added to the software interface of the syringe pump. This provides a single interface for processes requiring temperature control during the pumping sequence. For a full description of the temperature control function, see the section titled "Temperature Controller Functionality".

Highlights include:

- On-screen temperature display and control.
- 16-Step temperature ramp.
- Setting the controllers setpoint as part of the Multi-Reagent program.
- **An optional software add-on allows the rate of reagent addition to be controlled as a function of reaction temperature.**



Adding a Temperature Controller to the Multi-Reagent Program – A temperature controller can be added as an element of the Multi-Reagent program. When this is done, the addition of reagents can be made to be a function of the sensed temperature. To add a controller to the form, connect a J-KEM temperature controller to a USB port on the PC running the syringe pump software, then select Find Controller from the Temperature Controller menu. When the software finds the controller, an image of the controller appears on the lower left corner of the form, and two new columns are added to the table. The first column in the table allows the user to enter a "Step Type". The Multi-Reagent program supports four step types.

	Step Type	Pump Inlet	Volume (mL)	Delivery Rate (mL/min)	Pause After Step (min)	Pump Outlet	Refill Rate (mL/min)	Pump Address	Temp (oC)
Step 1	Pump Step	A	12.5	2.0	0	C	62.50	1	
Step 2	Pump Step	E	50.0	2.0	25	C	62.50	1	

The first step type is a "Pump Step" step. A pump step allows the user to program a standard addition step that adds a specified volume of reagent over a specified period of time. For a pump step, as soon as the current step completes, it immediately starts the next step in the table.

Step 2	Pump Step	E	50.0	2.0	25	C	62.50	1	
Step 3	Temperature				0		62.50	1	100.0
Step 4	Pump Step	B	5.5	1.0	0	C	62.50	1	

The second step type is a "Temperature" step. A temperature step (Step 3 above) allows the user to change the set point temperature of the controller. In the example above, as soon as Step 2 completed, Step 3 would change the set point in the attached controller to 100° C, and then immediately start Step 4.
For a Temperature step, only the desired set point temperature needs to be entered in Temp column.

Step 5	Pump Step	C	5.5	1.0	0	C	62.50	1	
Step 6	Cool to Temp				0		62.50	1	50.0
Step 7	Pump Step	B	10.0	5.0	0	D	62.50	1	

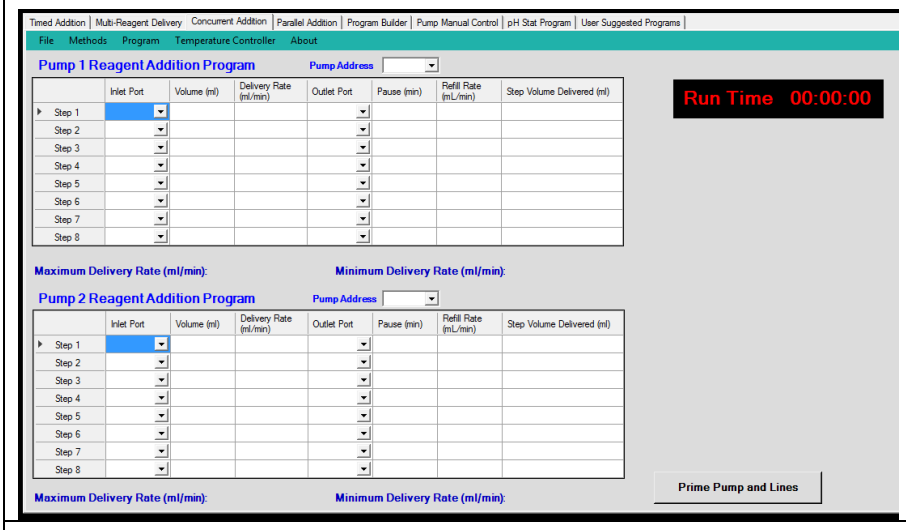
The third step type is a "Cool to Temperature" step. A cool to temp step changes the temperature controllers set point to the value entered in the table, and then pauses the syringe pump program until the temperature sensed by the controller falls to the entered temperature. In the example above, as soon as Step 5 completes, Step 6 changes the temperature controllers set point temperature to 50° C, and then holds at Step 6 until the temperature sensed by the controller cools to 50° C. As soon as the sensed temperature cools to 50° C, the program continues to Step 7.
For a Cool to Temperature step, only the desired set point temperature needs to be entered in Temp column.

Step 7	Pump Step	B	10.0	5.0	0	D	62.50	1	
Step 8	Heat to Temp				0		62.50	1	75
Step 9	Pump Step	F	10.0	5.0	0	C	62.50	1	

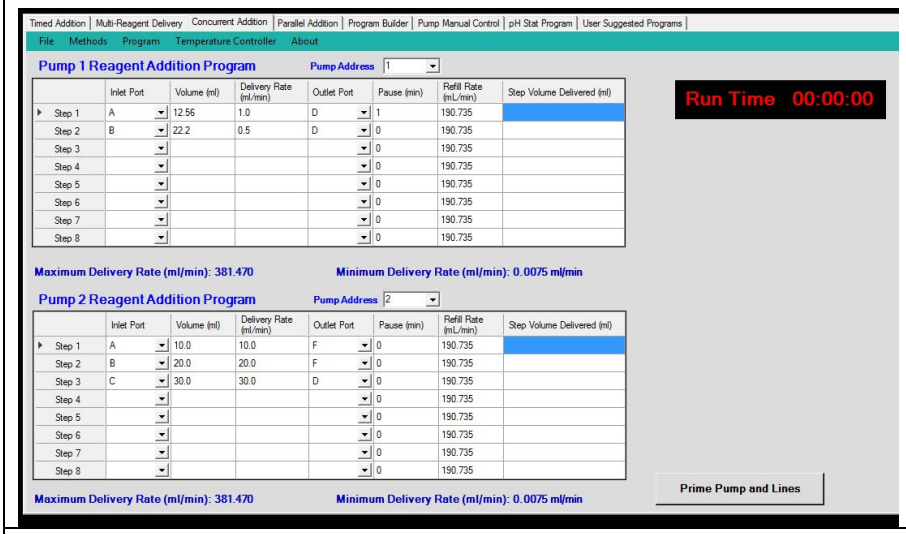
The forth step type is a "Heat to Temperature" step. A heat to temp step changes the temperature controllers set point to the value entered in the table, and then pauses the syringe pump program until the temperature sensed by the controller rises to the entered temperature. In the example above, as soon as Step 7 completes, Step 8 changes the temperature controllers set point temperature to 75° C, and then holds at Step 8 until the temperature sensed by the controller heats to 75° C. As soon as the sensed temperature heats to 75° C, the program continues to Step 9.
For a Heat to Temperature step, only the desired set point temperature needs to be entered in Temp column.

The Concurrent Addition Program

The Concurrent Addition Program only appears for Dual Syringe Pump systems. This program simultaneously runs two completely independent reagent delivery programs, one from each pump, in parallel with independent rates, port selection, and volumes.
The program can be used to simultaneously add two different reagents to the same process, or run two independent processes.



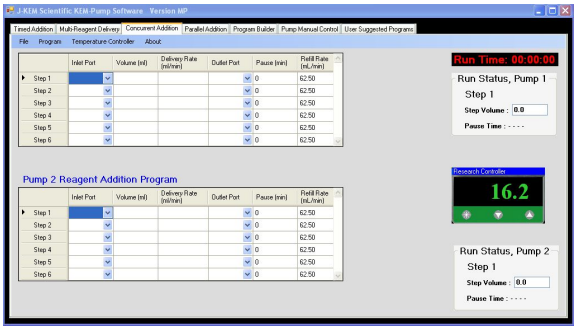
Reagent Addition Program
Each pump has an 8-step table that is used to construct the addition program for that pump. The addition programs for each pump run simultaneously, but independently of each other. The tables for each pump can have the same, or different, number of steps. A program terminates when the last user programmed step completes.



The table at the left shows an example of a five step program entered for Pump 1 and a four step program entered for Pump 2. To start these programs, select Start from the Program menu on the Concurrent Addition tab. The Run Status box to the right of each of the pump programs updates during the run to show the status of that pump.
A running program can be aborted by selecting the Abort command from the Program menu. Aborting a program terminates the run for both pumps.

Inlet Port – The port on the distribution valve that the reagent reservoir is attached to.
Volume (mL) – The volume of reagent to deliver.
Delivery Rate (mL/min) – The rate to dose the reagent from the syringe pump.
Outlet Port – The port on the distribution valve that the reagent is delivered from.
Pause (min) – Following the addition of the reagent, or a temperature equilibration step, the process can pause for a set period of time before proceeding to the next step.
Refill Rate (mL/min) – The rate to fill the syringe can be optionally set. This is useful when filling the syringe with viscose reagents.

To clear both tables in preparation for another program, select Reset Program from the Program menu.



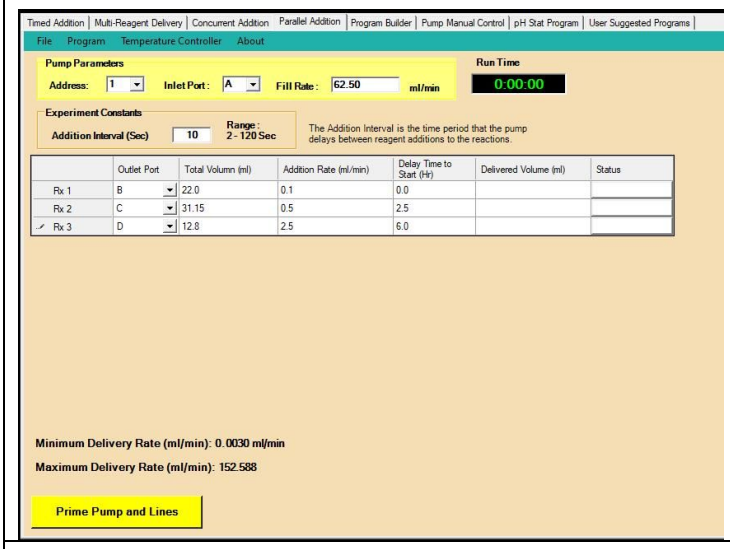
The function of a J-KEM temperature controller can be added to the software interface of the syringe pump. This provides a single interface for processes requiring temperature control during the pumping sequence. For a full description of the temperature control function, see the section titled "Temperature Controller Functionality".

Highlights include:

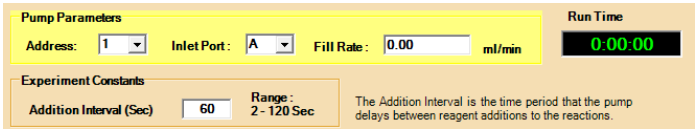
- On-screen temperature display and control.
- 16-Step temperature ramp.
- **An optional software add-on allows the rate of reagent addition to be controlled as a function of reaction temperature.**

Parallel Addition Program

This program uses a single pump (or dual pump system) to add a single reagent to multiple reactors in parallel at independent addition rates. For example, a common reagent can be attached to one of the pumps distribution valve ports (this is an inlet port), then delivery lines to 4 separate reactors are attached to 4 separate ports on the pumps distribution valve, (these will be outlet ports.).



The pump fills the syringe with reagent from the common reagent port, and then sequentially accesses each of the ports connected to the 4 different reactors. When each reactor is accessed, the pump delivers the aliquot of reagent needed to satisfy the delivery rate specified by the user. This process continues until the volume of reagent has been delivered to each reactor at the rate specified.



.

Inlet Port – Select the port that the common reagent is attached to.

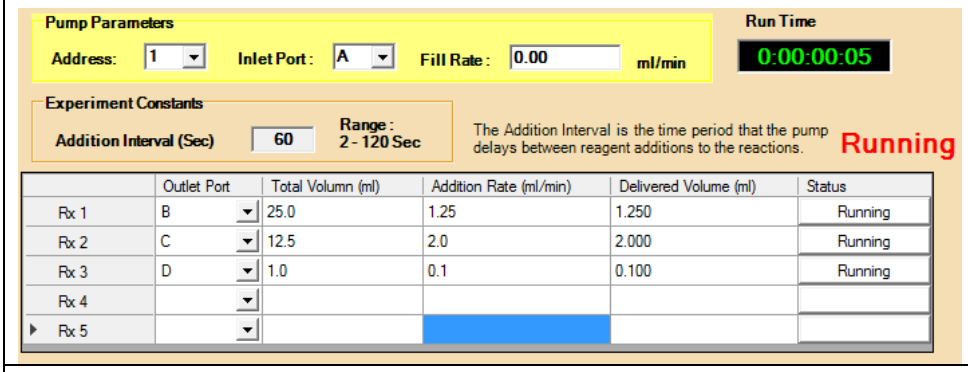
Fill Rate – Enter the speed that the pump should use when refilling the syringe. This box contains the default speed of the pump, but for viscose reagents, the speed should be set to lower values.

Additional Interval – This program works by sequentially moving the distribution valve to the outlet port of each reactor and dispensing small amounts of reagent each time the port is accessed. The Addition Interval value is the amount of time that the pump pauses between addition cycles. One cycle is the process of the pump dispensing reagent from each active port. How often the pump starts an addition cycle determines the aliquot volume added to each reactor. For example, if the addition rate to a reactor is set to 1 ml/min, and the Addition Interval is set to 1 second, then 60 times per minute, the pump will add 16.7 ul aliquots of the reagent to the reactor (i.e., 16.7 ul * 60 = 1 ml). If the addition rate to a reactor is set to 1 ml/min, and the Addition Interval is set to 5 seconds, then 12 times per minute, the pump will add 83.3 ul aliquots of the reagent to the reactor (i.e., 83.3 ul * 12 = 1 ml). The shorter the Addition Interval, the smaller the aliquot of reagent that is added to a reactor, but short Addition Intervals may require many thousands of operations of the pump's distribution valve, causing it to age faster. In general, pick the longest Addition Interval that provides an aliquot addition volume suitable to the addition requirements. If the addition interval is shorter than the time needed for one addition cycle, the program will automatically change it to the shortest time possible.

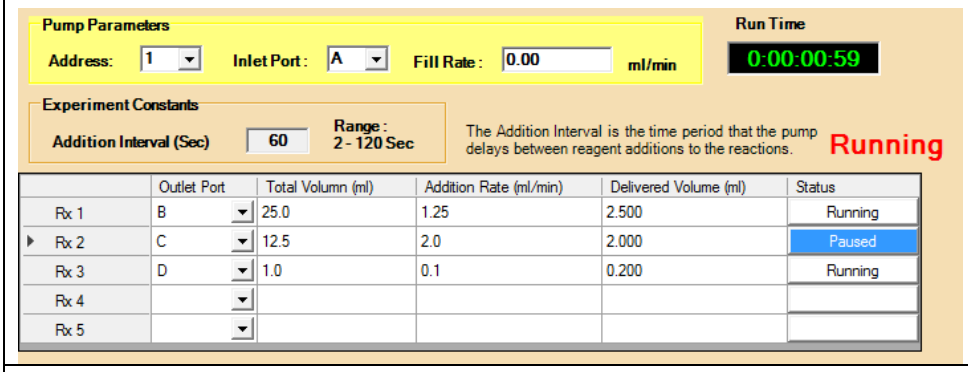
	Outlet Port	Total Volumn (ml)	Addition Rate (ml/min)	Delay Time to Start (Hr)	Delivered Volume (ml)	Status
Rx 1	B	22.0	0.1	0.0		
Rx 2	C	31.15	0.5	2.5		
Rx 3	D	12.8	2.5	6.0		

The reaction construction table populates with one less row than the number of ports on the pumps distribution valve.
Enter the volume of reagent to add and the rate of addition for each reactor in use.

By default all additions start at the same time, but there is the option of starting one or more additions after a user entered delay time. In this example, Rx 1 start immediately, Rx 2 starts 2.5 hours after the experiment begins and Rx 3 six hours after the experiment begins.



To start the additions, select Start from the Program menu. The table column titled Delivered Volume updates continuously during the course of the addition.



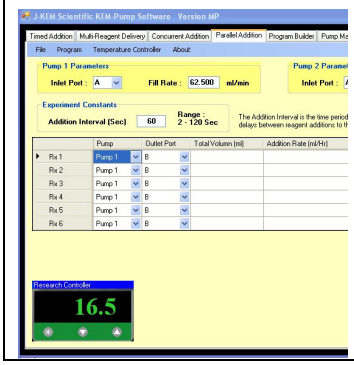
During a run, the addition to any reactor can be paused by clicking on the "Ready" button in the run-time table. When clicked the state of the button changes to Paused.
To release the pause and resume addition to the reactor, click on the "Pause" button to set its state back to Ready.

Menu Commands

Program -> Start Starts the experiment. When a program is started, all other experiment tabs are deactivated to prevent the user from starting a second syringe pump program while this experiment is running.

