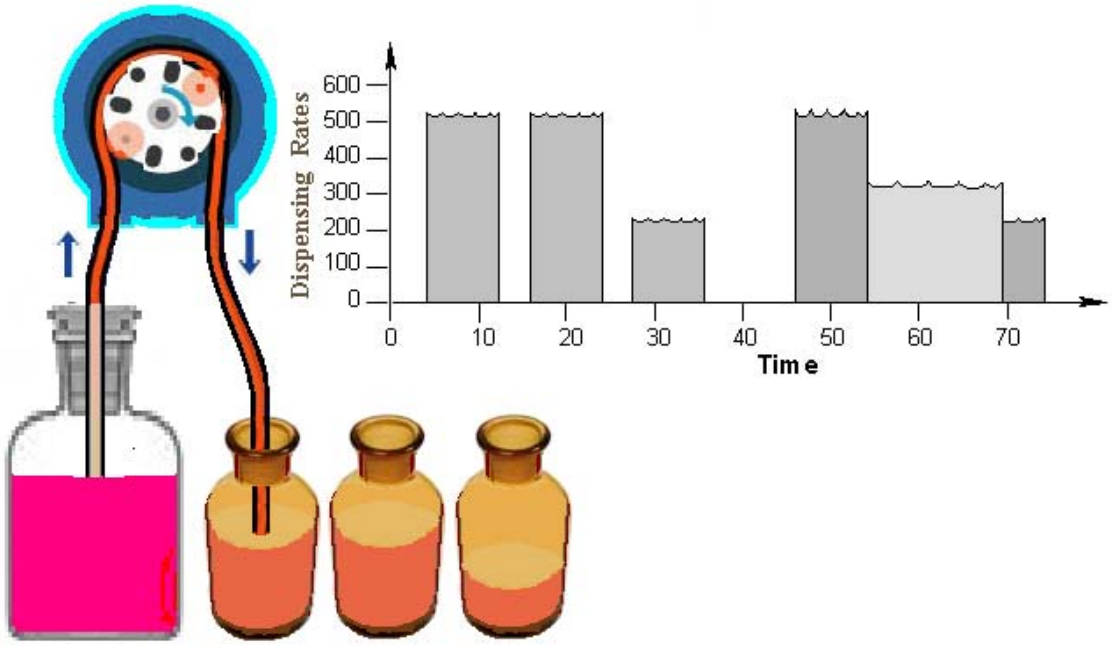
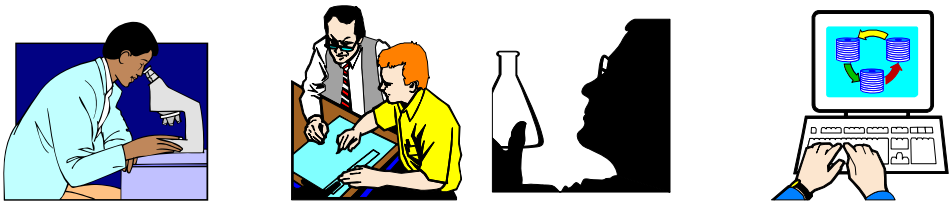
BRAINTREE SCIENTIFIC, INC.
LAB RESEARCH PRODUCTS

Model: BS-900
Basic User Manual

Programmable Peristaltic Pump
"Learn & Repeat"™



"WHAT'S YOUR APPLICATION?"™



WARNING

NOT FOR CLINICAL USE ON HUMANS

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BS-900 Peristaltic Pump
Quick Start Instructions

Assumes that the pump was not previously programmed with a multiple Phase Pumping Program. Otherwise execute pump reset.

- Plug in the pump. Use appropriate power supply.
- Press the power switch on the back of the pump to turn on power.
- Press any key to stop the display from blinking.

Setup Pumping Parameters

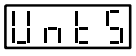
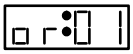
To Change Numbers:

- Press the up arrow keys to increment individual digits.
- **To set/clear the decimal point**: Simultaneously press the 2 up-arrow keys under the 2 digits next to the decimal point position.
- Press any non-arrow key, or wait for the display to blink. The new value is entered and stored in memory.

Peristaltic Tube ID (Inside Diameter):

- Tubing diameter is pre-set to 3/16" ID. See full instructions to change the default tubing diameter.

Set the Pumping Rate:

- Display the pumping rate by momentarily pressing the 'Rate' key.
- To change the **pumping rate units**:
  - Momentarily press the 'Rate' key again. The display will show: 
  - Press any up arrow key to select the next available rate units while they blink.
  - Press any non-arrow key, or wait for the time out to set the rate units.
- Set the pumping rate. If the pumping rate is out of range, the display will show: 

Set the Volume to be Dispensed or Continuous Pumping

- Display the volume by momentarily pressing the 'Volume' key. 'Dispensed' LED should be off.
- When the display shows  , the pump is set for continuous pumping. Pressing any up arrow key will change the display to 0.
- For continuous pumping: Set the volume to 0.
- For a Volume to be Dispensed: Set the volume.
- To change volume units, momentarily press the 'Volume' key again. The 'Dispensed' LED should be lit. Use the up arrow keys to select the volume units.

Set the Pumping Direction

- When the 'Withdraw' LED is lit, the pump is set for withdrawing. When not lit, the pump is set for dispensing. Use the ' ' key to change the pumping direction.

Load the Peristaltic Tubing

- Prepare new tube with two tie wraps 5 3/8" apart, both knots facing the same direction.
- Remove pump head by turning cassette counterclockwise, Remove rotor.
- Add grease to pump shaft and tubing.
- Insert rotor onto Shaft, Placing tube between Cassette and rotor. Tie Wrap knots facing Cassette.
- Install pump head to base by first, lining up rotor and driving axle, and second applying forward pressure and rotating cassette clockwise until it enters its groove. Continue turning until it stops.

Prime/Purge: Press and hold the 'Start/Stop' key for one second. Release to stop.

Start the Pump: Momentarily press the 'Start/Stop' key to start or stop the pump.

While Pumping

- The pumping rate can be changed.
- With continuous pumping, the pumping direction can be changed.

PUMP RESET:

Press and hold the right-most up arrow key while turning on power to the pump.

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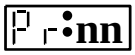
Selecting Dispense Programs

Multiple dispense settings can be stored and selected as needed. The last selected dispensing program will be the default dispense program when the pump is powered on. Up to 40 dispense programs can be stored.

To view or select the current dispense program number or to select a different program, press and hold either the **'Rate'** or **'Volume'** key. The display will show:



Where 'nn' indicates the currently selected dispense program. Use the arrow keys to change the dispense program number. Press **'LEARN'** to select, or wait for the 5 second time out. The display will blink when selected.

Press the **'Start'** key to immediately start the selected dispense.

Press the **'Rate'** or **'Volume'** keys to display the settings for the selected dispense. Any changes made to the pumping rate or dispense volume will be stored in the selected dispense program.

Learn and Repeat

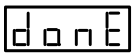
Learn and repeat easily teaches the pump a dispense volume. Then you can immediately repeat this dispense.

While turning on power, press and hold the **'LEARN'** key. The display will show:

Press and hold the **'Start'** key to begin dispensing. As the desired volume is approached, you can release the key to stop the pump, then periodically press the 'Start' key to slowly and accurately approach your dispense volume.

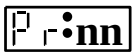
While pumping, the volume dispensed will be displayed. When the 'Start' key is released, the display will alternate between displaying the volume dispensed and the currently selected dispense setting number.

Press the **'LEARN'** key, or wait for the time out, to immediately store the dispensed volume in the currently selected dispense setting. A double beep will sound and the display will show:

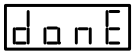


Press any key to return to the currently selected dispense program display.
Press '**Start'** to immediately begin the newly learned dispensed.

The learned dispense can be stored in a different dispense setting number. After the required dispense volume is reached, press any of the up arrow keys. The display will show:



Where 'nn' is the crrently selected dispense setting number. Use the up arrow keys to select a different location to store the dispense. Press the **'LEARN'** button or wait for the time out. A double beep will sound and the display will show:



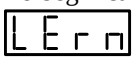
Press the '**Start'** button to immediate begin dispensing the learned dispense.

Tubing Calibration

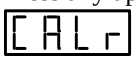
Calibration mode fine tunes the dispense accuracy. Continued use of tubing will cause it to stretch and deform which creates dispensing errors. Also, differing viscosities and/or pumping speeds can also affect pumping accuracy.

Calibration uses the currently selected dispense program. Also, you will need a calibrated measuring cup to verify the actual dispense volume.

To begin calibration: While turning on power, press and hold the **'LEARN'** key until the display shows:



Press any up arrow key for the next Learn selection: Calibration:



Press the **'Start'** key to begin the dispense.

When the dispense is complete, the pump will stop, and the dispensed volume will be displayed with the volume units LED blinking.

Press the **'LEARN'** key to accept this volume, or use the up arrow keys to enter a measured dispense volume.

Press **'LEARN'** after the measured dispense volume has been entered.

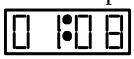
The pump uses the entered volume to recalibrate the dispense volumes. Dispense volumes will be adjusted according to the measured volume entered.

Tubing Inside Diameter Setting

For most applications, the default tubing inside diameter does not need to be changed since the pumping head is optimized for 3/16" inside diameter (ID) tubing.

If needed, to change the tubing diameter setting, enter Diameter Setting mode:
While turning on power, press and hold the **'Diameter'** key until the display shows:

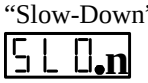
Press the **'DIAMETER'** key again to select. The display will show the current diameter and the 'mm' units LED will blink. While the units LED is blinking, use the up arrow keys to enter the new diameter. For example, to enter 1/8" id tubing, use the up arrow keys to change the display to:



Press the **'LEARN'** key, or wait for the time out to enter the new setting. The tubing diameter will now be set to the new setting. The new diameter will be used as the current calibration setting.

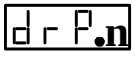
Special Modes

Press and hold the **'Diameter'/'Setup'** key to access the Special Modes setup menu The first mode, "Slow-Down" will be displayed:



Press the**'LEARN'** key to move to the next mode, or wait for the time out. The following is the sequence of diplays:

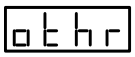
Slow Down mode, where 'n' is the current setting.



Anti-Drip mode, where 'n' is the current setting.

Dispense and pause mode, where ‘n’ is the current setting.

When pasue mode is enabled, displays the pause setting.



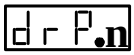
Display secondary setup menu: Press any up arrow key to select.

Slow Down Mode

Setting: ‘0’ = Disabled, ‘1’ = Enabled.

Slow-Down mode prevents over dispensing when pumping a large volume at a high speed. When enabled, the pumping speed will ramp down as the volume dispensed approaches the target dispense volume.

Anti-Drip Mode



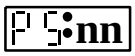
Setting: ‘0’ = Disabled, ‘1’ = Enabled.

When enabled, Anti-Drip mode will withdraw a small volume after the completion of a dispense to prevent dripping or oozing when the pump stops. The volume withdrawn is added to the next dispense.

Dispense, Pause, Repeat Mode

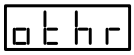
Setting: ‘0’ = Disabled, ‘1’ = Enabled.

When enabled, will create a more automated dispensing system, whereby the pump will continuously repeat the current dispense after a fixed time delay. The time delay will be displayed next:



Where ‘nn’ is the pause time in seconds. Use the arrow keys to change the dispense time.

