SyringeONE

CBL-DUAL-3

Pump Synchronization Cable

www.SyringePump.com

NewEra
pump systems

This is a special communications cable that synchronizes the operation of two pumps in one of the special communications modes. (3' in length)

How to Connect Pumps

1) Turn off the power to both pumps

2) Attach one end of the "Dual Pumps Cable" to the "**To Computer**" connector on the back of the Master Pump.

3) Attach the other end of the "Dual Pumps Cable" to the "**To Computer**" connector on the back of the Secondary Pump.
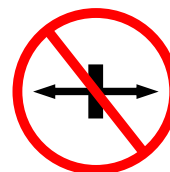
Master Pump (connect to "RS-232 To Computer")   Secondary Pump (connect to "RS-232 To Computer")
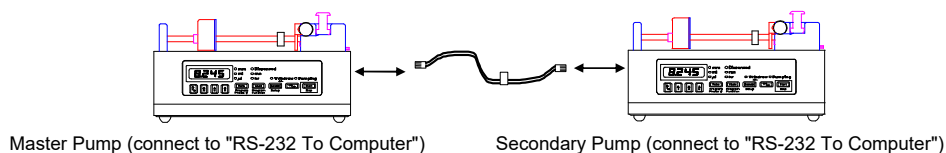
1. Plumbing of a Continuous Infusion System (P-DKIT)
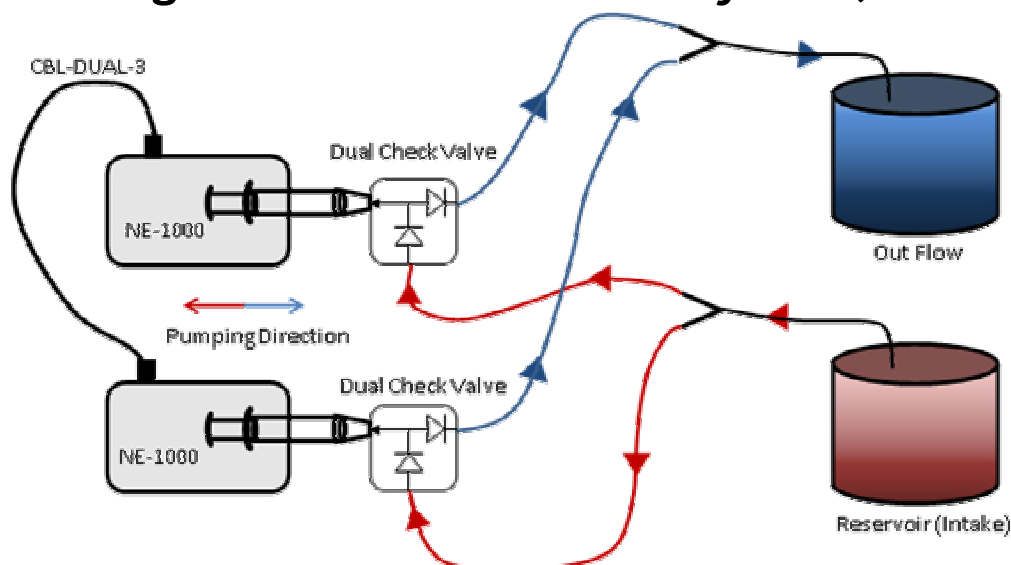
1.1 Components of this System:

Quantity	P-DKIT	Description
2		SyringeONE Model Pump
1		**CBL-DUAL-3** control cable
2	✓	Syringes (60 mL)
2	✓	Dual Check Valve
2	✓	Y Connector
6	✓	Sections of Tubing

2. Instructions

To select the Master pump control mode:

1. Enter **Setup** on the Master pump by pressing and holding the [Diameter] key ("Setup" key).

2. Scroll through setup parameters, then when the pump address **[Ad:00]**, or other current mode is displayed, press the left-most up arrow key to scroll through the communications modes:

Mode	Display in Setup	Description
Address mode	Addr	Communications with PC using cable **CBL-PC-PUMP-7.**