Program -> End Experiment A program naturally ends when the requested volume of reagent is added to each reactor. To end an experiment before all the reagent is added, select the End Experiment menu option.

Program -> Reset After an experiment completes, select the Reset menu option to clear the table in order to enter data for a new experiment.



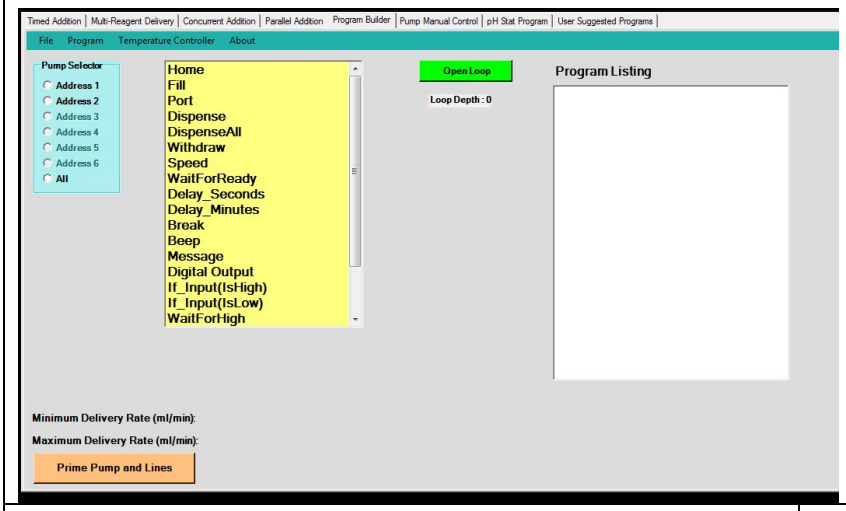
The function of a J-KEM temperature controller can be added to the software interface of the syringe pump. This provides a single interface for processes requiring temperature control during the pumping sequence. For a full description of the temperature control function, see the section titled "Temperature Controller Functionality".

Highlights include:

- On-screen temperature display and control.
- 16-Step temperature ramp.
- **An optional software add-on allows the rate of reagent addition to be controlled as a function of reaction temperature.**

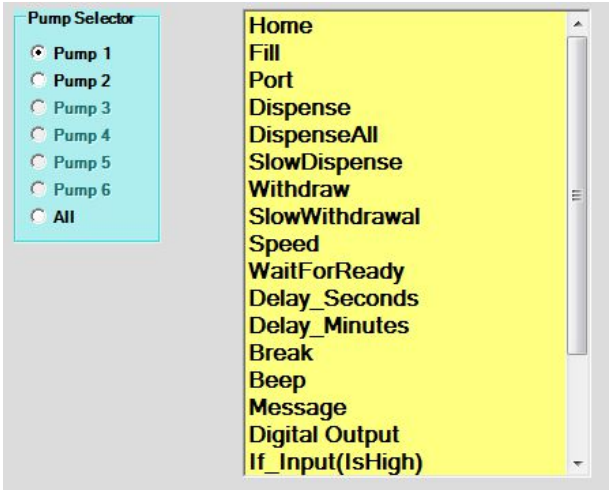
Program Builder

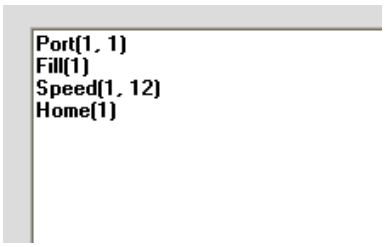
Program builder allows the user to arrange a sequence of pump commands in order to accomplish virtually any desired fluid motion/delivery program. Program builder can be run in either Local mode from the PC connected to the syringe pump, or Remote mode where commands are sent to the pump's PC one at a time from a remote PC, such as when the pump is incorporated into a robotic system.



Local Mode

The user creates a list of commands that the pump executes sequentially. This command list can include discrete pump actions, like change a port position, or dispensing a volume, and the list can include loops and delay times.



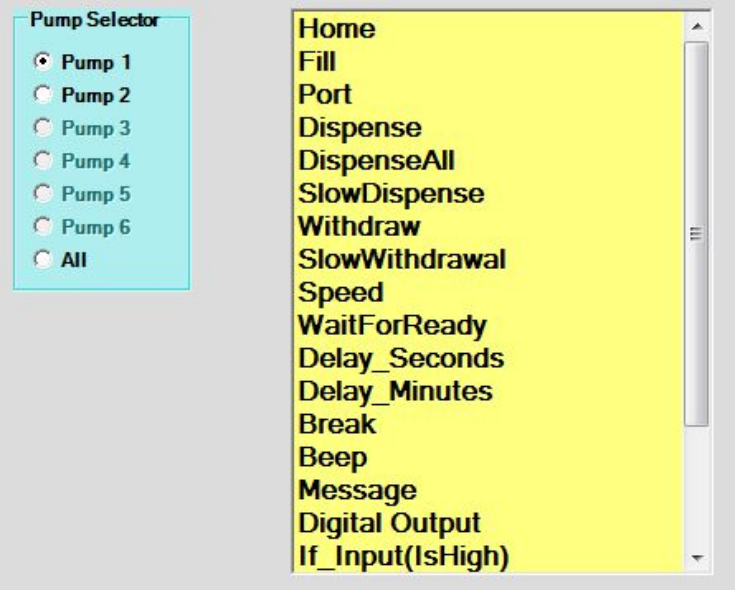


Program Builder consists of several controls, the first is the Command Selection Box. Depending on the options installed on your pump, the command selection box populates with the command available. For systems with a single pump, only the pump 1 pump selection is activated. For dual pump systems, to have pump 1 execute the command, click the Pump 1 radio box, to have pump 2 execute the command, click the Pump 2 radio button, and to have both pumps execute it, click the Both radio button. As an example, if Pump 1 were selected, when the Home command is clicked on, the resulting command is: Home(1)
if Pump 2 were selected, the resulting command would be: Home(2), and if Both pumps are selected, the command would be Home(0). An address of 0 is a global address that causes all connected pumps to execute the command.
As commands are selected from the Command Selection box, they appear in the Program box in the order that they were selected.

Note on Multi-Pump Systems

Multi-pump systems (2 pumps or more) have the option of sending select commands to both pumps simultaneously in order to implement coordinated actions between the pumps. For example, it might be desirable to instruct Pump 1 to deliver 5 ml of reagent at a rate of 1 ml/min and Pump 2 to simultaneously deliver 10 ml of reagent at a rate of 2 ml/min. The execution of simultaneous commands requires special consideration which is dealt with at the end of the Program Builder section of this manual. Look for the section title Execution of Simultaneous Program Builder Commands.

The four commands that allow simultaneous execution are Home, Fill, Dispense, and Withdraw

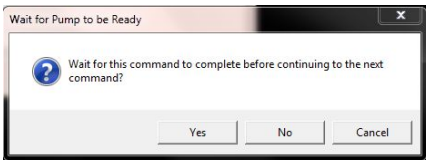


Home – Instructs the selected pump to Home, which expels the entire content of the syringe.

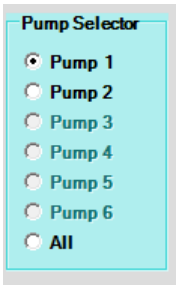
Single Pump Systems – The Home(1) command is added to the Program box as soon as the command is selected.

Multi-Pump Systems – The Home command is one of the four commands that can run simultaneously with other pump commands. When the Home command is selected, a message is displayed asking the user if the command should 'complete' before executing the next command. If you click Yes (the default response), then the specified pump homes its syringe before performing the next command in the command list. For a discussion regarding simultaneously commands, see the section titled

Execution of Simultaneous Program Builder Commands. Remember – for multi-pump systems, you must select the pump that you want to perform the action (i.e. Pump 1, Pump 2, or Both) before clicking on the command in the Command Selection box.



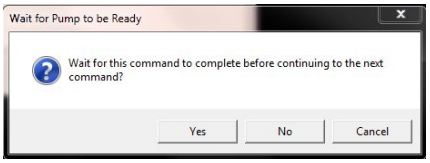
For example, if Pump 1 is selected, then the command that would be added is: Home(1), which will home pump 1, but is Pump 2 is selected, then the command that would be added is: Home(2), which will home pump 2. If 'All' is selected, then the command created is: Home(0), where the address 0 is a global address that causes all connected pumps to simultaneously perform the action.



Fill – Instructs the selected pump to Fill the syringe to its maximum volume.

Single Pump Systems – The Fill(1) command is added to the Program box as soon as the command is selected.

Multi-Pump Systems – The Fill command is one of the four commands that can run simultaneously with other pump commands. When the Fill command is selected, a message is displayed asking the user if the command should 'complete' before executing the next command. If you click Yes (the default response), then the specified pump fill its syringe before performing the next command in the command list. For a discussion regarding simultaneously commands, see the section titled Execution of Simultaneous Program Builder Commands.



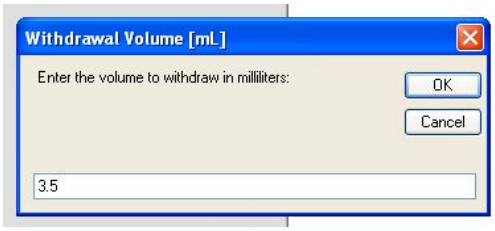
Dispense - Causes the pump to dispense the requested volume.

Single Pump Systems – An input box opens prompting the user to enter the volume to dispense. If a volume is entered that is greater than the current syringe volume, only the content of the syringe is dispensed, then the additional requested volume is ignored. If a volume is entered that is greater than the size of the syringe, an error message is displayed prompting the user to enter a volume no greater than the size of the syringe.

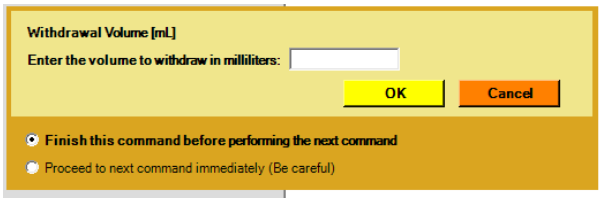
Multi-Pump Systems – An input box opens prompting the user to enter the volume to dispense. Additionally, radio buttons at the bottom of the input box allow the user to select if the dispense action must complete before continuing to the next program command, or if this command should simultaneously be executed with the following command. For a discussion regarding simultaneously commands, see the section titled Execution of Simultaneous Program Builder Commands.

Withdraw – Causes the pump to withdraw the entered volume from the currently selected syringe pump port.

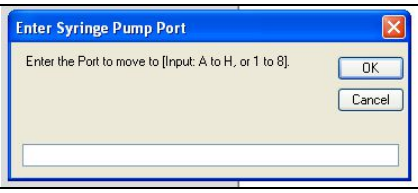
Single Pump Systems – An input box opens prompting the user to enter the volume to withdraw. If a volume is entered that is greater than the volume that will fill the syringe, then the additional requested volume is ignored. If a volume is entered that is greater than the size of the syringe, an error message is displayed prompting the user to enter a volume no greater than the size of the syringe.



Multi-Pump Systems – An input box opens prompting the user to enter the volume to withdraw. Additionally, radio buttons at the bottom of the input box allow the user to select if the withdrawal action must complete before continuing to the next program command, or if this command should simultaneously be executed with the following command. For a discussion regarding simultaneously commands, see the section titled Execution of Simultaneous Program Builder Commands.

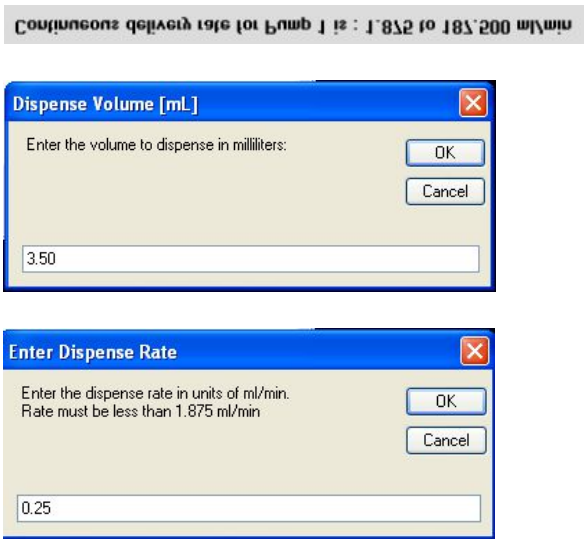
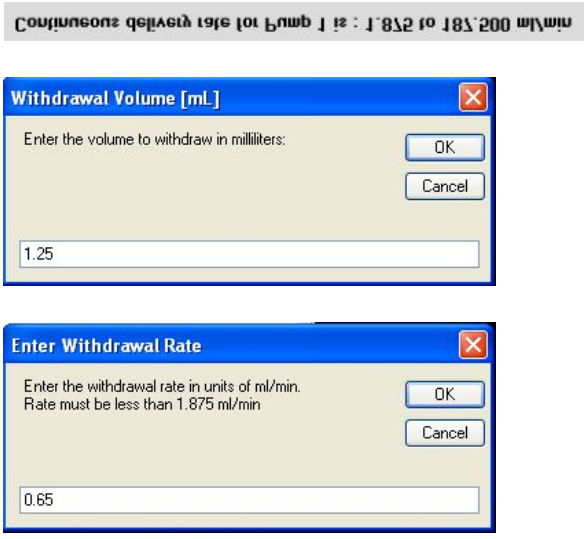
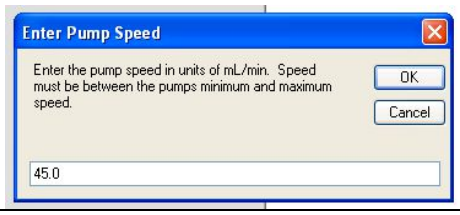


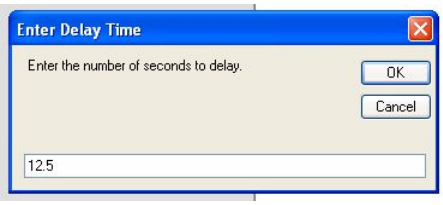
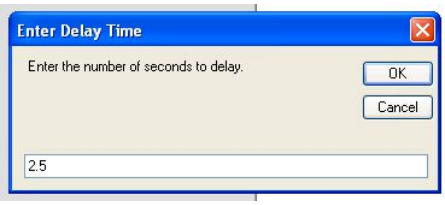
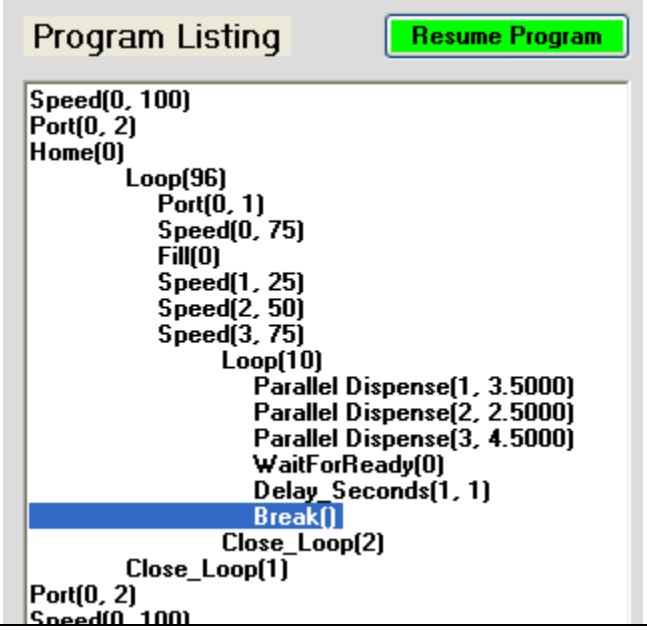
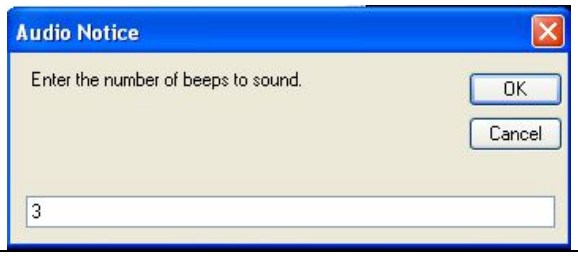
Port – When the Port command is clicked, a input box opens to prompt the user for the port to go to.
Enter the desired port, then clock OK



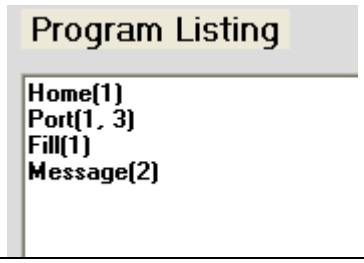
WaitForReady – This command is exclusively used when simultaneous commands are issued. See the section titled Execution of Simultaneous Program Builder Commands.

