Precision Instruments for Research and Industry

J-KEM Scientific Syringe Pump

J-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.

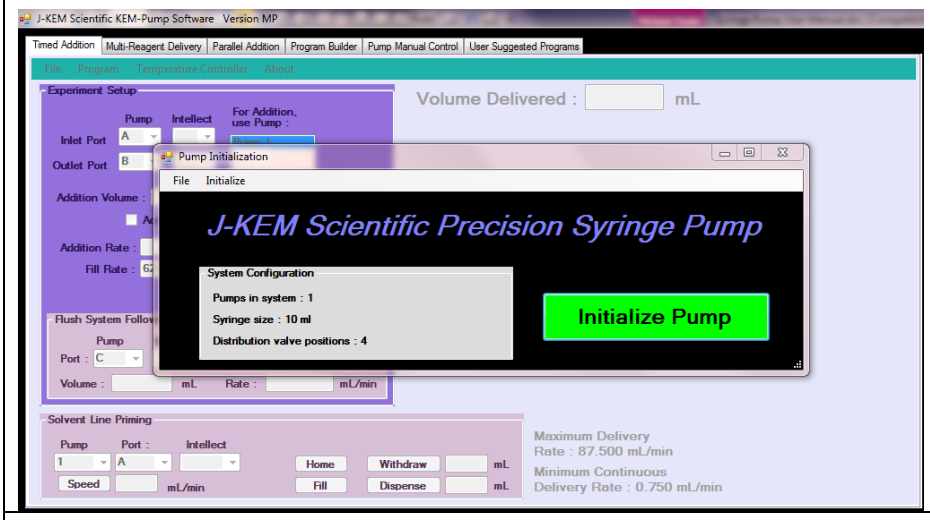
If the pump initializes and the software appears normal, then congratulations, you are ready to user your pump. If a message appears stating that the pump cannot be found, then the drives were not installed properly on your PC and you should contact you IT group.

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

KEM-Pump 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.

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

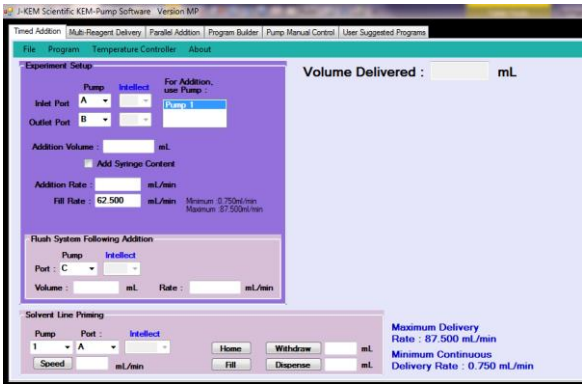


Initialize the software and the pump by clicking on the green Initialize Pump button. Once initialized, KEM-Pump activates different programs, depending on the model and configuration of the syringe pump. The names of the available programs appear on the tabs along the top portion of the screen. Each program is described in its own section later in this manual.

Custom Initializations –
When the syringe pump initializes, it moves the distribution valve to Port A and then empties the content of the syringe through port A. In some cases, users may want to empty the contend of the syringe through a different port. To initialize through a different port, select the option 'Initialize to Port' from the Initialize menu. When prompted, enter the pump number to initialize to, then click the green Initialize button.

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.

Addition Rate – Enter the flow rate for the addition of the reagent. The maximum flow rate is shown at the bottom of the screen, there is no minimum flow rate. At the bottom of the screen is listed the "Minimum Continuous Delivery Rate, this is the minimum flow rate that the pump can deliver at with no interruption in the motion of the syringe plunger.

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.

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 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 alternating 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 7-10 seconds while it refills.

If this break in the continuous delivery of solvent is undesirable, the dual pump addition should be selected. A dual pump delivery fill ones syringe while the other syringe is delivering, then just at the moment that the one syringe empties, the second syringe starts. This results in a continuous, uninterrupted delivery of the requested reagent.

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.

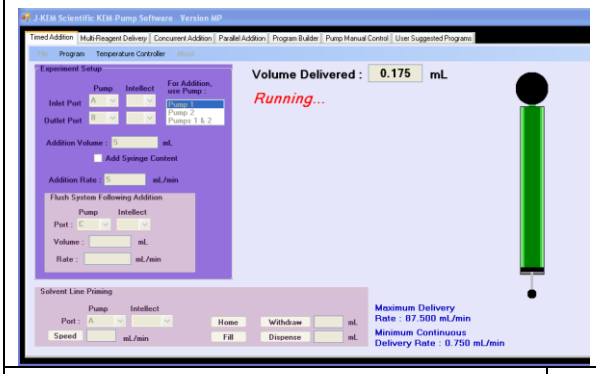
A useful set of controls is present in the group box titled "Solvent Line Priming". Often when a reaction is set up, the solvent line connecting the reagent reservoir to the distribution valve is full of air. With air in the line, the first time the syringe draws reagent into the syringe, it will first fill with the air in the line and then the reagent. A second potential problem, is when the syringe starts to deliver reagent to the reactor, if the line connecting the pump to the reactor is full of air, reagent won't really be delivered to the reactor until air is flushed forward through this line. The controls in this group box address both these issues. A step-by-step example below demonstrates how these controls can be used.

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.
Fill – Fills the syringe from the selected syringe pump port.
Home – Empties the syringe from to selected syringe pump port.
Withdraw – Withdraws the specified volume into the syringe
Dispense – Dispenses the specified volume from 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.

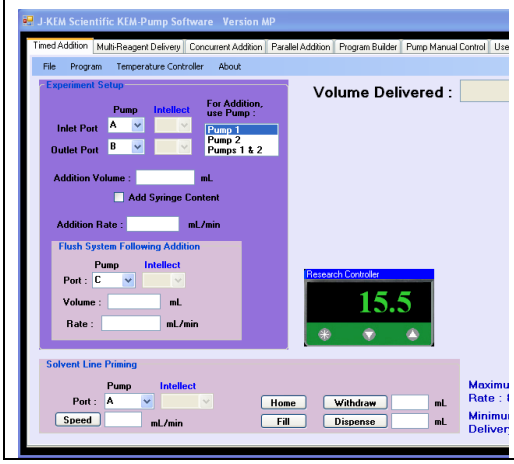
Add Syringe Content Feature

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.



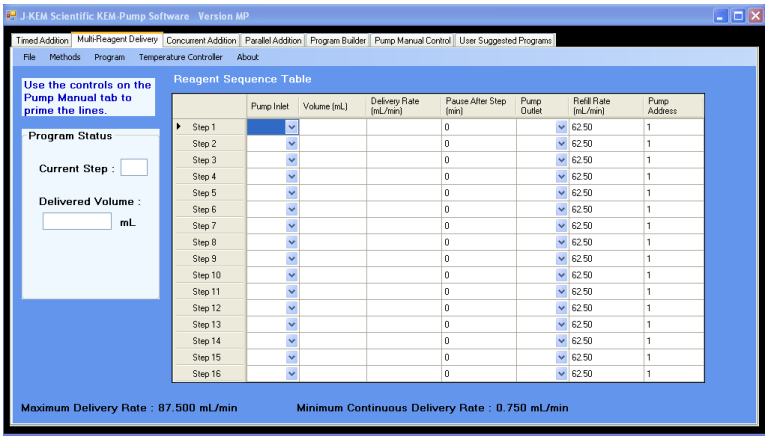
The function of a J-KEM temperature controller can be added to the software interface of the syringe pump. This provides a single interface for processes requiring temperature control during the pumping sequence. For a full description of the temperature control function, see the section titled "Temperature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

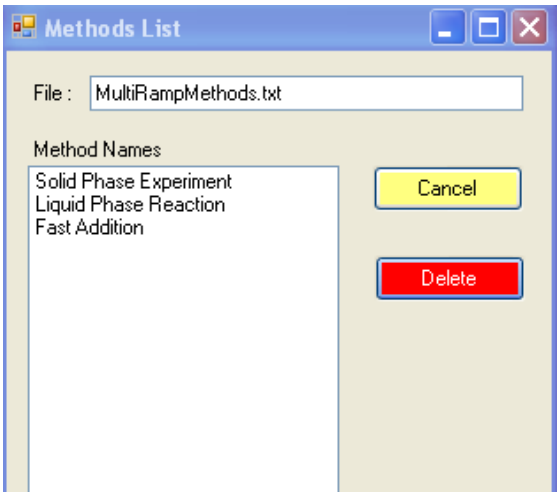
Before starting an experiment, inlet and outlet lines can be manually primed by using the controls on the Manual Control tab. Once the system is in an appropriate starting condition, reselect the Multi-Reagent Delivery tab.

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 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.

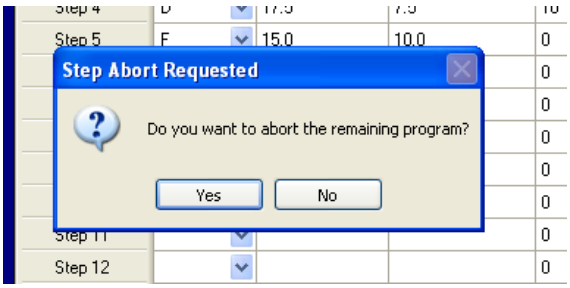


Once an experimental method if fully defined (by entering all the required information in the Reagent Sequence Table), you have 2 options. You can either start the experiment, or you can first save the method for future recall. The Methods menu contains three options:

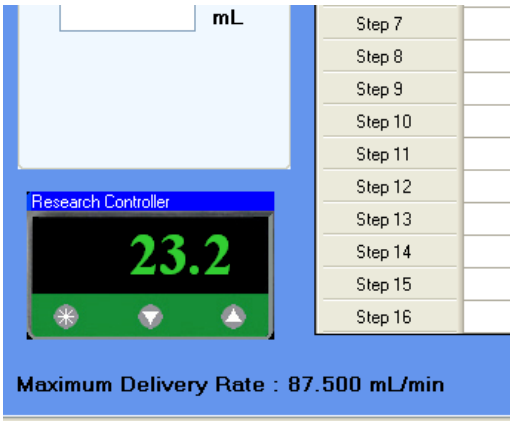
Save Method – To save the method currently defined on the screens, choose this option. When selected, a pop-up window appears prompting for a method name. Enter the name, then click OK.

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.