2.1 CBL-DUAL-3 Cable Special Communications Modes

Mode	Display in Setup	'X Firmware Version Only	Description
Dual Pumps	dUAL		Secondary pump duplicates the master pump
Reciprocating Pumps or Continuous Infusion	rECP		Continuous infusion / auto-refill
Alternating Pump Control	ALtr	Bonus Features	Second pump starts when first pump stops.
Next Generation Continuous Infusion	Cont	✓	Continuous infusion when minimizing flow rate pauses and drop outs while changing directions
Constant Flow Rate Gradient	GrAd	✓	Dual pumps inverse linear functions combine for a constant flow rate

All modes are set to have a 19,200 baud rate. In Address mode, the baud rate can be set and is the next setting that appears on the display.

The secondary pump should remain in Address mode **[Ad:00]** with 19,200 baud rate **[1920]** which are factory default settings.

> **NOTE:** In Alternating Pumps mode, the secondary pump can also be set to Alternating Pumps mode.

2.2 Default Program Selection

Use one pump as the Master control pump, and the other as the Secondary pump. After selecting a default program, the default parameters can be modified. **Do not load the program on the second pump.** Set the syringe diameter on both pumps.

### 2.2.1 Basic Pump Setup: Select Default Dual Pumps Program

On the Master Pump ONLY:

1. Turn the power off.
2. Press and hold the "Program Function" key (Volume key).
3. Turn the power on, and then release the "Program Function" key.
4. Press any up-arrow key to select a default program.
5. Default program will be loaded and the communications mode will be set.

Selectable Default Programs

Description	Displayed as	'X Version Only
Reciprocating Pumps / Auto Refill	rECP	
Next Generation Continuous Infusion	Cont	✓
Gradient Inverse Linear Constant Rate	GrAd	✓

3. Reciprocating and Dual Modes

Reciprocating Mode		**Dual Mode**
Opposite Pumping Directions		Same Pumping Directions
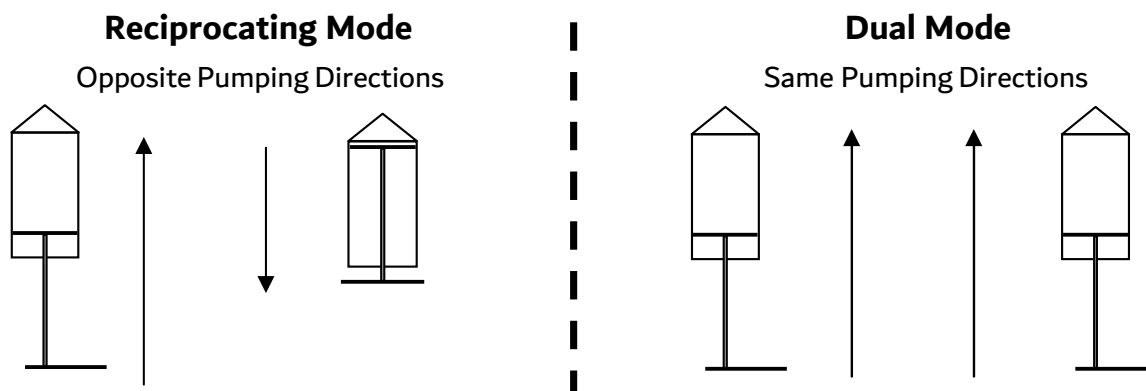
Syringes: If using different size syringes, ensure the pumping rates on the Master pump are within range of the Secondary pump.

 ➤ **NOTE:** If pumping rates are out of range for the Secondary pump, it will have no effect.

Master Pump: Pumping rate and direction are only transmitted to the Secondary pump if the Master is pumping. Changes made to the rate and direction of the Secondary pump will not be transmitted to the Master pump.

 ➤ **NOTE:** If the Master pump starts or stops, the Secondary will also start or stop.

Reciprocating Mode: Master pump Rate and opposite pumping direction.
Dual Mode: Master pump Rate and current pumping direction.

Pump Stall: If either pump stalls, then the other pump will also stop.

Synchronization between pumps: Due to communications delay, the secondary pump will operate ~30 milliseconds after the Master pump.