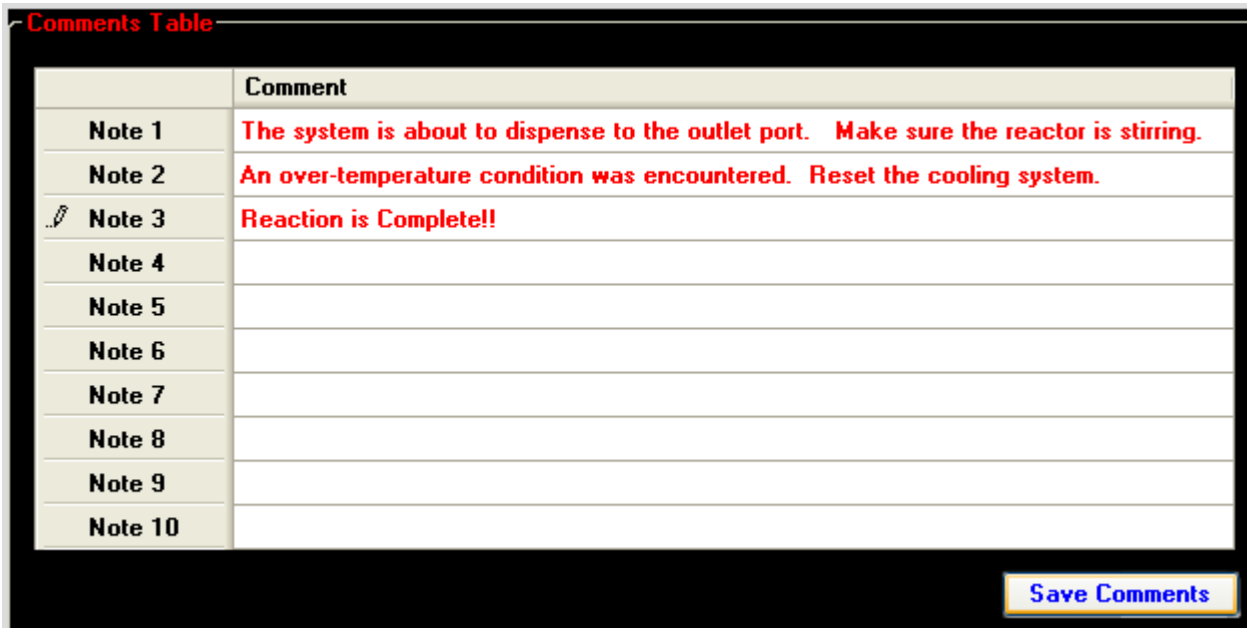
DispenseAll – Causes the pump to dispense the entire user entered volume, independent of what is the current volume or the size of the syringe. When selected, the DispenseAll command first prompts the user to enter the volume to dispense, it then prompts the user to enter the port on the distribution valve that the reagent is connected to. This command works by first using the current content of the syringe to dispense the requested volume. If that volume is less that the requested volume, then the pump positions the valve to the port the reagent is connected to, and continues to refill and dispense the reagent until the requested volume is dispensed. When this command completes, the volume in the syringe is 0.0 ml.

SlowDispense – The syringe pump has two delivery modes, continuous mode and step mode. When possible, continuous delivery mode is the best because it dispenses a continuous stream of fluid with no pauses or gaps, but at very low flow rates, continuous mode does not operate. At the bottom of the form, KEM-Pump shows the range of flow rates that can be achieved using continuous delivery mode, rates below the minimum continuous delivery rate must use step delivery mode. In step mode the pump delivers small aliquots of fluid once per second to achieve the desired flow rate. There is no lower limit to the flow rate in step mode. When SlowDispense is selected, you'll be prompted to enter the volume to deliver and dispense rate in units of ml/min. For dual syringe pump systems, a SlowDispense can be performed in just one pump, or in both simultaneously. The delivery rate for at least one of the two pumps should be its' minimum continuous delivery rate.	
SlowWithdrawal – The syringe pump has two delivery modes, continuous mode and step mode. When possible, continuous delivery mode is the best because it withdraws a continuous stream of fluid with no pauses or gaps, but at very low flow rates, continuous mode does not operate. At the bottom of the form, KEM-Pump shows the range of flow rates that can be achieved using continuous delivery mode, rates below the minimum continuous delivery rate must use step delivery mode. In step mode the pump withdraws small aliquots of fluid once per second to achieve the desired flow rate. There is no lower limit to the flow rate in step mode. When SlowWithdrawal is selected, you'll be prompted to enter the volume to withdraw and the withdrawal rate in units of ml/min. For dual syringe pump systems, a SlowWithdrawal can be performed in just one pump, or in both simultaneously. The withdrawal rate for at least one of the two pumps should be its' minimum continuous delivery rate.	
Speed – Causes the pump to set the speed for withdrawals and dispenses to the user entered value. Speeds are set in units of ml/min. The entered speed must be between the minimum and maximum delivery rate for the pump shown on the bottom of the KEM-Pump screen.	

Delay_Seconds – Causes the pump program to insert a delay for the user entered amount of time before continuing to the next pump command. Times are entered as seconds and can be floating point numbers in the range of 0.001 to 20,000,000. For delays greater or equal to 1 second, the program displays a digital clock that shows the amount to time remaining in the delay. For delays less than 1 second, the digital clock is not displayed.	
Delay_Minutes – Causes the pump program to insert a delay for the user entered amount of time before continuing to the next pump command. Times are entered as minutes and can be floating point numbers in the range of 0.001 to 20,000,000. During the delay, the program displays a digital clock that shows the amount to time remaining in the delay.	
Break – When the Break command appears in a program, the program will run up to the command and then halt execution. The program remains at the Break command until the user clicks the "Resume Program" button appearing at the top of the screen	
Beep – Causes the computers audio system to play a *beep* sound as a warning or to capture the users attention. When prompted, enter the number of Beeps to play when the command is encountered.	

Message – Program Builder allows the user to create up to 10 messages that can be displayed during program execution. The messages are saved to a comment table, then can be displayed by passing the index of the message to display. For example, the code segment to the right causes the message stored at message

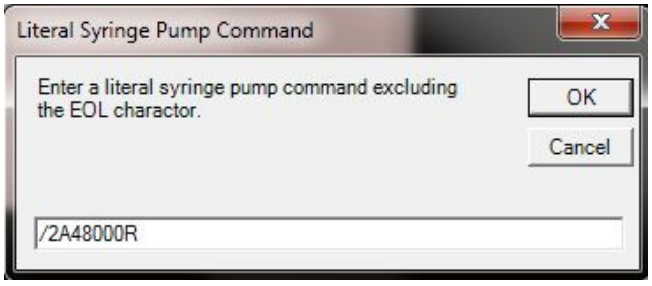




location #2 to display. This is a convenient way to pass program critical messages to a user. While a message is displayed, the program pauses until the user acknowledges the message by clicking the 'OK' button that's displayed with the message.
Messages can be added, edited or deleted by selecting the menu command "Display Comment Table" in the Programs menu tab. When done entering messages, click the Save Comments button.

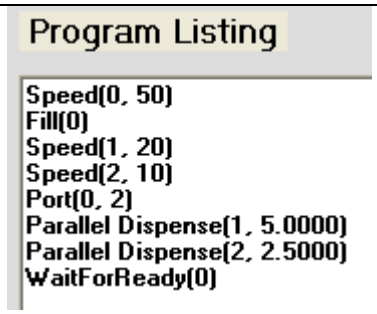
LiteralCommand – This is the most versatile command in Program Builder, but it's also the most difficult. This command allows the user to send in multiple syringe pump commands in one single string by using the pumps native command language. For example, the single command in this program instructs pump 1 to:
Go to Port 2
Set the speed to 5000 steps per second
Go to pump position 48000 (fill the pump)
Go to Port 1
Set the speed to 2000 steps per second

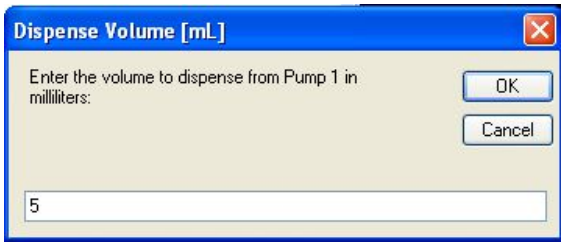
If you have an application that none of the other commands accomplish, contact J-KEM for assistance with the LiteralCommand

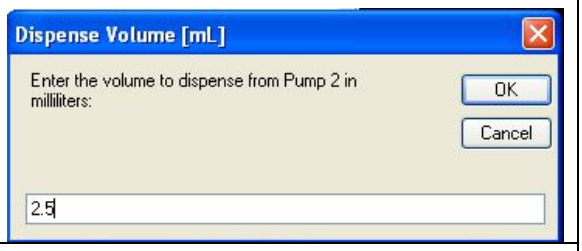



```
Home(1)
LiteralCommand(/1o2v5000A48000o1v2000R, False)
Fill(2)
WaitForReady(1)
```

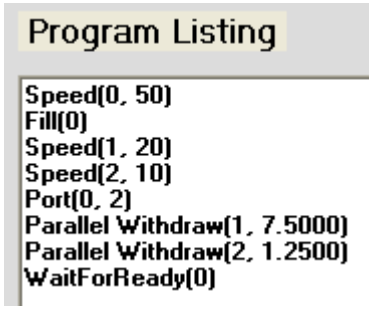
Parallel Dispense – This command handles a special case for multi-position pumps when it's desirable for two different dispense operations to occur simultaneously.
Most commands in the program file occur sequentially, and a command later in the list does not execute until the one preceding it completes. The Parallel Dispense command allows the pumps to dispense different volumes in parallel rather than sequentially. For example, in the short program segment shown to the right, pump 1 will dispense 5ml while pump 2 dispenses 2.5ml in parallel with one another. Earlier in the program, the speed of pump 1 was set to 20ml/min and the speed of pump 2 was set to 10ml/min, so even though the two pumps are delivering different volumes, because they are at different rates, they will complete the dispense at the same time. When selected from the command list, Parallel Dispense prompts the user for the volume to dispense from each active syringe pump. The command WaitForReady(0) is added by the program automatically to ensure that the program waits until both pumps have completed the dispense before proceeding.

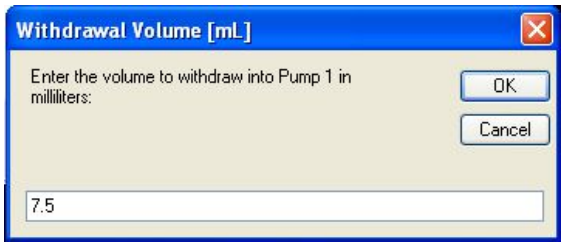


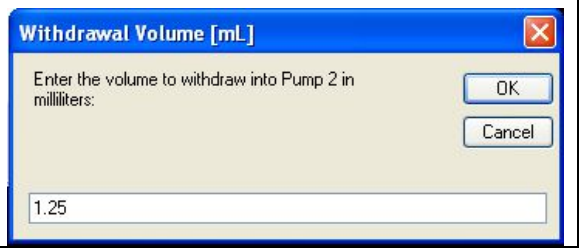


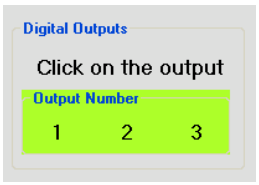
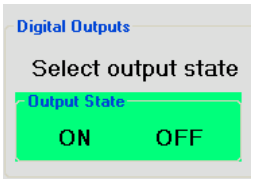
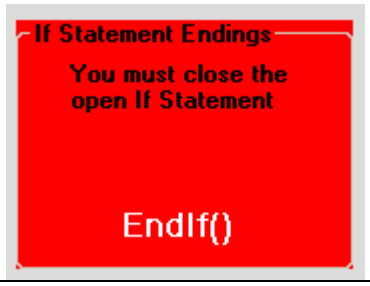
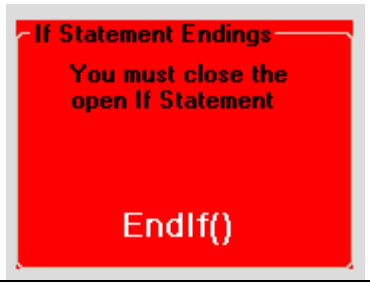


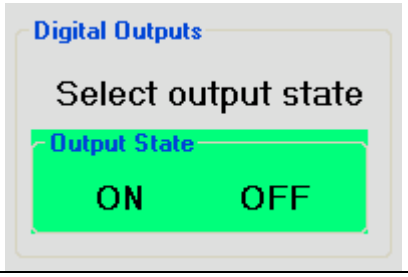
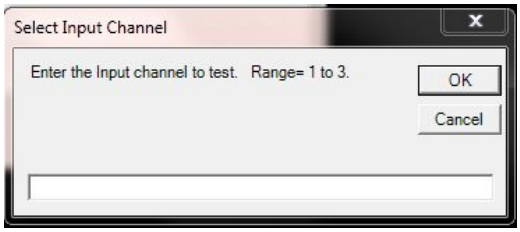
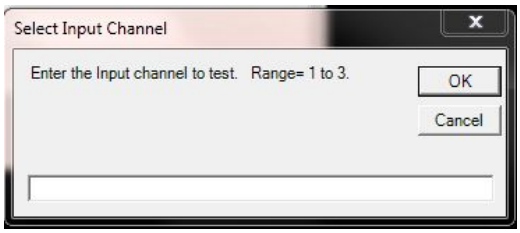
Parallel Withdrawal - This command handles a special case for multi-position pumps when it's desirable for two different withdrawal operations to occur simultaneously.
Most commands in the program file occur sequentially, and a command later in the list does not execute until the one preceding it completes. The Parallel Withdrawal command allows the pumps to withdraw different volumes in parallel rather than sequentially. For example, in the short program segment shown to the right, pump 1 will withdraw 7.5ml while pump 2 withdraws 1.25ml in parallel with one another. Earlier in the program, the speed of pump 1 was set to 20ml/min and the speed of pump 2 was set to 10ml/min, just to show that the pump speeds do not need to be the same. When selected from the command list, Parallel Withdrawal prompts the user for the volume to withdraw from each active syringe pump. The command WaitForReady(0) is added by the program automatically to ensure that the program waits until both pumps have completed the dispense before proceeding.



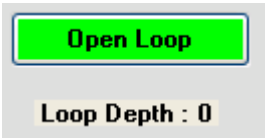


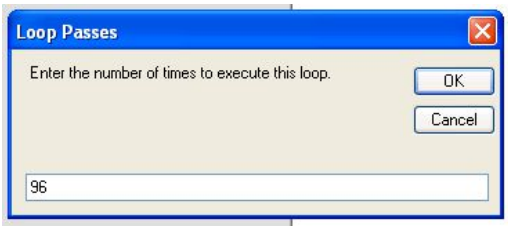


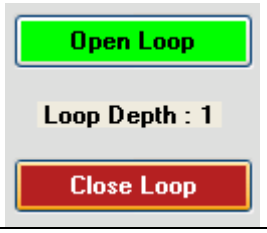
Digital Output – If the pump is equipped with the optional IO package, this command sets the state, either On or Off, of the specified digital output. When selected, the program prompts the user to select the output channel (1-3), then once the channel is selected to specify its state (On or Off). For dual position pumps, each pump can have its own output bank consisting of three outputs. If the pump is configured with 3 outputs, these outputs are operated by Pump 1, if it has 6 outputs, then the first three outputs are operated by Pump 1, and the second three are operated by Pump 2. Make sure that the radio button for the correct pump is checked before selecting this command.	 
If_Input(IsHigh) – For units equipped with the optional IO package, this command examines the state of the specified input (1-3), and if the state is High (i.e., >3 Vdc) executes the statements that appear between the If_Input(IsHigh) statement and the EndIf() statement. If the input is low (i.e., <1 Vdc), then the statements in the If block are skipped. When the If_Input(IsHigh) statement is selected, the program prompts the user for the digital input to examine (Range 1-3). After selecting the input to examine, the software opens the If statement. Add any syringe pump commands that should be executed if the selected input is high. When done, click the EndIf() command in the red box to close the loop. Note that another If statement cannot be nested inside of an open If statement.	 
If_Input(IsLow) – For units equipped with the option al IO package, this command examines the state of the specified input (1-3), and if the state is Low (i.e., <1 Vdc) executes the statements that appear between the If_Input(IsLow) statement and the EndIf() statement. If the input is high (i.e., >3 Vdc), then the statements in the If block are skipped. When the If_Input(IsLow) statement is selected, the program prompts the user for the digital input to examine (Range 1-3). After selecting the input to examine, the software opens the If statement. Add any syringe pump commands that should be executed if the selected input is low. When done, click the EndIf() command in the red box to close the loop. Note that another If statement cannot be nested inside of an open If statement.	 