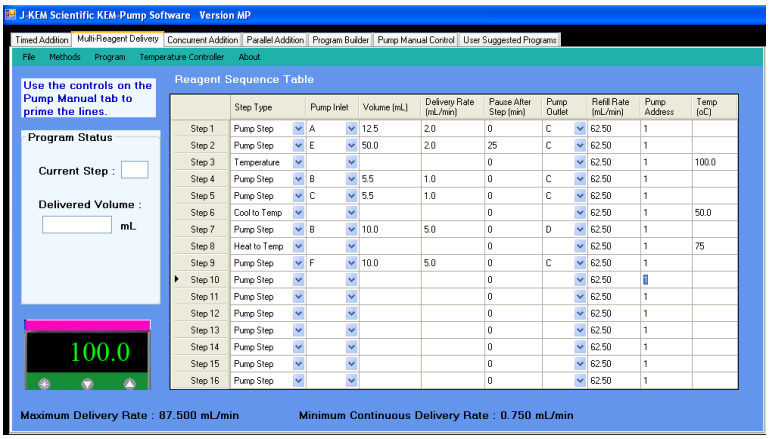
A running program can be terminated by selecting Abort from the Programs menu. When Abort is selected a popup window offers the option of aborting all remaining steps or just the current step. If you select Yes, the running program with any remaining addition steps are aborted. If you select No, the 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	

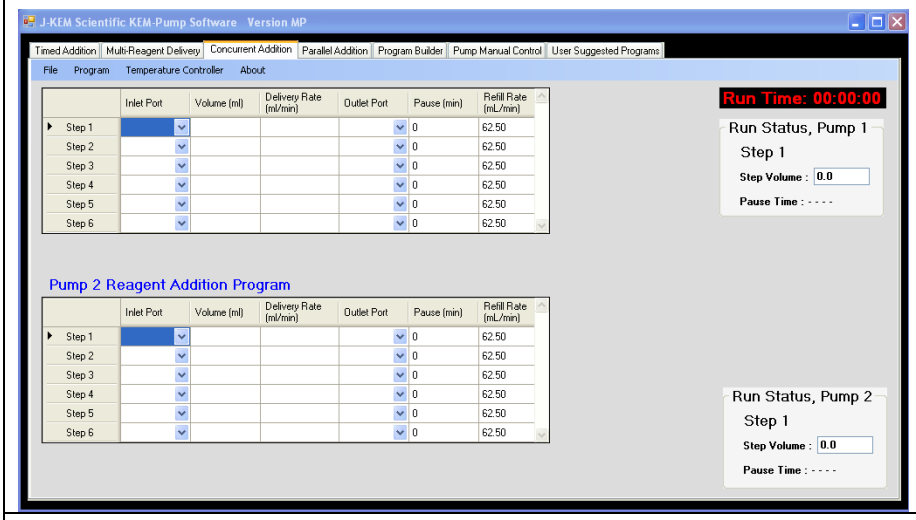
The third step type is a "Cool to Temperature" step. A cool to temp step changes the temperature controllers set point to the value entered in the table, and then pauses the syringe pump program until the temperature sensed by the controller falls to the entered temperature. In the example above, as 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	

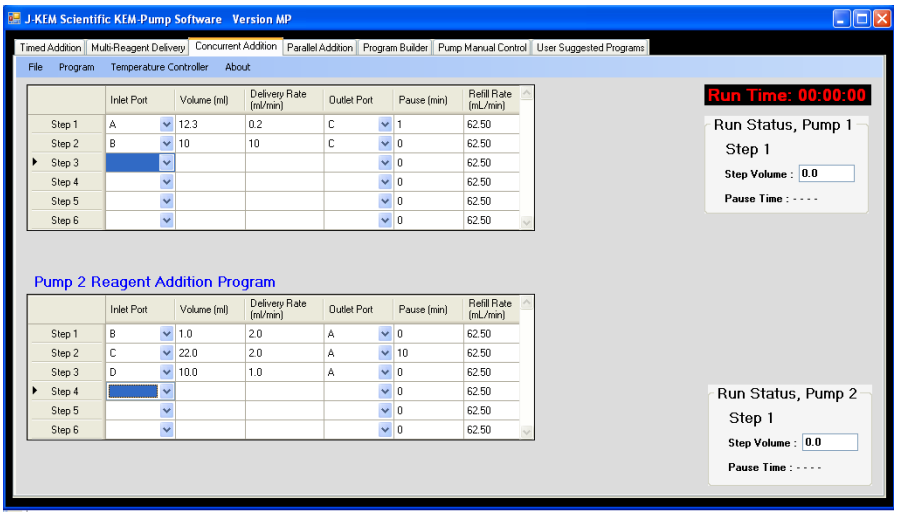
The forth step type is a “Heat to Temperature” step. A heat to temp step changes the temperature controllers set point to the value entered in the table, and then pauses the syringe pump program until the temperature sensed by the controller rises to the entered temperature. In the example above, as 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.



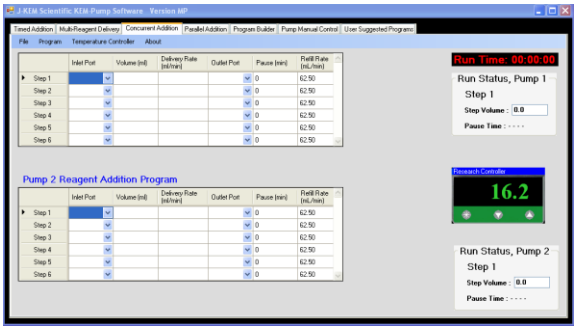
Reagent Addition Program
Each pump has an 8-step table that is used to construct the addition program for that pump. The addition programs for each pump run simultaneously, but independently of each other. The tables for each pump can have the same, or different, number of steps. A program terminates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



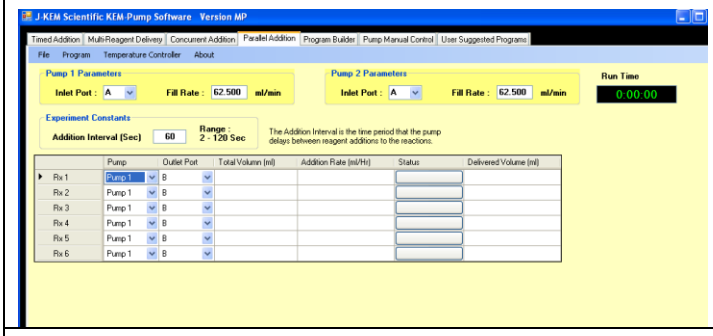
The function of a J-KEM temperature controller can be added to the software interface of the syringe pump. This provides a single interface for processes requiring temperature control during the pumping sequence. For a full description of the temperature control function, see the section titled "Temperature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

Highlights include:

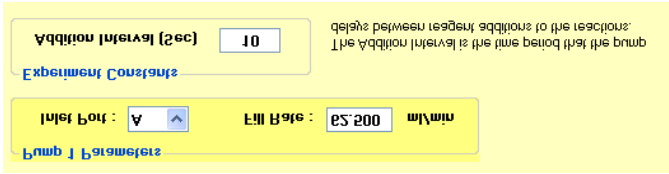
- On-screen temperature display and control.
- 16-Step temperature ramp.
- **An optional software add-on allows the rate of reagent addition to be controlled as a function of reaction temperature.**

Parallel Addition Program

This program uses a single pump (or dual pumps) to add a single reagent to multiple reactions 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.

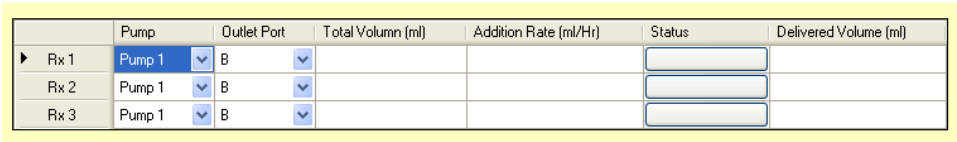


For dual pump systems, a group box for Pump 2 Parameters also appears. The second pump can be used to run a second series of independent additions of different or the same reactors as those accessed by pump 1.

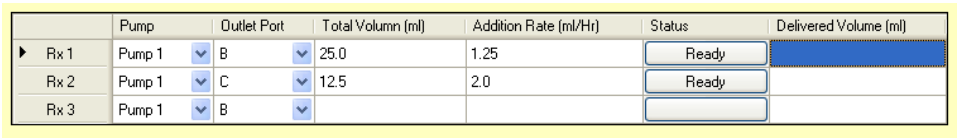
Inlet Port – Select the port that the common reagent is attached to.

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.

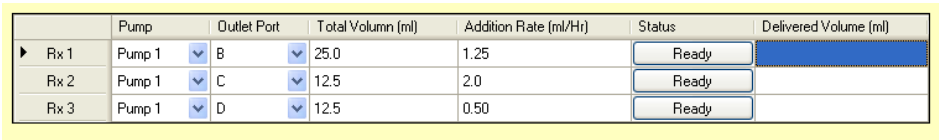
Additional Interval – This program works by sequentially moving the distribution valve to the outlet port of each reactor and dispensing small amounts of reagent each time the port is accessed. The Addition Interval value is the amount of time that the pump pauses between addition cycles. One cycle is 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.



	Pump	Outlet Port	Total Volumn (ml)	Addition Rate (ml/Hr)	Status	Delivered Volume (ml)
Rx 1	Pump 1	B				
Rx 2	Pump 1	B				
Rx 3	Pump 1	B				

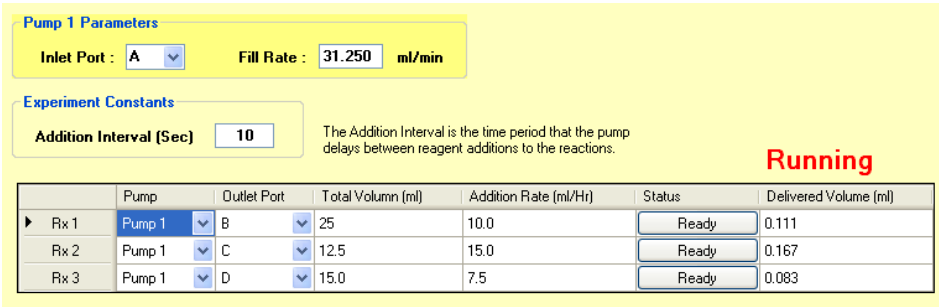


	Pump	Outlet Port	Total Volumn (ml)	Addition Rate (ml/Hr)	Status	Delivered Volume (ml)
Rx 1	Pump 1	B	25.0	1.25	Ready	
Rx 2	Pump 1	C	12.5	2.0	Ready	
Rx 3	Pump 1	B				



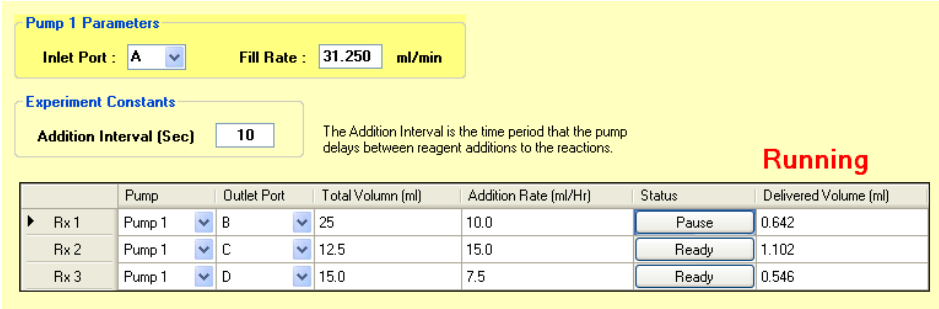
	Pump	Outlet Port	Total Volumn (ml)	Addition Rate (ml/Hr)	Status	Delivered Volume (ml)
Rx 1	Pump 1	B	25.0	1.25	Ready	
Rx 2	Pump 1	C	12.5	2.0	Ready	
Rx 3	Pump 1	D	12.5	0.50	Ready	

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. As the parameters for each reaction are entered, the Status label for that reactor turns to "Ready".