3.1 Reciprocating Pump Program

Below are examples of how to set up the pumps for reciprocating, continuous flow operation. The Pump 1 program is the default program that is loaded as indicated in the "Default Program Selection" section. Pump 1 is the Master pump which controls the Secondary pump's (Pump 2) operation. In Reciprocating mode, Pump 2 will pump continuously in the opposite direction of Pump 1, at the same rate as Pump 1, and will change direction when Pump 1 changes direction.
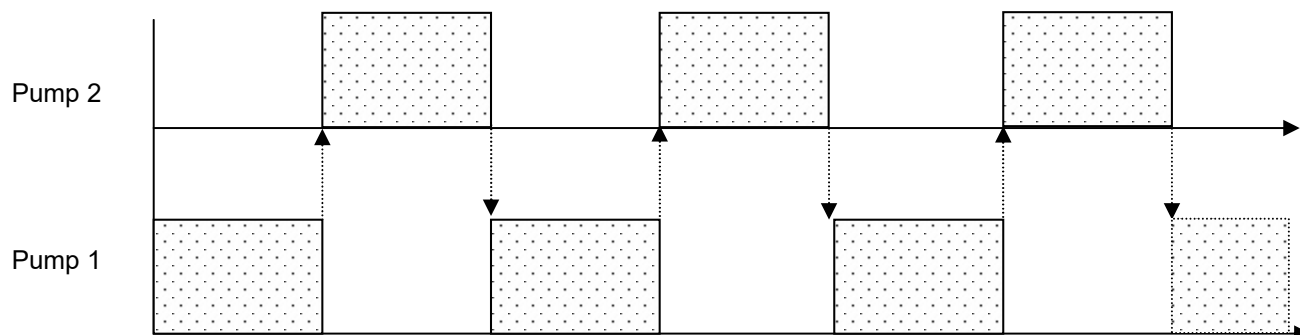
Pump 1 (Master Pump)

Phase	Function	Rate	Volume	Direction
1	RATE	500 mL/hr	10.0 mL	Infuse
2	FILL	0.0 mL/hr	-----------	------------
3	JP:01			

Pump 2 (Secondary Pump)

Phase	Function	Rate	Volume	Direction
1	RATE	500 mL/hr	0.0 mL (off)	Withdraw
2	STOP			

4. Alternating Pumps Mode

Creates a semi-automated continuous infusion system using pre-loaded syringes.

- The infusing pump will automatically start the alternate pump when the Pumping Program stops.
- A Pause Function at the beginning of the alternate pump's program will delay the start of the program.
- The empty syringe can be manually replaced during the infusion of the alternate pump.
- Set both pumps to Alternating communications mode ("ALtr") to create a continuous system.

4.1 X Version Firmware Only (Enhanced Features)

- **The Alternate pump starts after a Pause function or when the program stops.**

    Set the TTL setup setting: RUN.0 (Default setting)
    - Alternate pump will start on execution of Pause function.

    Set the TTL setup setting: RUN.1
    - Alternate pump will start when the Pumping Program has stopped.

- **Overlapping the start of an alternate pump:**

    Pumping Program Function: OUT.0
    - Immediately sends start to alternate pump when OUT.0 function is executed.

    - Allows the creation of an overlap between the infusing and the alternate pump to allow the alternate pump to prime the syringe before the infusing pump stops.