120Vac Outlet – For pumps with the optional 120Vac outlet installed, selecting this command provides the option of turning the Outlet On or Off. When the 120Vac Outlet command is clicked, a new screen appears that prompts the user to select the outlet state, either On or Off. Click on the selected state.	
WaitForHigh – For units equipped with the optional IO package, this command pauses execution of the program until the specified digital input is set to a logical high input level. During program execution, when this statement is encountered, if the specified input is low, program execution pauses until the input goes high. If the specified input is high when the command is encountered, then the program continues past this command.	
WaitForLow – For units equipped with the optional IO package, this command pauses execution of the program until the specified digital input is set to a logical low input level. During program execution, when this statement is encountered, if the specified input is high, program execution pauses until the input goes low. If the specified input is low when the command is encountered, then the program continues past this command.	

Open Loop – Clicking on the Open Loop button, opens a programming element that allows the user to enter a series of commands that appear between the Open Loop and a Close Loop command. Any commands that appear between the Open and Close Loop commands are executed for the number of loop passes entered by the user. For example, clicking on the Open Loop button brings up an input box that prompts the user to enter the number of times to execute the statements in the loop. Once the number of loop passes is entered, the commands inside the loop are added. After adding the last command to run inside the loop, the loop is closed by clicking on the Close Loop button.
The nature of Loops (more commonly known as Do Loops) is beyond the scope of this syringe pump manual to fully cover, but several examples are presented for instruction.

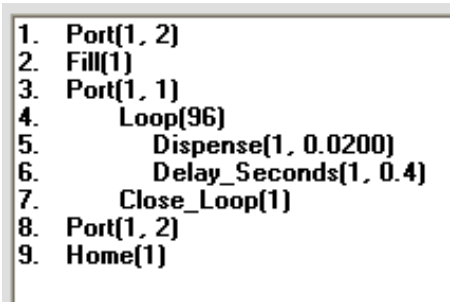






Example 1 – Filling a microtiter plate.
Note, line numbers normally don't appear in pump programs, they were added only for illustration purposes.
This is a line-by-line execution of the program.
Line 1 – The pump positions the valve to Port 2.
Line 2 – The pump fills the syringe.
Line 3 – The pump moves to Port 1 (connected to the outlet line).
Line 4 – The Loop() command is not executable, but it does load the number of loop repetitions, in this case 96.
Line 5 – The pump dispenses 20 microliters
Line 6 – The program delays 0.4 seconds (to give the user time to move the outlet probe to the next well in the titer plate).
Line 7 – The program examines how many times it has executed the loop (Lines 5 & 6), if it is less than 96 times, then the program jumps back to line 5, if this is this is the 96th pass, the program jumps to line 8.
Line 8 – The pump moves the valve to Position 2.
Line 9 – The pump returns the remaining reagent to the reagent reservoir.

What should be noticed in this program is that the user must make sure that the syringe always has enough reagent in the syringe to make the required dispense.



Example 2 – Filling a titer plate with automatic refills

In this example, the pump is fitted with a 10ml syringe, the reagent reservoir is on pump port 2, and the dispensing tip is on pump port 1. This program will allow Loops to be nested 3 deep, in this case, the loop is nested 2 deep.

The program enters the first loop on line 2, this loop consists of all the statements from lines 2 to 10. The statements in the outer loop will be executed 12 times. On lines 3-5 the pump fills with reagents and positions the valve to the dispense port. The nested loop consists of all the statements from lines 6 to 9. The statements on lines 7 & 8 will be executed 8 times before exiting the nested loop. When the nested loop is entered on line 6, the syringe has 10ml of fluid. After executing the nested loop 8 times, the loop exits on line 9. When line 10 is hit, the program jumps back to line 3, where the syringe refills with reagents, then positions itself back to the dispense port. It then reenters the nested loop. The process continues until the outer loop executes 12 times. At the end of this simple program, the pump has added 1ml to each well of a 96 well titer plate (96 ml) using a 10 ml syringe.

```
1.  Home(1)
2.      Loop(12)
3.          Port(1, 2)
4.          Fill(1)
5.          Port(1, 1)
6.              Loop(8)
7.                  Dispense(1, 1.0000)
8.                  Delay_Seconds(1, 0.4)
9.              Close_Loop(2)
10.     Close_Loop(1)
11. Port(1, 2)
12. Home(1)
```

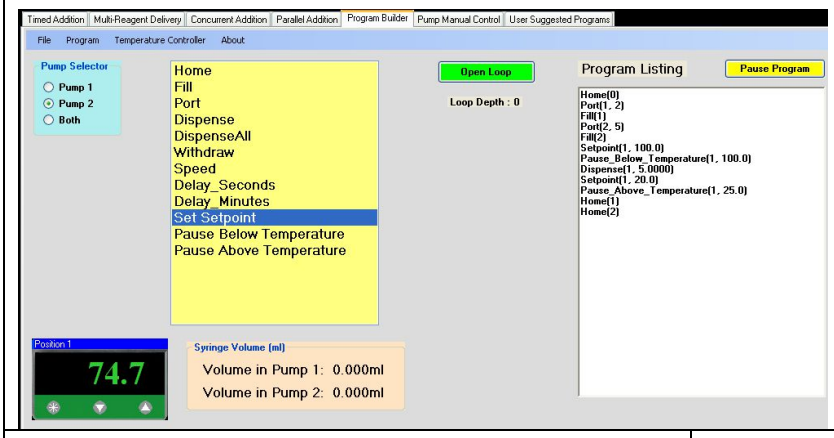
Rules for Ifs **and Loop**s

Loops can be nested 3 deep.

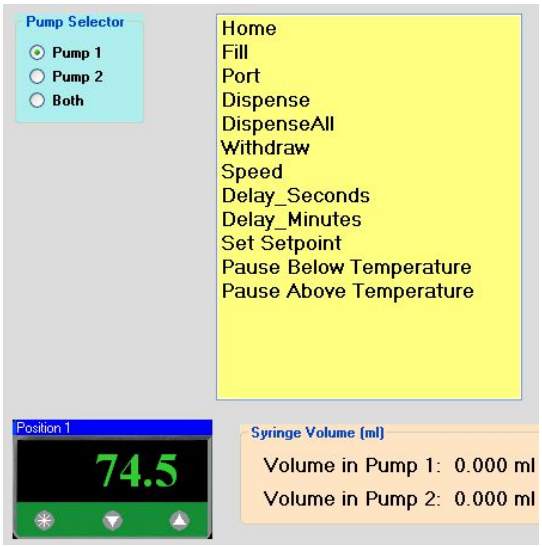
A single If can appear in a Loop, but then no other If's or Loops can be nested until the If is closed.

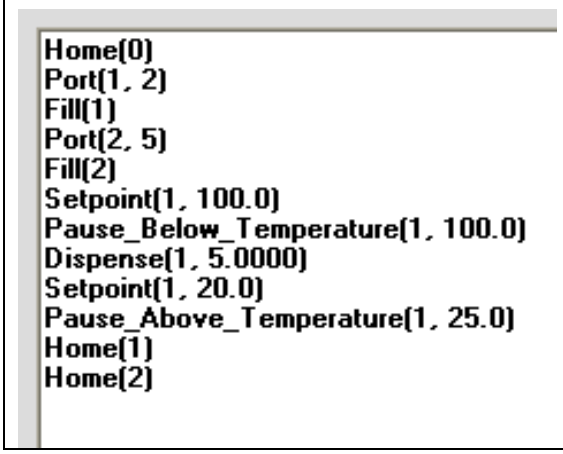
A single Loop can appear in an If, but no other If's or Loops can appear until the Loop is closed.

Temperature Controller Functions



The function of a J-KEM temperature controller can be added to the form. This allows the user to control the temperature of an attached reaction, or control the addition of reagents as a function of reaction temperature.
To add the controller to the form, connect a USB enabled J-KEM controller to any of the USB ports on the PC running the syringe pump. Turn on power to the controller, the select 'Find Controller' from the Temperature Controller menu.





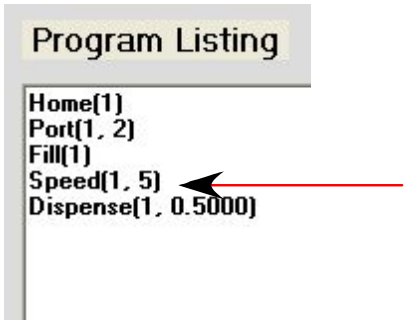
When the controller is added to the form, three new commands are added to the Command Selection Box. The function of these commands are:

Set Setpoint – Enters a new setpoint temperature (i.e., desired reaction temperature) into the temperature controller.

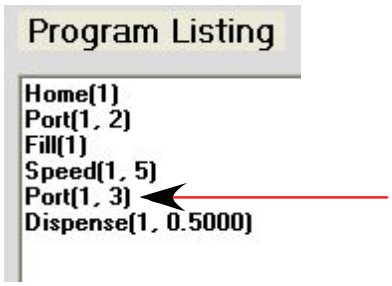
Pause Below Temperature – When this command is encountered during a syringe pump program, the program pauses or continues based on the current reaction temperature. If the user enters a "Pause Below Temperature" of 50° C, the progress of the syringe pump program will pause as long as the sensed temperature is below 50° C. When the sensed temperature reaches 50° C, the pump program continues.

Pause Above Temperature – When this command is encountered during a syringe pump program, the program pauses or continues based on the current reaction temperature. If the user enters a "Pause Above Temperature" of 40° C, the progress of the syringe pump program will pause as long as the sensed temperature is above 40° C. When the sensed temperature falls to 40° C, the pump program continues.

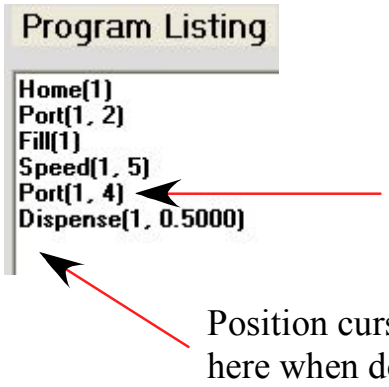
Editing Syringe Pump Programs



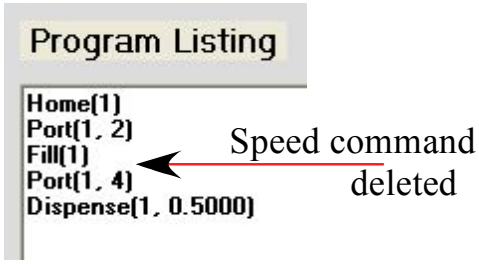
As long as a program is under construction, it is simply a text file. As such, it can be edited, statements inserted or deleted, or entire sections of code added. This section describes the editing controls.



Inserting a Single Statement – While a program is under construction, statements that were inadvertently forgotten can be added at the point in the program they need to appear. For example, if a Port statement should have been entered between the Speed and Dispense statements, the Port command can be added by positioning the text cursor at the end of the end of the Speed command (immediately after the right most parenthesis), then click on the Port command

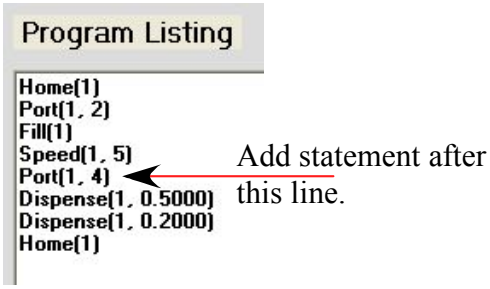


Editing a Statement – The text of any statement can be edited. For example, if the pump should have been directed to port 4, rather than port 3 in the newly entered command, the user can simply delete the '3' and replace it with '4'. When you are done editing, you must position the cursor on the first line after the last program statement, so that new commands are entered at the end of the program.

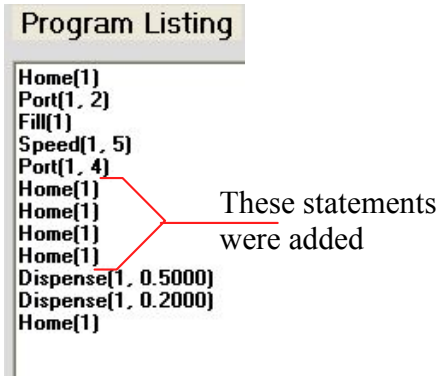


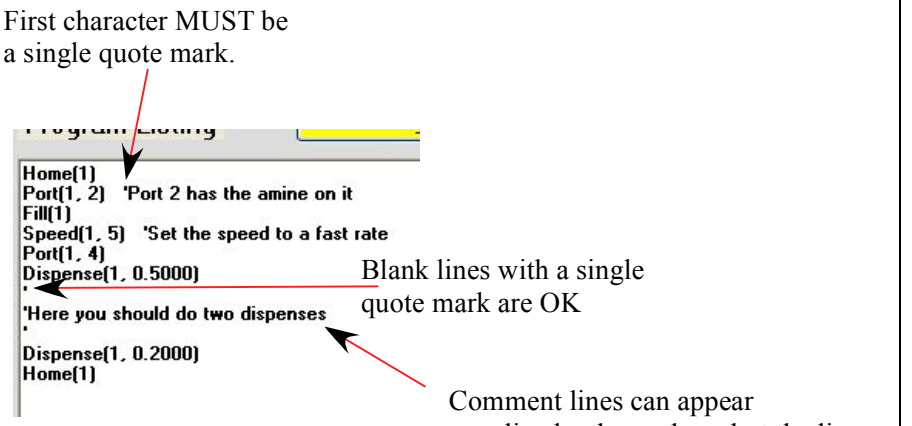
Deleting a Statement – Any line in the program can be deleted simply by selecting the line in the program window and deleting it. You must delete the entire statement and remove any blank lines. Once the statement is deleted, you must position the cursor on the first line after the last program statement, so that new commands are entered at the end of the program.

Saving a Code Block – After a program is created, it might be useful to save sections of the program that perform a useful task. Then when new programs are created, rather than having to enter the individual statements that perform the task, the entire block of statements can be added at one time. To save a block of statements, highlight the desired statements in the Program Listing Box, then select Save Code Block from the Program menu. You will be prompted to enter a name for the code.



Inserting a Code Block – Code blocks previously saved can be added to a program under construction. Position the cursor at the end of the line where the code block should be inserted after (in this case at the end of the Port(1, 4) command) and then select Insert Code Block from the Program menu. In this case, the code block (previously saved) that was inserted are the four Home(1) commands.





Adding Comment Statements – Comments statements, or non-executed text statements, can be added at any point in a program. Comment statements are useful to document what the program does.

Saving a Program – Once a program is created, it can be saved to dish by selecting Save Program from the Program menu. Once selected, the user is prompted for a file name to save the program to.

Recalling a Program – A program previously saved to disk can be recalled by selecting Recall Program from the Program menu.

Deleting a Program – A program previously saved to disk can be deleted by selecting Delete Program from the Program menu, then selecting the program to delete.

Menu Commands

These options in the program menu have the follow effects.

Start – The Start command causes the syringe pump to begin executing the program script as it appears in the Program Listing window at the first command.

Pause Program - A running program can be paused by selecting this command. The currently active command is completed, then the program pauses.

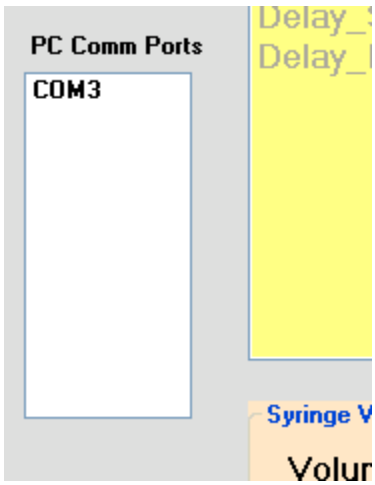
Resume Program – A paused program is resumed by selecting this command.

Abort Program – Causes a running program to terminate after completing the currently running command.

Remote Mode

In Remote mode, a remote PC, for example, a PC that's part of a robotic system or other larger piece of equipment, sends serial commands to the PC controller operating the syringe pump. The commands are executed one-by-one as they are received by the PC physically connected to the syringe pump.

Hardware connections - Contact J-KEM if you need additional assistance.
RS232- to RS232 serial connection using a null modem cable.
Baud – 9600, 8 data bits, 1 stop bit, no parity, no hardware or software handshaking.
Commands are terminated with a carriage return <Cr>, 0x0D (don't include a line feed).
Commands are case insensitive.



To activate remote mode, select Run by Remote Serial Command from the Program menu. After selecting this option, a list of available comm ports appears , click on the comm port used for communications on the PC attached to the syringe pump. At this point, the syringe pump PC is ready to receive commands.