	Pump	Outlet Port	Total Volumn (ml)	Addition Rate (ml/Hr)	Status	Delivered Volume (ml)
Rx 1	Pump 1	B	25	10.0	Ready	0.111
Rx 2	Pump 1	C	12.5	15.0	Ready	0.167
Rx 3	Pump 1	D	15.0	7.5	Ready	0.083

To start the additions, select Start from the Program menu. The table column titled Delivered Volume updates continuously during the course of the addition.
The only variable that can be changed while a run is in progress is the Total Volume of the reagent to all to a particular reactor.



	Pump	Outlet Port	Total Volumn (ml)	Addition Rate (ml/Hr)	Status	Delivered Volume (ml)
Rx 1	Pump 1	B	25	10.0	Pause	0.642
Rx 2	Pump 1	C	12.5	15.0	Ready	1.102
Rx 3	Pump 1	D	15.0	7.5	Ready	0.546

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.

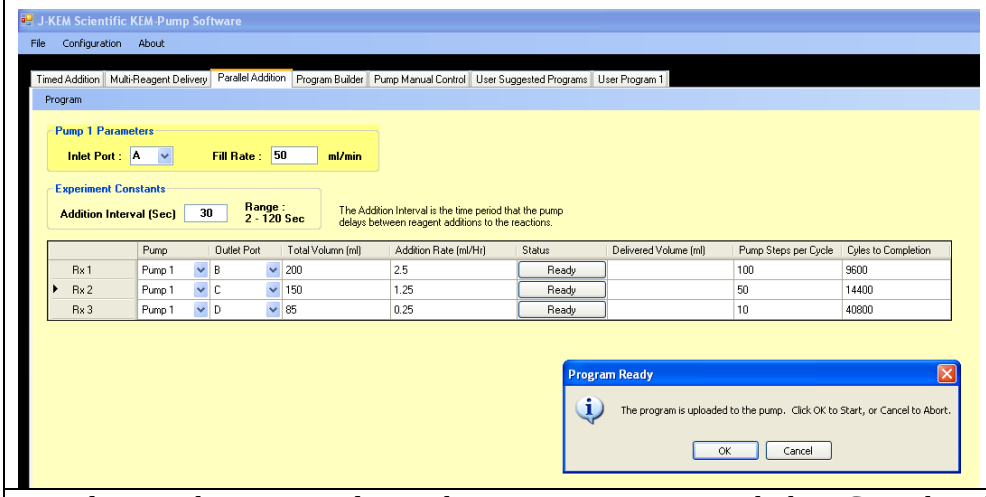
Menu Commands

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 eh 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.

Program -> Upload for Autonomous Run Uploads a program to the syringe pump that allows the program to run even when the pump is disconnected from the PC. See the section titled Autonomous Syringe Pump Runs.



Autonomous Syringe Pump Runs.
The feature uploads the syringe pump program to RAM memory in the syringe pump module, and then executes the program from the Pumps memory. When a program is run from the pumps RAM memory, the connection with the PC is disabled. After uploading the program to the pump, the KEM-Pump software can be exited, since the pump no longer has communications with the PC. The advantage of this option is that it allows very long programs to be run without any need of being connected to the PC.

To use this feature:

1) Create the addition program in the table as normal.
2) Select Upload for Autonomous Run from the Program menu
3) In response to the message stating that the program was uploaded, click the OK button. Once the program starts in the pump, the KEM-Pump software can be exited, and the PC turned off. The program uploaded to the syringe pump is erased when power is turned off to the pump.

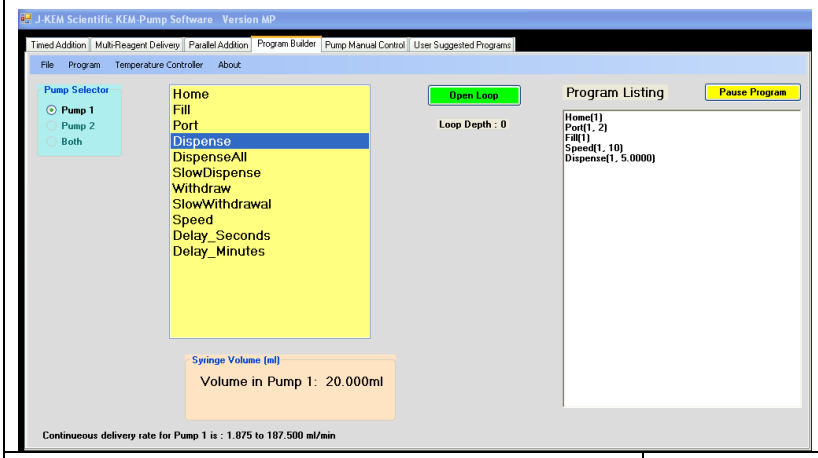
The function of a J-KEM temperature controller can be added to the software interface of the syringe pump. This provides a single interface for processes requiring temperature control during the pumping sequence. For a full description of the temperature control function, see the section titled “Temperature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

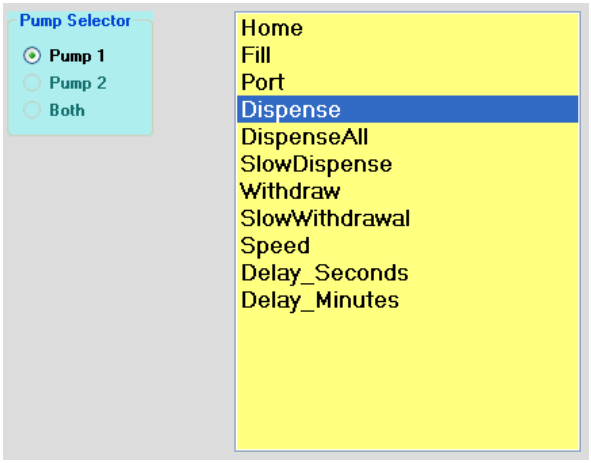
Program Builder

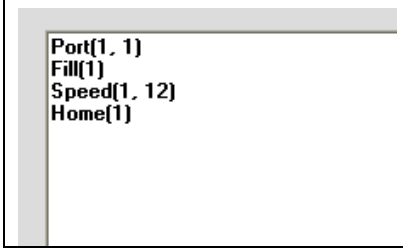
Program builder allows the user to arrange a sequence of pump commands in order to accomplish virtually any desired fluid motion/delivery program. Program builder can be run in either Local mode from the PC that operates the syringe pump, or Remote mode where a separate PC sends commands to the PC running the syringe pump. Remote mode is useful to incorporate the pump into a robotic or other automation application.



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.



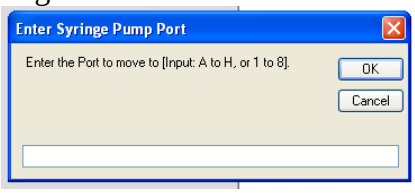


Program Builder consists of several controls, the first is the Command Selection Box. Depending on the options installed on your pump, the command selection box populates with the command available. For systems with a single pump, only the pump 1 pump selection is activated. For dual pump systems, to 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 command are selected from the Command Selection box, they appear in the Program box in the order that they were selected.

Home – Instructs the selected pump to Home, which expels the entire content of the syringe. Remember – for multi-pump systems, you must select the pump (Pump 1, Pump 2, or Both) to perform the action before clicking on any command in the Command Selection box.

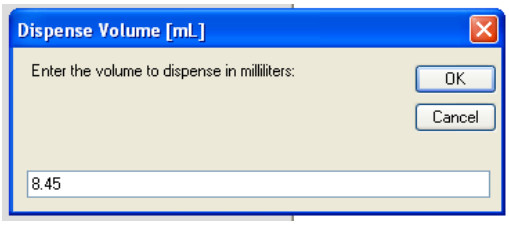
Fill – Instructs the selected pump to Fill the syringe to its maximum volume.

Port – When the Port command is clicked, a input box opens to prompt the user for the port to go to.