Advanced Settings Menu



The “Other” menu selection provides access to the additonal settings menu.

Table of Contents

1. General Information

Thank you for purchasing the BS-900 Programmable Peristaltic Pump. With the BS-900 peristaltic pump you will be able to perform simple fluid dispensing or implement a complex automated dispensing system.

Please familiarize yourself with the BS-900's operation by reading this user's manual. For future reference, record the serial number, located on the rear of the pump, and the date of purchase.

Serial Number _____, Date of Purchase _____,

This Operating Manual, and the BS-900's hardware, electronics and firmware are copyrighted.

1.1. Safety

In the interests of safety, this pump and the tubing selected should only be installed and used by competent, suitably trained personnel after they have read and understood this manual, and considered any hazards involved.

Markings & Symbols

The following are the meanings of the markings and symbols used in these Safety Precautions.

⚠ Warning	This symbol indicates information that, if ignored or applied incorrectly, creates the possibility of death or serious personal injury. i.e. fire, explosion.
ⓘ Caution	This symbol indicates information that, if ignored or applied incorrectly, possibility of minor or moderate personal injury or property damage.

⚠ Warning

- Read the user's manual
- This product is designed for liquid only.
- User is responsible to determine the suitability of the pump to its desired function.
- Verify that tubing is appropriate for liquid being pumped.
- Disconnect power from the pump when replacing tubing or connecting or disconnecting cables.
- Never leave any dangerous liquid inside of tubing when replacing tubing and disposing pump. Remaining liquid may cause serious injury.
- Never use in atmosphere with flammable gas.
- Never use in any location where there is a possibility of high humidity, high temperature, or extreme dust.
- Use only with the supplied power supply connected to a power source as specified on the power supply label.
- Never use a voltage that is different from voltage specified in this manual. Unless Authorized by NEW ERA PUMP SYSTEMS INC.
- Do not operate with any foreign matter (water, dirt, metal or other materials) inside the Pump-head.
- Do not push objects of any kind into the chassis openings, except for appropriate cables and connectors.
- Never try to take the unit apart or modify it except as described in this manual or authorized by NEW ERA PUMP SYSTEMS INC.. No user serviceable parts inside.
- Do not immerse the pump in liquid. If spilling occurs unplug pump immediately.
- Install on a stable surface.
- The pump can automatically start when the Pumping Program is operating or when attached to an external control device.
- Prevent liquids from entering openings in the rear of the pump.
- If the pump becomes damaged, do not use unless certified safe by a qualified technician. Damage includes, but is not excluded to, frayed cords and deterioration in performance.

⚠ Caution

- Do not transport and store this product where the temperature and the humidity are high or fluctuate greatly, or the product is subjected to direct sunlight.
- Remove tubing from pump when not in use. Tubing will become deformed changing dispensed volume per rotation.
- Tubing wall may become permanently damaged if the roller compresses the same part of the tubing for a long time.
- During installation and use, be careful not to cut yourself on the edge of the Pump parts.
- Tubing life depends upon chemical and operating environment.
- Tubing Chemical compatibility list mentioned is only a guide. The user is responsible to determine the tubing compatibility to the chemical to be used.
- Keep delivery and suction lines as short as possible, use a minimum number of bends.
- Pump operates best at medium speeds. At very slow speeds pump will get hot. At high speeds pump and tubing life will decrease, pump will lose force/ pressure and may stall.
- Run at slow speed and use larger diameter tubing when pumping viscous liquid.
- User is responsible to determine the maximum speed the pump can operate.
- Discharge static from control cables before connecting by touching the cable to ground.
- Before touching the pump, discharge static by touching ground.

1.2. Disclaimer

NEW ERA PUMP SYSTEMS INC. makes no representations or warranties, expressed, statutory or implied, regarding the fitness or merchantability of this product for any particular purpose. Further, NEW ERA PUMP SYSTEMS INC. is not liable for any damages, including but not limited to, lost profits, lost savings, or other incidental or consequential damages arising from ownership or use of this product, or for any delay in the performance of its obligations under the warranty due to causes beyond its control. NEW ERA PUMP SYSTEMS INC. reserves the right to make any improvements or modifications to the product described in this manual at any time, without notice.
Design and specifications are subject to change without notice.
The information contained in this document is believed to be correct but NEW ERA PUMP SYSTEMS INC. accepts no liability for any errors it contains, and reserves the right to modify this document without notice.
NEW ERA PUMP SYSTEMS INC. products are not designed, intended, or authorized for use in applications or as system components intended to support or sustain human life, as a clinical medical device for humans, or for any application in which the failure of the product could create a situation where personal injury or death may occur.

All brand and product names used in this manual are the trademarks of their respective owners.

1.3. Warranty

NEW ERA PUMP SYSTEMS INC. warranties this product and accessories for a period of two year, parts and labor, from the date of purchase. The repaired unit will be covered for the period of the remainder of the original warranty or 90 days, whichever is greater.

The Peristaltic Pump Head Assembly and peristaltic tubing are considered replaceable items and are not covered under overall product warranty.

A return authorization number must be obtained from NEW ERA PUMP SYSTEMS INC. before returning a unit for repair. Warranty covered repairs will not be performed without a return authorization number. At the option of NEW ERA PUMP SYSTEMS INC., a defective unit will be either repaired or replaced.

This warranty does not cover damage by any cause including, but not limited to, any malfunction, defect or failure caused by or resulting from unauthorized service or parts, improper maintenance, operation contrary to furnished instructions, shipping or transit accidents, modifications or repair by the user, harsh environments, misuse, neglect, abuse, accident, incorrect line voltage, fire, flood, other natural disasters, or normal wear and tear. Changes or modifications not approved by NEW ERA PUMP SYSTEMS INC. could void the warranty.

The foregoing is in lieu of all other expressed warranties and NEW ERA PUMP SYSTEMS INC. does not assume or authorize any party to assume for it any other obligation or liability.

1.4. Packing List

Included with the BS-900 Programmable Peristaltic Pump are the following items:

- One of the following external unregulated power supply adapters:
  - Input: One of: 120V AC 60 Hz, 220V AC 50 Hz, 240V AC 50 HZ, or other custom specified power supply
  - Output: 24V DC @ 1A
- 4 feet of Norprene A-60-G® tubing.
- 4 tie wraps (2 assembled).
- 0.5oz sample of Super-Lube®.
- This Operating Manual

2. Overview

The BS-900 is a general purpose single peristaltic pump capable of dispensing and withdrawal. It is controlled from a microcontroller based system which drives a step motor, allowing a wide range of pumping rates configured to the inside diameter of the peristaltic tube.

Features:

- ♦ Dispense and withdrawal pumping
- ♦ Pumping rates from 0.041 ml/min to 904.4 ml/min with a 3/16 ID tubing. Depending on tube characteristics.
- ♦ Dispense and withdrawal volumes separately accumulated.
- ♦ Programmable dispense volumes.
- ♦ Non-volatile memory of all operating parameters and Pumping Program.
- ♦ Programmable Phases allowing complex pumping applications and interaction with external devices.
- ♦ RS-232 bi-directional control.
- ♦ Built-in pump network driver. Pump network supports up to 100 pumps and other devices.
- ♦ Two modes of RS-232 control, Basic and Safe. Safe mode provides communication error detection, loss of communication detection, and automatic transmitting of alarm conditions.
- ♦ TTL I/O with software filtered control inputs to eliminate glitches and ringing on the control inputs.
- ♦ Configurable TTL operational trigger.
- ♦ Power Failure Mode: Restarts the Pumping Program after a power interruption.
- ♦ Audible Alarm.
- ♦ Many more features!

2.1. Glossary of Terminology and Concepts

When a device has as many features as the BS-900, understanding its operation could be a daunting task at first. By understanding the key concepts and terminology used in this manual, the operation of the BS-900 will become quite intuitive. Every effort has been made to design the BS-900 with a consistent and intuitive user interface.

To facilitate and enhance your understanding of the BS-900's operation, please take the time to familiarize yourself with the basic concepts below:

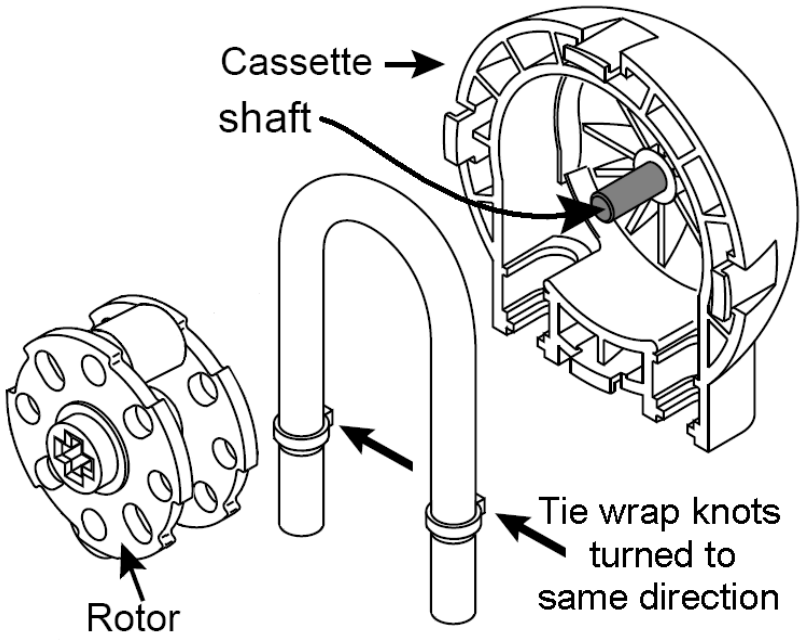
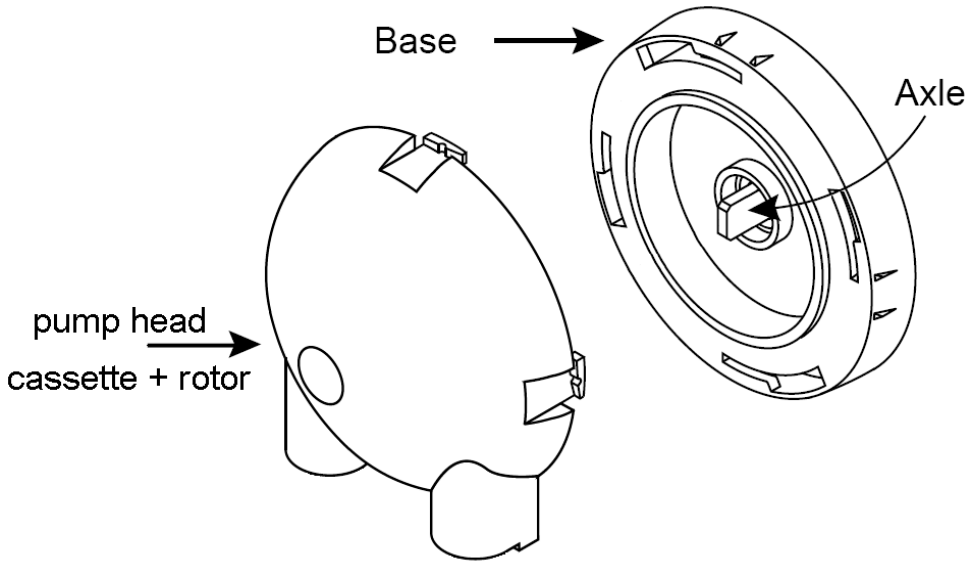


Fig 1. Pump Head Assembly



Terminology

Momentary Press: A quick press, less then 1 second, then release of a key on the keypad.