Serial Protocol. The remote PC initiates all communications by sending a syringe pump command. The command is executed and the syringe pump replies after the sent command is completed. Do not send a new command until the pump replies to the current command. Note, monitoring for the reply from the syringe pump is the only reliable way to know when it's safe to send the next command.
The reply of a correctly formatted command is the command itself with the characters 'OK' appended to the end. All commands are terminated by carriage return, of 0xOD.

Example: Remote PC sends "HOME(1)", the reply is "HOME(1)OK<Cr>."
If an incorrectly formatted command is send, the pump replies with the command sent and then appends the characters 'BAD' to the end.
Example; Remote PC sends "HOOME(1), the reply is "HOOME(1)BAD<Cr>"
If an improper command causes an unrecognized error, the pumps reply is simply "BAD<Cr>.
You must monitor for the pumps reply and not send a new command until the current command is complete, because sending a command before the current command completes may cause the pump program to hang.

Addressing – For a single pump system, the address of the pump is '1'. For a dual pump system, the address of the first pump is '1', and the second pump is '2'. An address of '0' can be used at any time, which globally addresses all pumps in the system.

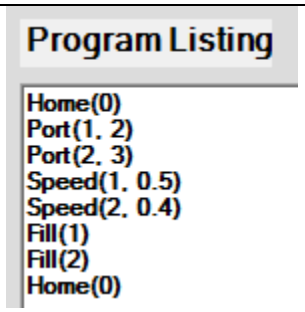
Command	Comments
Home(address)	Dispenses the entire volume of the syringe and resets all counters to 0.
Dispense(address, volume) *volume* is the volume of fluid to dispense as a floating point number in units of milliliters.	Dispenses the requested volume. If the requested volume exceeds the volume in the syringe, the entire content of the syringe is dispensed and the command terminates.
DispenseAll(address, volume, port) *volume* is the volume of fluid to dispense as a floating point number in units of milliliters. *port* is the distribution valve port to refill from (the port the reagent is on). The port that the pump is on when the command starts, is the dispense port.	Dispenses the entire volume requested, independent of the size of the syringe, or the volume currently in the syringe. This command only operates on a single syringe pump. For dual syringe pump systems, a continuous delivery of solvent using both syringes can be run using the command Timeddelivery() below.
SlowDispense(address, volume, rate) *volume* is the volume of fluid to dispense as a floating point number in units of milliliters. *rate* is the dispense rate in units of ml/min as a floating point number.	Dispenses the requested volume at the specified rate. If the requested volume exceeds the volume in the syringe, the entire content of the syringe is dispensed and the command terminates. The rate specified must be less than the 'Continuous Delivery Rate' for the syringe size in use or the command will not execute.
Fill(address)	Fills the syringe to if maximum volume.
Withdraw(address, volume) *volume* is the volume of fluid to dispense as a floating point number in units of milliliters.	Withdraws the requested volume, but does not exceed the filling the syringe to its maximum volume.
SlowWithdrawal(address, volume, rate) *volume* is the volume of fluid to withdraw as a floating point number in units of milliliters. *rate* is the withdrawal rate in units of ml/min as a floating point number.	Withdraws the requested volume at the specified rate. If the requested volume exceeds the volume in the syringe, the syringe fills, then the command terminates. The rate specified must be less than the 'Continuous Delivery Rate' for the syringe size in use or the command will not execute.
Port(address, port) *port* is the distribution valve port to move to.	Moves the distribution valve to the requested position.
Speed(address, speed) *speed* in units of ml/min.	Sets the withdrawal and dispense speed to the specified volume, but does not exceed the minimum or maximum speed of the syringe.
TimedDelivery(address, volume, rate, inletport) *address* is the pump address to use for the delivery. In a dual pump system, if the address is 0, both pumps are used for a continuous delivery of reagent. *volume* is the volume of fluid to dispense as a floating point number in units of milliliters. *rate* is the reagent delivery rate in units of ml/min. *inletport* is the distribution valve port that the reagent is attached to, i.e., the port the syringes refill from. The port that reagent is delivered to is the port the pumps are set to when the command is issued.	This command is used to run the timed delivery program. For single pump systems, or dual pump systems when you only want to use one pump, this command is equivalent to the Dispenseall() command. For dual pump systems, this command allows the user to use both pumps to dispense reagent in an unbroken stream. This command is equivalent to the Timed Delivery program.
IsReady(address)	Queries the addressed pump to determine if it's at a state where it is ready to execute a new command of not. When a pump is in motion, it cannot execute a new command. If the pump is in motion, the reply is 'False', if at rest, the reply is 'True'.
For systems with the optional IO package **Input(line)** *line* is the input or output line to test or set (1-3). *state* of the output. Must be either "On" or' "Off". **Output(line, state)**	Queries the state of the specified digital input. This command is unique from all other commands in that it must return a value to the query. If the input has a logical high state the returned reply is "Input(address)1OK", the '1' indicates the logical high state. If the input has a logical low state the returned reply is "Input(address)0OK", the '0' indicates the logical high state. Sets the state of the specified output to the specified value.
For systems with the optional 120 VAC output **120V_Outlet(state)** *state* of the outlet. Either "On" or "Off"	Sets the state of the 120Vac to the specified value.

Execution of Simultaneous Program Builder Commands.

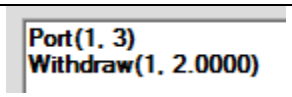
For multi-pump systems, it is sometimes useful to have the two pumps act independently from each other, but simultaneously performing a specified independent task. The most common example is adding two different reagents from the two pumps at different flow rates simultaneously.
The best way to understand the effect, and versatility, of simultaneously executing commands is to consider an example. For all examples, assume the system have 25 ml syringes on both pumps.

Home(0) - The program waits for both pump to complete homing before continuing on to the next step.
Port(1,2) – Pump 1 moves its valve to Port 2.
Port(2,3) – Pump 2 moves its valve to Port 3.
Speed(1,0.5) – The speed of Pump 1 is set to 0.5 ml/min.
Speed(2,0.4) – The speed of Pump 2 is set to 0.4 ml/min.
Fill(1) – Pump 1 is instructed to fill, but since the speed of pump 1 is set to 0.5 ml/min, this command will take 50 minutes to complete.
Fill(2) – Pump 2 is instructed to fill, but since the speed of pump 2 is set to 0.4 ml/min, this command will take 62 minutes to complete.

Since commands execute sequentially, pump 2 will not start to fill until pump 1 has completed its instructed action to fill, which is an enormous waste of time. Executing the Fill(1) followed sequentially by Fill(2), these commands will take 112 minutes to complete.
Since the filling of pump 1 is independent of pump 2, it would be better to have the two pumps simultaneously fill, which is accomplished in this program example.



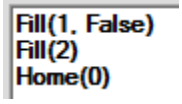
By default, a pump command must complete before the program advances to execute the next command, and in most cases, this is exactly the behavior that you would want. For example, the instruction for pump 1 to move to port 3 must fully complete before the pump starts to withdraw 2 ml of fluid, because if the pumps was withdrawing fluid while the valve moved from port 6 to port 3, the pump would withdraw a little fluid from each port the valve scanned past during its rotation.

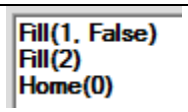
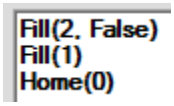
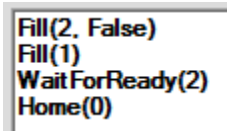
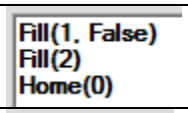
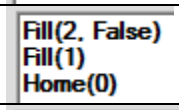
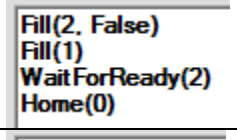
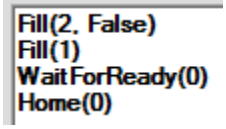
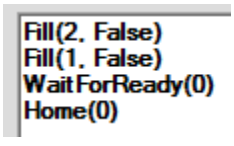
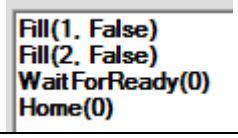


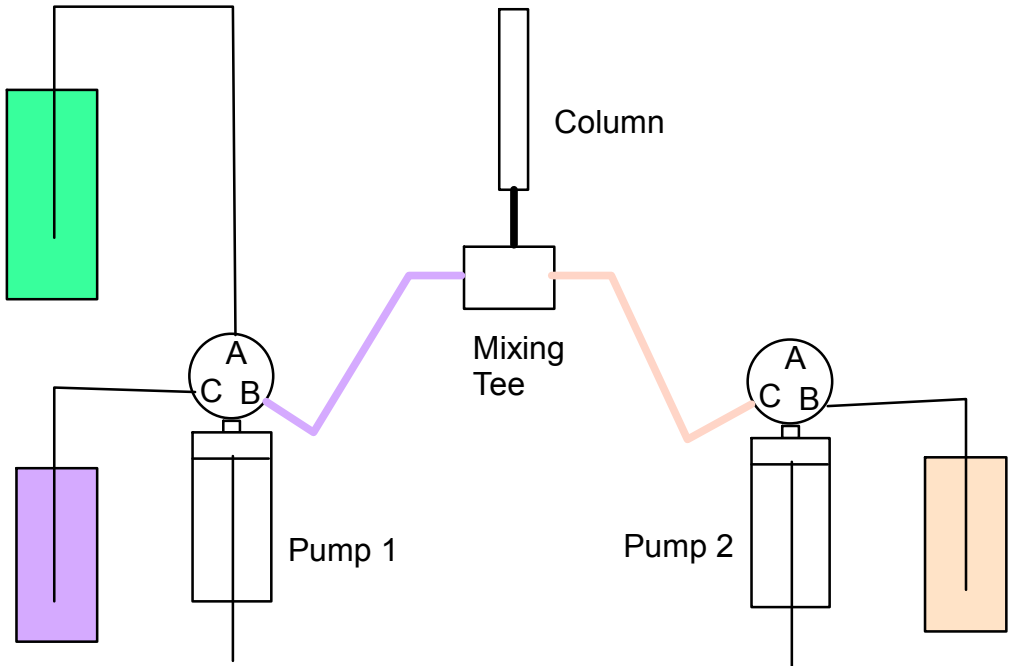
But there are times when it's desirable for the pump to simultaneously execute two independent commands. For example, consider the program above. It's a great time saver to have pumps 1 and 2 simultaneously fill, which means that both pumps will be full in 62 minutes as opposed to 112 minutes. To do this, four commands, Home, Fill, Dispense, and Withdraw have an optional argument that can be added to the command which instructions the program to start the current command and then immediately proceed to the next command <u>without</u> waiting for the first command to complete. The optional argument that can be added to these commands causing them to immediately proceed to the next command is "False" (which has the meaning of *do not wait for the command to complete*).

In this command sequence, Pump 1 will fill, wait until the command is complete, then start to fill pump 2, wait until that command is complete, and then home both pumps.

In this command sequence, pump 1 starts to fill, it them immediately proceeds to the next command which starts to fill pump 2. Since both pumps are filling simultaneously, the program runs faster.



Caution must be taken when adding the 'False' argument to a command. For example, the Fill(1, False) command starts pump 1 filling (which will take 50 minutes) and then immediately issues the Fill(2) command to start pump 2 filling (which will take 62 minutes). Because Fill(2) does not have the optional 'False' command, it will not proceed to the Home(0) command until it's completed. This is a safe series of commands because pump 1 will have completed its filling before pump 2 has completed its filling, which makes it safe to home both pumps simultaneously. But consider these commands. The Fill(2,False) command causes pump 2 to start filling and then immediately proceeds to issue Fill(1) to cause pump 1 to fill. The Fill(1) command completes in 50 minutes and then proceeds to issue the Home(0) command that will home both pumps. The problem is that Pump 2 is still filling, because it takes 62 minutes to fill. In this case, the program would cause an error and stop execution. The WaitForReady() command can be used to insure that the program is always at a safe point before proceeding to a new command. In this example, pump 2 starts to fill, then pump 1 starts to fill. Pump 1 completes in 50 minutes while pump 2 is still filling. When pump 1 completes its command, it continues to the WaitForReady(2) command which has the effect of pausing program execution until pump 2 is "Ready".	  
The user must be careful when issuing simultaneously commands, by means of using the 'False' keyword. Consider these examples.	
This works because pump 2 takes longer to fill than pump 1, but it is still a bad program.	
This fails because pump 1 is done filling and issues the Home(0) command before pump 2 is done.	
This works, because even though pump 1 completes filling before pump 2, the WaitForPumpReady(2) command prevents the program from continuing before pump 2 is ready.	
This is the best program, because it doesn't matter which pump completes filling first, the WaitForPumpReady(0) command prevents the program from continuing until all pumps are ready. All 3 of these programs accomplish the same task, and are equally good.	  



The ability to simultaneously perform multiple parallel commands can be very powerful.

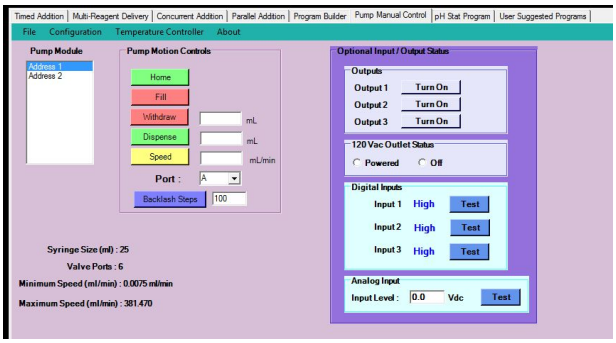
Consider this program.
Speeds are set for both pumps.
Each pump is set to a port connected to a reagent bottle.
Pump 1 is instructed to withdraw 3 ml and pump 2 simultaneously withdraws 4.5 ml (simultaneous fill saves time).
The WaitForReady(0) command insures that the program doesn't proceed until both pumps are ready.
Both pumps set their valve to the port attached to the column.
Pump 2 begins to dispense its entire content (at a very slow rate) to the attached column and immediately pump 1 starts to simultaneously dispense 1.5ml of its content onto the column.
As soon as pump 1 finishes, it goes to port A (green reagent), withdraws 2.3 ml, then goes back to the port connected to the column and immediately begins to dispense 2.5 ml of the green reagent to the column, combining it with the Pump 2 solvent stream.
At this point in the program, it doesn't matter which pump finishes last, because the WaitForPumpReady(0) command prevents the programing from continuing until both pumps are ready.
Pump 1 goes to port 3, pump 2 goes to port 2, them both pumps fill.

```
Speed(1, 5.0)
Speed(2, 0.1)
Port(1, 3)
Port(2, 2)
Withdraw(1, 3.0000, False)
Withdraw(2, 4.5000)
WaitForReady(0)
Port(1, 2)
Port(2, 3)
Home(2, False)
Dispense(1, 1.5000)
Port(1, 1)
Withdraw(1, 2.3000)
Port(1, 2)
Dispense(1, 1.2500)
WaitForReady(0)
Port(1, 3)
Port(2, 2)
Fill(0)
```

The user of simultaneously executing commands can be very powerful, but the program must be constructed properly. J-KEM is glad to help you understand the use of this feature and to help implement any custom program you need.

Manual Control

This tab provides a way to manually adjust the syringe pump and distribution valves state.



Pump Module – Select the pump module to operate on.

Home – Clicking this button causes the syringe to empty its content through the port the distribution valve is currently set to.

Fill – Clicking this button fills the syringe from port currently selected on the distribution valve.

Withdraw – Clicking this button causes the pump to withdraw the volume entered into the associated text box. The pump will not withdraw more than the volume remaining to fill the syringe.

Dispense – Clicking this button causes the pump to dispense the volume entered into the associated text box. The pump will not dispense more than the volume remaining in the syringe.

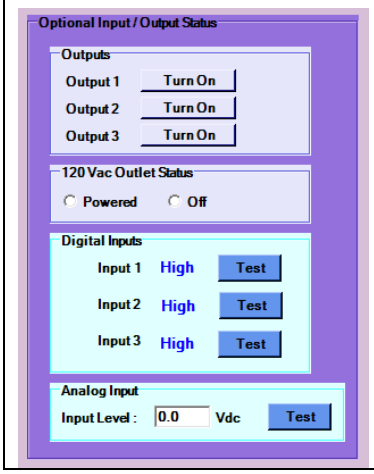
Speed – Clicking this button sets the pump to the speed entered into the associated text box. This speed is used for both withdrawals and dispenses.

Port – Selects the port the distribution valve is set to.

Backlash Steps – When the syringe performs an aspirate (withdrawal) motion, it normally withdraws a certain number of extra steps and then reverses direction and dispenses the extra steps. This acts to re-tension the pump in preparation for the next dispense motion. These extra steps are called backlash steps. The default value is 100, but can be set to any value from 0 to 1000.

