**Precision Control for Research and Industry**

# Laboratory and Industrial Peristaltic Pumps

KEM Scientific, Inc.

*Instruments for Science from Scientists*

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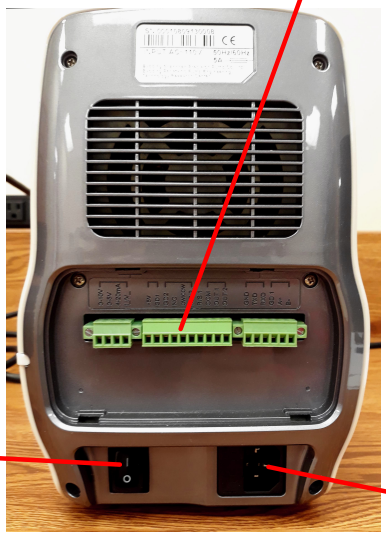
# Pump Overview


Color touch screen

Control Keys

Serial communication and digital and analog Input/Output

Pump Head



Power On/Off

Power input module

J-KEM's Peri-Pump operate in three dispense modes:

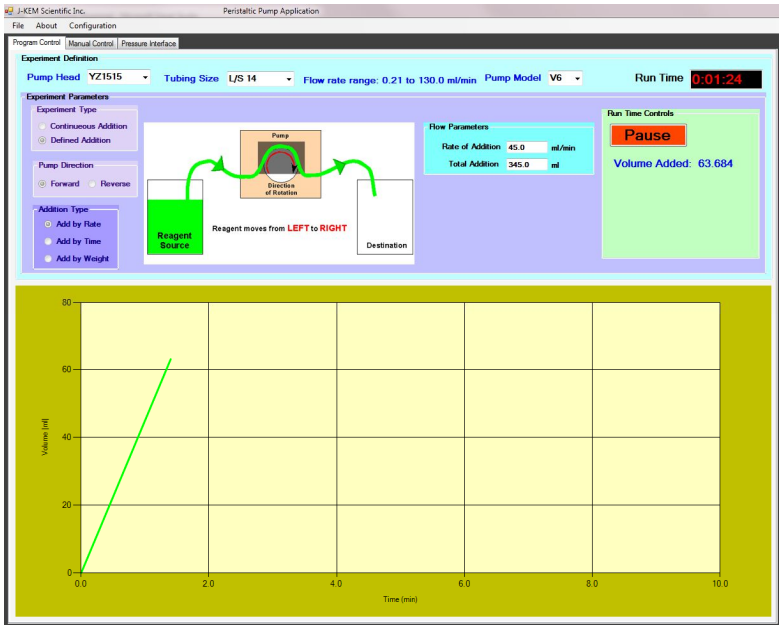
Continuous Dispense at a Fixed Flow Rate – (hereafter called "Continuous Dispense") In this mode, the user sets the desired flow rate and then manually starts and stops flow as desired.

Flow Rate Controlled Dispense (hereafter called "Fixed Volume Dispense")– In this mode, the user enters both the desired flow rate and the total volume to dispense. Then every time the start key is pressed, the pump dispensed the requested volume. For example, "Dispense 5 ml at a flow rate of 2 ml/min."

Fixed Time Controlled Dispense (hereafter called "Fixed Time Dispense")– In this mode the volume and the duration of the dispense are entered (the pump automatically determines the needed flow rate).. For example, "Dispense 5 ml in 20 seconds".

## Optional Features

Many advances features have been built into J-KEM Scientific's peristaltic pump that can be accesses through our optional PeriPump Software.

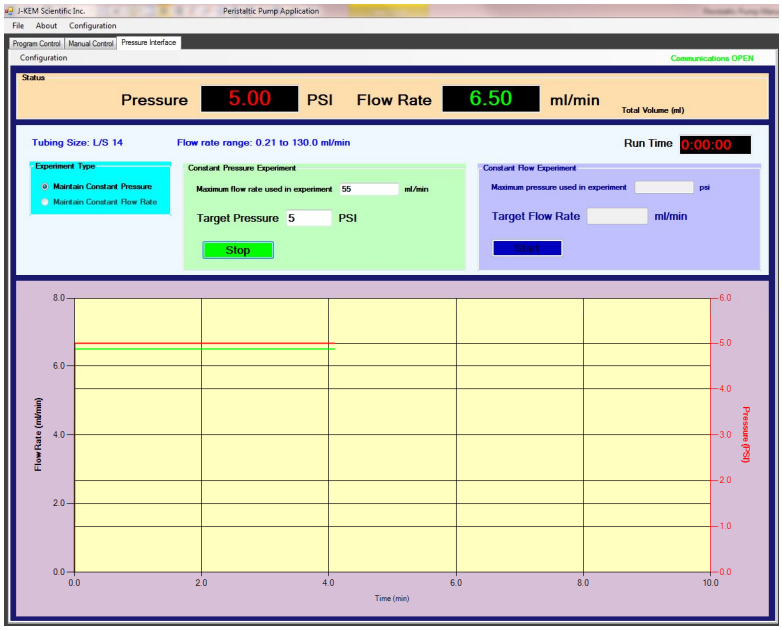



### Remote Control of Peristaltic Pump

PeriPump software allows the user to operate the pump by means of a graphical user interface from a remote PC.

### Add By Weight

Peristaltic pumps have the invaluable features of a wide flow rate range, being relatively inexpensive, and using disposable tubing. The primary disadvantage of peristaltic pumps is that their dispense accuracy is not as good as other pump styles, such as J-KEM Scientific's precision syringe pumps. To overcome this disadvantage, PeriPump software allows the user to add a balance to the pump system and then dispense reagent as a function of weight. This combines the versatility of peristaltic pumps with the precision of analytical balances to produce a system with extraordinary accuracy.




### Add as a Function of Pressure

Sensor modules can be added to the peristaltic pump that adjust flow rate of the pump to maintain a constant system pressure, or log system pressure at a constant flow rate.

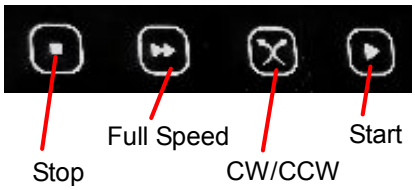
These features are valuable to study the characteristics of flow systems, like filters.

### Other Input Modules

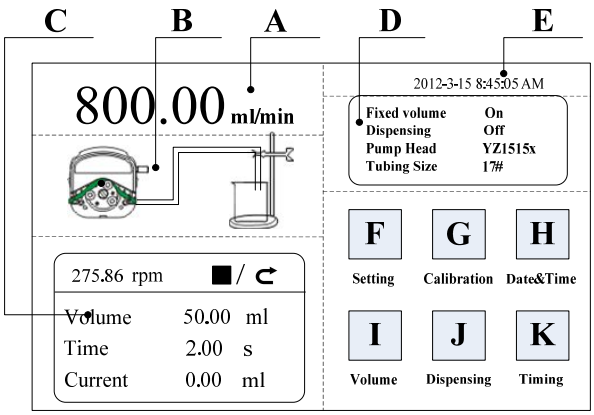
J-KEM has input modules to adjust flow rate as a function of:

- pH
- Dissolved oxygen
- Electrical conductivity
- Temperature
- Gas concentration: $CO_2$, $O_2$
- Oxidation potential
- Custom modules.

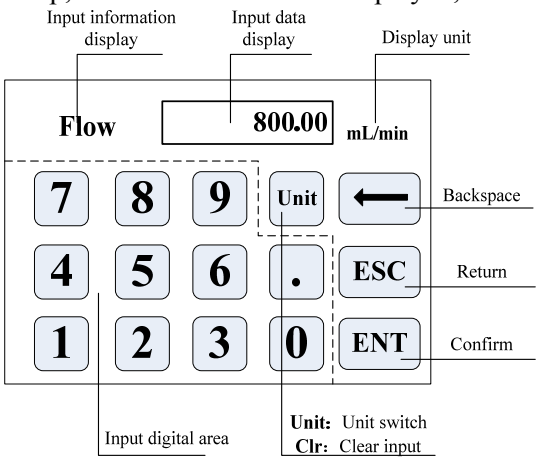
**User Controls**




Start button – Press to start the dispense operation.
Stop button – Press to stop any dispense operation, even if the operation is not fully complete.
Full Speed – Pressing and holding this button causes the pump to dispense at the maximum rate depending on the diameter of the tubing in use. This feature is useful when priming or purging air from the delivery lines.
CW/CCW – Selects the direction of rotation of the pump's rollers. CW (clockwise) cause fluid to enter on the left side of the pump head, and emerge from the right, while CCW (counter clockwise) causes fluid to enter on the right side of the pump head and emerge from the left. The direction of flow is indicated on the graphical display of the system

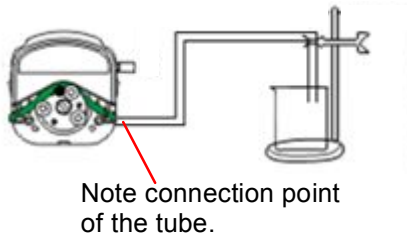



A. Speed/Flow Rate Display. This portion of the screen displays either the flow rate of the pump in units of ml/min, or it can display the rotation rate of the pump's rollers in units of RPM (the display setting is selected in the Settings screen (letter F). Generally, the more useful setting is to display flow rate. For the Continuous Dispense and the Fixed Volume Dispense modes, the flow rate can be changed by touching the section of the screen, at the top, where the flow rate is displayed, which causes a keyboard to appear.

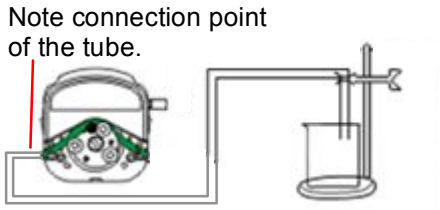



Enter the desired flow rate and then press the ENT button. The units button allows the user to select the units that flow rate is displayed in, either ul/min, or ml/min, or L/min. The minimum and maximum flow rate of the pump depends on the tubing size and pump head currently on the pump. See point "F" below.