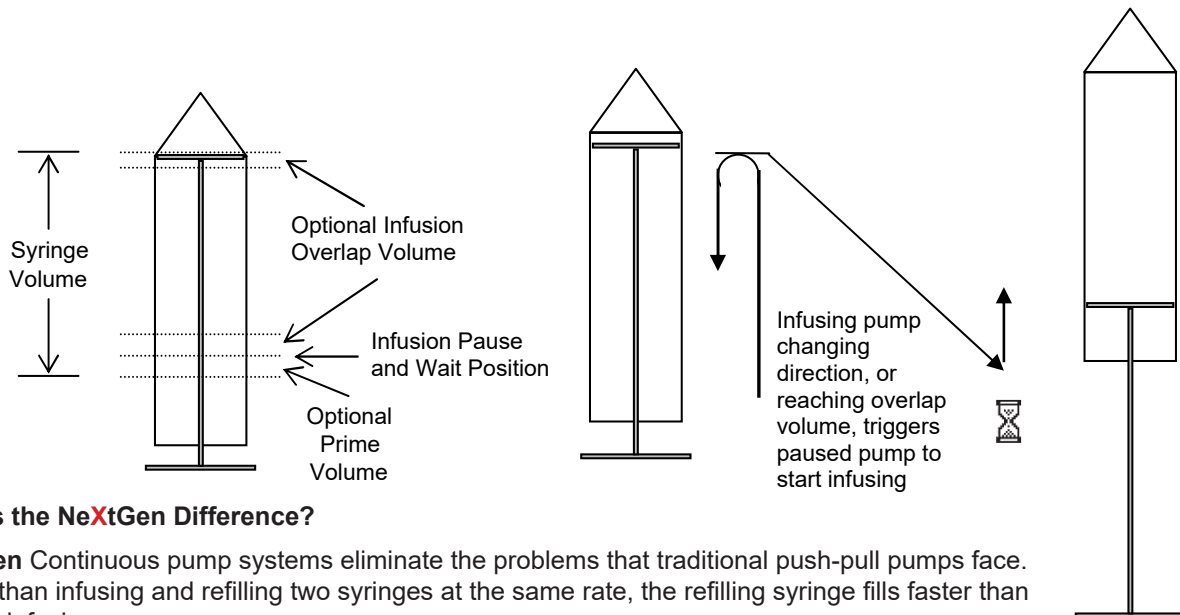   Simultaneously start both pumps:
    - If Phase 1 is set to function OUT.0, the alternate pump will immediately start when the Master pump starts.
    - This overrides sending a start command to the alternate pump when the pump stops.

- **Stopping Alternating Mode:**

    Set the TTL Trigger Mode to "Off":
    - When the trigger is set to "Off", a start command will not be sent to the alternate pump.

    - Within a Pumping Program, the trigger mode can be changed with the Trigger Off function: ("tr:of"). This allows a Pumping Program to limit the number of times that the alternate pump will execute it.

5. *"Next Generation"* Continuous Pumping Mode

Syringe Volume

Optional Infusion Overlap Volume

Infusion Pause and Wait Position

Optional Prime Volume

Infusing pump changing direction, or reaching overlap volume, triggers paused pump to start infusing

What is the NeXtGen Difference?

NeXtGen Continuous pump systems eliminate the problems that traditional push-pull pumps face. Rather than infusing and refilling two syringes at the same rate, the refilling syringe fills faster than the one infusing.

The **NeXtGen** system eliminates issues that typical push-pull pump systems have, which means there are *NO* flow rate drop-offs, *NO* pauses, and *NO* inconsistencies in flow rates. Additionally, the **NeXtGen** mode allows the refilled syringe to begin infusing before the infusing syringe is completely empty.

Requirements:

- 2 Pumps from the SyringeONE-X model of syringe pumps. (*Pumps can be different models*)
- 1 Dual pump cable, **Part #: CBL-DUAL-3**.

5.1 Set communications mode to Continuous Mode [Cont]

Master Pump only: In Setup, when the network address is displayed **[Ad:nn]**, press the left-most up-arrow key to select **[Cont]**.

➢ **NOTE: Do not** change the default settings on the **second pump** (Address 0 **[Ad:00]** and 19,200 baud rate **[1920]**). If unsure, reset the secondary pump by holding the left-most up-arrow key while turning on the power. The display will show: `rESt`

5.2 Pumping Parameters

Set the syringe diameter and pumping parameters on the Master pump. The syringe diameter and pumping parameters are transmitted to the second pump when the Master pump starts. Both syringes start empty, unless prefilled syringes are specified.