Input / Output Options

This screen appears as one of the program tabs if any of the optional Input / Output packages are installed on the pump. Depending on which of the two optional features listed below, are installed, different portions of this screen will be enabled.

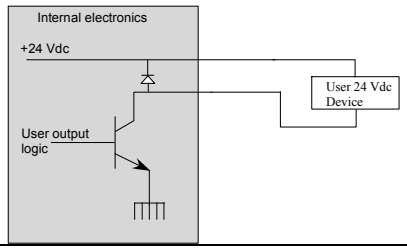


Optional Input / Output Status – This group box is enabled if the I/O Package option is installed. This package provides three TTL level digital inputs, three 24Vdc high current outputs, and one 0-10Vdc analog input.

120Vac Outlet – This group box is enabled if the programmable 120 Vac outlet option is installed. This option provides a 120 Vac outlet that can be used to turn On (or Off) other pieces of equipment under program control.

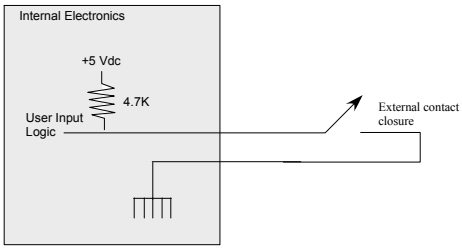
Analog Input – If the I/O package is installed, digital input 3 also acts as an analog input. When this input is queried as a digital input, a high logic level input yields a reply of '1', and a low logical low level yields a reply of '0'. When this input is queried as an analog input it returns a floating point value of the input voltage.

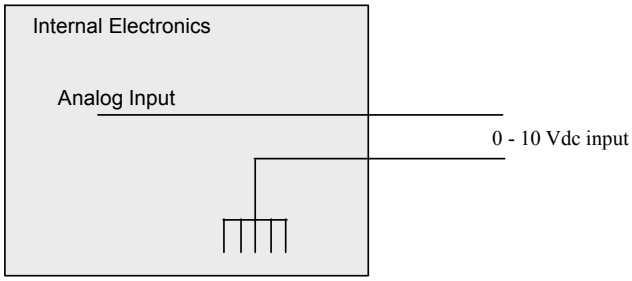
The User IO feature provides three high current outputs and three TTL level digital inputs.



User Outputs - The outputs are open collector and can sink 170 mA each at 24 Vdc. Wiring of the outputs is shown in the drawing above.
The KEM-Pump programmers' manual contains detailed information on the functions controlling user output. The relevant function is:
`Pump.UserOutput()`

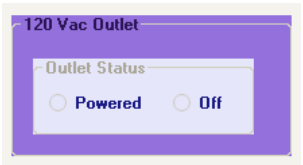
Wiring options for the external Inputs



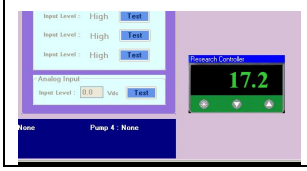


Digital Inputs - The digital inputs measure TTL logic levels (0-5 Vdc) and have 4.7 K pull-up resistors on input 1 and 2, not 3.
Logical 0 is any voltage <= 1 Vdc. Logical 1 is any voltage >= 3.5 Vdc.
Digital input 3 also doubles as the analog input. The analog input returns the voltage applied to the input in the range of 0 to 10.0 Vdc.
Do not apply voltages outside of the range of 0 to 10 Vdc or damage may result to the pump.

120 Vac Power Outlet Option



The 120 Outlet Option – This option provides a 120 Vac outlet with 10 amps of outlet current that is under program control. The receptacle is located on the back of the syringe pump.
When present, the state of the 120 Vac receptacle is controlled by user output #1. The command to turn On the receptacle is:
`Pump.UserOutput(1, SyringePumpDef.PumpPowerState.PowerOn)`
The command to turn Off the receptacle is:
`Pump.UserOutput(1, SyringePumpDef.PumpPowerState.PowerOff)`



The function of a J-KEM temperature controller can be added to the software interface of the syringe pump. This provides a single interface for processes requiring temperature control during the pumping sequence. For a full description of the temperature control function, see the section titled "Temperature Controller Functionality".

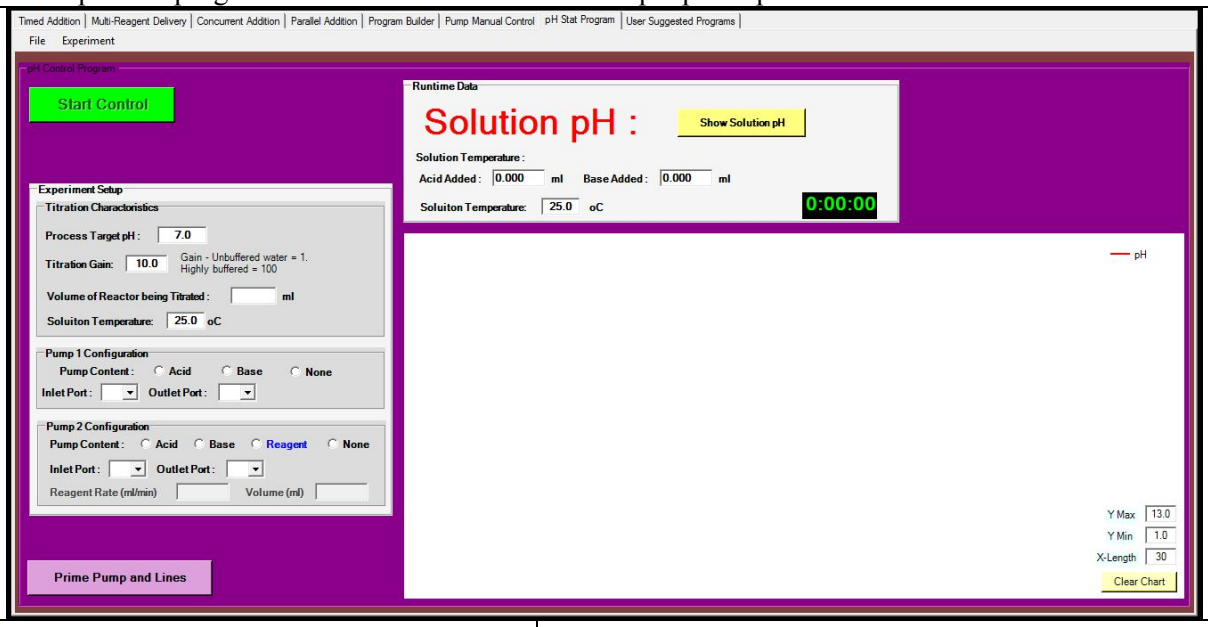
pH Stat Program

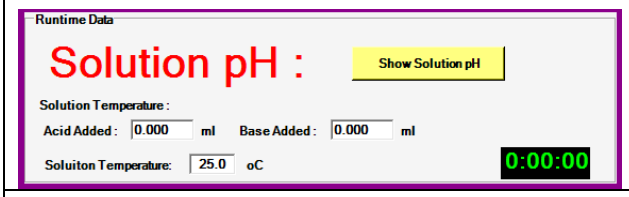
For pumps with the optional pH module installed, the pH Stat Program tab is enabled. This program allows the user to titrate and then maintain a solution to a user entered pH value.

Connect a combination pH electrode to the BNC connector on the back of the syringe pump. Any combination electrode with a BNC connector will work with the pump.

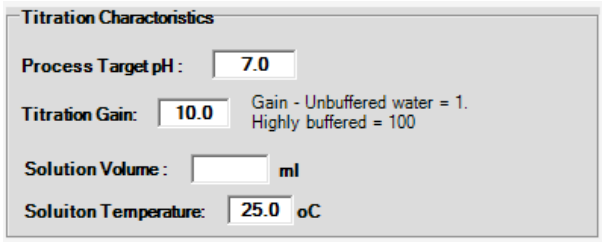
Single pump systems can regulate the pH of a solution by adding either acid or base. Dual pump systems can use Pump 1 to maintain the pH of the solution while Pump 2 adds a reagent at a user specified rate.

Note, that the pH Stat program must be calibrated with a new pH probe prior to use.





Prior to starting a pH titration, you can observe the pH of the solution to clicking the button "Show Solution pH".



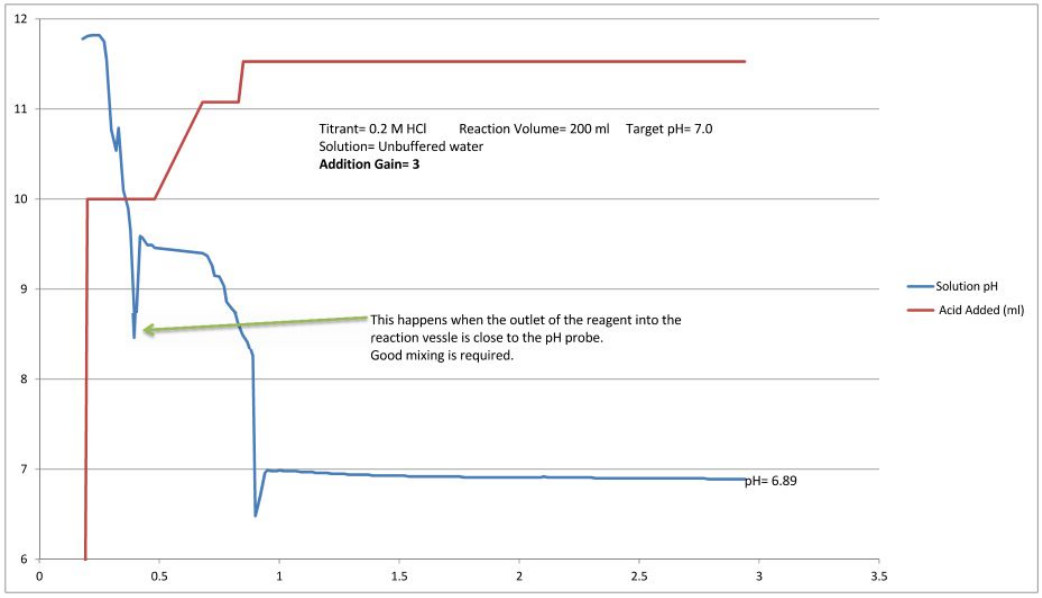
The variables required to perform a pH titration and then maintenance of solution pH are shown in this screen.

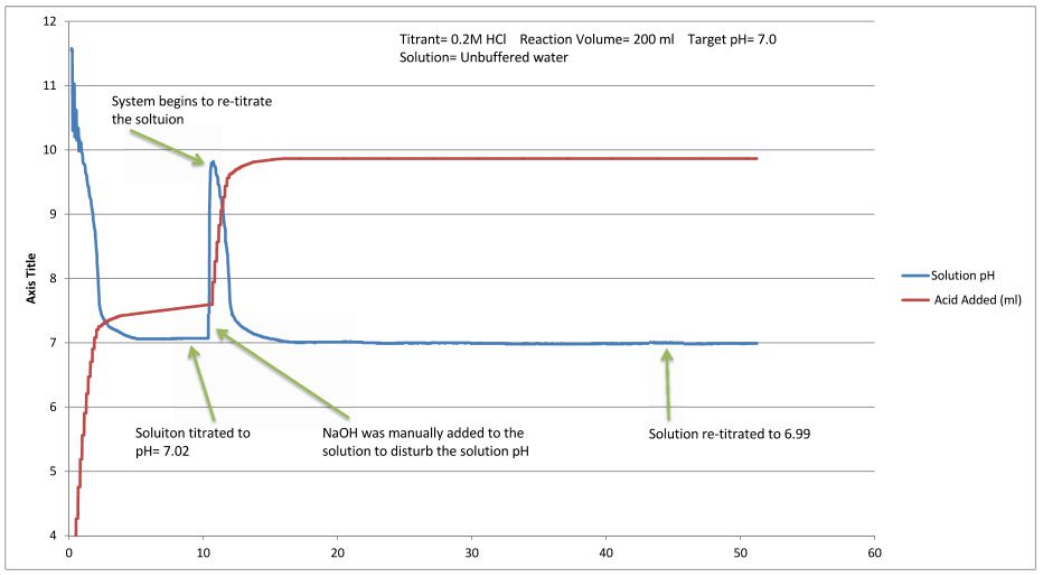
Process Target pH – The pH that the solution should be titrated to. The target pH of the reaction can be changed any time during a run by entering a new value.

Solution Volume – The volume of the solution being titrated.

Solution Temperature – The temperature of the solution being titrated. The pH value of a solution is a function of temperature, so this parameter must be entered.

Titration Gain – Titration gain is a factor that describes how responsive the solution is to the addition of acid or base. For example, a liter of solution with no buffer capacity, such as pure water, will change from pH= 7 to pH= 3 with the addition of 1 ml of 1 molar HCl, whereas a 1 molar solution of TRIS buffer would only change about 0.02 pH units. The gain value directly affects how rapidly acid or base is added to adjust solution pH. If nothing is known about the buffer capacity of the solution being titrated, then the titration should start using a low value of gain, in the range of 1-5. If the titration is proceeding too slowly, then gain can be increased, and if it is proceeding too rapidly or is unstable, then gain should be reduced.





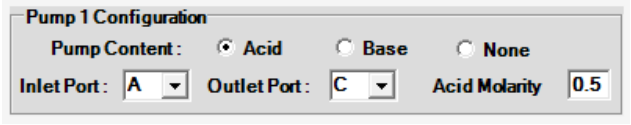
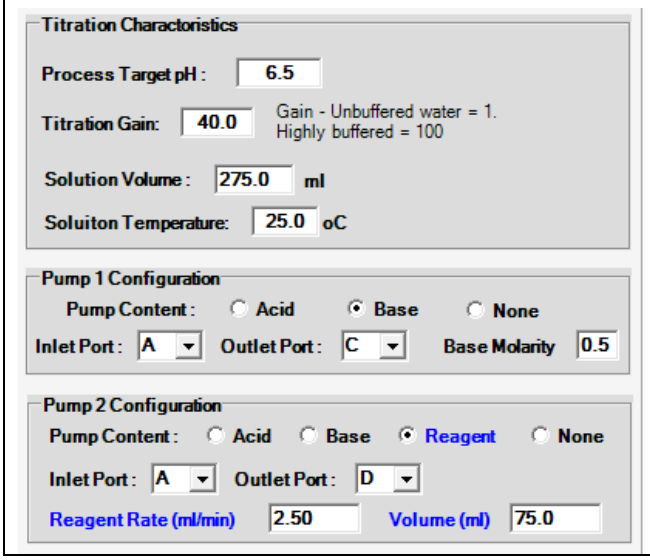
Titration gain is probably the most important factor for solution stability when performing a titration.
Consider these two examples which are identical except for the titration gain. In the top example Gain= 3.0.
For unbuffered water, and using HCl the titration occurs much too fast and results in an over-shoot of the target pH. In the bottom example, the gain is set to 1.0
This results in a slower titration, but with much improved accuracy.

Factors to consider when setting the titration gain.

* The nature of the titrant. Using a soft acid, like acetic acid will titrate slower, so a higher gain can be used. Using a hard acid, like HCl requires smaller gains. In the case of bases, using a soft base, like TRIS will require higher gains than when using a hard base like NaOH.

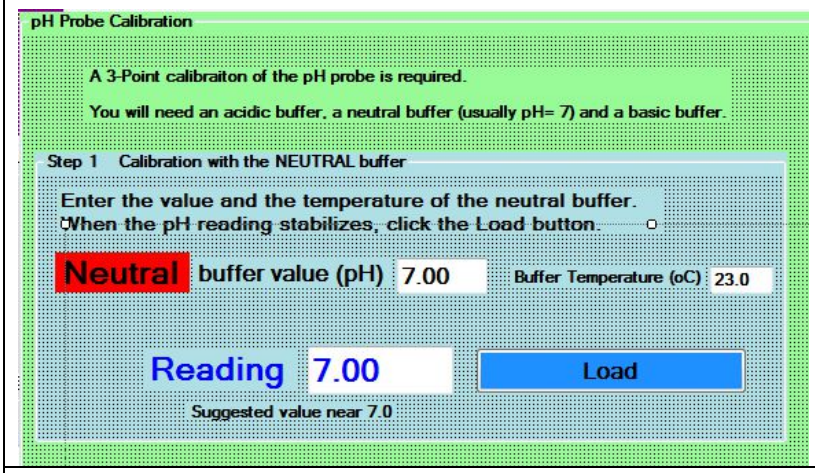
* A very important factor is whether the solution being titrated has any buffering capacity. Unbuffered water is the most sensitive medium to titrate. For maximum accuracy, titrating a solution with some buffering capacity is very helpful.