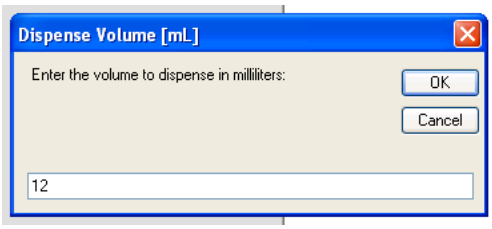


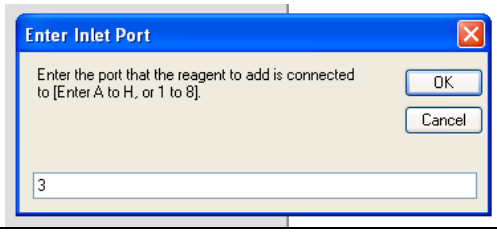
Enter the desired port, then clock OK

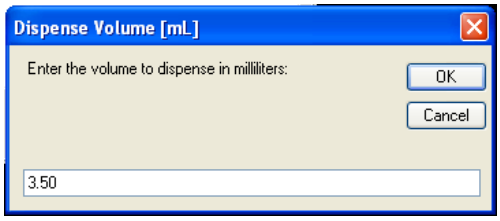
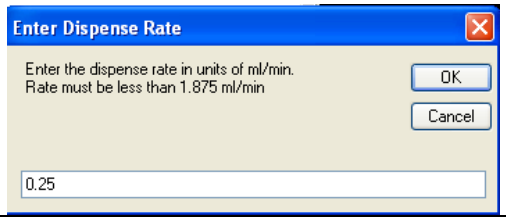
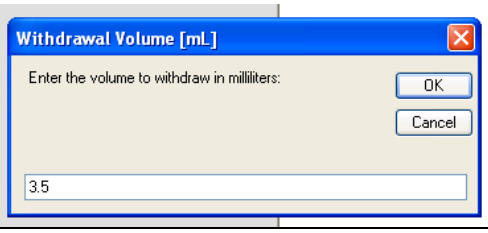
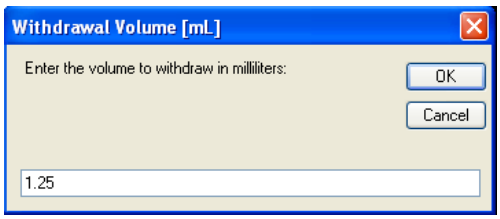
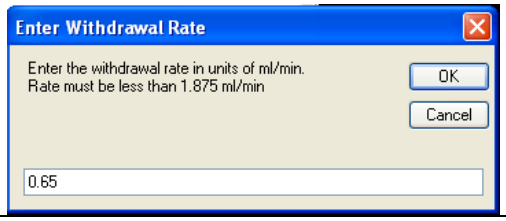
Dispense - Causes the pump to dispense the requested volume. An input box opens prompting the user to input the volume to dispense. If a volume is entered that is greater than the current syringe volume, only the content of the syringe is dispensed, then the additional requested volume is ignored. If a volume is entered that is greater than the size of the syringe, en error message is displayed prompting the user to enter a volume no greater than the size of the syringe.

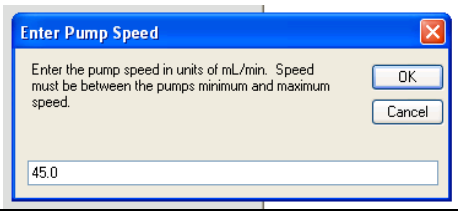
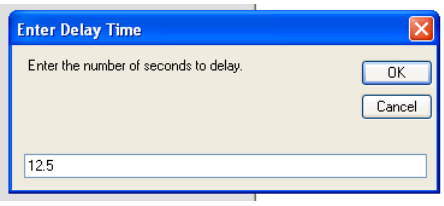
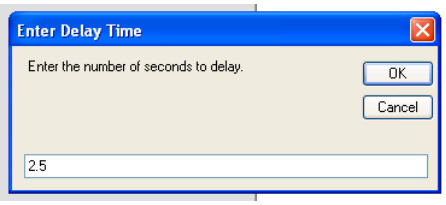
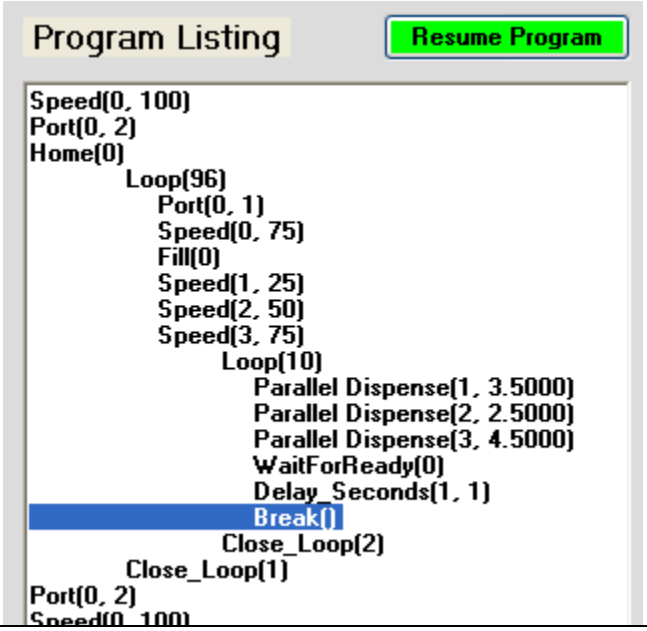


DispenseAll – Causes the pump to dispense the entire user entered volume, independent of what is the current volume or the size of the syringe. When selected, the DispenseAll command first prompts the user to enter the volume to dispense, it then prompts the user to enter the port on the distribution 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.

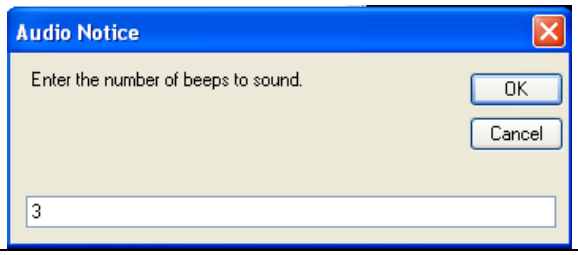




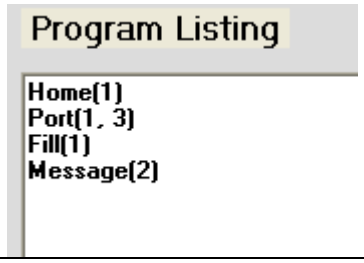
SlowDispense – The syringe pump has two delivery modes, continuous mode and step mode. When possible, continuous delivery mode is the best because it dispenses a continuous stream of fluid with no pauses or gaps, but at very low flow rates, continuous mode does not operate. At the bottom of the form, 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.	 
Withdraw – Causes the pump to withdraw the entered volume from the currently selected syringe pump port. If the volume entered is greater than the volume of the syringe, a message is displayed prompting the user to enter a smaller volume.	
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.	 

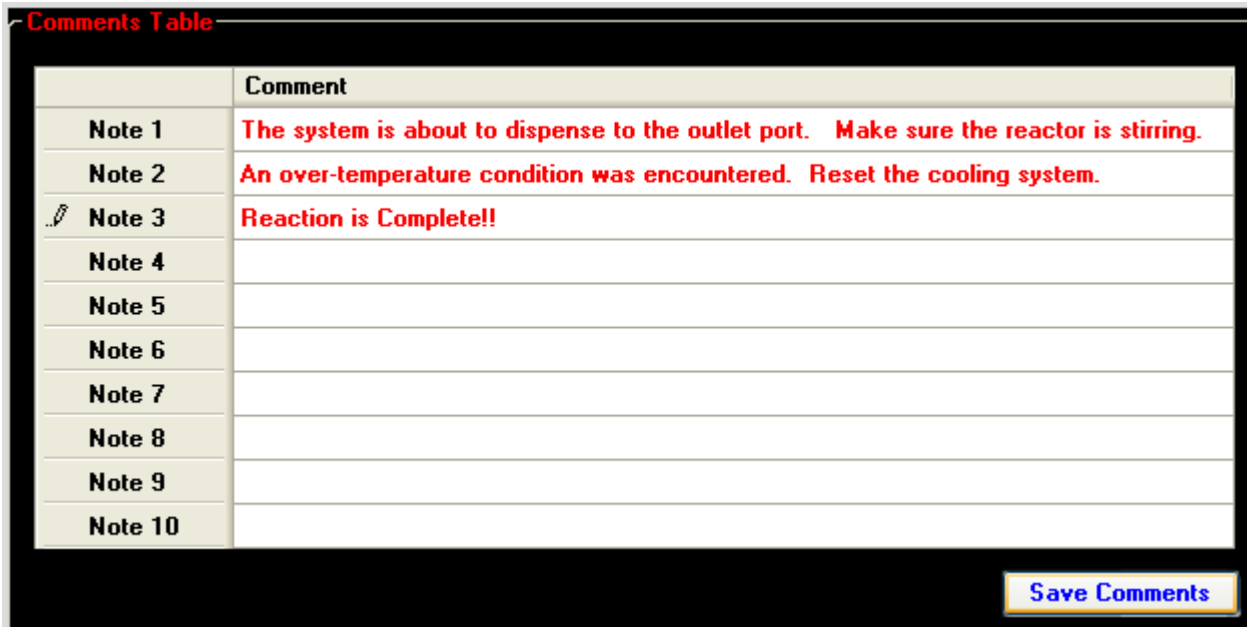
Speed – Causes the pump to set the speed for withdrawals and dispenses to the user entered value. Speeds are set in units of ml/min. The entered speed must be between the minimum and maximum delivery rate for the pump shown on the bottom of the KEM-Pump screen.	
Delay_Seconds – Causes the pump program 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

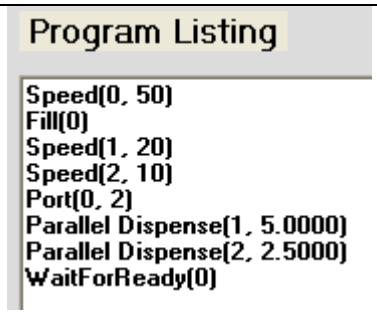


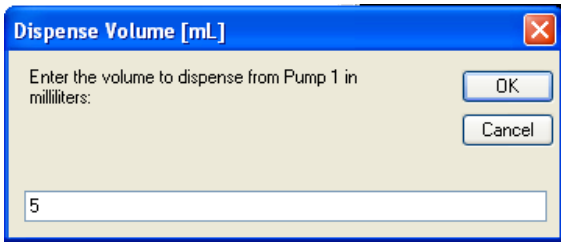


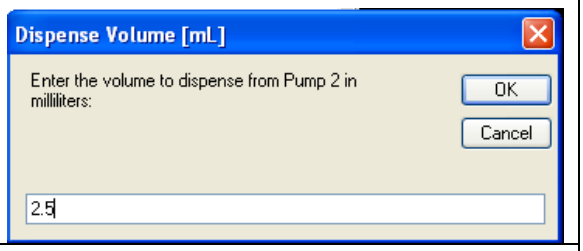
location #2 to display. This is a convenient way to pass program critical messages to a user. While a message is displayed, the program pauses until the user acknowledges the message by clicking the 'OK' button that's displayed with the message.

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.

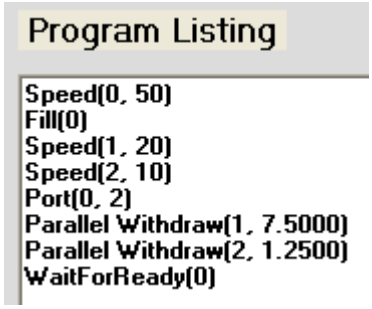
Parallel Dispense – This command handles a special case for multi-position pumps when it's desirable for two different dispense operations to occur simultaneously.
Most commands in the program file occur sequentially, and a command later in the list does not execute until the one preceding it completes. The Parallel Dispense command allows the pumps to dispense different volumes in parallel rather then 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.

