


DUAL PUMPS COMMUNICATIONS CABLE

<u>Part #</u>	<u>Description</u>	<u>Contents</u>
CBL-DUAL-3	RS-232 Dual pumps communications cable (3 ½’).	

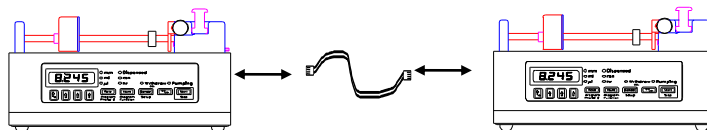
Synchronizes the operation of two pumps in one of the special communications modes.

Figure 1: Dual Pumps Cable CBL-DUAL-3

Dual Pumps Cable Attachment Instructions

NE-1000 / NE-1000X Series of Syringe Pumps

- 1) Turn off 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 "To Computer")

Secondary Pump (connect to "To Computer")

Detailed Setup Instructions

To select the Master pump control mode, enter Setup on the Master pump by pressing and holding the "Setup" key (“Diameter” key), until setup is entered. The pump will scroll through the setup parameters. 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.

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 / Continuous Infusion	rECP		Continuous infusion / auto-refill
Alternating Pump Control	ALtr	Extra Features	Second pump starts when first pump stops.
Next Generation Continuous Infusion	COnt	✓	Continuous infusion while minimizing flow rate pauses and drop outs when changing directions
Constant Flow Rate Gradient	GrAd	✓	Dual pumps inverse linear functions combine for a constant flow rate

All modes (except Address) are set to 19,200 baud rate. In Address mode, the next setting is the baud rate setting.

Except for Alternating Pumps mode, the secondary pump should remain in Address mode [Ad:00] and 19,200 baud rate [1920] setting, which are the factory defaults. With Alternating Pumps mode, the secondary pump can also be set to Alternating Pumps mode.

Default Program Selection

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

Basic Pump Setup: Select Default Dual Pumps Program

On the Master Pump ONLY: Turn power off.

Press and hold the “Program Function” key (Volume key).

Turn power on, and then release the “Program Function” key.

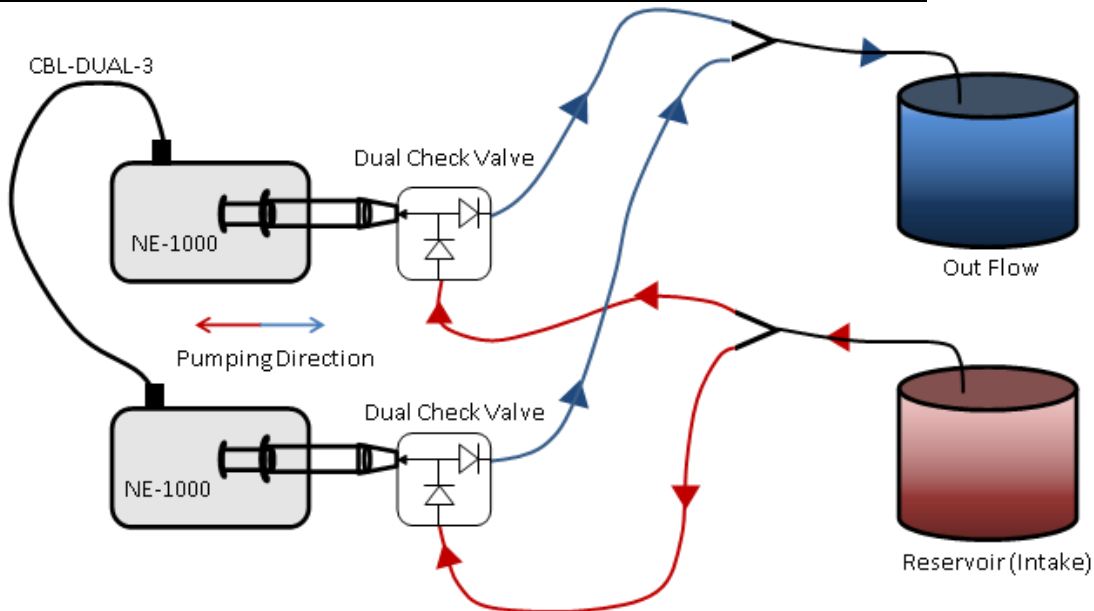
Press any up-arrow key to select a default program.

Default program will be loaded and the communications mode will be set.