B. Real-time Dynamic Display. Displays real-time information on the state of dispensing and the direction of flow. The animated graphic moves when the pump is actively dispensing and is static when it is not. The graphic changes its appearance depending on the direction of flow, whether the left or right side or the head is the inlet or the outlet. The direction of flow is set by pressing the CW/CCW front panel button.



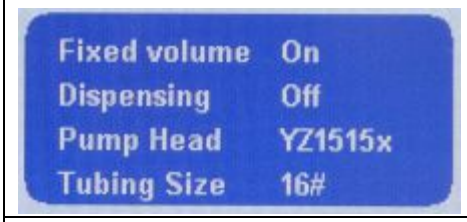
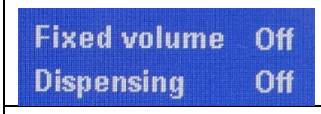
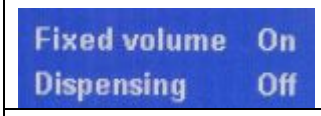
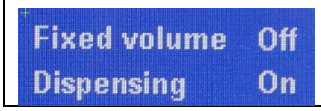

This graphic indicates that the fluid enters on the left side and exits on the right side of the head.




This graphic indicates that the fluid enters on the right and exits on the left side of the head.

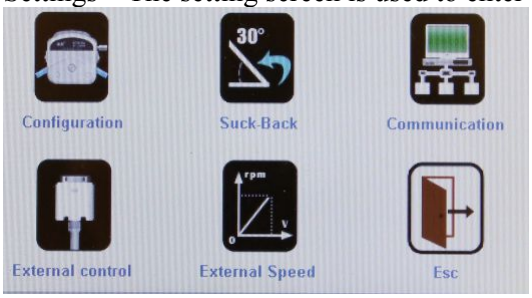
C. Real-time Parameter Display. Displays the real-time flow rate, dispensed volumes and run time of the current run.

D. Parameter Display - Displays the type of experiment being run and the setup parameters

| | |
|---|---|
|  | The type of dispensing selected is shown by the value of the first two lines. The pump head and tubing size are displayed. For instructions on how to set each parameter, see later in the manual. |
|  | To indicate that the Continuous Dispense mode is selected (i.e., dispense until stopped), both the Fixed volume and Dispensing modes are labeled 'Off'. |
|  | To indicate that the Fixed Volume mode is selected, the Fixed volume label displays "On'. |
|  | To indicate that the Time Dispense mode is selected, the Dispensing label displays 'On". |

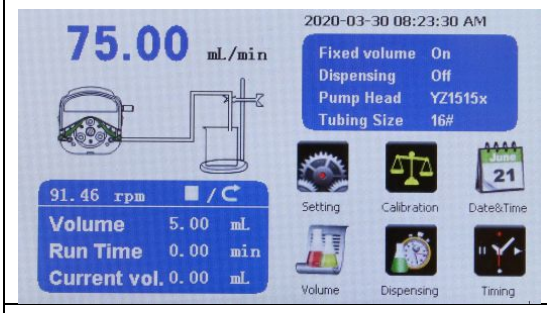
E. Displays the current date and time. This can be changed, see point H, Data & Time

F. Settings – The setting screen is used to enter the configuration of the pump.

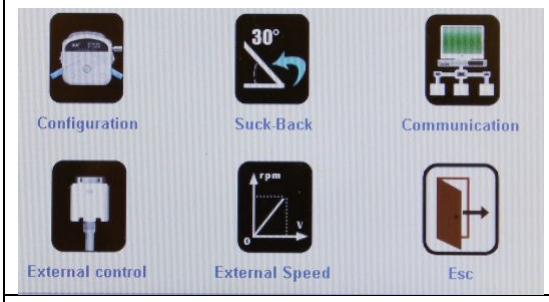


# Pump Configuration

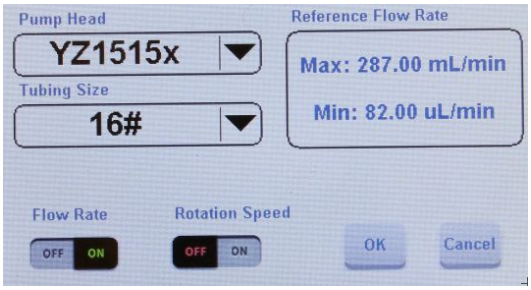
This screen is used to define the basic configuration of the pump, including the pump head in use, tubing size, and whether the pump is controlled by the front panel controls of remotely.




From the main screen, press the Settings button.




The Setting screen presents 5 options, Configuration and Suck Back will be addressed here. Serial communications and external control are addressed later in their respective sections.



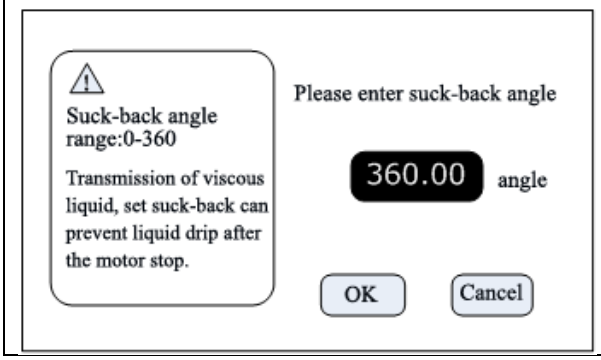

**Specifying Pump Head and Tubing Size**

Touch the Pump Head icon to see the available options for your pump, then select the actual installed head.

Touch the Tubing Size display box to see the tubing options your pump supports, then select the actual tubing size in use. The display updates to show Min and Max flow rates based on the tubing size selected. To view the flow rate range for each tubing size, see the Appendix.

This screen also allows you to select if the main screen displays dispense rates in units of ml/min (select ON for Flow Rate) or in units of pump RPM (select Rotation Speed).

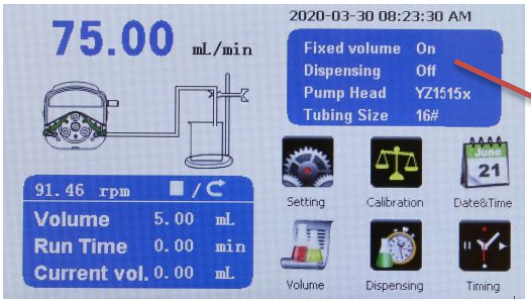
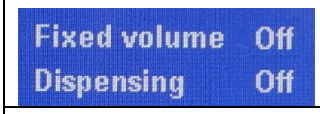
To confirm your selections, press the OK button.

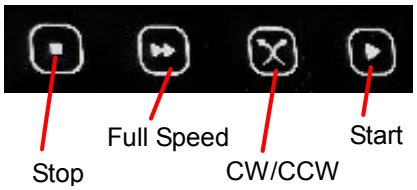



**Suck-back Angle**

At the end of a dispense cycle, the pump can be programmed to reverse its flow and *suck-back* any fluid that might be hanging on the end of the dispense tubing, thus preventing it from dripping off the end of the tube. The unit of suck-back is “degrees of pump rotation”. An angle of 0 performs no suck-back, an angle of 90 rotates the peristaltic rollers ¼ turn in the reverse direction, and an angle of 360 rotates the peristaltic rollers one full rotation backwards.

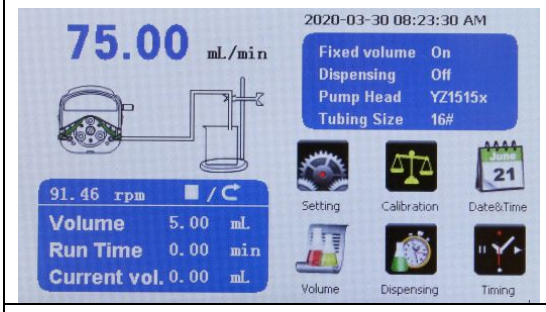
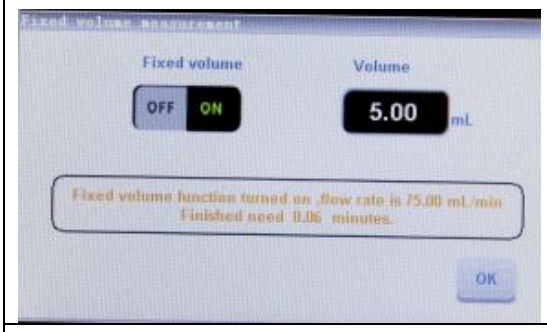
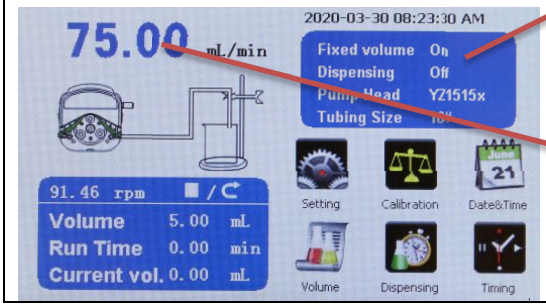
# Configuring a Continuous Dispense Experiment

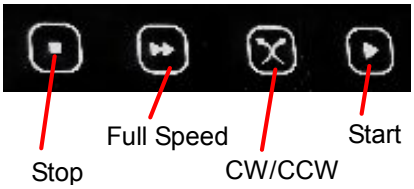
<table>
<tr>
<td> 
</td>
<td>A continuous dispense experiment requires only that the user set a dispense rate. The pump starts when the Run key is pressed and continues until the Stop key is pressed.<br><br>The continuous dispense mode is selected by turning OFF the ‘Fixed volume’ dispense mode and the ‘Dispensing dispense’ mode.. The state of these experiments is indicated by the first two lines of the parameter display screen. To turn off the fixed volume dispense mode, press the Volume key on the main screen, then press the OFF key. To turn off Dispensing mode, press the Dispensing key on the main screen, then press the OFF key.</td>
</tr>
<tr>
<td> 
</td>
<td>This is the correct display to indicated that the Continuous Dispense Experiment is selected.</td>
</tr>
<tr>
<td> 
</td>
<td>To specify the dispense rate, press the displayed dispense rate in the top, left portion of the main screen.<br>From the keypad that appears, enter the desired value, then press Ent.<br>Pressing the Unit key, cycles the input between Liters and milliliters.</td>
</tr>
</table>




To start flow, press the Start key and to stop flow, press the Stop key.