Pumping Parameters			
Phase #	**Function**	**Rate**	**Volume**
1	RATE	**Infusion**	Syringe Volume
2	RATE	**Refill**	Overlap ⟵Optional parameters
3	RATE	**Prime**	Prime ⟵Optional parameters
4	RATE	Prefilled Syringe Mode (Optional Parameter) 00 = Both empty (default) 11 = Both pre-filled 10 = Master only 01 = Secondary only

To create a Continuous Pumping Program, first set the Master pump syringe diameter (in mm) on the Master pump by pressing the diameter key and using the up-arrow keys, then:

Hold down the ⎡Diameter⎤ key until **[Ad:nn]** appears. Wait until one of the communication modes appears on the display, then press the up-arrow keys until **[Cont]** appears and wait 2 seconds.
The pump is now in Continuous Mode.

5.2.1 Setting Pumping Parameters

Phase 1: *Infusion*

a. Hold the ⎡Rate⎤ key until **[PH:01]** is on the display, then press ⎡Rate⎤ again and input your desired rate, then press it a third time to set the rate units with the up-arrow keys.

b. Hold the ⎡Volume⎤ key until **[rAtE]** is on the display, then press ⎡Volume⎤ again and use the up-arrow keys to set the desired infusion volume. Press the volume key a third time, then use the up-arrow keys to set the volume units.

Phase 2: *Refill/Overlap*

c. Follow the same instructions as Phase 1(a), except set the Phase number to 02 when **[PH:nn]** is on the display using the two right-most up-arrow keys.

d. In this phase, the Volume setting is used to set an overlap between the two pumps. *(If an overlap setting of 5 mL is set, the refilling pump will begin to infuse when the infusing pump has 5 mL left to infuse)*. To set an overlap, follow Phase 1 (b) and input the desired overlap volume and volume units.

> ➢ **NOTE:** When setting the refill rate, set it at a much higher than the initial infusion. This ensures that there is no gap in the program.

Phase 3: *Prime*

To set parameters that prime the syringes, follow the same instructions as Phase 1 (a) and (b). However for this phase, the rate should be slightly larger than Phase 1, but the **volume should be extremely low. Priming occurs immediately after Phase 2 is complete**.

Phase 4: *Prefilled Syringes*

If prefilled syringes are being used, first reach the **[PH:nn]** screen and set 'nn' to 04. Then, press the rate key once more, and instead of setting a rate, input one of these numbers based on the state of the syringes:

- 00 - Both of the syringes are empty (This is the default setting)
- 01 - Only the Secondary pump begins pre-filled
- 10 - Only the Master pump begins pre-filled
- 11 - Both of the syringes begin pre-filled

If any optional parameters are not used, turn them off by setting them to 0.000. Pumping parameter settings that are not set will default to the same as the Default Continuous Pumping Program.

5.2.2 Hardware Setup

Attach the cable, **CBL-DUAL-3**, to the "To Computer" connector on the back of both pumps.

5.2.3 Operational Sequence

1. Both syringes start empty. (*Set Phase 4, Prefilled Syringes, to use prefilled syringes*)
2. Start the Master pump: Both pumps will start filling. (*Unless prefilled syringes are set and specified*)
3. When syringes are filled:
   - The Master pump will begin infusing.
   - Second pump primes *(if enabled)*, then pauses.
4. When the infusing pump reaches the overlap position, if enabled, or changes pumping direction, the paused pump will start to infuse.
5. The sequence then repeats:
   - Refilling pump fills, primes, pauses and waits for the other pump.
   - Infusing pump infuses to the overlap position or syringe empty, and then signals the other pump to start infusing. When empty, changes direction and refills.

5.2.4 While Pumping

The pumping rate <u>can be changed</u>. The new pumping rate will be transmitted to the other pump, into the corresponding pumping sequence.

Pressing the $\boxed{\text{Start / Stop}}$ key on either pump, will pause the sequence on both pumps. Pressing $\boxed{\text{Start / Stop}}$ on the Master pump will resume the pumping sequence.

5.3 Power Failure Mode – Auto-Synchronization

After a power failure restart, or to start the infusion with partially filled syringes, limit switches can be attached to the pump at the syringe refill position. The limit switch wires should be attached between the Trigger Input (pin 2) and Ground (pin 9) on the pump's 9 pin TTL connector.

Next, enable Power Failure Mode in the Master pump's setup menu.

When the pumps start, they begin by filling the syringes until the syringe volume target is reached or the limit switch is triggered.