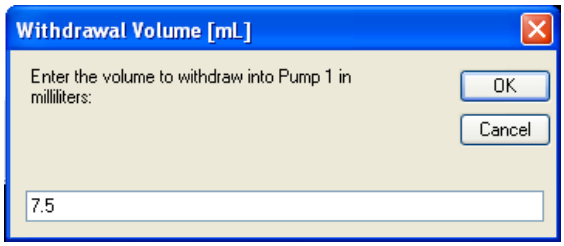


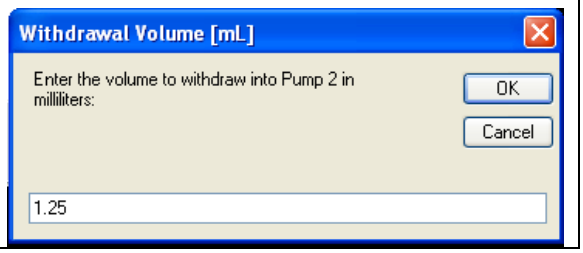


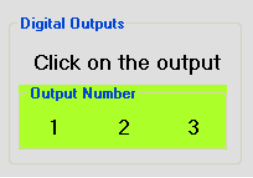
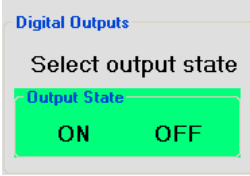
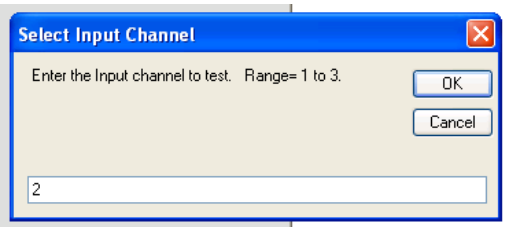
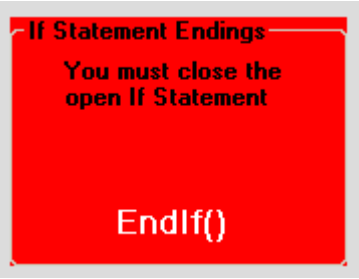


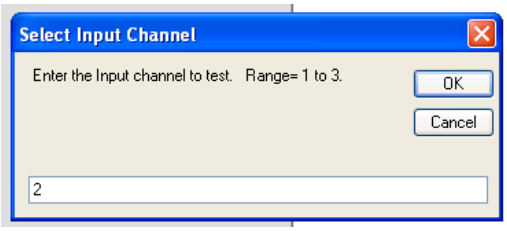
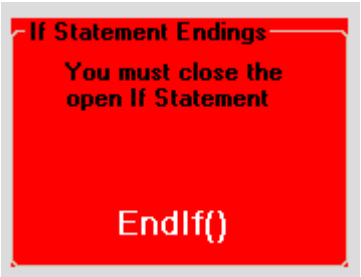
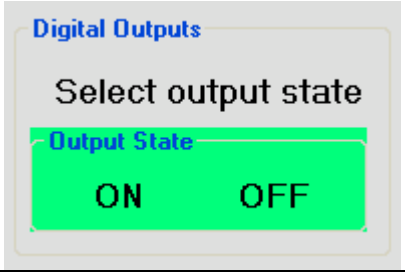
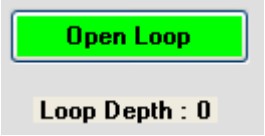
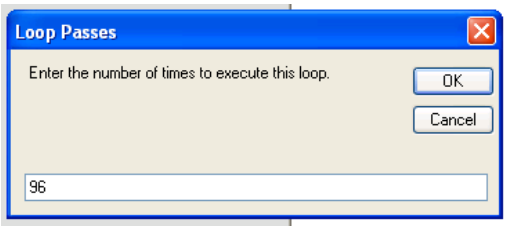
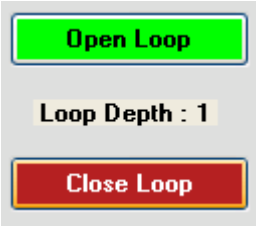
Parallel Withdrawal - This command handles a special case for multi-position pumps when it's desirable for two different withdrawal operations to occur simultaneously.
Most commands in the program file occur sequentially, and a command later in the list does not execute until the one preceding it completes. The Parallel Withdrawal command allows the pumps to withdraw different volumes in parallel rather then 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 of 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 can not 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 can not 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.	
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 know 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.

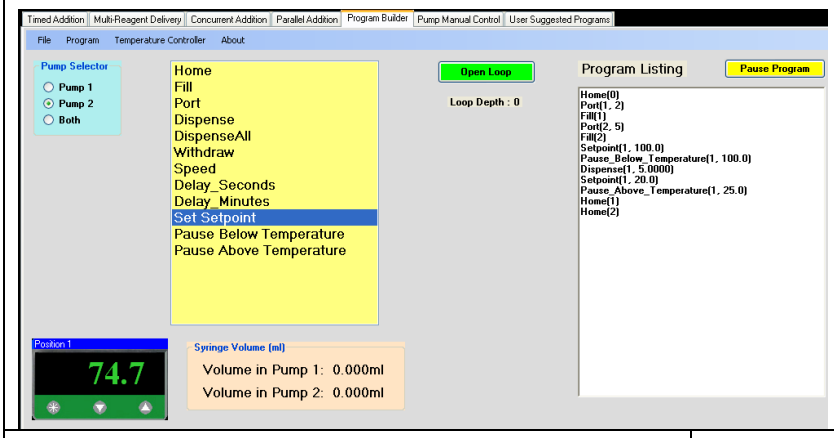
```
1.  Port(1, 2)
2.  Fill(1)
3.  Port(1, 1)
4.      Loop(96)
5.          Dispense(1, 0.0200)
6.          Delay_Seconds(1, 0.4)
7.      Close_Loop(1)
8.  Port(1, 2)
9.  Home(1)
```

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.

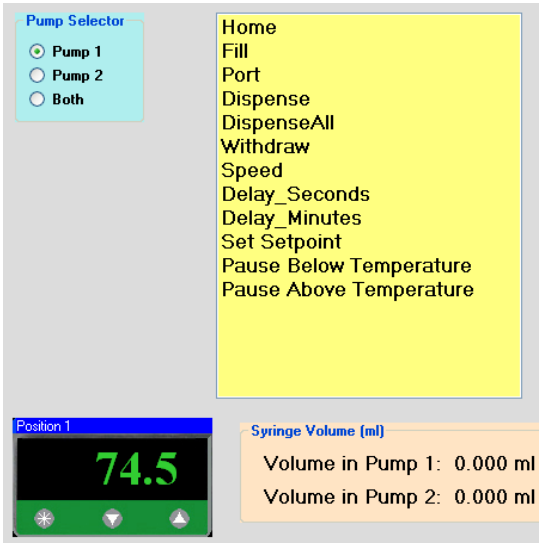
```
1.  Home(1)
2.      Loop(12)
3.          Port(1, 2)
4.          Fill(1)
5.          Port(1, 1)
6.              Loop(8)
7.                  Dispense(1, 1.0000)
8.                  Delay_Seconds(1, 0.4)
9.              Close_Loop(2)
10.     Close_Loop(1)
11. Port(1, 2)
12. Home(1)
```

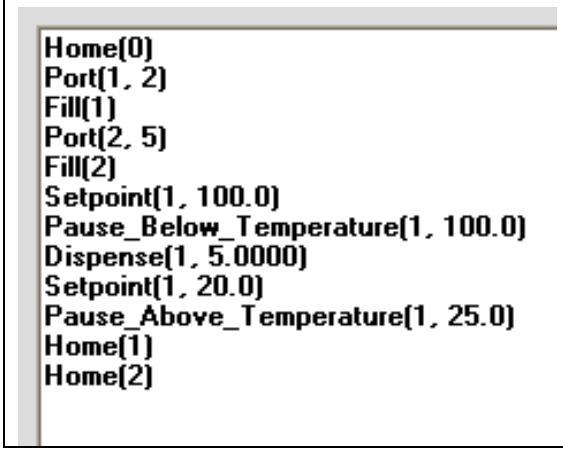
Rules for Ifs **and Loop**s
Loops can be nested 3 deep.
A single If can appear in a Loop, but then no other If's or Loops can be nested until the If is closed.
A single Loop can appear in an If, but no other If's or Loops can appear until the Loop is closed.

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.





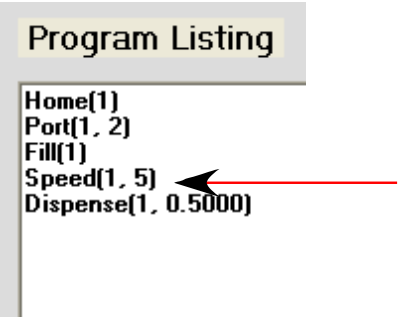
When the controller is added to the form, three new commands are added to the Command Selection Box. The function of these commands are:

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

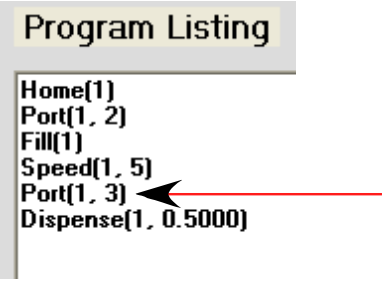
Pause Below Temperature – When this command is encountered during a syringe pump program, the program pauses or continues based on the current reaction temperature. If the user enters a "Pause Below Temperature" of 50° C, the progress of the syringe pump program will pause as long as the sensed temperature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

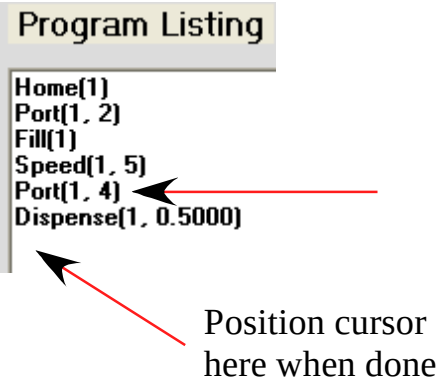
Editing Syringe Pump Programs



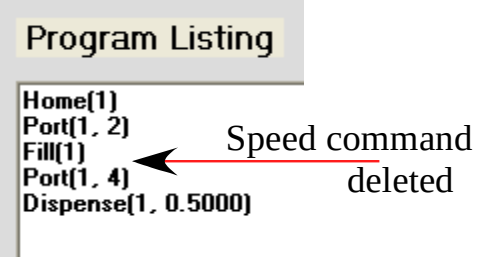
As long as a program is under construction, it is simply a text file. As such, it can be edited, statements inserted or deleted, or entire sections of code added. This section describes the editing controls.