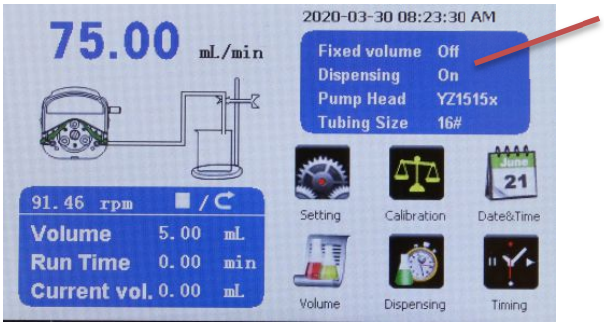
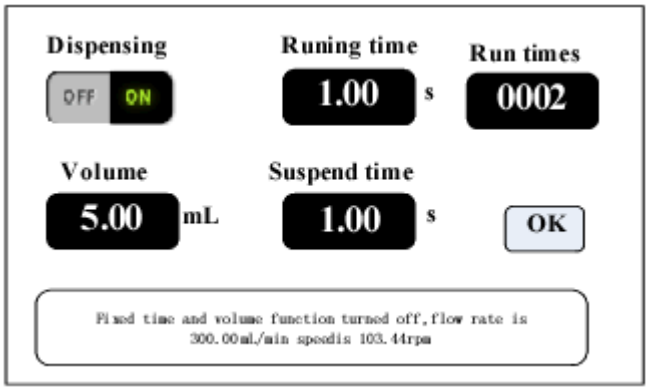
# Configuring the Fixed Volume Dispense Experiment

| | |
|---|---|
|  | The fixed volume experiment dispenses a user specified volume every time the Start key is pressed. This experiment is useful for filling vials, or for any experiment that requires a specific volume to be repeatedly dispensed. |
|  | Press the Volume key on the home screen.<br>Turn ON fixed volume dispensing.<br>Press the Volume display box, then from the resulting keypad, enter the desired volume. The units key can be pressed to toggle volume entries between liters and milliliters.<br>Press the OK key when done. |
|  | The parameter display screen shows that Fixed Volume Dispensing is selected.<br><br>To change the volume dispensed, press the volume display on the top, left of the home screen, then from the keypad that appears, enter the desired volume. |

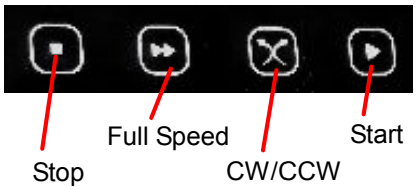



Every time the Start key is pressed the requested volume is dispensed.

# Configuring the Fixed Time Dispense Experiment

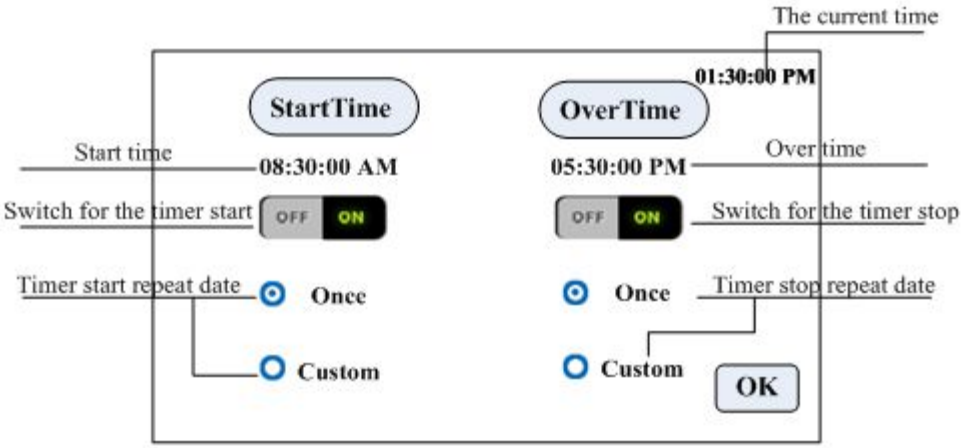
| | |
|---|---|
|  | The Fixed Time Dispense experiment dispenses a user specified volume over a user specified period. For example, dispense 10 ml over the course of 2 minutes.<br>A feature of the fixed time experiment allows the user to enter the number of times the experiment runs and a delay time between runs. This experiment type is useful when adding a set volume to a rack of sample tubes.<br>For example, you can specify that the experiment dispenses 1 ml 96 times in a row with a half second delay time between dispenses. |
|  | From the home screen, press the Dispensing key.<br><br>Press the ON key to turn Dispensing on.<br>Enter the time duration for the dispense by pressing the Running time text box, then enter the desired time on the resulting key pad.<br>Enter the number of sequential dispense to make by pressing the Run times text box.<br>Enter the volume to dispense by pressing the Volume text box.<br>Enter a delay time between dispenses |
|  | Program example.<br>With this configuration, the Fixed time program will dispense 1 ml, over the course of 2 seconds (i.e., 30 ml/min), 96 times in a row, with a 0.75 sec delay between dispenses. This would be useful to fill 96 test tubes. Between dispenses, you have 0.75 seconds to move from one tube to the next before a new dispense is made. |

To start the experiment, press the Start key.



# Alarm Clock Dispense Feature

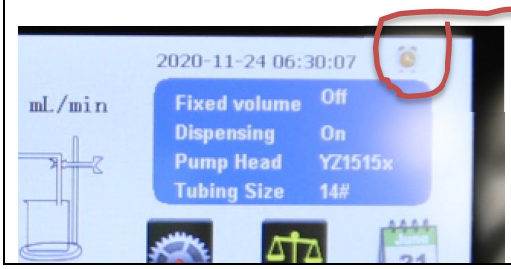
The J-KEM Scientific peristaltic pump has a feature that allows the pump to automatically turn On and Off at pre-programmed times. This 'Alarm Clock' feature is useful for experiments that require adding a set volume of fluid to the experiment every day at a specific time.
For example, to study the migration rate of a test material through a soil column, it may be required to add 10 ml of water to the top of the column every day for 30 days. The alarm clock feature of the pump can automate this. From the home screen, press the Timing key.




Start Time – This is the time of day to start the dispense. Enter the start time by pressing the start time clock, then on the resulting keypad, enter the time of day that the pump should start. For example to enter 8:30 AM, press 8 <Ent> 30 <Ent> 00 <Ent>.
To enable the start time feature press the ON switch under the start timer.

Stop Time – Enter the time of day to turn off the pump by pressing the clock under the Over Time. To enable the Stop time feature press the ON switch under the Over timer.

You have the option of performing the automated addition Once or on a custom schedule. If you select the Once radio button, the timed program will be run once. The other option is to set up a Custom program. By pressing the Custom radio button, a screen appears were you can pick the days of the week when the program should be run.



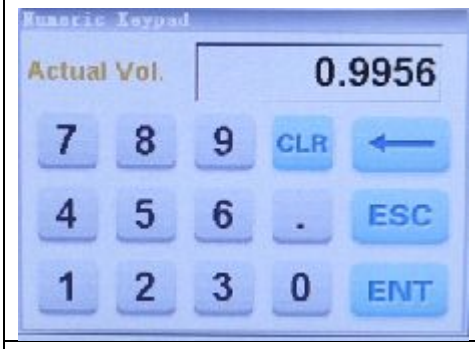
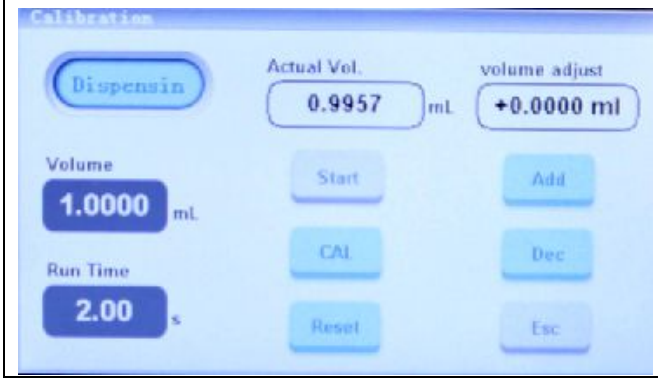

When an alarm clock program is active, the symbol of an alarm clock appears in the upper right portion of the home screen display.

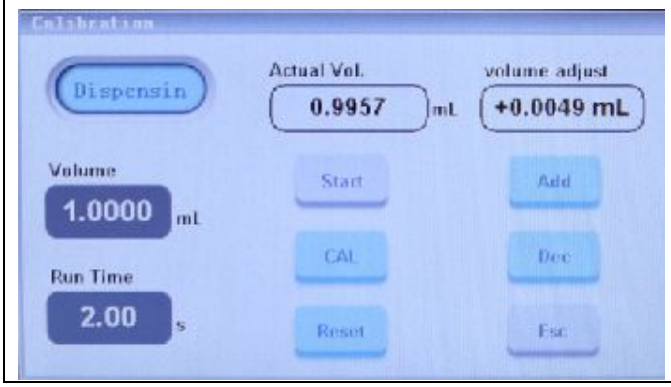
Set the flow rate of the pump by pressing the flow rate display in the upper, left portion of the home screen.

Note that the Start Time (On) program and the End Time (Off) program are independent of each other. If the Start Time program is turned ON, but the over time program is turned off, then the pump will start according to the entered schedule, and you must manually turn it off. Alternately, the pump can be programmed to automatically turn Off every day at a specific time, but you must start it manually. To fully automate the program, you need to turn On the Start Time and the OverTime.