> ➢ **NOTE:** Power Failure Mode **overrides** pre-filled syringe mode settings.

5.4 Notes and Error Messages

- The refill rate needs to be fast enough so that the syringe is refilled and primed before the infusing pump has emptied.
- If the refilling pump is still pumping when the infusing pump empties, an error message will be displayed and the pumps will stop.
- If the second pump is not the same model as the Master pump and the flow rates are not compatible with the second pump, the Master pump will display an error message.

<u>General Setup Error Messages:</u>

[Er:02] At Phase 1, the infusion volume is set to 0. *(Input the desired Infusion Volume in Phase 1b)*

[Er:03] At Phase 2, there is invalid overlapping of the volume setting. *(Confirm the Volume Setting in Phase 2)*

[Er:10] Communications fault exists with secondary pump. (*Check cable and secondary pump setup)*

[Er:11] The Secondary pump is reporting invalid setup data. *(Reset both pumps and re-enter the Program)*

**[Er:41]** Invalid pumping parameters. *(Reset both pumps and re-enter the Program)*

[Er:99] The second pump does not have the required 'X' Version firmware.

5.5 The Default Continuous Pumping Program

To load the default program while turning on power to the Master pump, Press and hold the $\boxed{\text{Volume}}$ key until **[Cont]** is displayed. Press the "Volume" key again to enter the default program.

Default Continuous Mode Pumping Parameters			
Phase #	**Function**	**Rate**	**Volume**
1	RATE	**Infusion** 100.0 mL/hr	Syringe 10.00 mL
2	RATE	**Refill** 500.0 mL/hr	Overlap 0.000 mL
3	RATE	**Prime** 200.0 mL/hr	Prime 0.100 mL
4	RATE	Prefilled mode 0.000 mL/hr	(not used) 0.000 mL
Address Mode is set to Continuous: [Cont]			

6. Dual Pumps Inverse Gradient Pumping Mode

Pump 1 + Pump 2 = Constant Rate
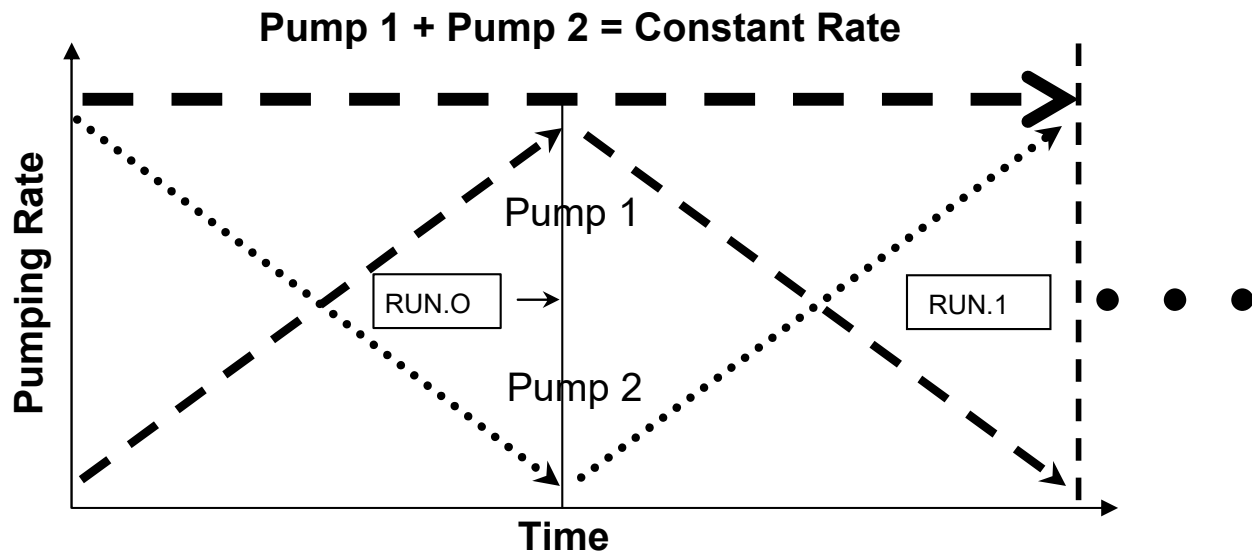
This mode maintains a constant total flow rate between 2 syringe pumps. A gradient (Linear function) dispensing function is programmed into the Master pump. The Secondary pump will be automatically programmed with the inverse of the Master pump's gradient function. The sum of the two pump's flow rates will be a constant, set volume. Both pumps will increase and decrease pumping rates in tandem.