Display Blink: A momentary blanking of the LCD display. This indicates that the new data entered by the user is valid and has taken affect.

Pumping Program Operating: When the pump is started with the 'Start'/'Stop' key, or any other source, the pump begins performing the operations in the Pumping Program until the Pumping Program either stops automatically or the pumped is stopped when the 'Start/Stop' key is pressed, or from any other source. While performing the operations defined in the Pumping Program, the Pumping Program is referred to as operating.

While Operating, the motor can be pumping or stopped, according to the Pumping Program.

Pumping Program Stopped: The motor is stopped and the pump is not operating the Pumping Program.

Pumping Program Paused: The Pumping Program has been stopped, but can be resumed at the point where it was stopped.

Pumping Program Resumed: Continuing a Pumping Program that was Paused before the completion of the Pumping Program. The Pumping Program continues at the point where the Pumping Program was stopped.

Executed: The pump has performed a single operational Phase as defined in the Pumping Program.

Start Trigger: The Pumping Program may be started, or stopped, from multiple sources. These are the keypad's 'Start'/'Stop' key, the TTL I/O 'Operational Trigger' input, or from a command received through the RS-232 connection.

3. Setup

- Place the pump on a stable surface.
- Plug the round connector end of the supplied power supply adapter into the power plug located on the lower right of the pump's rear. See section 13, Logic Interface: TTL Input and Output, for a diagram of the rear of the pump. Plug the other end of the power supply adapter into an appropriate electrical outlet. The pump will be powered when the bottom of the power switch, located on the upper right of the rear of the pump, labeled '1', is pressed. The red indicator on the switch is visible when the power switch is in the 'on' position. After power is applied to the pump, the pump's display will flash.
- Next the Pumping Program can be entered. Before the Pumping Program can be operated, the pump needs the measurement of the peristaltic tube inside diameter. The peristaltic tube inside diameter can be entered using the keypad. Refer to 'Diameter' and 'Setup' Key.
- Finally, the peristaltic tube can be loaded and the pump started.

4. Loading Peristaltic Tubing

ⓘ Remove tubing from pump when not in use. Tubing will become deformed changing dispensed volume.

4.1 Remove Tubing from Pump

4.1.1. Remove liquid from tubing.

1) Turn on power to the Pump.
2) Press and hold Start/Stop and purge out fluid in Tubing.
3) Remove tubing from liquid.
4) Turn off power to the pump.

⚠ Warning: Liquid will siphon through tubing when it is removed from pump.

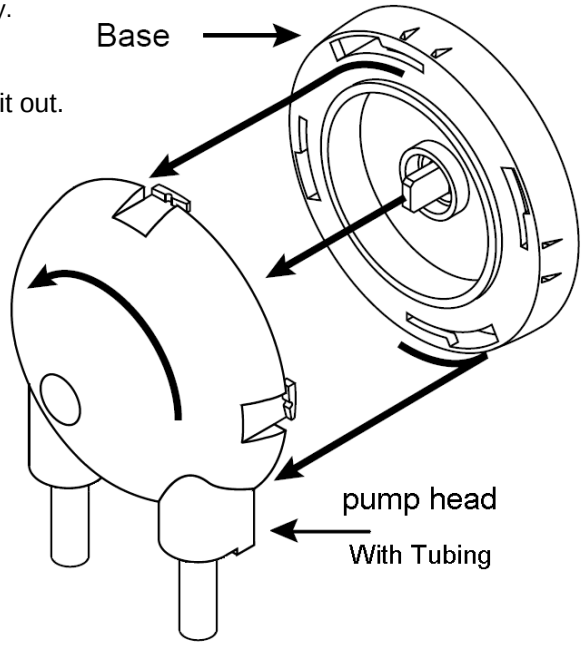
⚠ Warning: Dangerous Liquid in the tubing may cause injury.

4.1.2. Uninstall Cassette

Turn Cassette counterclockwise until it stops. Then pull it out.

4.1.3. Remove Tubing

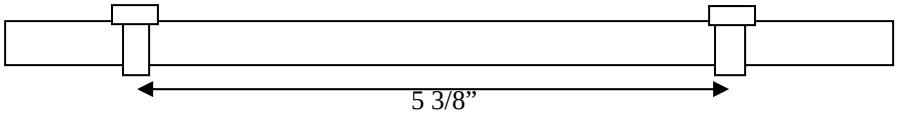
1. Remove one side of peristaltic tubing from Cassette.
2. Pull out Tubing. Hold rotor from falling.
3. Remove the other side of tube from Cassette.

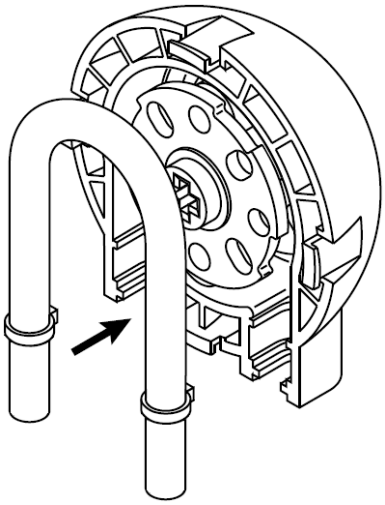


4.2. Install New Tubing

4.2.1. Prepare New Tubing

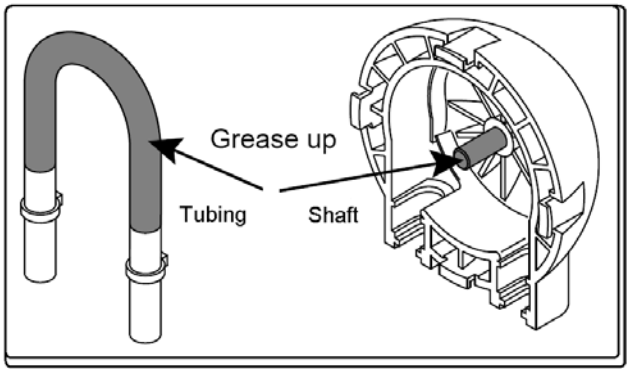
1) Wrap 2 tie wraps 5 3/8" apart (136 millimeters apart) on the new Tubing. Tie wrap knots facing the same direction

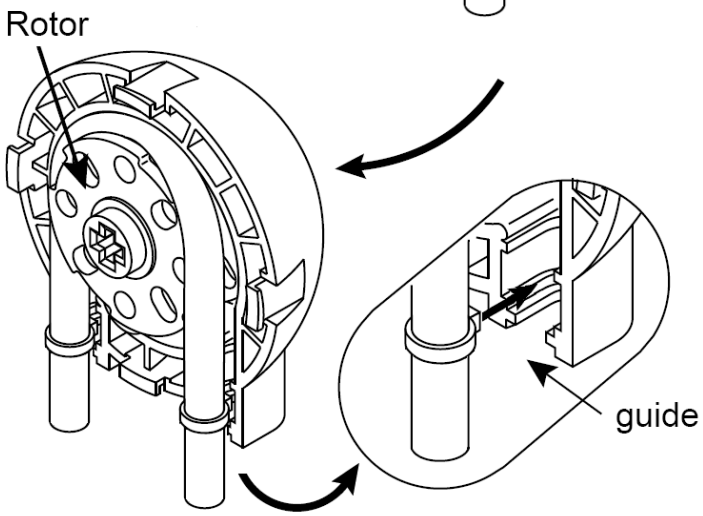




4.2.2. Install New Tubing

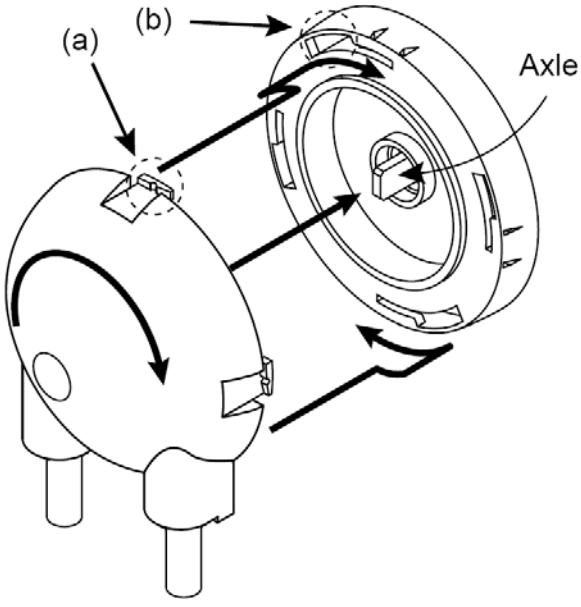
2) Remove Rotor
3) Add grease to the Cassette shaft and the surface of New Tubing. (See gray area below)
4) Return Rotor to shaft of Cassette.
5) With both knots of the tubing facing the Cassette install one knot into the guide.
6) Pull out the Rotor a little bit and place Tubing between the Cassette and the Roller.
7) Install the other knot into the guide.





4.2.3. Install Cassette to Base

1) Rotate Rotor so that it fits into axle.
2) Attach Cassette onto Base of Pump by placing (a) into (b).
3) Turn Cassette clockwise until it stops. Verify that each indent of the Cassette is matched perfectly with each marking on the Base of Pump.
4) Prime Pump before Starting Dispense Cycle.



⚠ Warning

Be careful not to be cut or injured by the edge of the Pump parts.

5. Peristaltic Tubing

Refer to last section of this Manual for tubing recommendations.

If you intend to use a long extension of tubing it is recommended that you (move the segment) change the segment that is used in the pump regularly.

Be aware that the tubing will wear out because of friction. The rotating mechanism will also wear out because of friction. Always lubricate rollers, shaft and tubing.

Note: The following flow rates and volumes are adjusted accordingly when the pump is calibrated.

Tube Size ID X OD [in]	Approximate Volume Dispensed Per 1 revolution	Flow Rate (mL/min) Maximum	Minimum
3/16 X 5/16	2.434 mL (0.0822 US fl.oz)	904.4	0.041
1/8 X 1/4	1.211 mL (0.0379 US fl.oz)	416.6	0.019
3/32 X 7/32	0.642 mL (0.0217 US fl.oz)	238.4	0.011

6. User Interface

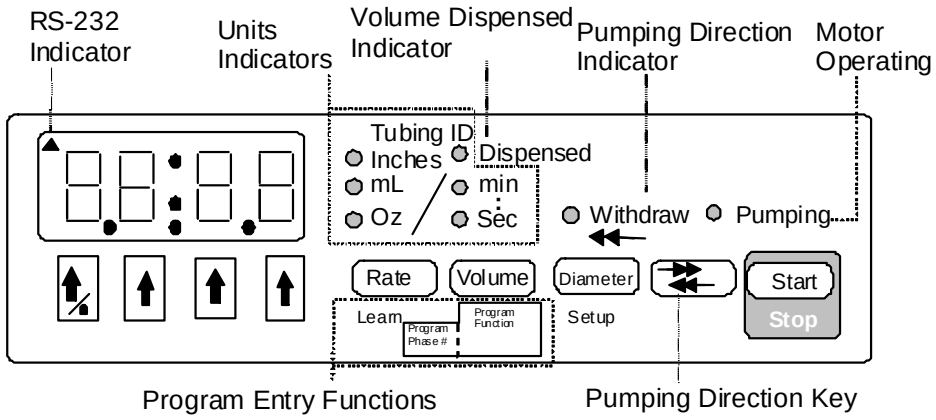


Figure 1: Front Panel

6.1. Entering Values

When applicable, values can be changed by either displaying the current value, then using the arrow keys, or from a computer connected to the pump. The new value will be stored in the pump's non-volatile memory, meaning that the new value will not be lost the next time that power is applied to the pump. The only exception is when the pumping rate is changed from an attached computer while the Pumping Program is operating. In this case the new pumping rate will not be stored in non-volatile memory.