# Calibrating the Pump

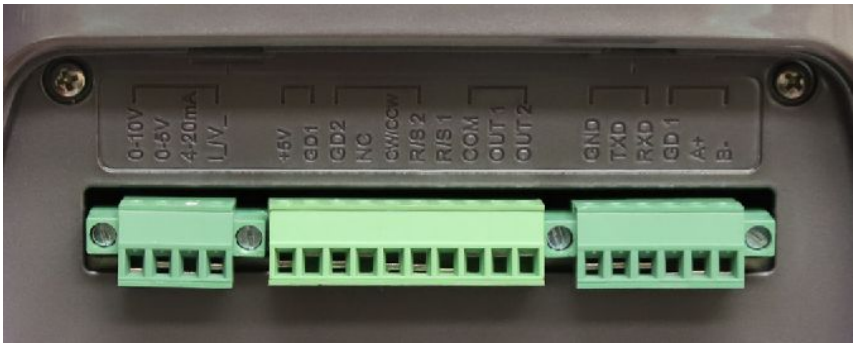
Peristaltic pumps generally have +- 2% dispense accuracy. The dispense accuracy can be improved by performing a calibration of the pump, then storing the results of the calibration to internal memory. Subsequently, the calibration values are applied to the pump to greatly improve the dispense accuracy. The J-KEM Pump has a built-in calibration feature.

| | |
|---|---|
|  | Press the Calibration key on the home screen.<br><br>A calibration volume and speed are selected based on the size tubing in use. Prior to staring the calibration, a set of vials should be weighed and their tare values recorded.<br>Place the outlet tube into a vial and then press the Start key. The volume shown, in this case 1.0000 ml is dispensed to the vial. |
|  | Weight the vial to determine the exact volume dispensed, then enter that volume into the screen that appears, then press the Ent key. |
|  | You can calibrate on a single dispense, or average as many dispenses you choose. To average additional dispense, press the Yes key. As long as you press the Yes key on the screen the pump will make additional dispenses and prompt for the actual volume dispensed. When enough samples have been dispensed to generate a representative sample set, press the NO key and the average of all samples taken will be calculated. |
|  | The pump shows the average dispensed volume in the display window. In this example, dispenses were on average low by 0.0043 ml. To compensate for this error, press the Add or Dec keys to enter a correction value into the Volume adjust screen. |

| | |
|---|---|
|  | In this case, press the ADD key until the closest value to 0.0043 is displayed, then press the Cal key to store this value, then Esc to exit this screen. All subsequent dispenses will be corrected by the percent correction factor entered into this screen/ |

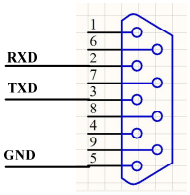
# Serial Communications and Remote IO Control

The J-KEM pump has multiple options for remote control of the pump, including RS232 and RS485 serial communications, analog inputs for speed control, and digital inputs for speed and direction control, and digital outputs to control other instruments.
Remove the back panel to gain access to the IO connectors.




# Serial Communications

The pump supports both RS232 and RS485 serial communications. To access the serial communication settings, press Settings from the home screen, then Communications.
Standard communication settings are:
Databits – 8, Parity – Even, Handshaking – None, Stopbits – 1

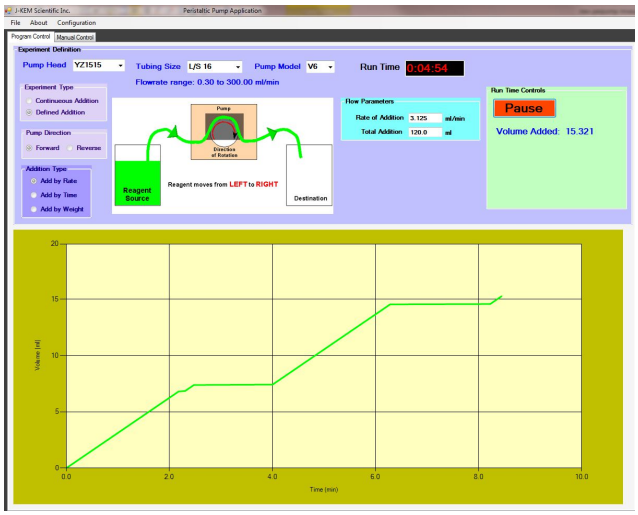

Female 9-pin connector

RS232 Connections

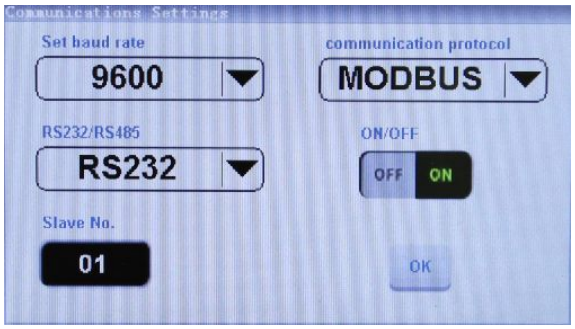
Connect the GND terminal to pin 5 of a female DB9 connector.
Connect TXD to pin 3.
Connect RXD to pin 2.

RS485 Hardware Connection

Connect A+ to networks A+ line.
Connect B- to networks B- line.
The GD1 (Gnd) is optional

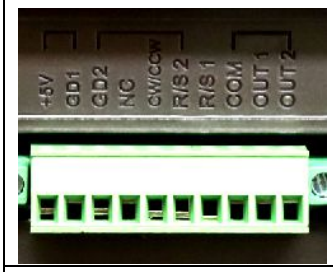



J-KEM's KEM-Control software is available for purchase and is used to automate all features of your peristaltic pump. KEM-Control presents a graphical user interface to automate experiments that add reagents by rate, time, or total volume. KEM-Control also has J-KEM's **Add-By-Weight** feature that automates the addition of reagents as a function of weight. The Add-By-Weight feature works by connecting a balance to the PC running KEM-Control, then placing either the reagent reservoir or the receiving reactor on the balance. Now enter the weight of reagent to transfer and the desired transfer rate. Once started, KEM-Control transfers the exact weight of reagent requested with better than 0.1% accuracy. J-KEM novel Add-By-Weight feature combines the versatility of peristaltic pumps with the accuracy of analytical balances to produce a superb laboratory pumping system.

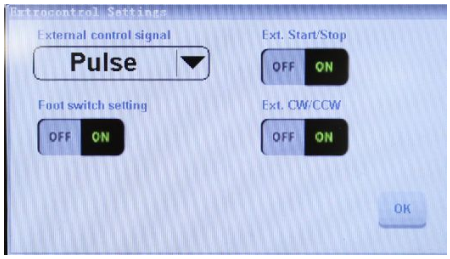
| | |
|---|---|
|  | To enable serial communications, select Settings, then Communications from the home screen.<br><br>Set the pumps baud rate. If using KEM-Control software, set the baud rate to 9600.<br>Select MODBUS as the communication protocol.<br>Select RS232 or RS485 communications. If you select RS485, then also specify the slave address for the pump.<br>Turn communications ON.<br>Select OK and return to the home screen for changes to take effect. |

A Programmer and Function manual for the MODBUS communication protocol is available for users who want to write their own communication program.

# External Control by Digital Input




The pump has three digital inputs, one controls the direction of pump rotation (withdraw/dispense), and two provide different types of On/Off control.

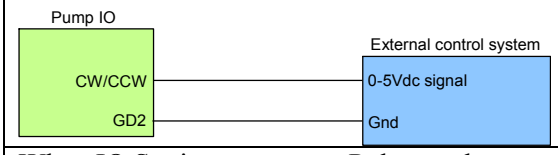



To enable the external digital inputs, from the home screen select Settings, then External Control.

The three inputs that can be individually enabled are:
1) Pump rotation direction (Ext. CW/CCW).
2) A Start/Stop input that requires an external digital signal (Ext. Start/Stop).
3) A Start/Stop input that accepts a contact closure input (Foot switch setting).

The pump's IO circuits can be configured to operate with two different types of external control systems. If your system sends logic level pulses to control external devices, then select the PULSE mode. If your system uses continuous logic voltage levels to control external devices, select LEVEL.

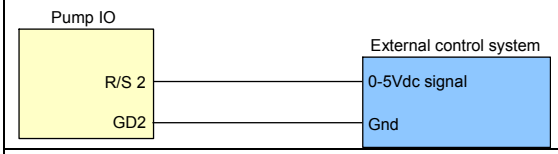
**Setting the pumps direction of rotation.**




From an external control system, connect the GD2 terminal to the external system's ground. The signal to the CW/CCW input must stay within 0-5 Vdc.

When IO Settings are set to Pulse mode, momentarily taking the CW/CCW line high will cause the pump to toggle between CW/CCW.
When IO Settings are set to Level mode, a logical high level on the CW/CCW line selects clockwise rotation and a low input signal selects counter clockwise rotation.

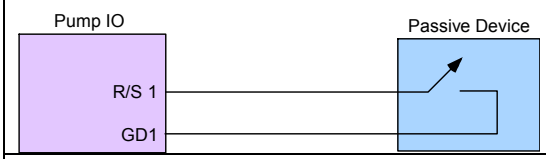
**Voltage Level Start/Stop input**




From an external control system, connect the GD2 terminal to the external system ground. The signal to the R/S 2 input must stay within 0-5 Vdc.

When IO Settings are set to Pulse mode, momentarily taking the R/S 2 line high will cause the pump to start delivery. Pulsing the line again with a logical high signal will stop delivery.
When IO Settings are set to Level mode, a logical high level on the R/S 2 line starts the pump and a logical low level stops the pump.

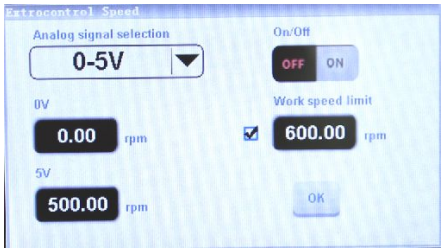
**Contact Closure Start/Stop input**




From an external switch, like a foot peddle, connect the GD1 terminal to one end of the switch, and the other end to the R/S 1 input thermal. In this mode, when the switch is momentarily closed, the program starts and runs to completion.

When IO Settings are set to Pulse mode, a momentary connection of the switch causes the pump to start, and a second momentary contact causes the pump to stop.
When IO Settings are set to Level mode, when the switch is closed the pump runs and when the switch is open the pump stops.