2 Modes of Operation

- Single cycle: Single ramp up or ramp down, then stop.

Set TTL setup setting RUN.0

- Continuous cycle: Ramp up, then ramp down, and repeat continuously.

Set TTL setup setting RUN.1

Requirements:

1) 2 Pumps from the NE-1000 Syringe Pump Series with 'X firmware upgrades.

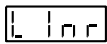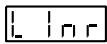2) **CBL-DUAL-3** dual pump communications cable.

6.1 Quick Setup

On the **Master pump only** – **DO NOT** change default settings on the second pump.

1) Attach the communications cable, **CBL-DUAL-3**, to the "To Computer" port on the back of both pumps.

2) Select the default Gradient Mode pumping program:
   - Turn on power to the pump WHILE holding down the ⎡Volume⎤ key.
   - Use any up-arrow key to select Gradient Mode, displayed as: ⎡6rAd⎤

   - Press the ⎡Volume⎤ key to save the setting, or wait two seconds for the display to blink.

3) **Only** set the syringe diameter on the Master pump. Both pumps will use the same diameter.
   (Default program assumes a minimum syringe diameter of 14.43 mm)

4) Press ⎡Start⎤ on the Master pump to start the dual pump Gradient pumping program.

6.2 Setup

1) Attach the dual pump cable, **CBL-DUAL-3**, to the "To Computer" port on both pumps.
2) Select Gradient communications mode:
   Hold down the ⬚Diameter⬚ key until **[Ad:nn]** appears. Wait until one of the communication modes appears on the display, then press the up-arrow keys until **[GrAd]** appears and wait 2 seconds. The pump is now in Gradient Mode.
3) Set the syringe diameter.
4) Enter a Linear function pumping program as a 2 Phase Pumping Program:

Phase	Function	Rate/Units	Time
n	⎿¦⊓�	Starting Flow Rate	Total Time: [Hours : Minutes]
n+1	⎿¦⊓⎤	Ending Flow Rate	Total Time: [Seconds : Tenth Seconds]

5) Change RUN.0 (default value), if needed to change from single cycle mode.

   ➢ **NOTE:** The secondary pump is set to the default communications settings of Address 0 and 19,200 baud rate.

6.3 Operation

When the Master pump is started, the Linear function will be expanded to a 3 or 5 Phase Pumping program *(dependent on mode, which represents the forward and inverse of the linear function, then repeat)*. The second pump will then be programmed with the syringe diameter and the inverse of the linear pumping program. The Second pump will start pumping when the Master pump starts pumping.

With the starting and ending pumping rates reversed on the secondary pump, the sum of the flow rates of the two pumps will always be the same.

➢ **NOTE:** The linear function updates the pumping rate every 100 ms, resulting in a synchronization error of up to 100 ms between the two pumps. This will cause a slight difference in the total volumes dispensed between the two pumps.

6.4 Default Gradient Pumping Program

To load the default program, hold the ⬚Volume⬚ key while turning on power to the Master Pump. Once **[Cont]** is on the display, press any up-arrow key until **[GrAd]** appears. Press the ⬚Volume⬚ key once more to enter the default program.

Default Gradient Mode Pumping Parameters					
Phase #	Function	Rate		Time	
1	Linr (Linear)	Starting Rate	0.000 mL/hr	00 : 01	Hours : Minutes
2	Linr (Linear)	Ending Rate	500.0 mL/hr	00 : 00	Seconds : 1/10 Seconds
3	Stop				
- *RS-232 Communications Address Mode set to Gradient:* - **[GrAd]** *Assumes a syringe diameter of at least 14.43 mm.* - *RUN.0 set for single cycle Gradient.*					