A displayed value can be changed by pressing the arrow keys below each digit. If the value to be changed is not currently displayed, when applicable, press the key associated with the required value. The display will show the setting's current value and its units, if any.

While the current value is being changed, the units LEDs associated with the value, if any, will blink. Except where noted, the new value is stored, and/or the selected operation takes affect, when either

If the new value is valid and different from the original value, the display will blink, indicating that the new value was stored. Otherwise, if the value was invalid, an error message will be displayed. Pressing any key clears the error message and restores the original value.

In general, if a parameter has 2 values, 'off' and 'on', they are represented by the numbers '0' and '1', respectfully.

6.2. LCD Display

The display consists of a 4 digit reflective LCD (Liquid Crystal Diode) display. This is the general purpose user display device for displaying numerical data, functions and parameters. The colon (:) is used for displaying time or for separating function abbreviations from their parameter values. In the upper left corner is a triangle that indicates valid reception of RS-232 remote communications.

6.3. LEDs

To the right of the LCD are 8 red, round, LED (Light Emitting Diode) indicators. The first 2 columns display the units of the displayed values. Units are expressed using 1 or 2 LEDs. For instance, 'ml / Sec' is expressed by lighting the 'ml' and the 'Sec' LEDs.

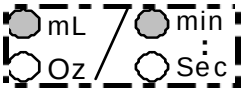
'Dispensed' indicates that the displayed volume is the total 'Volume Dispensed' or pumped.

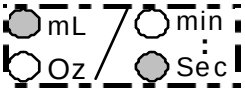
When **'Pumping'** is lit (not blinking), the motor is operating, either dispensing or withdrawing. If blinking, the motor is not operating, and the Pumping Program is paused. When the pump is restarted, the Pumping Program will resume at the point where the Pumping Program was interrupted. When not lit (not blinking) the pump is stopped, but the Pumping Program may be operating a pause Phase. Starting the pump, when the Pumping Program is stopped, will start the Pumping Program from the beginning (Phase 1).

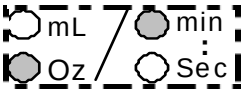
'Withdraw' indicates that the pumping direction is set for withdrawing. If not lit, then the pumping direction is set for dispensing. Also, the 'Withdraw' LED indicates that the "Volume Dispensed" refers to the volume withdrawn. If not lit, the "Volume Dispensed" refers to the volume dispensed.

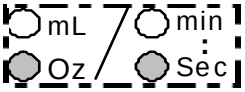
LED	Description
Inches	Tubing inside diameter in inches
mL	Milliliters
min	Minutes
Oz	Ounces
sec	Seconds
Dispensed	Volume dispensed displayed
Withdraw ◄◄	Pumping Direction: Lit: Withdraw Not lit: Dispense
Pumping	Lit: Motor is operating Blinking: The Pumping Program is paused Not lit: The Pumping Program is stopped or executing a pause Phase

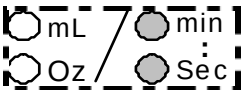
Pumping rate units are expressed using 2 LEDs:

'ml/min' = 

'ml/sec' = 

'Oz/min' = 

'Oz/Sec' = 

'min:sec' = 

6.4. Arrow and Decimal Point Keys

Each of the four digits in the display is associated with the up arrow key directly below it. When applicable, the arrow key is used to increment the value of that digit, or advance to the next selection in a list of functions or settings.

Each press of an up arrow key will increase the digit by 1, up to 9, and then back to 0. The arrow keys may also be held down for continuous incrementing of numbers. Some parameters, such as the RS-232 baud rate, scroll through a selection of values when the arrow keys are pressed. Other parameters have a fixed range of values, such as some setup parameters that are either turned on or off. In these cases, the arrow key will only scroll up to the maximum value for that parameter, then back to the minimum value.

When changing the pumping rate units, each press of any arrow key will change the units LEDs to the next units selection.

When the display blinks, the new value is stored and takes affect. This will occur when a non-arrow key is pressed or after a 2 second delay since the last key press.

6.4.1. Decimal Point Key

There are 4 decimal point positions on the LCD display. Each decimal point position is to the right of a digit in the display. The last decimal point position, to the right of the right-most digit is not displayed, indicating whole numbers with no decimal point.

To move the decimal point, simultaneously press the 2 up arrow keys under the 2 digits next to the decimal point position. Press the same 2 up arrow keys to clear the decimal point, to display a whole number.

Alternatively, to move the decimal point position, use the left-most arrow key / decimal point key (↑/●). Press and hold this key for at least 1 second and wait until the left-most digit scrolls past '9' to '0'. While continuing to hold this key, the decimal point will shift 1 position to the right. After the right-most decimal point position, the decimal point will shift to the first decimal point position. Release the key when the decimal point is in the required position.

6.5. 'Diameter' and 'Setup' Key

The 'Diameter' key allows the peristaltic tube inside diameter to be viewed and set. While being displayed, the 'Tubing ID Inches' LED is lit. The diameter can be changed by holding the 'Diameter' key while turning on power, then selecting 'DIA'.

If the 'Diameter' key is pressed and held, 'Setup' mode will be entered. (see sec. 6.11, 'Setup').

When the Pumping Program is operating, pressing this key will display the current peristaltic tube diameter for review. When the key is released, the display returns to its previous display.

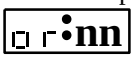
The diameter is displayed as a fraction: 03:16 indicates 3/16" ID tubing.

6.6. 'Rate' and 'Learn / Program Phase #' Key

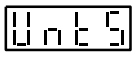
When the Pumping Program is stopped, except in "Program Entry Mode", the 'Rate' key allows the pumping rate to be viewed or changed. If the currently selected function allows selection of rate units, momentarily pressing this key will switch between the 'Rate' display and the select rate units mode.

To change the pumping rate displayed, use the arrow keys.

While the Pumping Program is operating, pressing this key will display the current pumping rate, if applicable. After the key is released, the pumping rate will continue to be displayed for 2 seconds. While displayed, the current pumping rate can be changed by pressing the arrow keys. The rate units will blink while the rate is being changed. The new pumping rate takes effect when the display blinks after a 2 second delay or when a non-arrow key is pressed. The new pumping rate is stored in the current Program Phase.

A pumping rate of 0.0 will stop the pump. When the pumping rate is changed, if it is out of range of the pumping rate limits, the display will show  , where 'nn' indicates the currently selected Phase Number. Pressing any key clears the message and returns to the previous pumping rate. See section 14.7, "Tube Chemical Characteristics", for a list of minimum and maximum pumping rates.

6.6.1. Pumping Rate Units

The pumping rate units can only be changed when the Pumping Program is not operating. If the currently selected function allows selection of rate units ('RATE' function), a momentary press of the 'Rate' key will enter Rate Units Change mode. The 2 LEDs representing the units will blink and the display will show:  .

Each press of any arrow key selects the next rate units, as indicated by the blinking units LEDs. When the required rate units are blinking, press any non-arrow key or wait 2 seconds. The display will blink, indicating the rate units are stored. The rate units are stored in the currently selected Program Phase. The rate units can be independently set for each Phase with a 'RATE' function.

6.6.2. Program Entry Mode or Dispense Selection

While the Pumping Program is stopped, pressing and holding the 'Rate' key will enter "Program Entry Mode" or "Dispense Selection Mode".

If Dispense mode is enabled, the display will show the currently select dispense: 

Otherwise, the current Program Phase number is displayed: 

'nn' indicates the currently selected dispense or Program Phase.

A momentary press of the Rate or Volume key will exit return to the rate or volume display.

6.7. 'Volume' and 'Program Function' Key

When the Pumping Program is stopped, except in "Program Entry Mode", momentary presses of this key will switch the display between the "Volume to be Dispensed" and the "Volume Dispensed" displays, as indicted by the 'Dispensed' LED.

While display "Volume to be Dispensed", use the up arrow keys to enter a new value. Enter 0.0 to disable the "Volume to be Dispensed" for continuous pumping. The new value is stored in the current Program Phase or selected dispense.

If the "Volume to be Dispensed" is disabled, pressing any arrow key will change the display to 0.0. The "Volume to be Dispensed" can now be set using the arrow keys.

While pumping, pressing and holding this key will display the current "Volume to be Dispensed".

6.7.1. Disabling "Volume to be Dispensed"

To disable the "Volume to be Dispensed", i.e. continuous pumping, set the "Volume to be Dispensed" to 0.0. After being stored, the display will show 

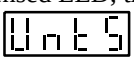
, indicating the "Volume to be Dispensed" is off. In this mode, the pump will not stop at a set volume and will pump continuously until the pump is stopped, or an "event trigger", programmed into the Pumping Program, occurs.

6.7.2. Clearing "Volume Dispensed"

While displaying the "Volume Dispensed", pressing and holding any up arrow key for one second will reset the dispense and withdrawal dispensed volumes to 0.

Pressing any arrow key while displaying the "Volume Dispensed" will enter the "Set Volume Units" mode.

6.7.3. Volume Units

With the Pumping Program stopped, and the "Volume Dispensed" displayed, as indicated by the Dispensed LED, the volume units can be changed. Momentarily press any up arrow key. The display will show 

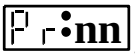
and the volume units will blink.

Press any up arrow key to change the volume units. Wait for the time out or press any non-arrow key to enter the setting.

NOTE: Changing the volume units changes the units for all dispenses and Program Phases.

6.7.4. Program Entry Mode

While the Pumping Program is stopped, pressing and holding the 'Volume' key will enter "Program Entry Mode" or "Dispense Selection Mode".

If Dispense mode is enabled, the display will show the currently select dispense:  , where 'nn' indicates the currently selected dispense.

Otherwise, the current Program Phase function is displayed: 

"Program Entry Mode" can be entered by pressing and holding the 'Rate' key. Release the key when the display shows the current Program Phase number:, where 'nn' indicates the current Program Phase number.

A momentary press of the Rate or Volume key will exit return to the rate or volume display.

6.8. Pumping Direction Key

The pumping direction key, '  ', changes the direction of pumping. Pressing this key switches the pumping direction between 'dispense' and 'withdraw', as indicated by the 'Withdraw' LED. When the LED is lit, the pumping direction is 'withdraw', otherwise the pumping direction is 'dispense'. The new pumping direction is stored in the current Program Phase.

The "Volume Dispensed" is accumulated separately for dispense and withdrawal. When the pumping direction is changed, the current "Volume Dispensed" is also changed accordingly between the dispense and withdrawal "Volume Dispensed" accumulations.

When the Pumping Program is operating and the "Volume to be Dispensed" is non-zero, the pumping direction cannot be changed. Otherwise, when pumping continuously ("Volume to be Dispensed" disabled), the pumping direction can be changed.