The best strategy for selecting gain – For a new process, where nothing is known about the nature of the titration, it's best to start with a titration gain of 1.0. Observe the rate of pH adjustment for about 1 minute and then adjust the gain either higher or lower. The gain can be changed while a titration is in process.

<table>
<tr>
<td> 
</td>
<td>In a syringe pump system with only one pump just this configuration box is enabled.
Select whether the pump will dispense acid or base.
Specify the Inlet port, the port the acid or base is attached to, and the Outlet port, the port the reactor is attached to. Additionally, enter the molarity of the acid or base being added.
Note that with a single pump system, only acid OR base can be added, not both. Fortunately, for most reaction systems, only one of the two, acid or base, is required.</td>
</tr>
<tr>
<td> 
</td>
<td>A syringe pump system with two pump modules has the option of simultaneously adding acid AND base, or even a chemical reagent to the reaction system.
Pump 1 can only add acid or base.
Pump 2 has the option of adding acid or base (but not the same reagent that’s being added by Pump 1), or a chemical reagent to the reaction.
For example, in the configuration shown, Pump 2 will add 75 ml of a reagent at a rate of 2.5 ml/min while Pump 1 simultaneously adds whatever amount of base is needed to maintain the solution pH at a value of 6.5.</td>
</tr>
</table>

pH Probe Calibration

Prior to starting a pH stat run, the pH electrode should be calibrated so that reaction pH values are properly displayed. To start the calibration procedure, select Calibrate pH Probe from the Experiment menu.



From the Experiment menu, select the Calibrate pH Probe menu item. A 3-point calibrations must be performed using an acid, neutral and basic buffer.

On-screen messages will appear instructing you to place the probe in Neutral, Acid, and Basic pH buffers in that order.

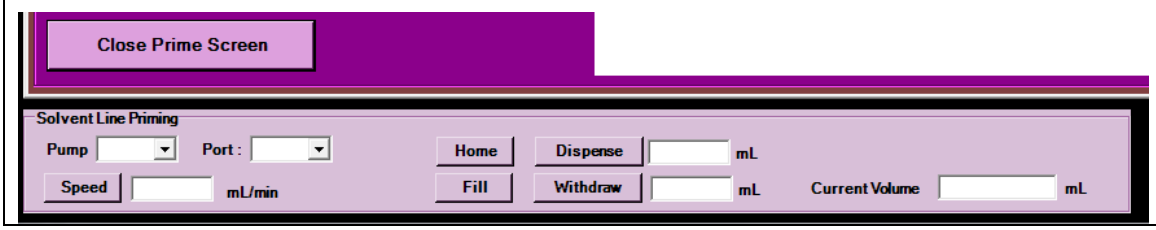
The specific pH values are not important, but one of the buffers should be a pH= 7 buffer. For example, the three buffers can be 4, 7, and 10, which are the standard buffers, but you can also use 2, 4, and 7 buffers if desired. The calibration screen requires that the buffers be calibrated in the order of 'neutral', 'acid', base', so in the case when non-standard buffers are used such as 2, 4, and 7, then the 'neutral' is the pH= 4 buffer (because it's in the middle), the 'acid' buffer is the pH= 2 buffer (because it's the lowest value buffer', and the basic buffer is the pH= 7 buffer.

Enter the values for the three buffers, when prompted, and the temperature in the boxes provided.

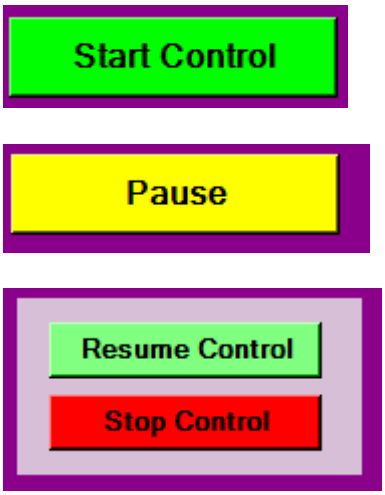
The calibration routine prompts for the probe to be placed in the correct buffer at the correct time. Allow the pH reading from the probe to stabilize, and then once stable click the Load button. Note, that during calibration the pH of the pH value of the buffers may not display properly, this is okay. After all three buffers have been read, the screen begins to display the pH sensed by the probe using the newly stored calibration values.

When satisfied with the results, click the Close Calibration button.

Starting the pH Stat Program



Prior to starting a pH stat run, it's important to prime the lines delivering acid and base to the reactor. Priming is the process of flushing air from the inlet and outlet lines and pre-filling the lines with reagent. The reason why it's important to prime the lines is because the pH stat algorithm is always evaluating the effect of the last addition of acid or base and then adjusting variables that affect the volume of reagent added during the next addition step. If the lines are filled with air at the start of a run, then while the system expects to be adding acid or base, it's really flushing air from the lines (which has no effect on the solution pH), which causes the algorithm that controls the addition of acid/base to initially miscalculate the volume of acid/base to add incorrectly.

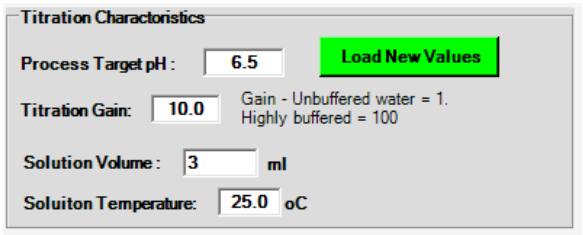


To start the pH stat program, click the Start Control button.
The program prompts the user to ask if the titration data should be logged to an Excel file. If logging is selected, the system prompts for the file name to save data to.

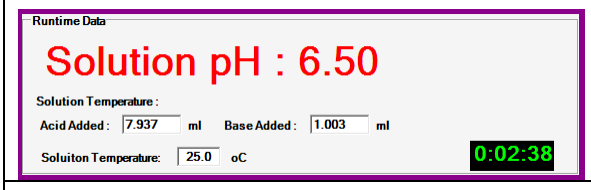
During a run the Start button changes to "Pause".

Clicking the Pause button causes the control of solution pH to pause and displays a new box containing the buttons "Resume Control" and "Stop Control". Clicking the Resume Control button restarts regulation of solution pH and clicking the Stop Control button turn off pH regulation.

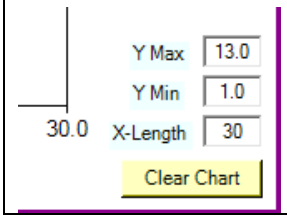
Controls Active While the pH Stat Program is Running



During a pH stat experiment, entering a new value for the target pH, the titration gain, solution volume, or solution temperature causes the button "Load New Values" to appear. After making the desired changes to any of these variables, clicking this button causes the new values to take effect.



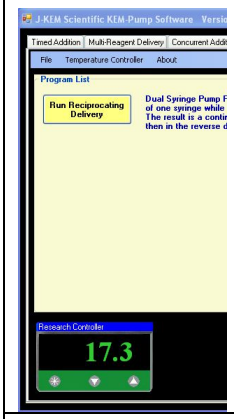
During a run, the volumes displayed for Acid Added and Base Added can be reset to 0.0 ml by clicking on the text box displaying the volume.



The user can manually set the minimum and maximum value of the Y-axis of the pH chart, and the length of the displayed X-axis.
Clicking on the button Clear Chart causes plotted data in the chart to be deleted and the chart starts again at time= 0.

User Suggested Programs

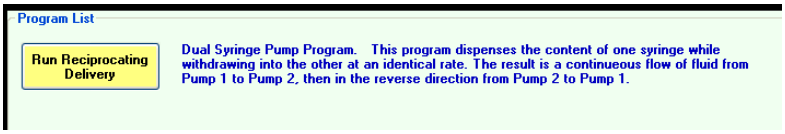
On occasion, users request custom programs that J-KEM thinks might be useful to other users. On the User Suggested Programs tab are those programs.



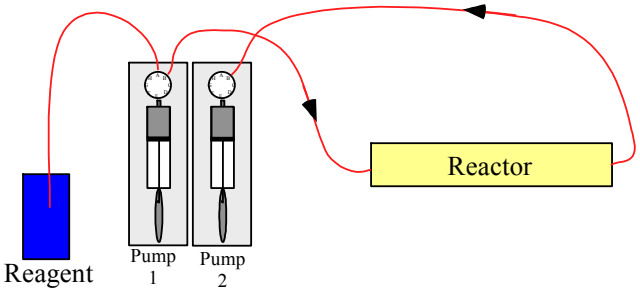
The function of a J-KEM temperature controller can be added to the software interface of the syringe pump. This provides a single interface for processes requiring temperature control during the pumping sequence. For a full description of the temperature control function, see the section titled "Temperature Controller Functionality".

Highlights include:

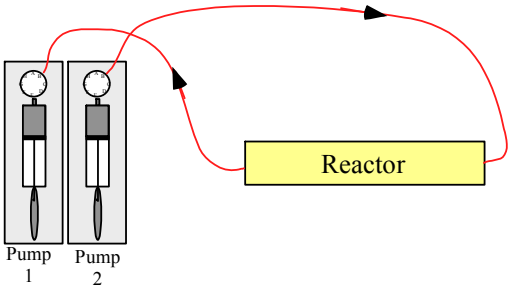
- On-screen temperature display and control.
- 16-Step temperature ramp.
- **An optional software add-on allows the rate of reagent addition to be controlled as a function of reaction temperature.**



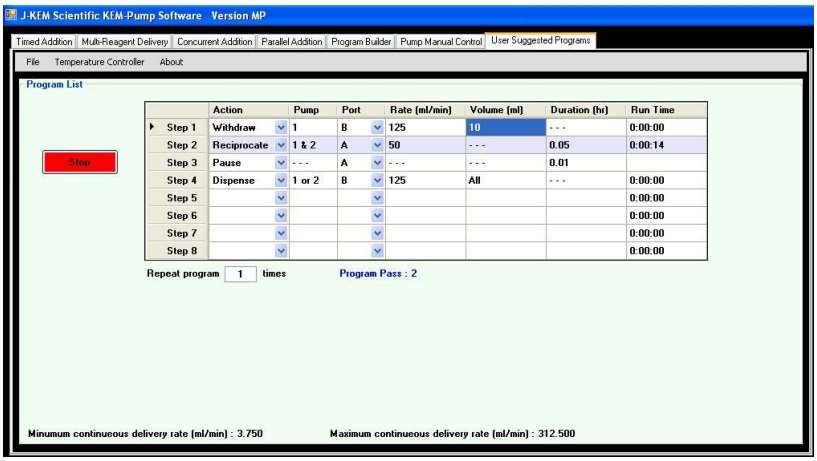
The Precipitating Delivery program is only available to dual syringe pump systems. This program uses one pump to add reagent/solvent to one port on a closed system reactor while simultaneously withdrawing reagent/solvent from a second port on a closed system reactor.
The net effect is that the fluids in the reactor remain in continuous motion in a back-and-forth flow patter.



For the first segment of the program, Pump 1 delivers fluid into one end of the reactor while Pump 2 withdraws from the other at the same rate.



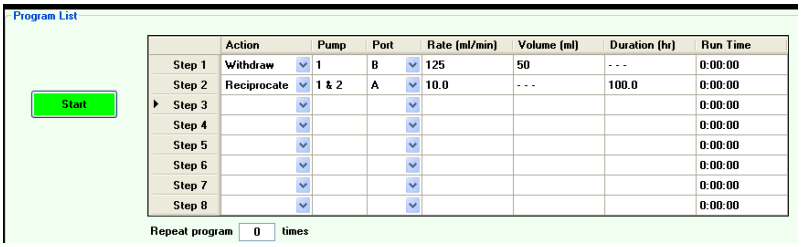
When Pump 1 completes it delivery, Pump 2 starts to deliver and Pump 1 starts to fill, thus reversing the flow through the reactor

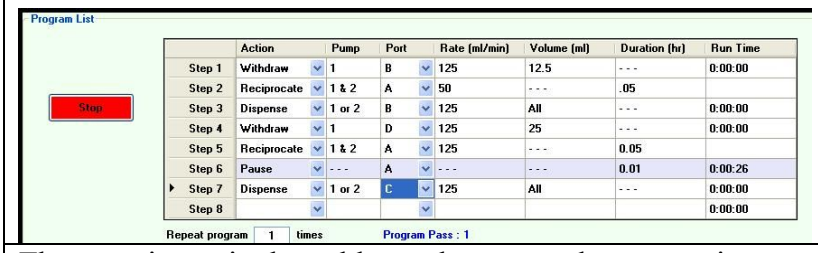


To make the experiments controls visible, click the Run Precipitating Delivery button.

Experiment Setup – An experiment can consist of up to 8 sequential steps. Additionally, each experiment can be repeated any number of times.
The experiment allows four types of pumps actions from the selection box in column 1.

Withdrawal – Used to initially fill pump 1 with the test solution.
Dispense – Used to empty the content of both pumps.
Pause – Simply pauses the program for the specified period of time.
Reciprocate – Starts the oscillating action of the two pumps withdrawing and dispensing solvent simultaneously
There is very little error checking in this program, it is up to the user to make sure that a rational sequence of steps is entered into the table to accomplish the desired task.





To begin the experiment, click the green Start button.
The First program step must be a Withdrawal step, since this initially fills syringe 1 with the test material that will oscillate between the two syringes.
The second program step is typically a Reciprocate step.
Dispense steps can be used to empty both syringes. If a withdrawal step follows a dispense step, this can be used to get fresh solution to reciprocate, or even a different solution to reciprocate.

The experiment in that table can be repeated as many times as desired by entering the Repeat count in the box provided at the bottom of the table. A repeat count of 0 will run the program once and then it will terminate. A repeat count of 1 will run the program twice, i.e., it will run the program once, and then it will repeat it once, for a total of two program passes.
During a run, the Stop button can be pressed. The current syringe action completes, and then the program exits.

Temperature Control Functionality

Each experiment has the menu item *Temperature Controller* which adds a software interface to a J-KEM temperature controller. The interface allows real-time monitoring of reaction temperatures and remote control of the temperature controller.

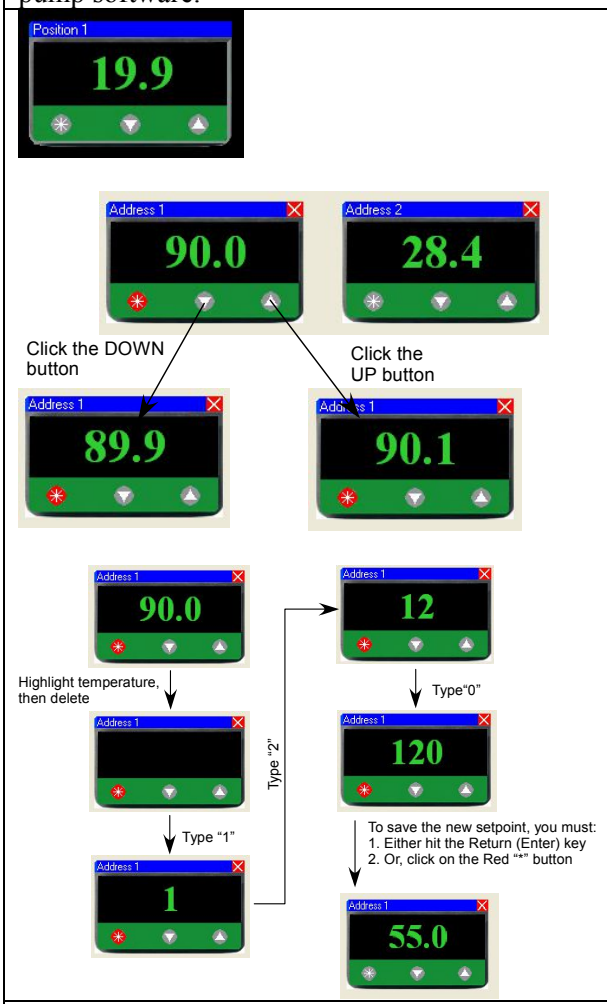
Hardware Setup

A J-KEM temperature controller with a USB interface is required. Connect a USB cord between the controller and a USB port on the PC operating the syringe pump.

Software Operation

To view the controller on the syringe pump experiment pages, the pump must be powered. The menu options related to temperature control are:

Discover Controller - Searches the USB ports on the PC. The first controller found on the USB bus causes an image of a digital meter to appear on the screen. If the model of controller connected to the PC has multiple digital meters, like the dual channel Gemini, or Apollo, only the first channel of the controller is connected to the syringe pump software.



Entering a Temperature Setpoint

The normal state of the meter is to show the temperature of the attached sensor.