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

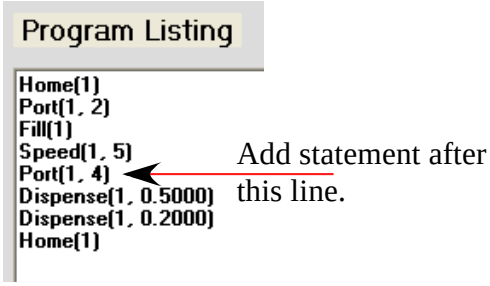


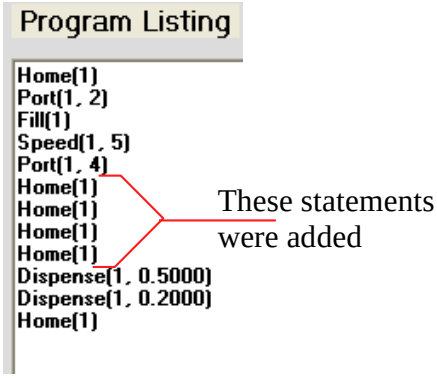
Editing a Statement – The text of any statement can be edited. For example, if the pump should have been directed to port 4, rather than port 3 in the newly entered command, the user can simply delete the '3' and replace it with '4'. When you are done editing, you must position the cursor on the first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



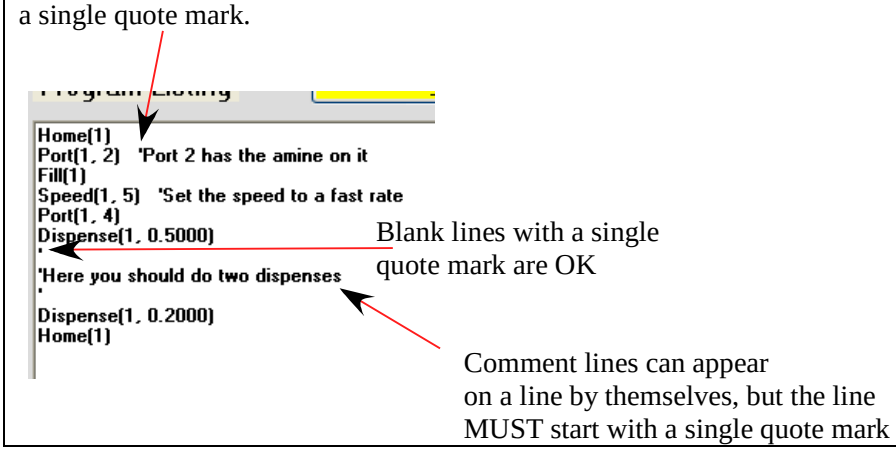
Deleting a Statement – Any line in the program can be deleted simply by selecting the line in the program window and deleting it. You must delete the entire statement and remove any blank lines. Once the statement is deleted, you must position the cursor on the first line after the last program statement,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

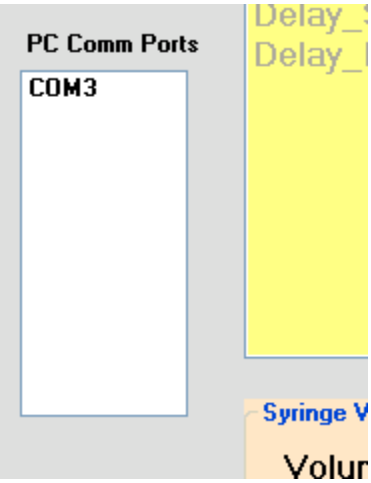
Resume Program – A paused program is resumed by selecting this command.

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 the 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.

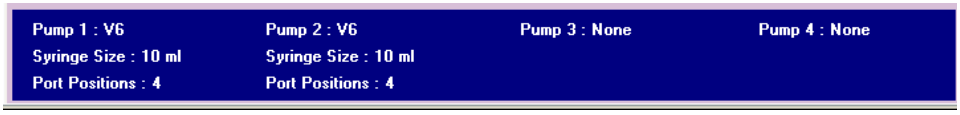
Example: Remote PC sends "HOME(1)", the reply is "HOME(1)OK<Cr>."
If an incorrectly formatted command is send, the pump replies with the command sent and then appends the characters 'BAD' to the end.
Example; Remote PC sends "HOOME(1), the reply is "HOOME(1)BAD<Cr>"
If an improper command causes an unrecognized 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.

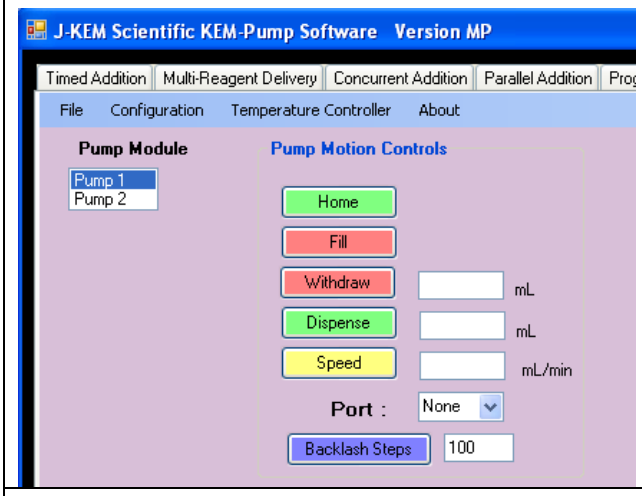
Command	Comments
Home(address)	Dispenses the entire volume of the syringe and resets all counters to 0.
Dispense(address, volume) *volume* is the volume of fluid to dispense as a floating point number in units of milliliters.	Dispenses the requested volume. If the requested volume exceeds the volume 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.
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 out put 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.

Manual Control

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



At the bottom of the screen is a window that shows the current configuration of the syringe pump system. The information shown on this panel must be correct for your syringe pump system. If you change the syringe size or the distribution valve on the pump, you must edit the syringe pump configuration to reflect these changes. For instructions on how to change the system's pump configuration, see the section titled 'Installing a Syringe or Distribution Valve.'



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.

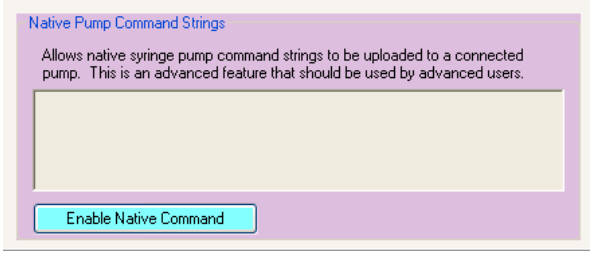
Dispense – Clicking this button causes the pump to dispense the volume entered into the associated text box. The pump will not dispense more than the volume remaining in the syringe.

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.

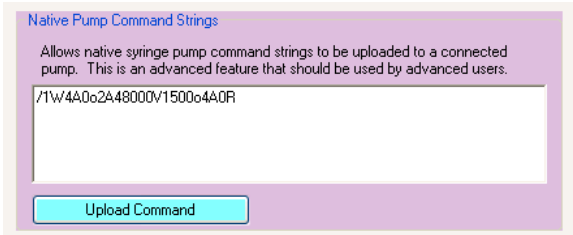
Port – Selects the port the distribution valve is set to.

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.

User Output 1, 2, and 3 – The syringe pump can optionally be equipped with three User addressable output ports capable of sinking 170 mA each at input voltages up to 40 Vdc. These controls set the state of the outputs.



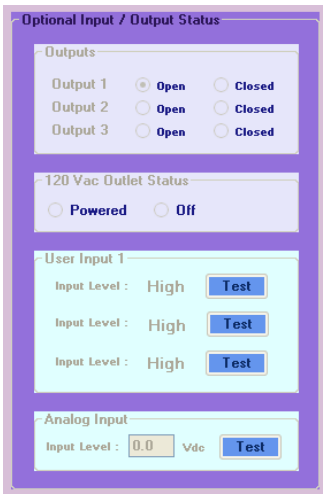
At the most basic level of operation, the pump communicates using its' native command language. KEM-Pump software is designed to insulate the user from the complexity of the native command language, but for some very advanced users being able to write a command string directly to the pump is a valuable feature. The structure of the native command language is well beyond the scope of this user manual.



To enable the command input box, click on the button titled Enable Native Command. Once enabled, the user can enter the desired command string, then click the Upload Command button. Include the terminating Run command 'R' but not do not include the terminating carriage return '0x0D'

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.

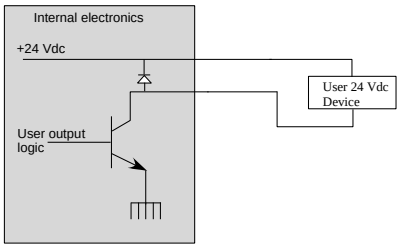


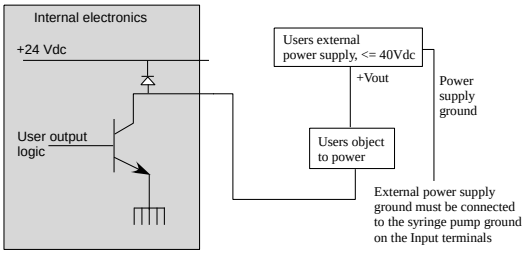
Optional Input / Output Status – This group box is enabled if the I/O Package option is installed. This package provides three TTL level digital inputs, three 24Vdc high current outputs, and one 0-5Vdc analog input.

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. If both the IO option and the 120Vac outlet are installed, the 120Vac outlet uses the User Output #1, which will be unavailable for other uses.