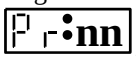
6.9. 'Start'/'Stop' Key

The 'Start/Stop' key starts or stops the Pumping Program's operation. Pressing this key switches between the Pumping Program operating and the Pumping Program paused. When the 'Start/Stop' key is pressed before the completion of a Program, the motor is stopped and the Pumping Program will be paused. The 'Pumping' LED will then blink, indicating that the Pumping Program is paused.

Pressing this key again will resume the Program at the point it was paused. If any other key is pressed while the Pumping Program is paused, the Pumping Program will be stopped and reset. Pressing the 'Start/Stop' key will then start the Pumping Program from the beginning (Phase 1).

Pressing and holding this key while starting the Pumping Program will start the prime/purge mode. Purge will begin after the key is held for one second, and continue until the key is released. The pump will stop after the key is released.

6.10. Dispense Selection

When in Dispense Mode, pressing and holding either the Rate or Volume keys will enter "Dispense Selection Mode". The display will show:  , where 'nn' is the current dispense selection.

To change the current Dispense Selection, press the up arrow keys below the Dispense Selection's digits. The maximum Dispense number is 40. To reset to Dispense number 1, press and hold either the Rate or Volume keys until Dispense number is 1.

Momentarily press the Rate or Volume keys to exit Dispense Selection Mode.

6.11. 'Setup' Key

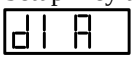
The secondary function of the 'Diameter' key is 'Setup'. While the Pumping Program is not operating, press and hold the 'Diameter' key until the first setup configuration parameter, "Slow Down Mode", is displayed:. 

The display will consecutively display, for about 2 seconds, each Setup Configuration parameter and its current setting. Pressing any non-arrow key will immediately advance to the next Setup Configuration parameter.

To change a Setup Configuration parameter, press an arrow key under the parameter's value. To store the new value, press any non-arrow key or wait 2 seconds. If the parameter value differs from its previous value, the display will blink. The new parameter value will be stored and the next parameter will be displayed.

After the last configuration parameter is displayed, the display reverts back to displaying the peristaltic tube diameter. Any new parameter value will take affect immediately upon being stored.

6.12. Special Setup Key

While turning on power to the pump, press and hold the 'Setup' key to access the special setup menu. The first menu entry "Set Tube Diameter" will be displayed: 

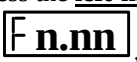
6.13. Learn Key

While turning on power to the pump, press and hold the 'Learn' key to access the Learn mode menu. The first menu entry "Learn and Repeat" will be displayed 

6.14. Special Power-Up Functions

The following special functions are accessed by pressing the relevant key, **while** turning on power to the pump.

6.14.1. Firmware Version Display

To display the pump's firmware version, press the **left-most up arrow key** (↑/●) while turning on power to the pump. The display will show:  , where 'n.nn' is the firmware version number. Pressing any key will clear the display.

6.14.2. Reset the Pump

To reset the pump, press the **right-most up arrow key** (↑) while turning on power to the pump. The display will show  . Pressing any key will clear the display.

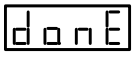
With a pump having as many complex features as the BS-900, it is easy for a novice user experimenting with the pump's setup to get the pump into a 'weird' state. Performing this reset function will bring the pump out of a 'weird' state. A default pumping rate and tubing diameter will be set.

6.14.3. Learn and Calibrate Selection

Pressing the **'Rate'/'LEARN'** key while turning on power to the pump will display the Learn selection menu. Use the up arrow keys (↑) to scroll through the selections. Press a non-arrow key or wait for the time out to select.

 Learn and Repeat Dispense

 Tubing calibration

 Exit without making any selection.

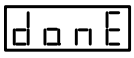
6.14.4. Special Setup

Pressing the **'Diameter'/'Setup'** key while turning on power to the pump will enter the Special Setup selection menu. Use the up arrow keys (↑) to scroll through the selections. Press a non-arrow key or wait for the time out to select.

 Set Tubing Inside Diameter

Set Dispense Mode

Set Program Mode Lockout

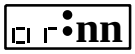


Exit without making any selection

6.15. Error and Alarm Messages

If the value entered is beyond the pump's capabilities or is invalid, or an operational problem occurred, one of the following error or alarm messages will be displayed:

Value entered is 'Out Of Range' of the pump's operational limits.



An out of range error occurred at Pumping Program Phase number 'nn', or the value just entered is out of range. Check the pumping parameters and peristaltic tube diameter.

A Pumping Program error was encountered at Pumping Program Phase number 'nn'. The indicated Phase is invalid in the context of the entire Pumping Program.

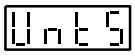
Key pressed is not currently applicable.

A communications time-out alarm occurred with an attached computer while operating in the "Safe Communications Mode". This most likely indicates that the RS-232 cable was detached or the communication program on the computer has ended without turning off "Safe Communications Mode".

An error was detected during power up, where 'n' indicates the error. If n=1, then the values stored in the pump's non-volatile memory were invalid and were reset. If n=2, then the non-volatile memory may need to be replaced.

Pump settings are locked out from the keypad. The lockout key is needed to change settings. Lockout can also be reset with the reset function.

6.16. Status Messages

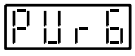


Indicates pumping rate units change mode. The units LED's will also be blinking.

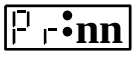
Indicates that the Pumping Program has paused and is waiting for the user to press 'Start', or for an external operational trigger, to continue.

Indicates that the pump is busy completing a long operation.

Indicates that the "Volume to be Dispensed" is 0.00, and is turned off. This is the continuous pumping mode.



Indicates that the pump is purging. Displayed while holding down the 'Start/Stop' key.



Indicates either the Dispense Mode dispense number selection, or a Pumping Program is waiting for the user to select a sub-program.

7. Operation

Before the pump can be operated, the pumping data must be setup. At minimum, the peristaltic tube inside diameter and a non-zero pumping rate needs to be set. The operation of the pump can then be started from the keypad, TTL I/O connector, or from RS-232 control. From the keypad, pressing the 'Start / Stop' key will start the pump operation.

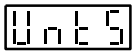
7.1. Peristaltic Tube inside Diameter

The peristaltic tube inside diameter can only be set from the Special Setup mode selected while turning on power with the Diameter key. Use the arrow keys to set the diameter value. While the diameter value is being set, the 'Tubing ID Inches' LED will blink. The new diameter value is stored after pressing any non-arrow key, or after a 2 second delay.

Any diameter setting under 1" can be entered. If the diameter is out of this range, the display will show [oor]. Pressing any key restores the diameter display to its previous value. Changing the diameter ***will not zero any current settings***.

7.1.1. Changing Volume Units

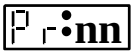
The volume units used for accumulated volumes and the "Volume to be Dispensed" settings can be changed to either 'mL' or 'Oz'. NOTE: A change in the volume units will affect all "Volume to be Dispensed" settings in the Pumping Program.

Display the "Volume Dispensed" by press and releasing the "Volume" key until the "Dispensed" LED is lit. Pressing any up arrow key will change the display to  and the current volume units will blink.

Then, press any up arrow key to switch the volume units between 'mL' and 'Oz'. Press any non-arrow key or wait 2 seconds to enter the new volume units. The display will blink when entered. The selected volume units will be stored in memory.

7.2. Stored Dispense Selections

In Dispense Mode, multiple dispense settings can be stored and selected as needed. The last selected dispensing program will be the default dispense program when the pump is powered on. Up to 40 dispense settings can be stored.

To view the currently selected dispense number or to select a different dispense number, press and hold either the **'Rate'** or **'Volume'** key. The display will show: 

Where 'nn' indicates the currently selected dispense number. Use the up arrow keys to change the dispense selection number. Press **'LEARN'** to select, or wait for the time out. The display will blink when the selection is entered.

Press the **'Start'** key to immediately start the selected dispense.

Press the **'Rate'** or **'Volume'** keys to display the settings for the selected dispense. Any changes made to the pumping rate or dispense volume will be stored in the selected dispense program.

7.3. Start/Stop Triggers

The Pumping Program can be started or stopped from any of the three sources: The keypad 'Start/Stop' key, RS-232 'RUN' command, or the TTL I/O Operational Trigger input. Each can control the Pumping Program's operation.

7.4. Operating the Pump

When the "Start/Stop" key is pressed, the Pumping Program begins to operate. In Dispense Mode, the currently selected dispense will begin. If Dispense mode is off, the Pumping Program will begin, starting with Phase 1. If the current Program Phase specifies a pumping rate, the pump will begin pumping, and the 'Pumping' LED will be lit.

The pumping direction will depend on the selected direction. The display will show the "Volume Dispensed" with a volume units LED ('mL' or 'Oz') and the 'Dispensed' LED lit.

While pumping, the pump will pump continuously in the current Program Phase, unless a "Volume to be Dispensed" is set, or an Event trigger is set. If a "Volume to be Dispensed" is set, the Program Phase will be complete after the set volume has been dispensed or withdrawn, measured from the start of the Phase.

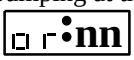
Pressing the 'Volume' or 'Diameter' keys will display the current "Volume to be Dispensed" or the diameter setting while the key is held.

7.5. Prime and Purging

To prime/purge, with the Pump stopped, press and hold the 'Start/Stop' key. The Pump will start, then, after one second, prime/purge will begin. The pump will pump at its top speed in the currently set direction. Purging will continue until the 'Start/Stop' key is released. Then the pump will stop. While purging the display will show:  .

7.6. Changing the Pumping Rate and Direction While Pumping

Except with some complex Pumping Programs, the pumping rate can be changed while the pump is operating. To change the pumping rate, momentarily press the 'Rate' key. While the pumping rate is displayed, press the up arrow keys to change the rate. The rate units will blink while the rate is being changed. If the up arrow keys are not pressed, the display will return to the "Volume Dispensed" display after a 2 second delay. Rate units can not be changed while pumping.

The new rate is stored after a 2 second delay or by pressing a non-arrow key. If the new rate is within the operating range of the pump, the display will blink and the new rate will be stored in the current Program Phase and the pump begins pumping at the new rate. If the new rate is out of the operating range of the pump, the display will show  . Pressing any key clears the error message.

The pumping direction can be changed while pumping if the "Volume to be Dispensed" is 0.0 (off). Pressing the direction key will immediately change the pumping direction and store the pumping direction in the current Program Phase. Also changing the pumping direction changes the accumulated "Volume Dispensed" according to the new pumping direction.

7.7. Volume Dispensed

While pumping, the display will show the total accumulated volume pumped with the 'mL' or 'Oz' LED lit and the 'Dispensed' LED lit. Volume is computed based upon the inside diameter setting.

The volume is accumulated separately for dispense and withdrawal. When the pump changes direction, the "Volume Dispensed" changes to the accumulated volume for the current pumping direction.

The "Volume Dispensed" accumulations, for dispense and withdrawal, are **reset to 0** when:

A) Pressing and holding any arrow key while displaying the "Volume Dispensed".

B) A sub-program is selected when the Pumping Program executes a Program Selection function.

C) The diameter is changed.

D) From the RS-232 clear "Volume Dispensed" command (CLD).

E) The accumulated Volume Dispensed rolls over from 9999 to 0.

F) The pump is powered on.

When the Pumping Program is stopped, and the display shows the Program function or pumping rate information, the accumulated Volume Dispensed can be displayed by pressing the 'Volume' key one, two, or three times, depending on the current display.