# External Control by Analog Input

| | |
|---|---|
|  | The pump has three analog inputs that can be used to set the rotational speed of the pump. In all cases, the direction of flow must be set from the pump's home screen. |
|  | To enable the analog inputs, you must first disable the Volume and Dispensing modes from the pumps home screen by selecting Volume from the home screen and turn it off, then select Dispensing from the home screen and turn it off.<br>To enable external analog control of the pump, select Settings, then External Speed from the home screen.<br><br>Enable one of the three analog inputs, either the 0-5 volt, 0-10 volt or 4-20 ma inputs. |

Enable one of the input lines. Using the Analog signal selection box, enable one of the three analog inputs, either the 0-5 volt, 0-10 volt or 4-20 ma inputs.

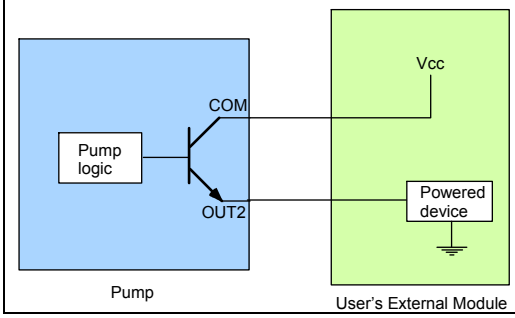
Make the correct electrical connections. From an external variable voltage, or current device, connect the devices ground to the terminal labeled "I_/V_", then connect the input control voltage line to the correct input line. If the control voltage is 0-10 Vdc, then connect to the 0-10V terminal. If 0-5 Vdc, then the 0-5 V terminal, and if a 4-20ma input is used, connect to the 4-20 ma terminal.

The analog configuration screen allows you to define rotational speed of the motor based on the input selected. In most cases, an input of 0 volts (or 4 ma) means a rotation speed of 0 RPM. You can also set the rotational speed of the maximum voltage (or current) input signal. This maximum rate must stay below the maximum rotational speed of the pump (either 300 or 600 rpm)

A maximum speed safety limit can be set by clicking the check box next to the "Work speed limit" box. You can then enter a maximum safety limit that the pump will not exceed not matter what the input voltage is.

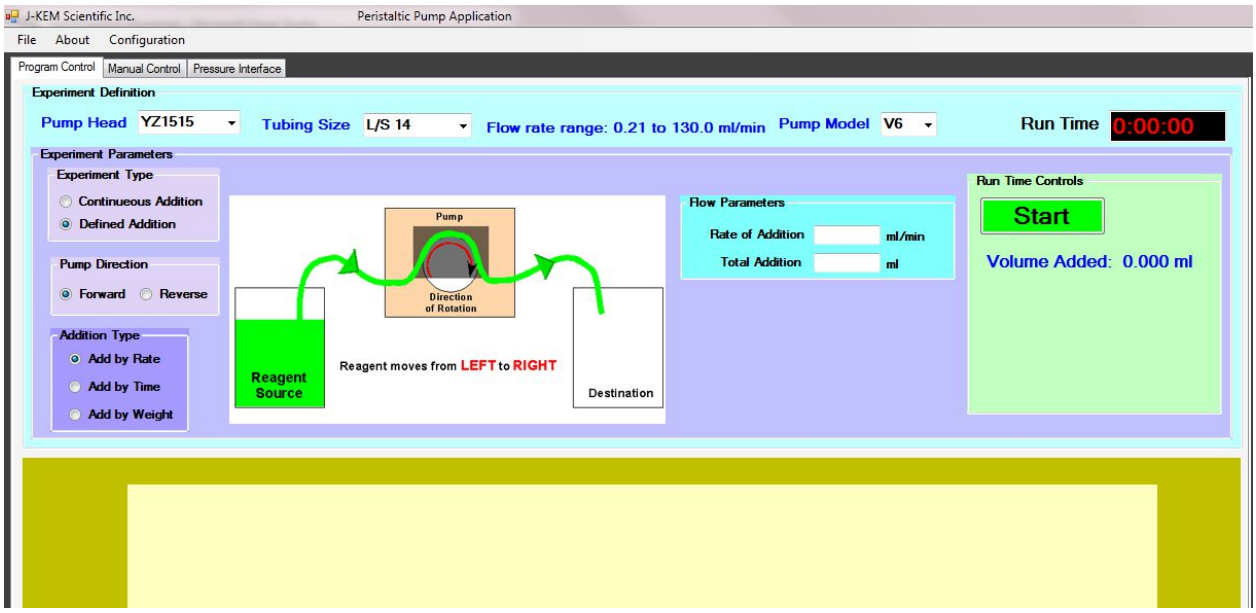
Lastly, turn ON the analog input option, then click OK to return to the home screen.

# External Output

| | |
|---|---|
|  | The pump has one output line capable of powering an external device. The output is a NPN transistor output with an input voltage maximum of 30 Vdc and can continuously supply 400 ma. |
|  | From an external power source, connect the voltage input to the COM terminal on the pump's output port, and then the OUT 2 terminal to devices power input side.<br>Do not exceed an input voltage of 30 Vdc, and a continuous current draw of 400 ma.<br><br>The output is conductive when the pump is running and non-conductive when the pump is not running. |

# PeriPump Peristaltic Pump Software

J-KEM's optional PeriPump provides PC control of your V-Series peristaltic pump. All V-Series pumps can be run from the pumps' front panel touch screen interface, and for simple dispensing operations, that may be the best option. PeriPump provides an interface that makes adding fluids by rate, volume, or time more intuitive than the touch screen controls of the V-Series pump, but the most valuable feature of PeriPump is the ability to add fluids as a function of weight, pressure, pH and other experimental inputs.




Analog modules are available that allow reagents to be added as a function of pressure, electrical conductivity, ORP, temperature, pH, gas concentrations, and any other properties. Contact J-KEM for additional information.

**Add By Weight Feature**

When connected to a laboratory balance, PeriPump software add reagents as a function to weight. This combines the flexible and simple addition characteristics of a peristaltic pump with the precision of a laboratory balance to achieve additions with 1 mg accuracy.

**Add By pH Feature**

Allows your peristaltic pump to titrate and then maintain the pH of your reaction mixture.

**Add by Pressure Feature**

This enables two valuable experiments, 1) Adds reagents at a constant rate while logging changes in system pressure, and 2) Adds reagents at a constant pressure while logging flow rate. Ideal for testing the flow characteristics of filters or other pressure systems.

**Custom Features**

Contact J-KEM to request any needed custom feature to be added to your pump system.

**Software and Hardware Installation**

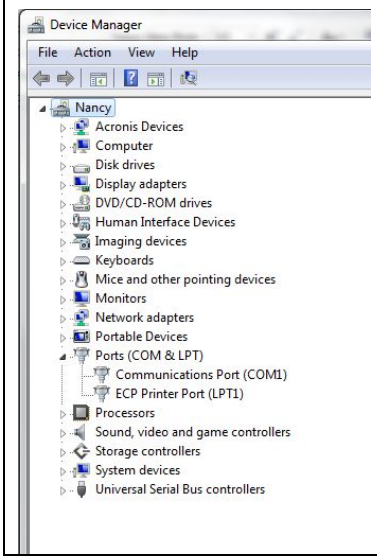
It's important to perform all sets in the order listed below.

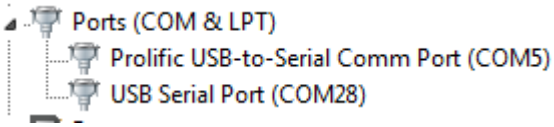
1) Do not connect the pump to the PC until the drivers have been loaded.

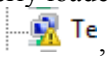
2) Install PeriPump software.
To install the PeriPump software, open the folder titled Application Software on the enclosed FLASH drive. Double click on the file titled Setup.exe. Accept all of the default selections.

3) Install the USB drivers
Open the folder titled USB Drivers and double click on the file titled CDM21288_Setup.exe, and accept all default settings.

4) Copy the entire folder titled "J-KEM Scientific" and paste it in the MyDocuments folder.



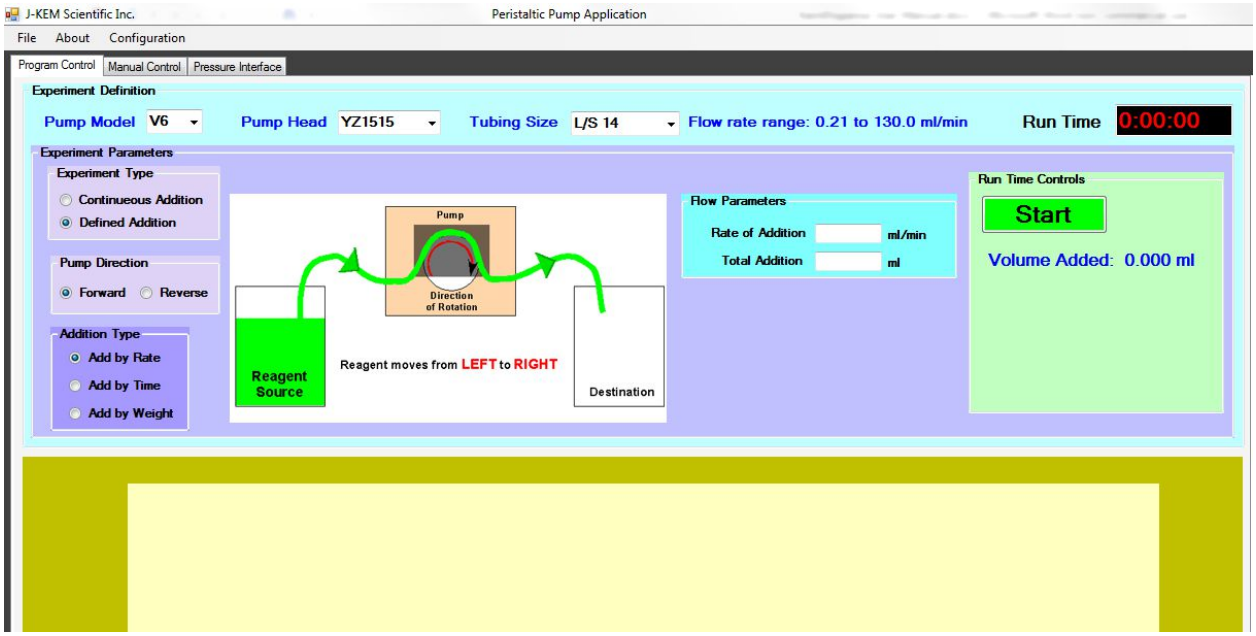

5) To verify that all drives were install properly, open Device Manager from the Control Panel and expand the item titled Ports. Now plug in all of the devices to your PC (using USB cables) that came with your system including the pump, balances, or sensor modules for pH, pressure, EC, or others.
As each item is plugged into the PC a new COM port appears in the list under Ports 

. If the new port populates with the appearance shown here, then the drivers for the connected device are properly loaded, but if the port populates with yellow triangle associated with it 

, then the driver did not load properly. Various implementations of Windows allow users different access to load drivers and you should contact you IT group for support.