Selectable Default Programs

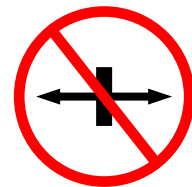
Description	Displayed as	'X Version Only
Reciprocating Pumps / Auto Refill	rECP	
Next Generation Continuous Infusion	COnt	✓
Gradient Inverse Linear Constant Rate	GrAd	✓

Plumbing for a Continuous Infusion System (P-DKIT)



Major Parts of the System

Quantity	P-DKIT	Description
2		NE-1000 Series Syringe Pump
1		CBL-DUAL-3 control cable
2	✓	Syringes (60 mL)
2	✓	Dual Check Valve
2	✓	Y Connector
6	✓	Sections of Tubing

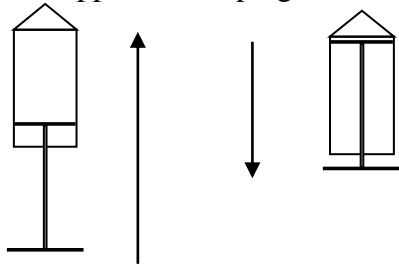


Visit www.SyringePump.com to download the complete CBL-DUAL-3 user manual with expanded details of the special communications modes.

Reciprocating and Dual Modes

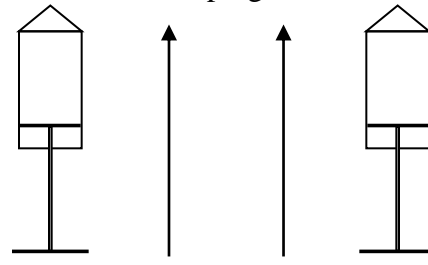
Reciprocating Mode

Opposite Pumping Directions



Dual Mode

Same Pumping Directions



Syringes: Each pump can have a different size syringe, but make sure that the pumping rates on the Master pump are within range of the syringe used on the Secondary pump. If an out-of-range pumping rate is sent to the Secondary pump, the rate will just be ignored by the Secondary pump without affecting the operation of the Master pump.

Master Pump: Pumping rate and direction are only transmitted to the Secondary pump from the Master pump while the Master pump is pumping. If the Master pump starts or stops, the Secondary pump will start or stop. Linear Function pumping rates will not be transmitted.

Secondary Pump Controlled as Follows:

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

Secondary Pump: Changes to the pumping rate and direction on the secondary pump will not be transmitted to the Master pump. If the Secondary pump stops, the Master pump **will** also stop.

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

Synchronization between pumps: The secondary pump will lag approximately 30 milliseconds behind the Master pump due to communications delay.

Reciprocating Pump Program

Below are examples of how to setup 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 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.

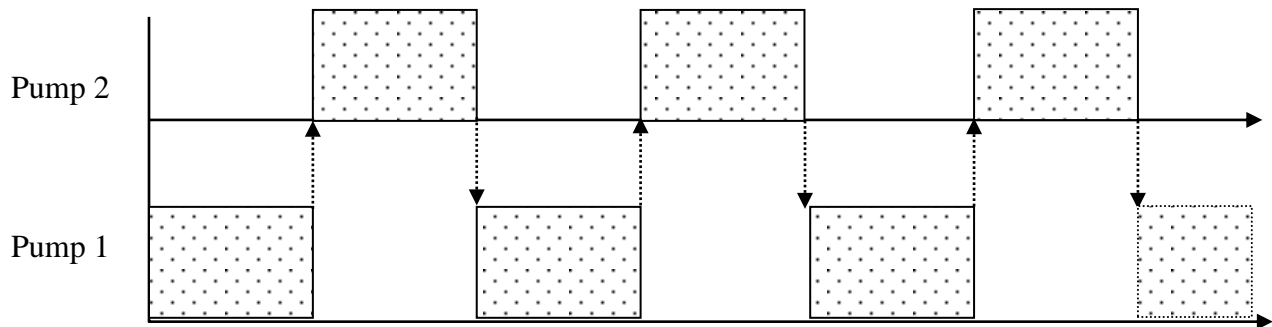
Pump 1 (Master Pump)

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			

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 pumping.

The empty syringe can then be manually replaced during the infusion of the alternate pump.

Set both pumps to Alternating communications mode ("ALtr") to create a continuous system.

'X Version Firmware Only (Enhanced Features)

- **Starts alternate pump after either a Pause function or when the program stops.**

Set the TTL setup setting: RUN.0, (Default setting)

Alternate pump will start on execution of a timed Pause function.

Set the TTL setup setting: RUN.1

Alternate pump will not start on execution of a timed Pause function.

- **Overlap start of 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.

Overrides sending a start command to the alternate pump when the pump stops.