7.8. Resuming When Paused

If the Pumping Program is stopped before the completion of the Pumping Program, the 'Pumping' LED will blink, indicating that the Pumping Program is paused. While the 'Pumping' LED is blinking, starting the pump again will resume the Pumping Program where it was stopped. This means that the Pumping Program will continue at the point in the Phase where it was stopped and the 'Volume to be Dispensed' will still be referenced from when the Program Phase first started.

Pressing any key other than the 'Start' key will cancel "Pumping Program paused" and the 'Pumping' LED will stop blinking. When the Pumping Program is started again, it will start from the beginning (Phase 1).

8. Learn and Repeat

Learn and repeat easily teaches the pump a dispense volume. Then you can immediately repeat this dispense. Dispense Mode must be set to repeat a dispense.

While turning on power, press and hold the **'LEARN'** key. The display will show:

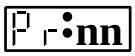
Press and hold the **'Start'** key to begin dispensing. As the desired volume is approached, you can release the key to stop the pump, then periodically press the 'Start' key to slowly and accurately approach your dispense volume.

While pumping, the volume dispensed will be displayed. When the 'Start' key is released, the display will alternate between displaying the volume dispensed and the currently selected dispense setting number.

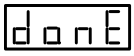
Press the **'LEARN'** key, or wait for the time out, to immediately store the dispensed volume in the currently selected dispense setting. A double beep will sound and the display will show:

Press any key to return to the currently selected dispense program display.
Press '**Start'** to immediately begin the newly learned dispensed.

Storing in a different dispense selection number
The learned dispense can be stored in a different dispense setting number. After the required dispense volume is reached, press any of the up arrow keys. The display will show:



Where 'nn' is the crrently selected dispense setting number. Use the up arrow keys to select a different location to store the dispense. Press the **'LEARN'** button or wait for the time out. A double beep will sound and the display will show:



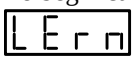
Press the '**Start'** key to immediate begin dispensing the learned dispense.

9. Calibration

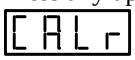
Calibration mode fine tunes the dispense accuracy. Continued use of tubing will cause it to stretch and deform which creates dispensing errors. Also, differing viscosities and/or pumping speeds can also affect pumping accuracy.

Calibration uses the currently selected dispense setting, or the first pumping rate in the Pumping Program. Otherwise, the calibration defaults to 250 mL at 500 mL/min Also, you will need a calibrated measuring cup to verify the actual dispense volume.

To begin calibration: While turning on power, press and hold the **'LEARN'** key until the display shows:



Press any up arrow key for the next Learn selection: Calibration:



Press the **'Start'** key to begin the dispense.

When the dispense is complete, the pump will stop, and the dispensed volume will be displayed with the volume units LED blinking.

Press the **'LEARN'** key to accept this volume, or use the up arrow keys to enter a measured dispense volume.

Press **'LEARN'** after the measured dispense volume has been entered.

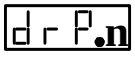
The pump uses the entered volume to recalibrate the pumping rate and dispense volume.

Changing the tubing diameter or reseting the pump will cancel the entered calibration. The pump will use the tube diameter as the calibration value.

10. Setup Configuration

To change or view the setup configuration, the Pumping Program must be stopped. Press the 'Diameter'/'Setup' key until the first parameter, 'SLO.n' is displayed. After 2 seconds, or when any non-arrow key is pressed, the next parameter will be displayed (see sec. 6.11, 'Setup' Key). Pressing an arrow key under a value will increment, select, or scroll through the valid values for the parameter. The Setup Configurations will be displayed in the following order:

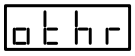
Slow Down mode, where 'n' is the current setting.



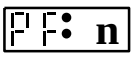
Anti-Drip mode, where 'n' is the current setting.

Dispense and pause mode, where 'n' is the current setting.

When pasue mode is enabled, displays the pause setting.



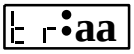
Display secondary setup menu: Press any arrow key to select.



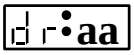
Power Failure mode, where 'n' is the current setting.

Alarm mode, where 'n' is the current setting.

Display TTL I/O external connector settings. Press any arrow key to select. If selected, the following will be displayed:



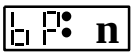
Operational Trigger setting. ‘aa’ is current setting.



Directional control setting. 'aa' is current setting.

'Pump Motor Operating' TTL output pin configuration. 'n' is the current setting.

=> The "Lockout Disable Key" needs to be inserted to display this setting. Lockout setting changes from the keypad. 'n' is the current setting.



Keypad beep enable, where ‘n’ is the current setting.

RS-232 pump network address, where ‘nn’ is the network address.

RS-232 pump network baud rate, where ‘nnnn’ indicates the baud rate.

Special Setup Menu

To access the special setup menu, press and hold the ‘Setup’ key while turning on power to the pump. The Setup Configurations will be displayed in the following order:

Set Tubing Inside Diameter

Set Dispense Mode

Set Program Mode Lockout

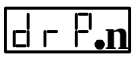
Exit without making any selection

10.1. Slow Down Mode

Setting: ‘0’ = Disabled, ‘1’ = Enabled.

Slow-Down mode prevents over dispensing when pumping a large volume at a high speed. When enabled, the pump will incrementally slow down as the volume dispensed approaches the target dispense volume.

10.2. Anti-Drip Mode



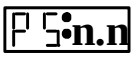
Setting: ‘0’ = Disabled, ‘1’ = Enabled.

When enabled, Anti-Drip mode will withdraw a small volume after the completion of a dispense to prevent dripping when the pump stops. The volume withdrawn is added to the next dispense.

10.3. Dispense, Pause, Repeat Mode

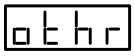
Setting: '0' = Disabled, '1' = Enabled.

When enabled, will create a more automated dispensing system, whereby the pump will continuously repeat the current dispense after a fixed time delay. The time delay will be displayed next:



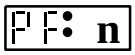
Where 'nn' is the pause time in seconds. Use the arrow keys to change the pause time. Valid pause times are 1 to 99 or 0.1 to 9.9 seconds. To set/clear the decimal point, scroll the right-most up arrow key past 9, or simultaneously press the 2 right-most up arrow keys.

10.4. Advanced Settings Menu



The "Other" menu selection provides access to the more advanced settings menu.

10.5. Power Failure Mode



Setting: '0' = Disabled, '1' = Enabled.

When enabled, if the Pumping Program was operating when power to the pump was disrupted, the Pumping Program will automatically start operating when power is reconnected to the pump. Pressing any key on the keypad while powering up the pump will stop the Pumping Program from starting.

In Dispense Mode, the pump will begin pumping according to the last selected Dispense.

☞ **CAUTION**: If Dispense Mode is not set, then Pumping Program will start operating from the beginning of the Pumping Program (Phase 1), regardless of what part of the Pumping Program was operating when the power was disrupted.

10.6. Audible Alarm Enable

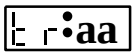
Setting: '0' = Disabled, '1' = Enabled.

When alarms are enabled, the buzzer will be sounded as follows:

Condition	Buzzer Action
Pumping Program ended	Continuous beeping
Pumping Program paused for start trigger	Continuous beeping
Alarm condition	Steady alarm

Pressing any key will stop the alarm.

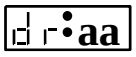
10.7. TTL I/O Operational Trigger Configuration



Configures how the TTL I/O 'Operational Trigger' (pin 2) will control the Pumping Program's operation. (See sec. 13.1, *TTL I/O Operational Controls*). The 2 letter configuration Setting parameter to the right of the colon (:) is defined as follows:

Setting	Name	Function
Ft	Foot Switch	Falling edge starts or stops the Pumping Program
FH	Foot Switch Hold	Falling edge starts the Pumping Program Rising edge stops the Pumping Program
F2	Foot Switch Reversed	Rising edge starts or stops the Pumping Program
LE	Level Control	Falling edge stops the Pumping Program Rising edge starts the Pumping Program
St	Start Only	Falling edge starts the Pumping Program
t2	Start Only Reversed	Rising edge starts the Pumping Program
SP	Stop Only	Falling edge stops the Pumping Program
P2	Stop Only Reversed	Rising edge stops the Pumping Program

10.8. TTL I/O Directional Control Input Configuration

 Configures how the TTL input 'Pumping Direction' (pin 3) will control the pumping direction. (See sec. 13.1, *TTL I/O Operational Controls*). The 2 letter configuration parameter to the right of the colon (:) is defined as follows:

Setting	Name	Function
rE	Reciprocating Pumps	Falling edge: Dispense; Rising edge: Withdraw
dU	Dual Pump	Falling edge: Withdraw; Rising edge: Dispense

The setting names are relevant to a 2 pump system, whereby the 'Directional Control Input' TTL pin is attached to the second pump's 'Pumping Direction Output' TTL pin.

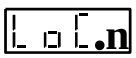
10.9. Pump Motor Operating TTL Output Configuration

 Configures the functionality of the 'Pump Motor Operating' TTL output pin (TTL pin 7).

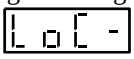
Settings: 0: Sets the output to logic high only when the motor is operating (pumping).
Sets the output to logic low when the motor is not operating or when the Pumping Program is executing a pause timer or is stopped

1: Sets the output to logic high when the motor is operating (pumping) or when the Pumping Program is executing a pause timer.
Set the output to logic low when the Pumping Program is stopped

10.10. Keypad Lockout

 Setting: '0' = Disabled, '1' = Enabled.

*** The "Lockout Disable Key" needs to be inserted into the TTL I/O connector to display this setting***

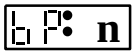
When enabled, the "Lockout Disable Key" needs to be inserted into the TTL I/O connector to change any of the pump's settings. When the key is removed, the user can only start or stop the pump and review current settings. Settings can still be changed from RS-232. When the user attempts to change a setting, the message  will be displayed.

Auto-Run Mode: When used in conjuction with the Program Select programming function as Phase 1, the pump will enter Auto-Run Mode. In this mode, on power up, the Pumping Program will immediately begin to execute and the user would be prompted to enter a dispensing program number.

The "Lockout Disable Key" connects the "Program Input", TTL connector pin 6, to Ground, pin 9. The "Lockout Disable Key" is available as an accessory item.

Lockout can also be disabled by performing a system reset, see sec. 6.14.2, "Reset the Pump."

10.11. Keypad Beep Enable



Setting: '0' = Disabled, '1' = Enabled.

When enabled, a single short beep will sound whenever a key is pressed on the keypad.

10.12. RS-232 Pump Network Configuration

The pump can be configured to communicate either with a computer or another pump. Communications with a computer (Address Mode) is the default setting and will be indicated by the [Ad:nn] display.

When in the default Address Mode, up to 100 pumps can be attached to a computer in a single pump network. The network address is defined by the 2 digits to the right of the colon (:). The valid range of addresses is from '00' to '99'. If only one pump is attached to the computer, set the network address to 0, [Ad:00] (factory default).

After the network address is displayed, the baud rate is displayed. Each pump in the pump network and the computer must have the same baud rate setting. Any arrow key can be used to scroll through the selection of baud rates. The supported baud rates are: 300, 1200, 2400, 9600, and 19200 (displayed as [1920]).