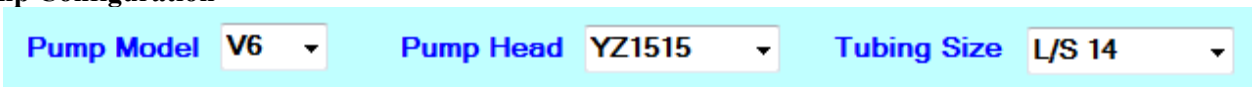
If all the drivers loaded properly, then the PeriPump software is ready to start.

## PeriPump Software




PeriPump has two experiment types, 1) Continuous Addition – Which simply adds liquids at a user entered flow rate until the addition is manually stopped, and 2) Defined Additions – Which add fluids according to a set of user defined parameters.

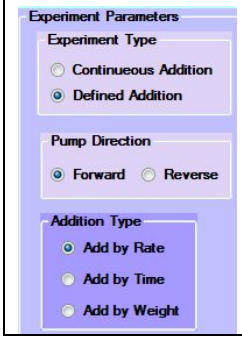
## Pump Configuration



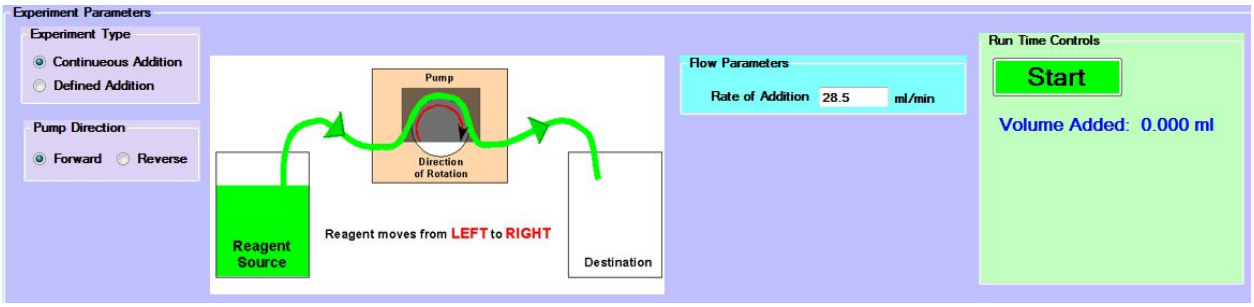

Before starting an experiment, you must:

1) Select the model of Pump Head that is mounted to your peristaltic pump from the drop down list of pump head options.
2) Select the size of tubing being used from the drop down list in the selection box titled Tubing Size.
3) Select the model of pump that you have from the drop down list in the selection box titled Pump Model. There are only two basic pump models, those whose model numbers start with "V3" and those that start with "V6".

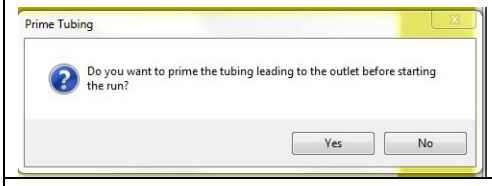
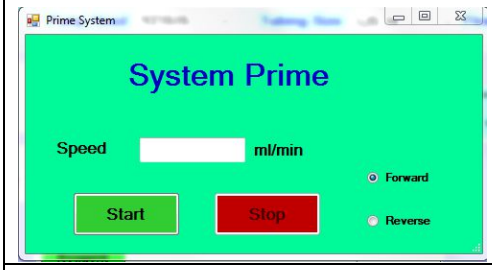
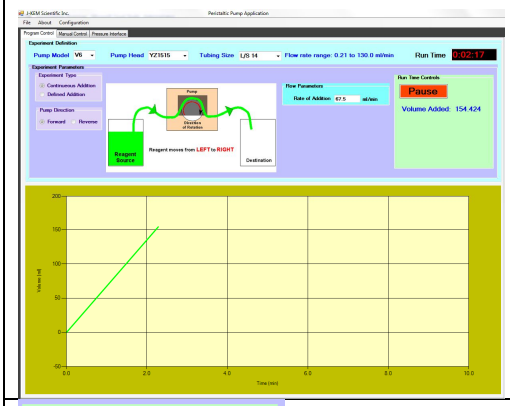
## Experiment Type

| | |
|---|---|
|   | Continuous Addition – This experiment dispenses a fluid at the user specified flow rate until the experiment is manually stopped.<br><br>Defined Addition – There are three types of defined addition experiments, experiments that add fluids as a function of rate, time, and weight.<br><br>Select either the Continuous addition or Defined addition experiment type by clicking the radio button associated with the experiment type name. |

## Continuous Addition Program



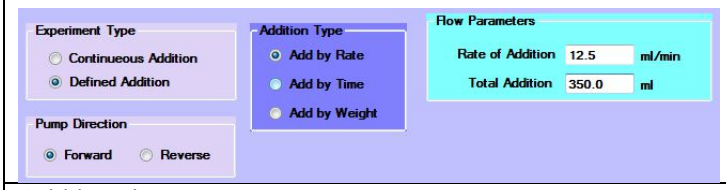
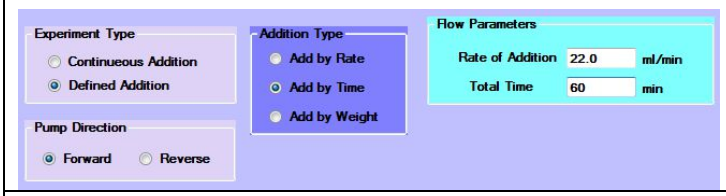
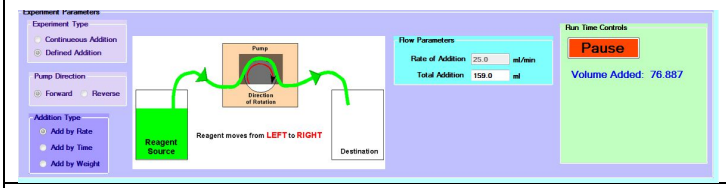
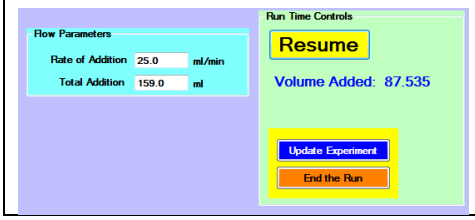

Enter the desired flow rate in the text box provided. The user can select whether the pump moves fluid in a *Forward* direction, for the left side to the right side of the pump, or in a *Reverse* direction (from the right side to the left side of the pump). The graphic in the center of the screen changes to indicate the direction of flow. When ready, click the Start button to start the pump.

| | |
|---|---|
|  | The system prompts to see if you want to prime the tubing leading from the reagent reservoir to the outlet.; |
|  | If you select Yes, a new screen appears that allows you to enter flow rates and manually start and stop the pump. When the system is primed, close this window and the dispense will start. |
|  | During the run, the volume dispensed and the chart continuously update to show the current status of the dispense. |
|  | Clicking the Pause button causes the dispense to pause and two new buttons to appear. During the paused state, a new flow rate can be typed into the Rate of Addition text box, to load the new value, click the Update Experiment button.<br>The addition can be resumed by clicking the Resume button or stopped by clicking End the Run. |

**Defined Addition Experiments**

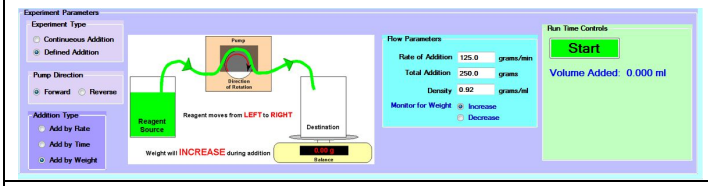
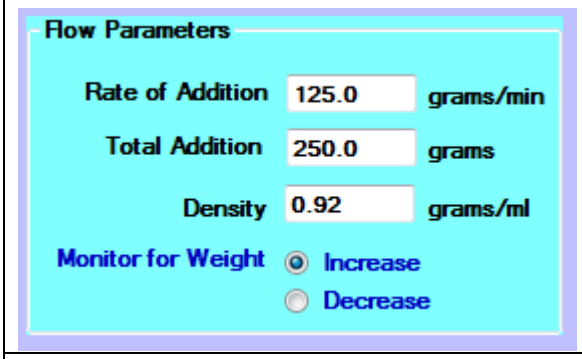
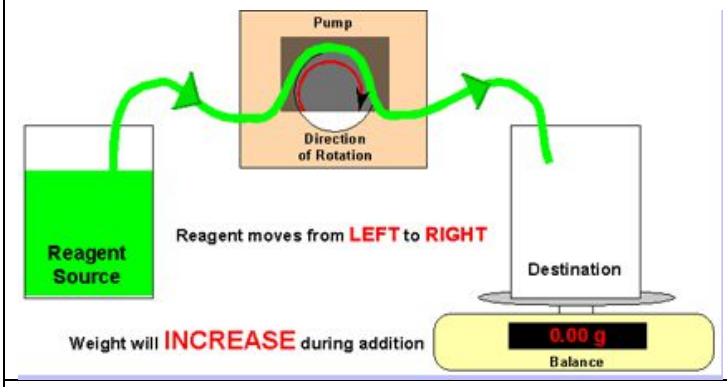
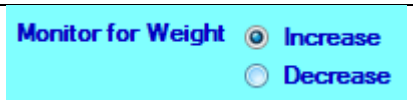
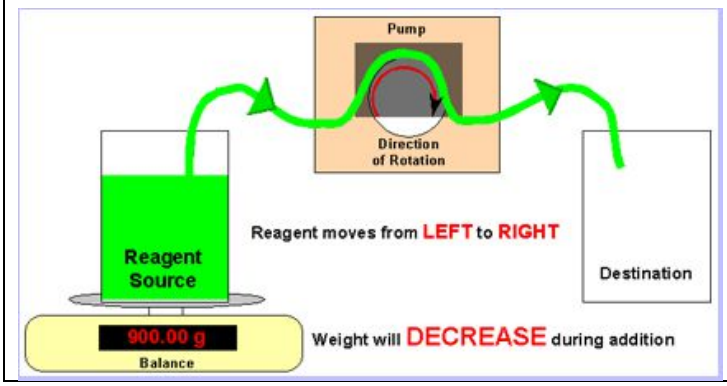
There are three types of Defined Addition Experiments