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

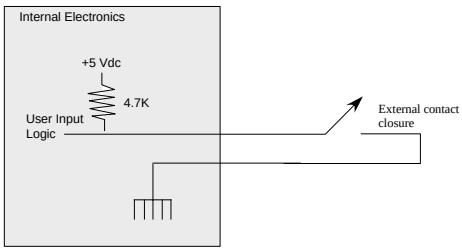
Wiring options for the external outputs

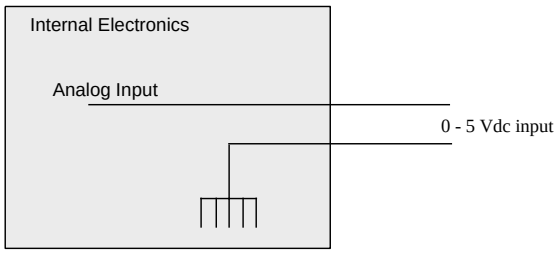




User Outputs - The outputs are open collector and can sink 170 mA each at 24 Vdc. Wiring of the outputs is shown in the drawing above.
The KEM-Pump programmers' manual contains detailed information on the functions controlling user output. The relevant function is: **`Pump.UserOutput()`**

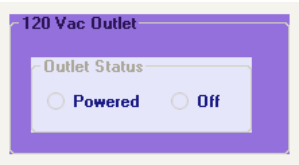
Wiring options for the external Inputs



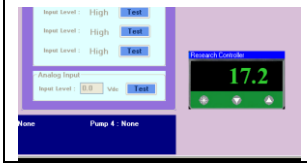


User Inputs - The digital inputs measure TTL logic levels (0-5 Vdc) and have 4.7 K pull-up resistors.
Logical 0 is any voltage <= 1 Vdc. Logical 1 is any voltage >= 3.5 Vdc.
The analog input returns the voltage applied to the input in the range of 0 to 5.0 Vdc.
Do not apply voltages outside of the range of 0 to 5 Vdc or damage may result to the pump.
The KEM-Pump programmers manual contains detailed information on the functions controlling user inputs. The relevant functions are: `Pump.UserInput() and Pump.AnalogInput()`

120 Vac Power Outlet Option



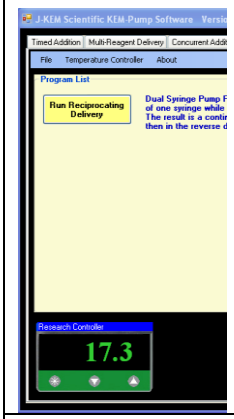
The 120 Outlet Option – This option provides a 120 Vac outlet with 10 amps of outlet current that is under program control. The receptacle is located on the back of the syringe pump.
When present, the state of the 120 Vac receptacle is controlled by user output #1.
The command to turn On the receptacle 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".

User Suggested Programs

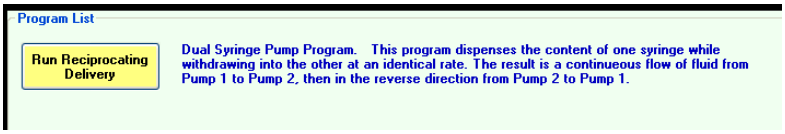
On occasion, users request custom programs that J-KEM thinks might be useful to other users. On the User Suggested Programs tab are those programs.



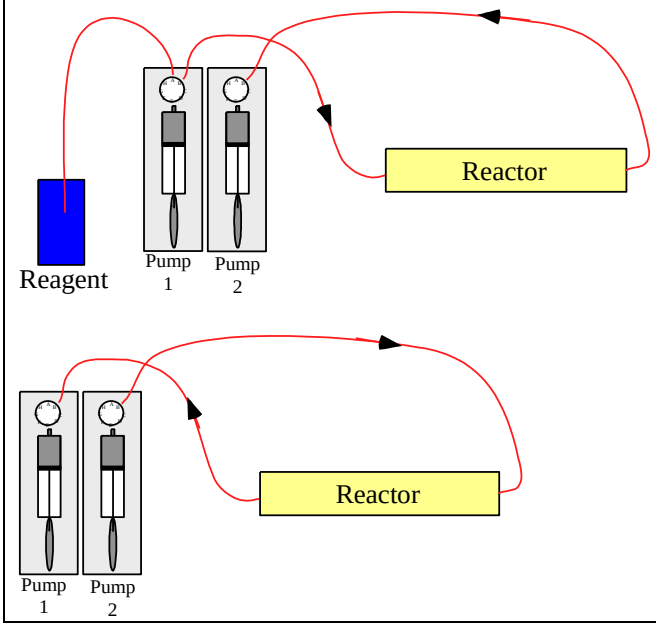
The function of a J-KEM temperature controller can be added to the software interface of the syringe pump. This provides a single interface for processes requiring temperature control during the pumping sequence. For a full description of the temperature control function, see the section titled "Temperature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

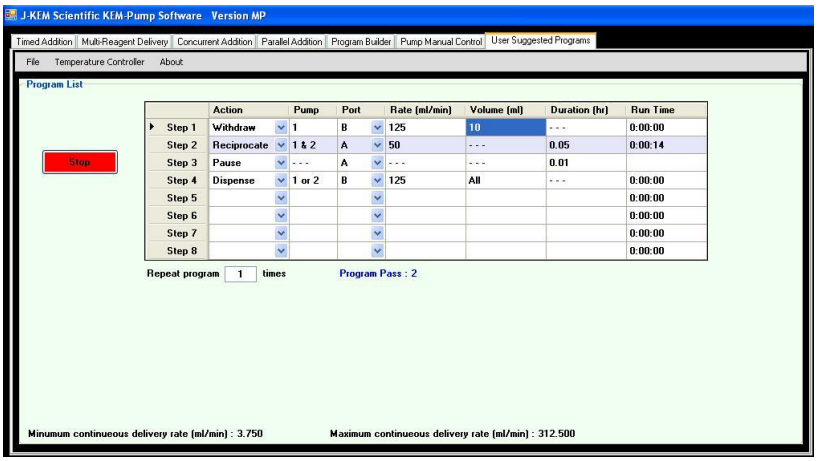


The Precipitating Delivery program is only available to dual syringe pump systems. This program uses one pump to add reagent/solvent to one port on a closed system reactor while simultaneously withdrawing reagent/solvent from a second port on a closed system reactor.
The net effect is that the fluids 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.

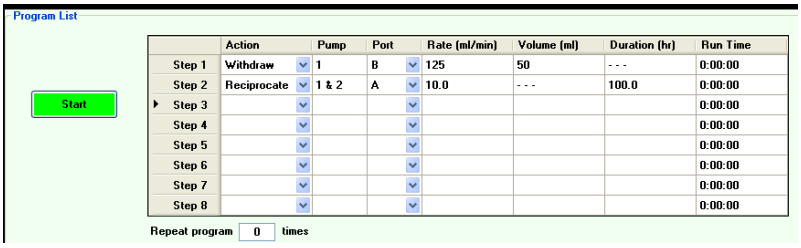
When Pump 1 completes it delivery, Pump 2 starts to deliver and Pump 1 starts to fill, thus reversing the flow through the reactor

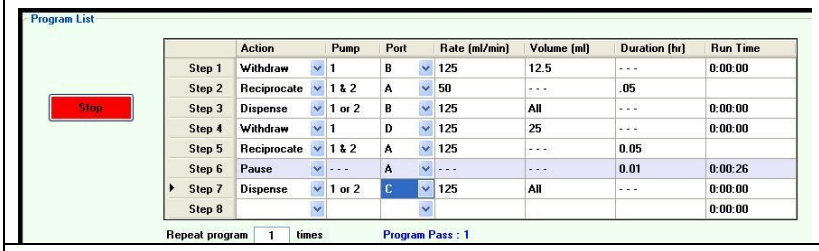


To make the experiments controls visible, click the Run Precipitating Delivery button.

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 to each experiments page. The interface allows real-time monitoring of reaction temperatures and remote control of the meters heating process.

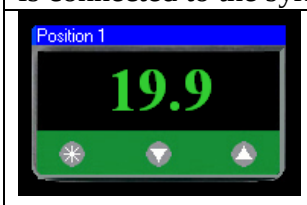
Hardware Setup

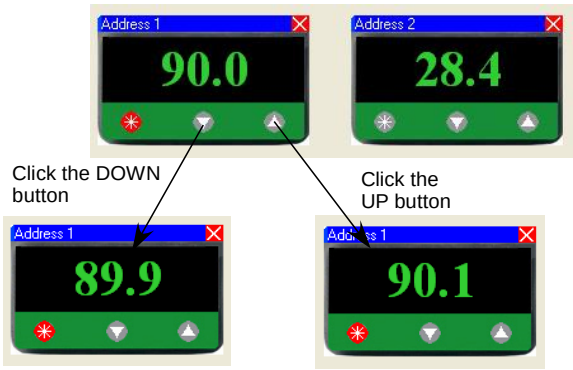
A J-KEM temperature controller with a USB interface is required. Connect a USB cord between the controller and a USB port on the PC operating the syringe pump. Set up the experiment involving the temperature controller and heater as you would normally.

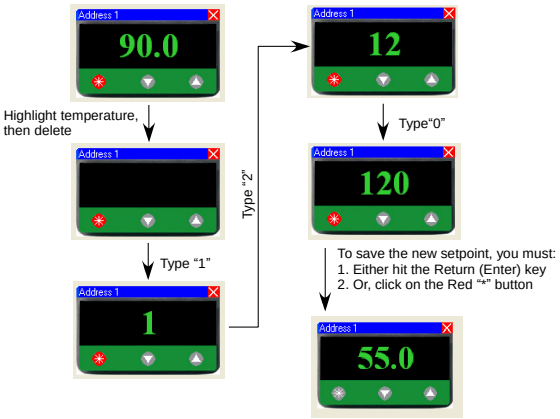
Software Operation

To view the controller on the syringe pump forms, 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

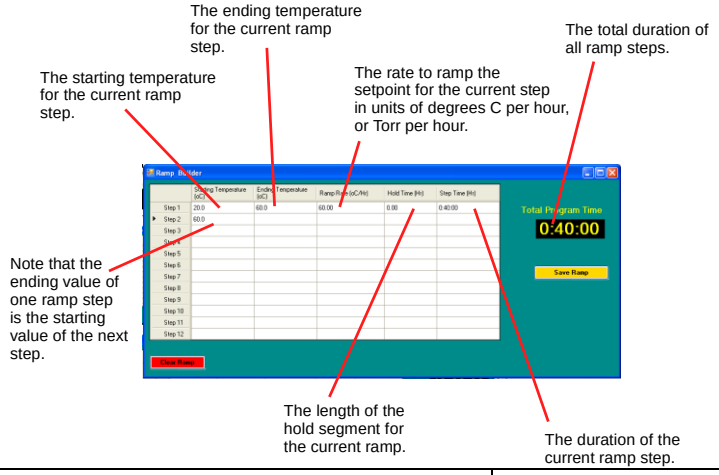
The normal state of the meter is to show the current temperature of the attached sensor.

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

1) A new setpoint can be entered into the physical meter itself without the use of software even when the controller is connected to the PC. A setpoint is physically entered by pressing the physical "*" 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 is showing 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 highlighting the current setpoint, displayed on the meters face, and 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.