To change the communications mode:

With the network address displayed [Ad:nn], press the left-most arrow key to enter the communications mode menu. Pressing any arrow key will scroll through the menu selections:

	Address Mode: Default communications with a computer mode.
	Reciprocating Pumps. Sends Start/Stop, Pumping rate and reverse pumping direction to an attached secondary pump.
	Reciprocating Pumps. Sends Start/Stop, Pumping rate and same pumping direction to an attached secondary pump.

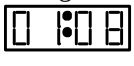
Note: Communications with a computer requires the accessory cable: CBL-PC-PUMP-7.
Communications with a secondary pump requires the accessory cable: CBL-DUAL

In Reciprocating or Dual Pumps Modes, the secondary pump must be left in its default communications setting of Address Mode, Address 0, and 19,200 baud rate. See the documentation with CBL-DUAL cable for more detailed information.

10.13. Set Tubing Inside Diameter Setting

For most applications, the default tubing inside diameter does not need to be changed since the pumping head is optimized for 3/16" inside diameter (ID) tubing.

When selected, the display will show the current diameter and the 'mm' units LED will blink. While the units LED is blinking, use the up arrow keys to enter the new diameter. For example, to enter 1/8" id tubing, use the up arrow keys to change the display to:



Press the **'LEARN'** key, or wait for the time out to enter the new setting. The tubing diameter will now be set to the new setting. The new diameter will be used as the current calibration setting and override any previously entered calibration volumes.

10.14. Set Dispense Mode

dISP When selected, the dispense mode setting is displayed: dIS.n, where 'n' is the setting: '0' = Disabled, '1' = Enabled.

When enabled, the pump will be in Dispense Mode. Also, "Program Mode Lockout" will also be enabled or disabled.

10.15. Set Program Mode Lockout

PLoC When selected, the "Program Mode Lockout" setting is displayed: P-L.n, where 'n' is the setting: '0' = Disabled, '1' = Enabled.

When enabled, the user will not be able to enter Pumping Program edit mode unless the pump is already programmed with a multi-phase pumping program.

10.16. Exit special setup menu

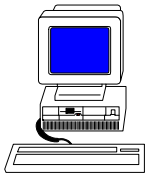
donE When selected, the special setup menu will be exited.

11. Pumping Program

Dispense Mode must be disabled to enter a pumping program. Download the complete user manual for the complete pumping program documentation.

12. RS-232 Communications

The BS-900 Peristaltic Pump can communicate with any computer or device with an RS-232 communications port. Download the complete user manual for complete RS-232 communications documentation.



13. Logic Interface: TTL Input and Output

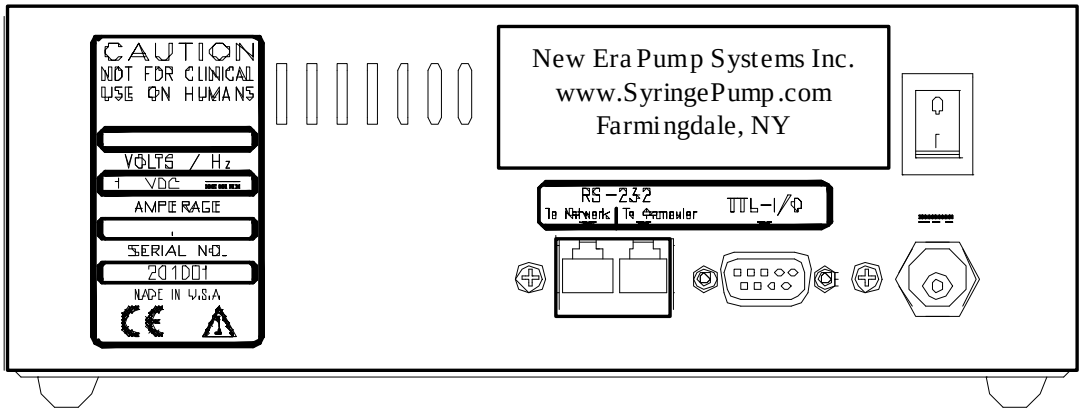


Figure 2: Rear of Pump

On the rear of the pump is a DB-9 connector, below the 'TTL-I/O' label, which is used for TTL I/O. The logic signals on this connector permit bi-directional control with external equipment.

Control input TTL logic levels must be held steady for a minimum of 100 ms to be recognized. To minimize the possibility of false signals caused by glitches and ringing, which could be caused by the closure of mechanical switches, TTL control inputs are software filtered. With a sampling period of 50 ms, glitches of less then 100 ms are filtered out.

Edge detection requires the detection of a change in TTL levels. With a minimum of 100 ms to detect a level, an edge requires a minimum of 200 ms to be detected. Since the next level change can be detected in 100 ms, creating another edge, the maximum edge to edge frequency is 10 Hz.

Edge changes to the 'Pumping Direction' and 'Operational Trigger' inputs must occur at least 50 ms apart.

Falling edge refers to a logic high to logic low transition. Rising edge refers to a logic low to a logic high transition. To guarantee recognition of logic levels, voltages on the input lines must be within the following ranges:

TTL logic low (0): 0 to 1.5 V
logic high (1): 3.5 to 5.25 V

The Vcc and Ground pins, pins 1 and 9, are for logic reference only. To assure proper voltage levels, the Ground pin should always be connected to the signal ground of a sensing or controlling device that is attached to any other pin on the TTL I/O connector. The Vcc pin should not be used to source current. The TTL I/O pins are defined as follows:

Pin #	**Definition**	***Type***	***Function***
1	Vcc (5V)	Reference	Logic high reference. Power on indicator.
2	Operational Trigger	Input	Configurable start/stop operational trigger input. [Ft] Foot Switch — Falling edge: Start or stop trigger [FH] Foot Switch Hold — Falling edge: Start trigger; Rising edge: Stop trigger [F2] Foot Switch Reverse — Rising edge: Start or stop trigger [LE] Level — Falling edge: Stop trigger; Rising edge: Start trigger [St] Start only — Falling edge: Start trigger [t2] Start only Reverse — Rising edge: Start trigger [SP] Stop only — Falling edge: Stop trigger [P2] Stop only Reverse — Rising edge: Stop trigger
3	Pumping Direction	Input	Changes pumping direction according to setup [dr:rE] / [dr:dU] Falling edge: Dispense / Withdraw Rising edge: Withdraw / Dispense
4	Event Trigger	Input	Event input or user definable input
5	Program Output	Output	Program controlled output or user definable output
6	Program Input	Input	Program conditional input read by the "IF" program function. Also user definable input. Also used by the keypad lockout function.
7	Pump Motor Operating	Output	[RUN.0] High: Pumping; Low: Not pumping [RUN.1] High: Pumping or Pause timer Low: Pumping Programmed stopped or paused
8	Pumping Direction	Output	High: Dispense; Low: Withdraw
9	Ground (0V)	Reference	Logic low reference

13.1. TTL I/O Operational Controls

While the user is changing settings or configuration from the keypad, external control by the 'Pumping Direction' and 'Operational Trigger' inputs will be ignored. These controls will also be ignored if an alarm condition exists.

Operational Trigger (Pin 2): The input signal on this pin controls the operation of the Pumping Program. Its functionality is user configurable. Use the 'TR:nn' Setup Configuration to configure this input pin (See Section 10.7, TTL I/O Operational Trigger Configuration).

Each option defines when the Operational Trigger input is activated. When activated, the trigger emulates the 'Start/Stop' key:

Foot Switch: Operates like the 'Start/Stop' key, whereby each **falling** edge (contact to ground) either starts or stops/pauses the Pumping Program.

Foot Switch Hold: **Falling** edge starts the Pumping Program and the **rising** edge stops the Pumping Program. With a foot switch, the Pumping Program will run while the foot switch was held down.

Foot Switch Reversed: Operates like the 'Start/Stop' key, whereby each **rising** edge either starts or stops/pauses the Pumping Program.

Level Control: **Falling** edge stops/pauses the Pumping Program, **Rising** edge starts the Pumping Program. This configuration can be used with a contact closure timer or in an automation setup, allowing logic level control over the operation of the pump.

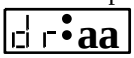
Start Only: **Falling** edge starts the Pumping Program. This configuration only allows the starting of the Pumping Program. This would be useful, for example, with a laboratory animal trained to press a lever. The animal can start the Pumping Program, but repeated presses would have no affect until the Pumping Program permits it.

Start Only Reversed: Same as 'Start Only', but operates on the **Rising** edge to start the Pumping Program.

Stop Only: **Falling** edge Stops the Pumping Program. This configuration only allows the stopping/pausing of the Pumping Program. This would be useful, for example, with an end of travel limit switch. Also, this switch can be used as a power on homing switch.

Stop Only Reversed: Same as 'Stop Only', but operates on the **Rising** edge to stop the Pumping Program.

Pump Motor Operating (Pin 7): This output provides an external signal indicating when the pump motor is operating. This pin is configured with the  setup command, or the "ROM" remote command. When set to 0, the output is only at logic high when the motor is operating (pumping). When set to 1, the output is logic high when the motor is operating or when the Pumping program is executing a pause timer. Otherwise, the output is a logic low.

Pump Direction Controls (Input: Pin 3; Output: Pin 8): Allows bi-directional control of the pumping direction. The input pin, when activated, emulates the pumping direction key, changing the pumping direction. This function, therefore, is only applicable where the pumping direction key would be applicable. The function of the input pin is configured with the  setup command, or the "DIN" remote command.

When the mode is set to reciprocating pumps ("RE" setup command or "0" remote), then if the current pumping direction is withdraw, a falling edge sets the direction to dispense. If the current pumping direction is dispense, a rising edge sets the direction to withdraw. Otherwise, this input pin has no affect.

When the mode is set to dual pumps ("dU" setup command or "1" remote), then if the current pumping direction is withdraw, a rising edge sets the direction to dispense. If the current pumping direction is dispense, a falling edge sets the direction to withdraw. Otherwise, this input pin has no affect.

Dual and reciprocating pumping systems are created using 2 pumps attached with the accessory cable CBL-TTL-1.

The output pin provides an output signal to external devices indicating the direction of pumping. A logic low indicates withdraw, and a logic high indicates dispense. For example, this pin can be used to control an external valve.

13.2. TTL I/O Control from the Pumping Program

Various Pumping Program functions can define how the pump reacts to levels on the TTL I/O connector or set output levels. These are summarized in the following table:

Pumping Program Function	TTL I/O Control Pin	Pin #	Action
OUT.n	Program Output	5	Set logic level output to 'n'
EV:nn	Event Trigger	4	Falling edge triggers a jump to Phase 'nn'
ES:nn	Event Square wave Trigger	4	Rising or falling edge triggers a jump to Phase 'nn'
IF:nn	Program Input	6	Low level causes a jump to Phase 'nn'
PS:00	Operational Trigger	2	Trigger activation resumes Program operation

13.3. TTL I/O Control from RS-232

The logic levels of pins 2, 3, 4, and 6 can be queried from an attached computer using the RS-232 'IN' command.

The output logic level of pin 5 can be set with the RS-232 'OUT' command.