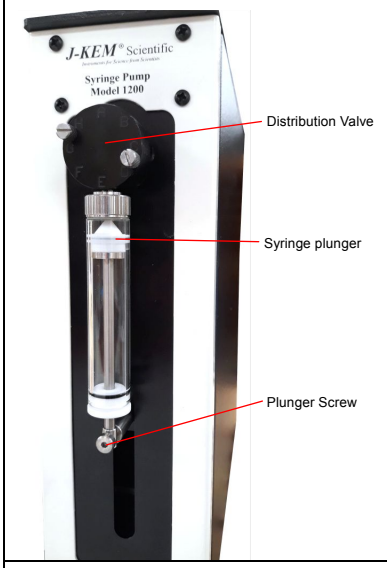
There are 3 ways to enter a new setpoint into the meter.

1) A new setpoint can be entered into the actual temperature controller meter itself without the use of software even when the controller is connected to the PC. A setpoint is physically entered by pressing the "*" button on the face of the digital meter, then pressing the Up or Down arrow keys on the meter.
2) A new setpoint can be entered using the software by clicking on the "*" button on the face of the meter as it appears on the PC screen. When in setpoint edit mode, the "*" button turns red and the current meter setpoint appears in the display. While in setpoint edit mode, clicking on the Down button will decrease and clicking on the Up button will increase the setpoint. When the desired setpoint appears in the display, clicking the red "*" button will upload the newly entered setpoint to the digital meter, which will then return to displaying the current process temperature.
3) Another method for entering a new setpoint is to click the "*" button, placing the meter in setpoint edit mode (the "*" turns red), then using the mouse, highlight the current setpoint, displayed on the meter's face, then typing in the new setpoint. When the desired setpoint is entered (i.e., typed) into the display, clicking the red "*" button will upload the new setpoint to the digital meter.

Log Temperature Data – Logs time and temperature data to a data file. If selected, the user is prompted for a data file name. The data file is stored as a comma separated '.CSV' file which can be directly opened by Excel. Data logging does not stop when an experiment completes, but continues until the software is exited.

Installing a Syringe or Distribution Valve

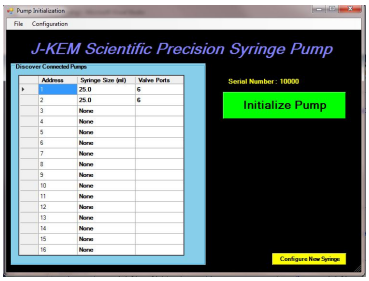
Replacing a syringe and/or distribution valve is not difficult and takes about one minute, but if performed improperly will result in leaks or damage to the pump.

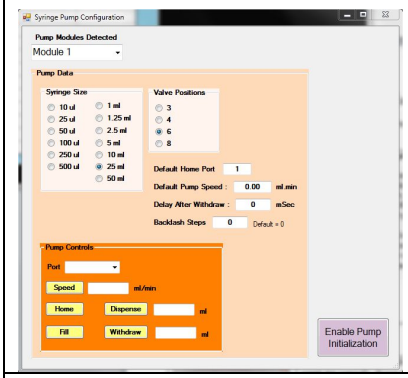


Syringe and Valve Replacement

There are only two reasons to change the syringe pump configuration:
1) When a new distribution valve with a different number of selection ports is installed (for example, you are placing a 6-port valve on a pump that used to have a 4-port valve), the syringe pump definition must be set to the correct number of valve ports.

2) When a new syringe is placed on the pump. When a new syringe is placed on the pump, you must make sure that plunger 'Home' position is set properly, and if the new syringe is a different volume than the syringe being replaced, then the volume of the new syringe must be set in the pump's configuration.





Start the syringe pump software. If the syringe size and the valve port count are correctly shown for each pump, then nothing needs to be reconfigured and you can click the Initialize Pump button.
If the number of valve ports or syringe sizes are not correctly shown for one of more of the pumps, then click the yellow 'Install new Syringe or Valve' button.

For a multi-pump system, you can see and adjust the current pump configuration of each pump module. In the list box titled 'Pump Modules Detected', select the pump module (i.e., pump position) that you want to change. The information boxes as the left populate with the current configuration of that pump module.

Syringe Size – Click on the radio button associated with the correct volume of the syringe on the pump.

Valve Positions – Click on the radio button associated with the number of ports on the currently installed valve.

Default Home Port – This specifies the port that the pump sets to before initializing the syringe on startup. On startup, any content left in the syringe is sent out of the default home port.

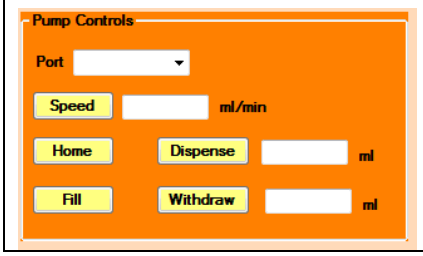
Default Pump Speed – Depending on the size of a syringe, different speeds are recommended as the default speed for the pump. Default syringe speeds are:

10ul syringe – 0.06 ml/min	25ul syringe – 0.15 ml/min	50ul syringe – 0.3 ml/min
100ul syringe – 0.62 ml/min	250ul syringe – 1.5 ml/min	500ul syringe – 3.0 ml/min
1ml syringe – 6.2 ml/min	1.25ml syringe – 8.0 ml/min	2.5ml syringe – 15.5 ml/min
5ml syringe – 30.0 ml/min	10ml syringe – 62.5 ml/min	25ml syringe – 120.0 ml/min
50ml syringe – 125.0 ml/min		

When the default speed is entered as "0.0" the listed default speed is automatically loaded. The default syringe speed is usually set to control the fill speed of the syringe. There are cases where entering a speed other than the default is appropriate. For example, if the syringe is being filled with a very volatile solvent, like pentane, the default speed will fill the syringe too quickly causing the pentane to boil as it's drawn into the syringe under reduces pressure. Another example is when very viscose materials are being pulled into the syringe. If the plunger of the syringe pulls down faster than the material can flow into the syringe, then air will form in the syringe barrel. In both these cases, slower default speeds should be entered for that pump position.

Delay After Withdrawal – The parameter is only used when loading very viscose fluids. If the plunger withdraws faster than a viscose material can flow into the syringe, then a vacuum develops inside the syringe. Delaying for a period of time after every withdrawal give viscose materials time to flow into the syringe filling this vacuum void.

Backlash Steps – This parameter is not often used. Following a withdrawal, the lead screen pulling the plunger of the syringe down may require a certain number of motor steps in the dispense direction to remove any looseness in the lead screw and to forward bias the lead screw for a dispense motion. Backlash steps is the number of forward (dispense) motor steps the pump automatically moves following any withdrawal motion.



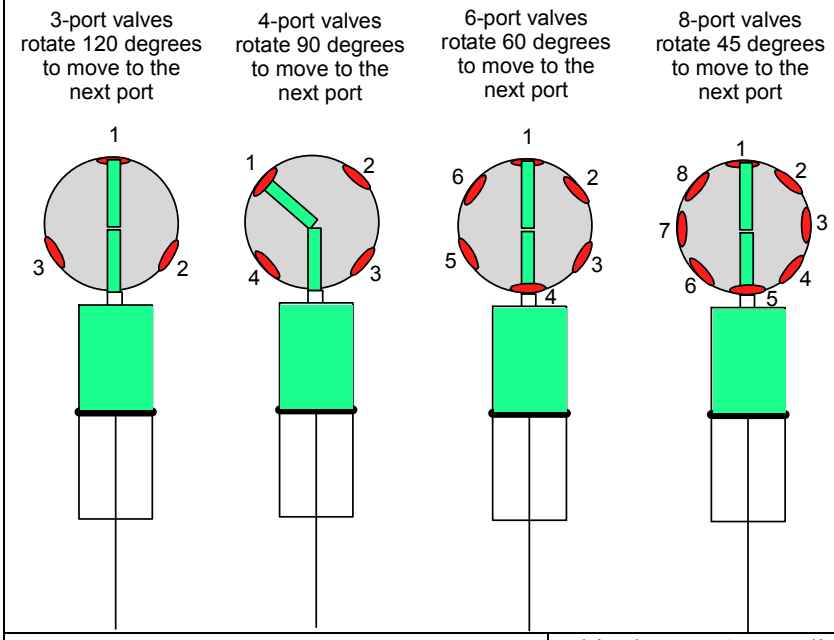
These controls allow the user to manually control the valve port position, pump speed, and plunger position of the syringe in order to test the current setting of the syringe pump.

Installing a New Valve

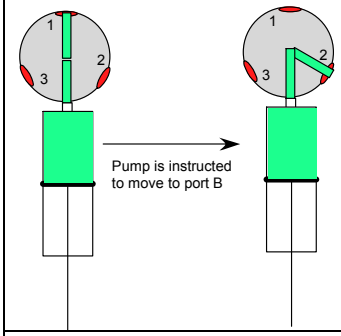
To remove the old distribution valve:

1) Remove the plunger screw as the base of the syringe plunger
2) Unscrew and remove the syringe from the distribution valve.
3) Remove the two bolts holding the current distribution valve to the face of the pump.
4) Place the new distribution valve onto the pump and tighten it into position by replacing the two valve bolts.
5) Screw the syringe back into the bottom of the distribution valve, using just finger pressure to securely seat the syringe, do not use any tools to tighten the syringe.
6) Move the syringe plunger around until the plunger screw goes through the fitting at the base of the plunger rod and then tighten this screw back onto the pump.
7) In the box titled Valve Positions, click the radio button that specifies the number of valve ports on the new valve.
8) Clicking the close box on this configuration page saves all entered value. The syringe pump software should be restarted following any changes to the syringe pumps configuration.

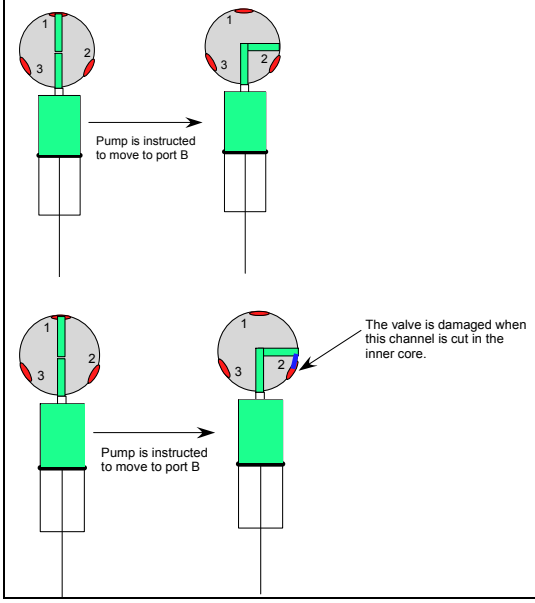
Entering a correct valve configuration is critically important. If the pumps configuration is incorrect for the new valve, it is likely that the valve will be damaged during its first use.



The syringe pump software must be configured to know whether the pump has a 3, 4, 6, or 8-port valve. The reason is that different valves have different home port locations and a different number of degrees of rotation are required to move each valve between neighboring ports. If the software is not configured for the correct valve, then the valve will home improperly and move to positions in between actual pump ports.



This shows a 3-port distribution valve. When the syringe pump software is configured to know that the pump has a 3-port valve. When a command is issued to go from port 1 to port 2, the pump rotates the inner selector core 120 degrees to mate with port 2 correctly.



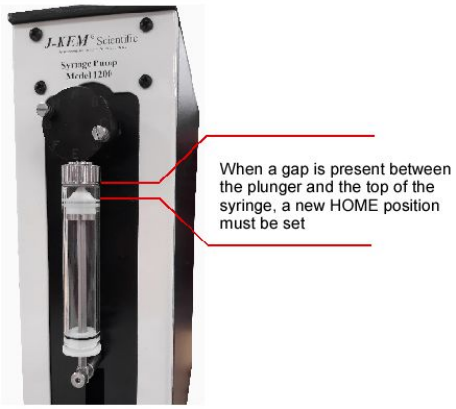
But, if the pump is configured for use with a 4-port valve, when it actually has a 3-port valve, then when the command is issued to move to port 2, the pump rotates the inner selector core only 90 degrees, which means that the fluid outlet of the inner selector core is not aligned with port 2, but is blocked.

Two things can happen in this situation. When the pump attempts to fill, no solvent is drawn into the syringe, because the selector core is not aligned with any port. Alternately, if the pump attempts to dispense fluid when the valve is in this configuration, the fluid will be forced, under high pressure, to cut a path through the inner portions of the Teflon valve, creating a flow path to port 2, in order to relieve the pressure.
When this happens, the valve cannot be repaired, but must be replaced.

Installing a New Syringe

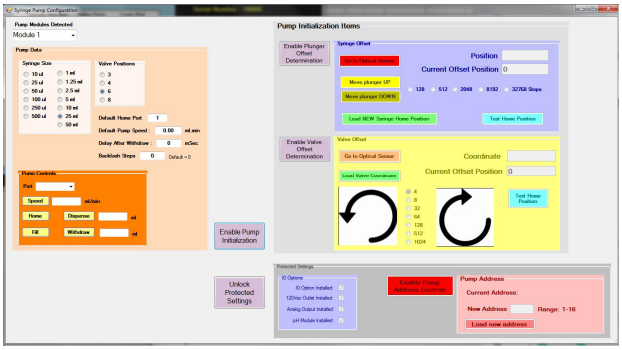
To remove the old syringe:

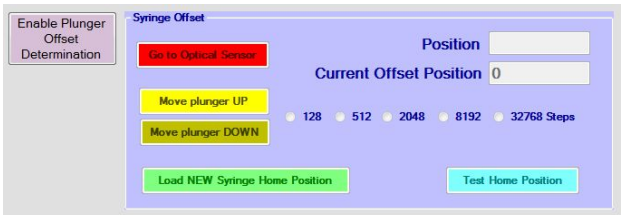
1) Remove the plunger screw as the base of the syringe plunger
2) Unscrew and remove the syringe from the distribution valve.
3) Screw the new syringe back into the bottom of the distribution valve, using just finger pressure to securely seat the syringe, do not use any tools to tighten the syringe.
4) Move the syringe plunger around until the plunger screw goes through the fitting at the base of the plunger rod and then tighten this screw back onto the pump.
5) In the box titled Syringe Size, click the radio button that specifies the volume of the new syringe.



When installing a new syringe you must make sure that the plunger is set to the correct HOME position. A home position that is too low leaves a gap between the plunger and the top of the syringe. A home position that is set too high causes the plunger to *smash* into the top of the syringe and my cause it to break.

If a new syringe is put on the pump, its home position should be reset.





Click the button titled Enable Pump Initialization and the form expands to that shown here.

Click the button titled Enable Plunger Offset Determination. Click the red button titled 'Go to optical sensor' and the plunger will come down a small amount leaving a gap between the plunger and the top of the syringe. These controls allow you to manually position the syringe so as to remove this gap. The radio buttons specify how many motor steps to take, initially click on the button titled '8192'. Look at the plunger of the syringe and then click the button titled 'Move plunger UP' and you'll see that plunger moves to close a small portion of the gap. Continue to click the Move Up button until the gap is complexly gone. Decrease the number of steps taken as the plunger gets closer to the top of the syringe. You may need a pair of magnifying glasses to properly see when the gag is completely closed. Do not over-tighten the plunger since this can cause the syringe to break. If the plunger becomes over tightened, then use the 'Move plunger Down' button to lower the plunger a little. You should try to completely remove the gap, but it's better to leave a small gap as opposed to over-tightening the plunger. When the plunger is at the location where the gap has been completely removed, click the button titled 'Load NEW Syringe Home Position'. The system will test the new home position, and then save it to memory. You can test the new home position by clicking the button titled 'Test Home Position'.

Other controls are present on this form that are not recommended that the user access without help from J-KEM. These controls include:

Enabling a New Valve Offset – Just as a syringe plunger, a valve also has a home position, but this almost never needs to be reset. If you think that adjustments need to be made, contact J-KEM for assistance.

Pump Address – See below

I/O Options – These are optional features that can be added to a syringe pump and should only be configured by J-KEM.

Clicking the close box on this configuration page saves all entered value. The syringe pump software should be restarted following any changes to the syringe pumps configuration.

Changing a Pump Address

Every pump in a system needs to have a unique *address*, so before shipping, J-KEM loads a default address into each pump. For a single pump, the address is always '1', for a dual position pump, the addresses are always 1 & 2. Sometimes a user might want to connect multiple pumps to the same PC and then control them with a single copy of KEM-Pump. In order to do this, each pump must have a unique address, if any of the pumps have the same address, then this will cause a conflict and the software will not start. Before multiple pumps can be operated from the same PC, each pump must be programmed with a unique address. For example, if two single position pumps are connected to the same PC, each pump will have an address of '1', and because of this conflict, KEM-Pump software will not start. One of the pumps address must be changed to '2' before the software can start. Changing an address if easy, but can have unexpected consequences if the address is set incorrectly, and may become unusable. Before changing a pumps address, a user should contact J-KEM Scientific's service department to discuss your application.