Ramping - This interface implements controls to allow the user to construct and run any where from a 1 to 12-step temperature control ramp.

Build Ramp – Clicking on this menu command opens a form that allows the user to build a multi-step temperature ramp program. When the ramp program is complete, click the Save Ramp button to upload the program to the meter and close the ramp construction from.



Start Ramp – Start the ramp that was built in the ramps construction windows. When the ramp starts, a ramp status panel appears in the green box at the bottom of the digital meter. The status panel shows the current step, temperature setpoint, and the time remaining in the step. As an additional indicator that a ramp is active, a red "R", for Ramping, appears in the upper corner of the meter.

Pause Ramp – A ramp in progress can be paused any time by clicking on the Pause Ramp menu items. When a ramp is paused, the red "R" at the top right of the meter is replaced with a red "P" for Pause. To resume the ramp at the point were it was paused, select the menu time "Resume Ramp".

Advance Ramp – This menu item terminates the current ramp step and advances the program to the beginning of the next step. If the running step is the last step in the ramp, the ramp program ends.

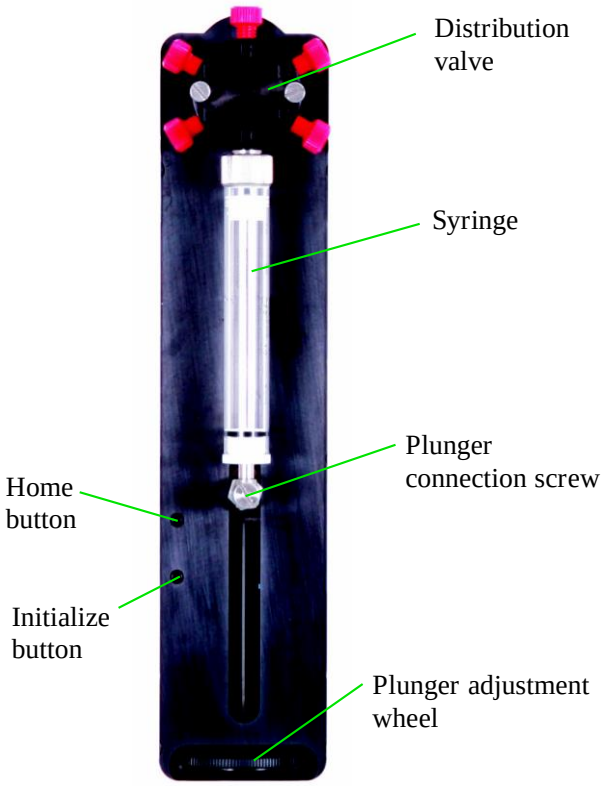
Abort Ramp – Immediately ends a running ramp. The meter setpoint remains at the temperature it was at when the ramp was aborted.

Name Meter – Stores a name for the digital meter that can be useful to identify the meter on screen. The meter displays the name on the top bar of 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 a simple task which takes about one minute, but if performed improperly will result in leaks or damage to the pump.



Syringe and Valve Removal

Step 1 Turn off power to the syringe pump.

Step 2 Using your finger, turn the Plunger adjustment wheel until the plunger of the syringe is about ½ inch below the top of the syringe.

Step 3 Remove the plunger connection screw (Cat # SPSS) attaching the syringe plunger to the syringe pump drive mechanism.

Step 4 Using only your hands (no tools), unscrew the syringe from the distribution valve body.

Step 5 If the distribution valve is being replaced, remove all of the tube fittings from the valve, then remove the two screws holding the valve to the face of the syringe pump (Cat # SPCC). The valve will pull straight off the pump now.

Syringe and Valve Replacement

Step 1 If the valve was removed from the pump, place the new valve on the pump and push gently until the back side of the valve is pressed flush against the face of the pump. Now replace the two silver screws that attach the valve to the pump. Reconnect any fluid fittings that were removed.

Step 2 Screw the syringe back into the valve using only your hands (no tools).

Step 3 Manually position the plunger rod so that the hole for the plunger connection screw aligns with the connector on the front of the pump. Insert the plunger connect screw through the plunger rod hole and into the connector on the body of the pump. **It is critically important** that this screw be replaced properly. Follow this procedure **exactly**.

a) Insert the screw until it bottoms out in the connector on the body of the pump.

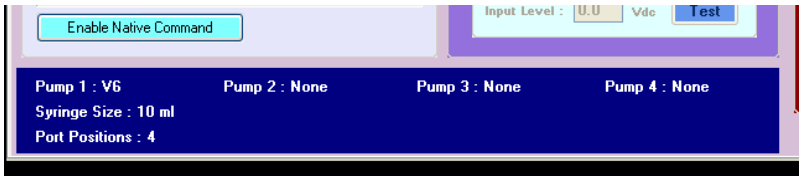
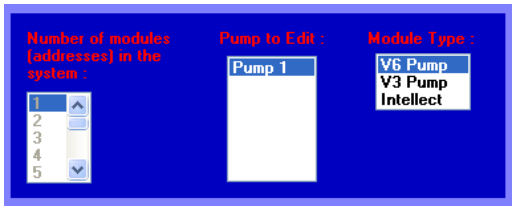
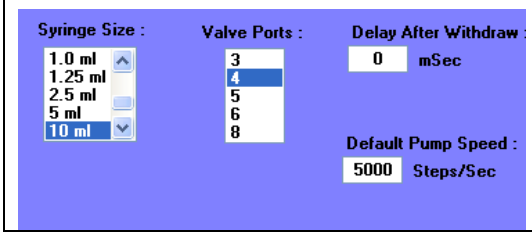
b) Using a screwdriver, press firmly on the screw and rotate it slowly **counterclockwise** until you fell a slight *click* (this aligns the threads of the screw with the threads of the connector body).

c) Now tighten the screw into the connector until it's firmly set.

Step 4 Turn on power to the pump and press the initialize button and the syringe plunger will move slightly. Using the plunger adjustment wheel, manually move the plunger until it bottoms out leaving no volume in the syringe.

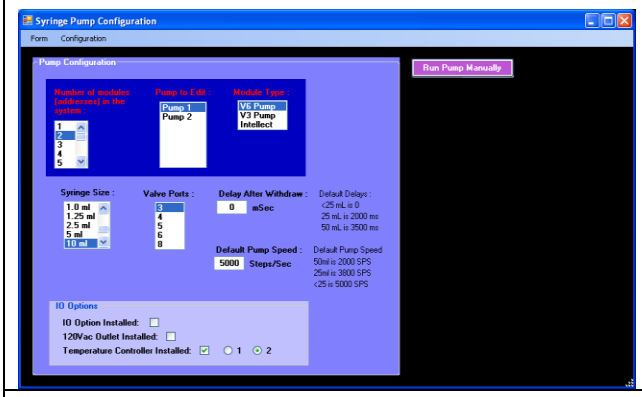
Step 5 Press the Home button. The plunger should move down, then return to top of the syringe.

Step 6 You must now configure the software for the new hardware.

	1) Start KEM-Pump and select the tab titled Pump Manual Control. A window at the bottom of the screen shows the last entered pump configuration. If the configuration is no longer correct and must be edited, select Pump Configuration from the Configuration menu.
 	2) On the pump configuration screen, select the pump, in the Pump to Edit box, that was changed, then for that pump, specify 1) the syringe size in the Syringe Size box, 2) the number of ports on the distribution valve, 3) the Default Pump Speed, and 4) and the Delay after Withdrawal (see below).

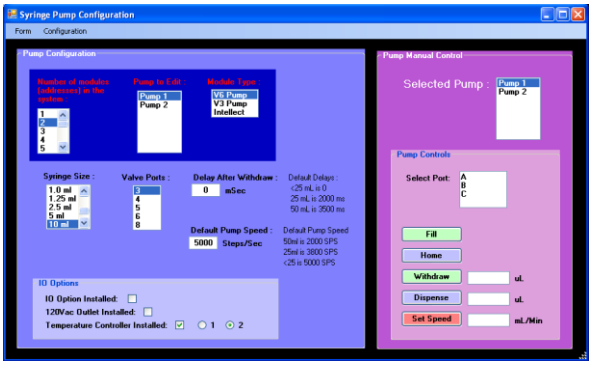
Pump Configuration Form

For a pump to operate correctly, the software must be programmed for its current configuration, including the number of syringe pump modules in the system, syringe sizes, the number of ports on each distribution valve, and each pumps default speed. This information is entered on the Syringe Pump Configuration screen. To open the configuration screen, select the Pump Manual Control tab, then select Pump Configuration from the Configuration menu.



Default Configuration Reset – If you're not sure how to reset the configuration of the pump, a good place to start is to reload the original pump configuration. Once reloaded, you can make any changes using the Pump Configuration Form as outlined below. To reload the original settings, select Reset to Factory Default from the Configuration menu.

To manually change system pump system settings:
1) First, select the number of modules (pumps) in the system. For example, if your system has two V6 pumps and one Intellect valve unit, then select "3" for the number of modules in the system.
2) Once the number of modules are specified, the listbox titled *Module to Edit* populates with one title for each module position.
3) Select the module of interest from the *Module to Edit* box to either see or change its current settings.
4) With the Module of interest highlighted, first specify the type of module that it is (either a V6 pump, V3 pump, or Intellect module). If the module type is a pump, you must specify the syringe size, the number of ports on its distribution valve, a PAW delay time, and a Default speed for the pump (see later). If the module is an Intellect valve, the only parameter that needs to be set is the number of ports on the valve.
PAW Delay stands for Pause After Withdrawal. For large syringes or very viscose fluids, its sometimes desirable to pause the system for a set period of time after drawing reagent into the syringe to allow the reagent to fully flow into and fill the syringe. For 25 ml syringes, the default value is 2000 ms, and for 50 ml syringes the default value is 3500 ms.
The default pump speed is the speed the pump uses at startup. The pump maintains this speed until the speed is explicitly changes in the programs code.
Before exiting this screen, make sure that all parameters for all of the modules are entered.
5) Specify the IO options installed in this system by checking the appropriate boxes.



The Syringe Pump Configuration screen allows the user to control the actions of each of the syringe pumps in the system manually. Click the Run Pump Manually button to load this screen. Highlight the pump of interest in the Selected Pump box. The controls below have the affects listed on the selected pump.

Selected Port – Clicking on a port letter causes the pumps valve to go to the selected port.
Fill – Causes the syringe to fully fill.
Home – Causes the syringe to dispense all of its content.
Withdraw – Causes the pump to withdraw the volume specified in the text box to the right of the button.
Dispense – Causes the pump to withdraw the volume specified in the text box to the right of the button.