14. Appendix

14.1. RS-232 Command Summary

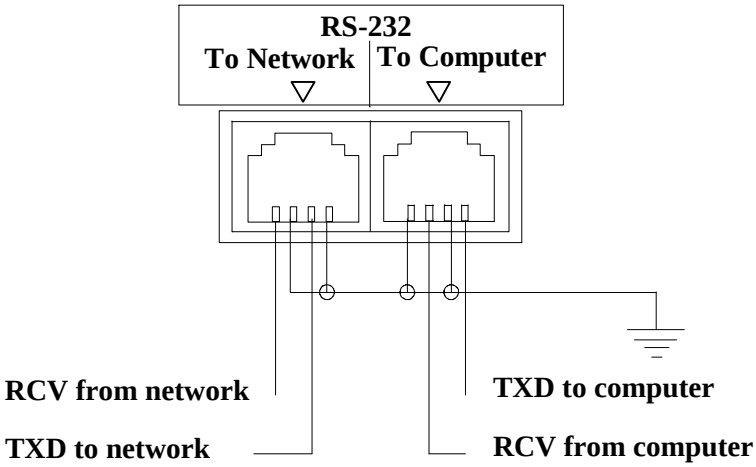
<command> =>	
DIA [<nn> / <nn>]	Tube inside diameter
CAL <float>	Tubing calibrated volume
PHN [< phase data >]	Program Phase number
FUN [< phase function >]	Program Phase function
< phase function > =>	
RAT	Pumping rate. 'RATE'
INC	Increment rate. 'INCR'
DEC	Decrement rate. 'DECR'
STP	Stop pump. 'STOP'
JMP <phase data>	Jump to Program Phase. 'JP:nn'
PRI	Program Selection Input. 'Pr:In'
PRL <phase data>	Program Selection Label definition. 'Pr:nn'
LOP <count data>	Loop to previous loop start 'nn' times. 'LP:nn'
LPS	Loop starting Phase. 'LP:ST'
LPE	Loop end Phase. 'LP:EN'
PAS [nn | n.n]	Pauses pumping for 'n.n' seconds. 'PS:n.n'
IF <phase data>	If Program input low, jump to Program Phase. 'IF:nn'
EVN <phase data>	Set event trigger. 'Et:nn'
EVS <phase data>	Set event square wave trigger. 'ES:nn'
EVR	Event trigger reset. 'Et:RS'
BEP	Sound short beep. 'BEEP'
OUT { 0 | 1 }	Set programmable output pin. 'OUT.n'
RAT [<float> [MS | OS | MM | OM]]	Pumping rate
VOL [<float> | <volume units>]	Volume to be Dispensed
TIM [<nn> : <nn>]	Volume / Time units and time setting
DIR [INF | WDR | REV]	Pumping direction
RUN [<phase data>]	Starts the Pumping Program
[E [<phase data>]]	Pumping Program event trigger
STP	Stop/pauses the Pumping Program

DIS	Query volume dispensed
CLD { INF | WDR }	Clear volume dispensed
PSM [nn | n.n]	Dispense pause mode
SLO [0 | 1]	Slow down mode
DRP [0 | 1]	Anti-drip mode
AL [0 | 1]	Alarm mode
PF [0 | 1]	Power failure mode
TRG [FT | FH | F2 | LE | ST | T2 | SP | P2]	Operational trigger mode
DIN [0 | 1]	Directional input control mode
ROM [0 | 1]	Pump Motor Operating TTL output mode
OUT 5 { 0 | 1 }	Set TTL output level
IN { 2 | 3 | 4 | 6 }	Query TTL input level
BUZ [0 | { 1 [< n >] }]	Buzzer control
BP [<on-off>]	Key beep mode
LOC [P | D] [0 | 1]	Keypad lockout mode or Program Entry Mode lockout
VER	Query firmware version
SAF [<n> [<n> [<n>]]]	Safe communications mode
*ADR [<n> [<n>] [B <baud-rate>]]	Network address and baud rate (system command, valid regardless of current address)
*ADR [DUAL | RECP]	Set Reciprocating or Dual pumping mode
*RESET	Clears program memory and resets communication parameters (system command, valid regardless of current address)

Network Command Burst => <n> <command> * [Network Command Burst]	Communicate with multiple pumps on a pump network simultaneously

Refer to section 10.2.1 RS-232 General Syntax Legend for symbol's description.

14.2. RS-232 Pump Network Connector Wiring



PC Com Port Connectors

25 Pin	9 Pin	
3 - Receive	2 - Receive	Connect to pump TXD
2 - Transmit	3 - Transmit	Connect to pump RCV
9 - Ground	5 - Ground	Connect to pump GND

14.3. Accessories

14.3.1. ANA-BOX

Part #: ADPT-ANABOX, Analog sensor interface.

Allows the BS-900 to be controlled by an external sensor, such as a pressure sensor, or other variable voltage source. Start or stop the pump at a specific voltage level. Set the pumping rate to be proportional to the voltage input. Creates a closed loop system.

14.3.2. RS-232 Network Cables

RS-232 Network Primary Cable

7 foot cable, part #: CBL-PC-PUMP-7
25 foot cable, part #: CBL-PC-PUMP-25

Cable to connect a pump, or the first pump in a pump network, to a standard personal computer's serial port with a DB-9 or DB-25 connector. Included with this cable is a 9 pin to 25 pin converter.

RS-232 Network Secondary Cable

7 foot cable, part #: CBL-NET-7
25 foot cable, part #: CBL-NET-25

Cable to connect additional pumps, after the first pump, to the pump network.

USB to RS-232 converter cable

USB to RS-232 cable, software drivers on CD, part#: CBL-USB232
Attached to the RS-232 Network Primary Cable, allows communication through a PC's USB port.

14.3.3. Automation Cable: Dual Pumps Control Cable

Part #: CBL-DUAL

Using two BS-900 peristaltic pumps, this cable creates a dual pumping system, with both pumps operating in the same direction.

This cable is attached to two BS-900 peristaltic pumps via their RS-232 connectors. In this setup, with the pumps configured for this operation, one pump acts as the Master controller. The pumps can be set to Dual Pump Mode, whereby the second pump will always follow the program on the first pump, including starting, stopping, direction changes, and rate changes.

When either pump stops, for any reason, the other pump will stop.

14.3.4. Valve Controller

Part# ADPT-VALVE-INTERFACE-1 (For one pump)
Part# ADPT-VALVE-INTERFACE-2 (For two pumps, includes CBL-TTL-1)

Provides a control interface for your electronic valves. Attach your electronic valves, and the interface will control the activation of the valves. The 2 pump interface is used to create a continuous dispense/refill system.

14.3.5. Foot Switch

Part #: ADPT-2

Allows the pump to be operated from a foot switch. Attaches to the TTL I/O connector.

14.3.6. Lockout Disable Key

Part#: ADPT-LOCKOUT-KEY

Enables setting Keypad Lockout mode and allows changing of settings while Keypad Lockout is set.

14.3.7. Firmware Upgrade

Part#: CPU-NE9000, Upgraded firmware.

Contact your dealer for this upgrade and to determine the current available version of the pumps internal firmware.

14.4. Troubleshooting and Maintenance

Maintenance: Periodically, a new tube should be used or a new section of peristaltic tubing should be used. Add grease to the Cassette shaft and the surface of new tubing.

Pump head may need to be replaced once a year depending on usage.

The mechanism should be kept clean to prevent wear and tear.

RS-232 Communications: If no RS-232 communications is possible or garbled responses are received from the pump, check the following:

If the triangle appears in the upper left of the LCD display, then the pump is receiving valid communications. The communications problem is probably with the receiving communication application or with the receive line on the cable.

If the Basic communications mode is used, check if the pump is in Safe communications mode. Verify the pump's baud rate and network address. To set the RS-232 communications parameters, see section 6.11, 'Setup' .

Using a lower baud rate may also improve the reliability of the RS-232 communications.

Pump stalls and is unable to turn: This may be because the pumping rate is set too high. Reduce rate.
Peristaltic tubing being used may be too rigid for this pump. Replace tubing.
Liquid may be too viscous or there may be too much pressure on the system.

There may be too much tubing in the pump head, reduce distance between tie-raps and recalibrate pump, refer to section 4.2.1.

Pump doesn't stop after dispensing a set volume: The pump was previously setup with a multiple Phase Pumping Program. To simply dispense a fixed volume at a fixed pumping rate, the second Program Phase must be the 'Stop' function.

Pump stops pumping after a period of time: A dispense volume has been set. Verify that the dispense volume is set to 0.

14.5. Specifications

14.5.1. Mechanical & Electrical

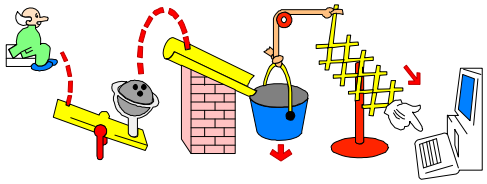
Number of pumps:	1
Motor type:	Step motor
Motor steps per revolution:	200
Microstepping:	1/8 to 1/1 depending on motor speed
DC connector:	2.1mm, center positive
Voltage at DC connector:	24V DC at full load
Amperage:	900mA at full load
Power supply type:	Unregulated linear external wall adapter, country and power source specific
Power supply output rating:	24V DC @ 1A
Dimensions:	7 ¾" x 5 1/4" x 5 3/4" High (19.685 cm x 13.335 cm x 14.605 cm)
Weight:	4.51 lbs. (2.05 kg)

14.5.2. Operational

Maximum speed:	476.7 rpm
Minimum speed:	0.00135 rpm
Maximum pumping rate:	904.4 mL/min with 3/16 ID tubing

Minimum pumping rate:	0.041 mL/min with 3/16 ID tubing
Number of Program Phases:	40
RS-232 pump network:	100 pumps maximum
RS-232 selectable baud rates:	300, 1200, 2400, 9600, 19200
Tubing inside diameter range:	Below 1” diameter

14.6. Custom Applications



For specialized and OEM applications, contact your dealer or NEW ERA PUMP SYSTEMS INC. Custom modifications can be made to the mechanics or the firmware.

14.7. Tube Chemical Characteristics

Tubing Chemical compatibility list mentioned is only a guide. The user is responsible to determine the tubing compatibility to the chemical being used.

This Peristaltic pump will only work with tubing with 1/16 [1.6mm] wall, peristaltic tubing that is relatively flexible, and that can be easily compressed.

Thus we have a couple of recommendations:

	Sterilization						
	Auto-clavable(2)	Gas(3)	Radiation(4)	Color	Odor	Taste	Toxicity
Tygon® LFL	Yes	Yes	No	Clear	Slight	None	Non-toxic
Tygon® R-3603	Yes	N/A(6)	No	Clear	Slight	None	Non-toxic
Tygon® R-1000	No	N/A(6)	No	Clear	Slight	-1	-1
Tygon® 2001	Yes	N/A(6)	N/A(6)	Clear	None	None	Non-toxic
Tygoprene™ XL-60	Yes	N/A(6)	N/A(6)	Translucent	Slight	Slight	Non-toxic
Fluran® F-5500-A	N/A(5)(7)	No	No	Black	Slight	-1	-1
Norprene® A-60-G	N/A(5)	N/A(5)	N/A(5)	Black	Slight	-1	-1
Norprene® A-60-F	Yes	N/A(6)	N/A(6)	Beige	Slight	Slight	Non-toxic
PharMed® BPT	Yes	Yes	Yes	Tan	Slight	Slight	Non-toxic

(1)Not to be used in contact with food, beverages, drugs

(2)Steam 30 minutes at 15 psi (250).

(3)Ethylene Oxide.

(4)Radiation up to 2.5 MRad.

(5)Restricted to chemical/industrial use only.

(6)Not a medical formulation.

(7)Food grade is available upon request.

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