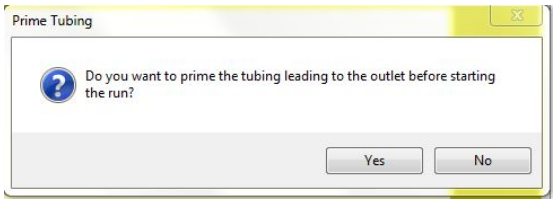
1) Add by Rate – This experiment allows the user to enter a total volume to dispense at a specified rate.
2) Add by Time – This experiment lets the user enter a dispense rate and the duration of the dispense.
3) Add by Weight – This experiment lets the user enter a dispense rate and total weight of material to dispense. Peristaltic pumps typically have 2-5% error in the dispense rate, which results in the same error for total volume dispensed. By using J-KEM's exclusive dispense by weight feature, the experiment replaces the inaccuracy of the pump with the accuracy of a balance, which results in dispense inaccuracies less 0.1%.

| | |
|---|---|
| Add by Rate<br>  | Enter the rate to dispense fluid at in units of milliliters per minute and the total volume to dispense.<br><br>Select whether the pump dispenses fluid in the *forward* direction(from left to right) or *reverse* direction (from right to left). |
| Add by Time<br>  | Enter the rate to dispense fluid at in units of milliliters per minute, and the total duration of the dispense.<br><br>Select whether the pump dispenses fluid in the *forward* direction(from left to right) or *reverse* direction (from right to left). |
|  | For either experiment, clicking the Start button causes the run to begin. |
|  | Clicking the Pause button stops fluid delivery and two new buttons to appear. During the paused state, a new flow rate or total volume can be typed into their respective text boxes, to load the new values, click the Update Experiment button.<br>The addition can be resumed by clicking the Resume button or stopped by clicking End the Run. |

**The Add by Weight Experiment**

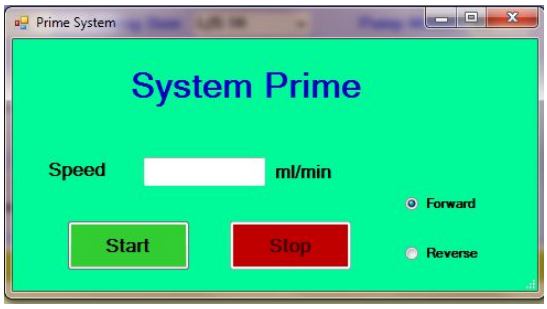
This experiment adds the requested weight of material as a user entered rate.

<table>
<tr><td> 
</td><td></td></tr>
<tr><td> 
</td><td>Enter the dispense rate for the reagent, the total weight of reagent to dispense, and the density of the reagent if known. If the density is not known, enter a value of 1.0.<br><br>There are two equipment setups for the Add by Weight experiment. In the first configuration, the receiving flask is on the balance pan, and in the second the reagent bottle is on the balance pan.</td></tr>
<tr><td>Receiving flask is on balance pan.<br> 
</td><td> 
<br>In this configuration, the program will expect the weight on the balance pan to increase during the dispense. This configuration is useful to fill vials or other empty containers.</td></tr>
<tr><td> 
</td><td> 
<br>In this configuration, the program will expect the weight on the balance pan to decrease during the dispense. This configuration is useful when adding reagents to large reactors that are stationary, or other destination vessels where it is not practical to place the reactor on the pan of the balance.</td></tr>
</table>



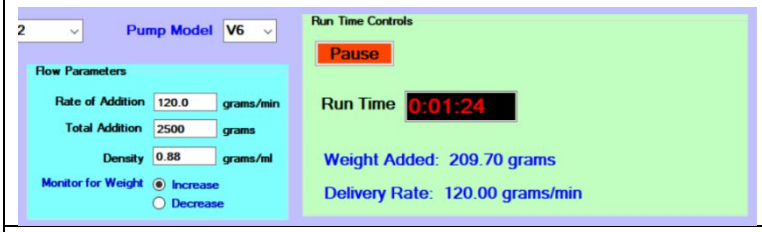

Click the Start button to begin the addition.

When the system is first set up, the tubing leading from the reagent reservoir to the reactor is full of air, so the user is presented the option of pre-filling the transfer tubing with the reagent prior to beginning the addition. In the case where the destination container is on the balance, it's not necessary to prime the line since air in the dispense line has no effect on the weight of material the balance senses. **But, priming the delivery line is required when the reagent source is on the balance pan.**




Consider this example.
The reagent bottle is on the balance and the reaction requires 25 grams of reagent to be delivered. Assume the density of the reagent is 1.0 g/ml.

At the start of the run the system zeros the balance and then starts to pump reagent out of the reservoir. If the line leading from the reservoir, through the pump, then into the reactor has a void volume of 5 ml, then 5 ml of reagent must be removed from the reservoir, and the balance will read -5 g when the first drop is delivered to the reactor. The pump continues until the weight on the balance is -25.0 g and then it stops. At this point, 20 grams of reagent has been delivered to the reactor, and 5 grams remains in the delivery line. The program performed property, and removed 25 g from the reagent bottle. The error occurred by not priming the delivery line. If the delivery line had been primed before starting the transfer, then 25 g would have been delivered to the reactor. As the end of the experiment, the program will provide the option of returning the 5 g in the delivery line back to the reservoir.




During an Add by Weight experiment. the screen shows the run time, the total weight of material added (measured by the balance), and the delivery rate in units of grams/min.
The displayed delivery rate is the actual delivery rate measured by the balance.

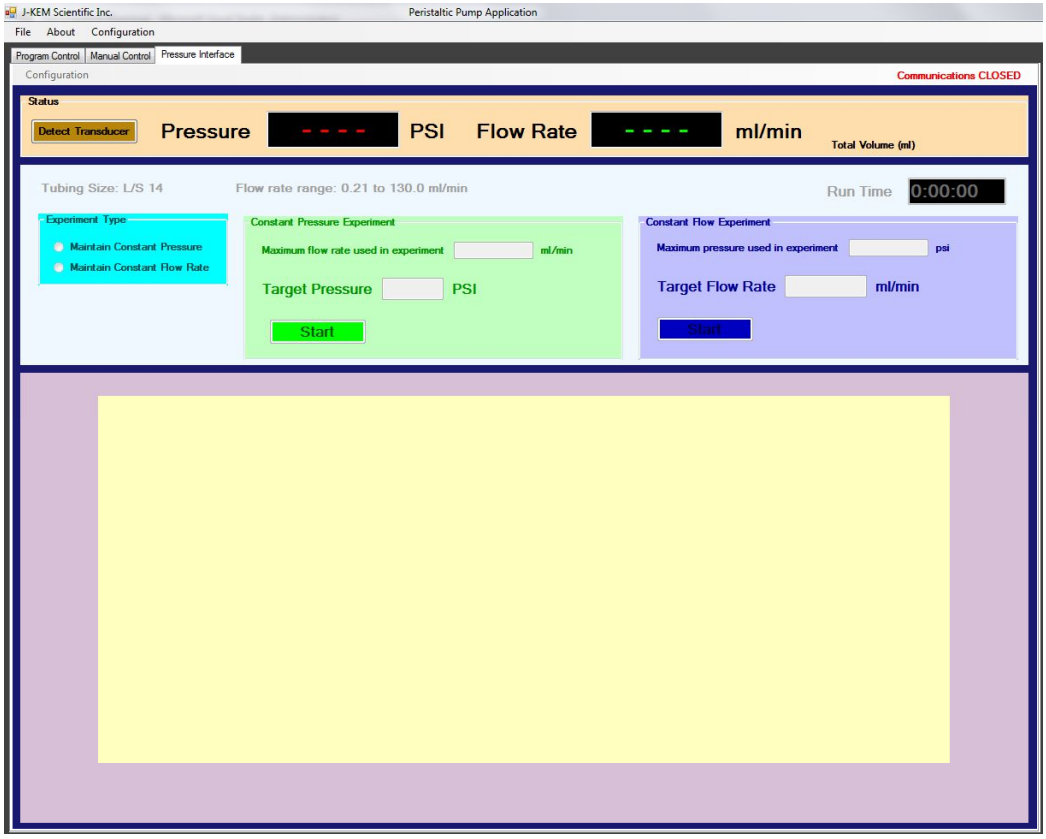
Notes about Delivery Rate:

1) The program displays the delivery rate determined by the balance. The program collects rate data for 1.5 minutes to get an accurate reading before this field appears.
2) The actual delivery rate (displayed) may not match the requested delivery rate. This is because peristaltic pumps are inherently inaccurate, so at the beginning of a run, the theoretical speed of the pump motor may not be the actual speed needed. As the addition progresses, the program automatically adjusts the speed of the pump so that the actual dispense rate matches the requested dispense rate, within 2% error.

# Analog Interface Module

If the pump system comes with the optional analog interface module, then programs are available that add reagent as a function of pressure, pH, temperature, conductivity, dissolved oxygen, and other characteristics of the system.

### Additions as a Function of Pressure Experiments

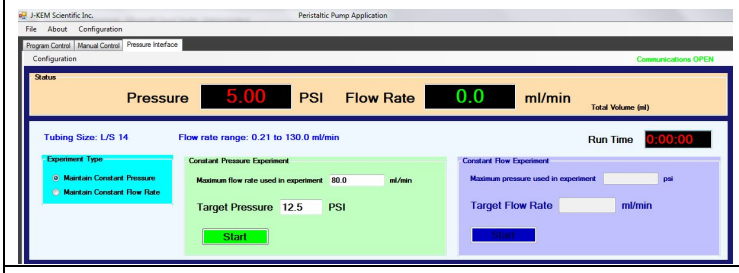
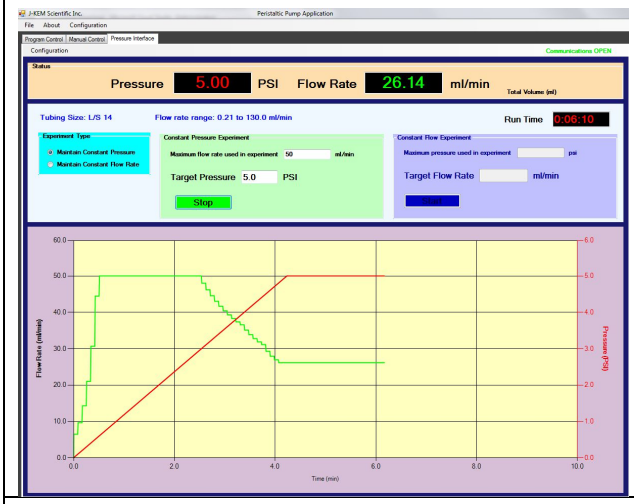
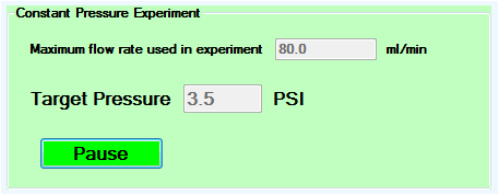
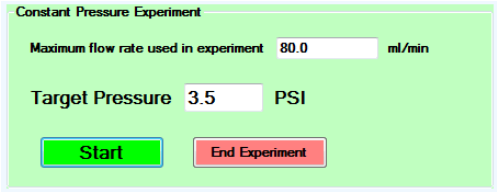



There are two pressure programs, the first adds fluid at a variable rate to maintain a constant pressure, and the second adds fluids at a constant rate while measuring system pressure.

### Constant Pressure Experiment

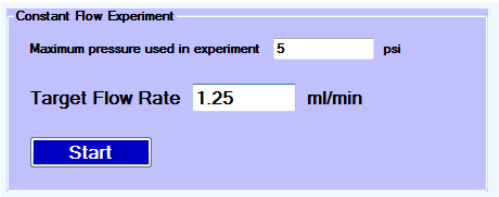
The constant pressure experiment continuously adjusts the flow rate of added solvent so as to maintain a constant pressure in the attached system. The setup of the system must have the pressure transducer connected to the reactor in such a way that added solvent produces a change in the system pressure sensed by the transducer.

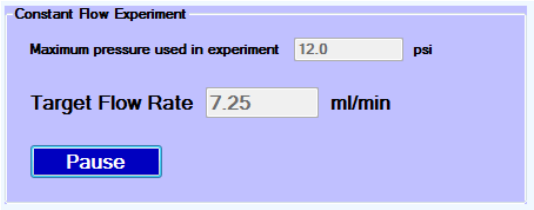
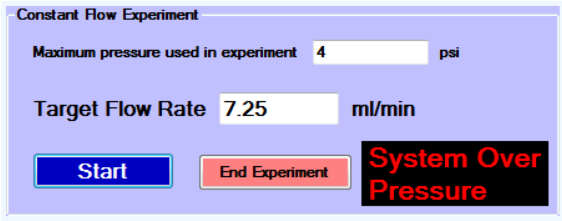
| | |
|---|---|
|  | First, click the button titled Detect Transducer. Once the pressure transducer is detected, the form becomes enabled. |

| | |
|---|---|
|  | To select the constant pressure experiment, click the radio button titled Maintain Constant Pressure.<br>Enter the desired system pressure and flow rate limit for the pump. |
|  | To start the experiment, click the Start button.<br>Before starting, the system will prompt to see if data from the run should be logged to a data file.<br>During the run, flow rate is continuously adjusted upwards or downwards to achieve and then maintain the entered pressure setpoint.<br><br>Prior to starting the experiment, the transducer can be zeroed, and the gain of the control algorithm can be changed. See Menu Options. |
|  <br>  | Once the experiment is started, the Start button changes to “Pause” and the maximum flow rate and target pressure boxes are disabled.<br><br>Clicking the Pause button causes pressure control to stop. During the paused state the maximum flow rate and target pressure boxes are enabled allowing the values to be changed. Also, the option to End the Experiment is presented. Clicking the Start button loads the new flow rate and pressure values, and then resumes the pressure control experiment. |

**Constant Flow Experiment**

The constant flow rate experiment adds a fluid at a constant flow rate then continuously monitors system pressure. The setup of the system must have the pressure transducer connected to the reactor in such a way that added solvent produces a change in the system pressure sensed by the transducer.

| | |
|---|---|
|  | Enter the maximum pressure that the system can be pressurized to as a safety limit.<br>Enter the desired flow rate, then click the Start button.<br><br>Prior to starting the experiment, the transducer can be zeroed, and the gain of the control algorithm can be changed. See Menu Options. |

| | |
|---|---|
|  | Once the experiment is started, the Start button changes to "Pause" and the maximum system pressure and target flow rate boxes are disabled.<br><br>Clicking the Pause button causes flow control to stop. During the paused state the maximum system pressure and target flow rate boxes are enabled allowing the values to be changed. Also, the option to End the Experiment is presented. Clicking the Start button loads the new flow rate and pressure values, and then resumes the pressure control experiment. |
|  | During a run, if the system pressure exceeds the limit entered as the maximum pressure, the pump stops and a warning message is displayed.<br>At this point, the option to End the Experiment is presented, or it can be restarted. Prior to restarting the experiment, the flow rate and the maximum pressure values can be modified if desired. |

**Menu Options**

The Pressure Interface tab presents a single menu option, the Configuration Menu. The Configuration menu presents these options;

**Zero the Transducer**

Before starting an experiment, if the value of the transducer displays an offset and is not exactly at 0.00 psi, this menu option zeros the reading of the transducer. If the displayed pressure is too large, at the start of a run, it may be necessary to recalibrate the transducer.

**Control Gain**

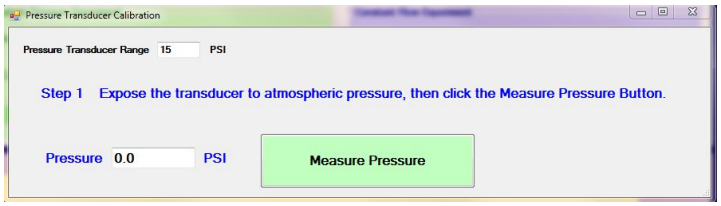
The Constant Pressure experiment works by starting the pump at a low flow rate and then waiting to see what affect that flow rate has on the pressure of the system. Based on the system pressure, the pumps flow rate is adjusted upwards of downwards in order to bring the system pressure to the requested pressure setpoint. The speed at which the system flow rate is adjusted, and thus how fast the system reaches the desired pressure, can be adjusted by setting the Control Gain factor, which is a system multiplication factor. The default control gain is 1.0, so fi the gain is set to 2.0, then flow rates are adjusted twice as fast as the default. If the gain is set to 0.5, then the flow rate is changed at ½ the rate of the default value in response to a change in system pressure. If the default algorithm changes flow rate in response to a pressure change in the system, then the control gain can be increased, if it changes too rapidly, then the control gain can be decreased. If the control gain is too high, then the system pressure will oscillate around the requested setpoint pressure. If the gain is too low, then the system will respond too slowly to a pressure change. During a run, when the program is Paused, the value of Control Gain can be adjusted. The range of Control Gain is 0.1 to 5.0.

**Transducer Range**

This is the pressure range of the transducer that the system is calibrated for. This is a read-only value and cannot be changed.

**Calibrate Transducer**

In frequently, it may be necessary to calibrate the pressure transducer. This should only be performed if it's known that the pressure readings are incorrect, or if a new transducer is used with the system.




This procedure is description for how to calibrate Gage-style transducers. If an Absolute-style transducer is being calibrated, contact J-KEM Scientific for assistance.
Enter the pressure maximum for the transducer in use.

Step 1 – Expose the transducer to atmospheric pressure. Enter the pressure value of "0.0" in the pressure box and then click the Measure Pressure button.

Step 2 – Place the transducer under a known pressure close to the maximum pressure of the transducer. Enter the reference pressure in the pressure box, and then click the Measure Pressure button. The measured values will be stored to the system for future use. The user should exit and then restart the software after calibrating the transducer to allow the new values to take effect.

**Balance Configuration**

The communication parameters of the balance in use must be set to the correct values to communicate with the PeriPump software. These parameters are set in the menu of the balance itself, and until they are set to the correct values, the Add-By-Weight program will not work.

**Veritas Balance**

From the Veritas menu, set these parameters

| Menu Parameter | Value | Comment |
|---|---|---|
| Baud | 9600 | Set communication baud rate to 9600. |
| PC – Prtr | PC- Cont | Set the serial port output to:<br>PC, Continuous output. |
| Auto 0 | Au0 oFF | Set Auto zero to Off |

**Mettler Balance**

From the Mettler menu, set these parameters

| Menu Parameter | Value | Comment |
|---|---|---|
| Baud | 9600 | Set communication baud rate to 9600. |
| PC – Prtr | PC- Cont | Set the serial port output to:<br>PC, Continuous output. |
| Auto 0 | Au0 oFF | Set Auto zero to Off |

**Ohaus Balance**

From the Ohaus menu, set these parameters

| Menu Parameter | Value | Comment |
|---|---|---|
| Baud | 9600 | Set communication baud rate to 9600. |
| PC – Prtr | PC- Cont | Set the serial port output to:<br>PC, Continuous output. |
| Auto 0 | Au0 oFF | Set Auto zero to Off |