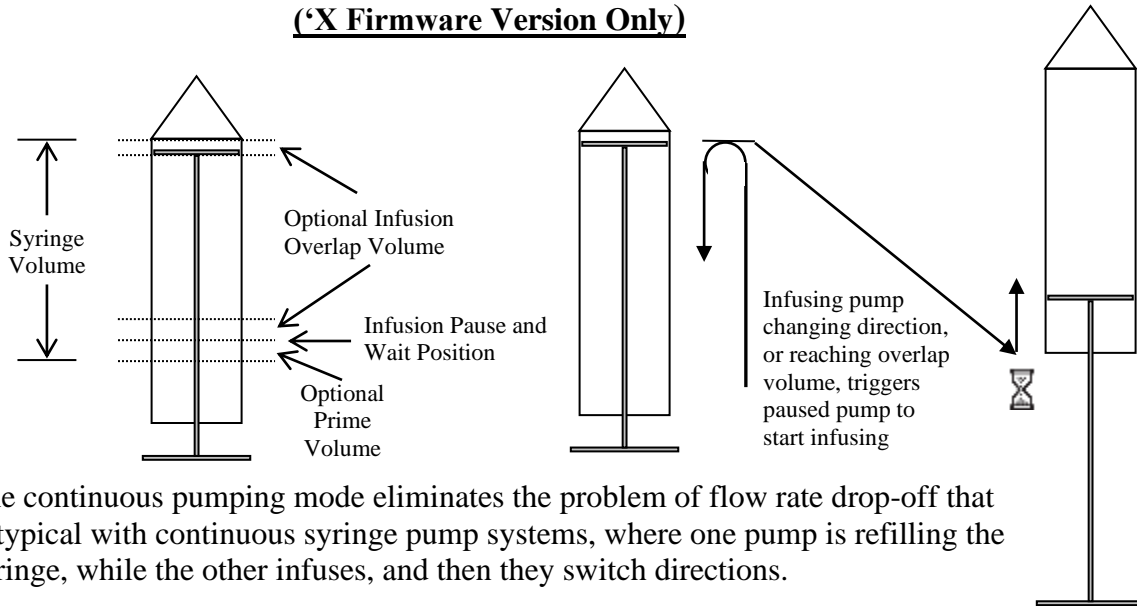
- **Stop Alternating Mode**

Set TTL Trigger Mode to "Off". When trigger is set to "Off", start command will not be sent to 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 its Pumping Program.

”Next Generation” Continuous Pumping Mode

(‘X Firmware Version Only)



The continuous pumping mode eliminates the problem of flow rate drop-off that is typical with continuous syringe pump systems, where one pump is refilling the syringe, while the other infuses, and then they switch directions.

In this system, the refilling pump refills at a faster rate than the infusing pump, giving it time to prime the syringe, then it pauses and waits for the infusing pump to empty.

Then, when the pumps switch directions, the refilled pump is primed and starts infusing at the set rate immediately. Additionally, an overlap can be set, whereby the refilled syringe begins infusing before the infusing pump is completely empty.

Requirements

- 2 Pumps from the NE-1000X series of syringe pumps. Pumps can be different models.
- 1 Dual pump cable, part #CBL-DUAL-3.

Set communications mode to Continuous Mode [Cont]

On the Master Pump only: In setup, when the network address is displayed [Ad:00], or other address mode, 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: While turning on power, hold the left-most up arrow button. The display will show [rESt].

Set Pumping Parameters on the Master Pump

Set 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 pre-filled 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	<u>Pre-filled Syringe Mode (Optional Parameter)</u> 00 = Both empty (default) 11 = Both pre-filled 10 = Master only 01 = Secondary only	

Set any optional parameter to 0.000 (off) if not used, or set the function to STOP. Pumping rates not set will default to the Infusion Pumping Rate.

Hardware Setup

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

Operational Sequence

- Both syringes start empty. Set Phase 4, pre-filled mode, to use pre-filled syringes.
- Start the Master pump: Both pumps start filling, unless pre-filled syringes are specified.
- When syringes are filled:
 - Master pump starts infusing
 - Second pump primes (if enabled), then pauses
- When the infusing pump reaches the overlap position, if enabled, or changes pumping direction, the paused pump will start to infuse
- Sequence repeats:
 - Refilling pump fills, primes, pausing 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 starts refilling

While Pumping

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

Pressing the Stop key on either pump, will Pause the sequence on both pumps. Pressing the Start key, on the Master pump, will continue the pumping sequence.

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 refill position of the syringes. Attach the limit switch wires between the Trigger Input (pin 2) and Ground (pin 9) on the pump’s 9 pin TTL connector.

Then enable Power Failure Mode in the Master pump’s setup menu.

When the pumps start, they will begin by filling the syringes until either the syringe volume target is reached or the limit switch is triggered. Power Failure Mode overrides pre-filled syringe mode settings.

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.

General Setup Error Messages:

[Er:02] Phase 1, syringe volume, is 0.

[Er:03] Phase 2, invalid overlapping volume setting.

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

[Er:11] Secondary pump reporting invalid setup data.

[Er:41] Error message indicates invalid pumping parameters.

[Er:99] Second pump is not an 'X version firmware.

Default Continuous Pumping Program

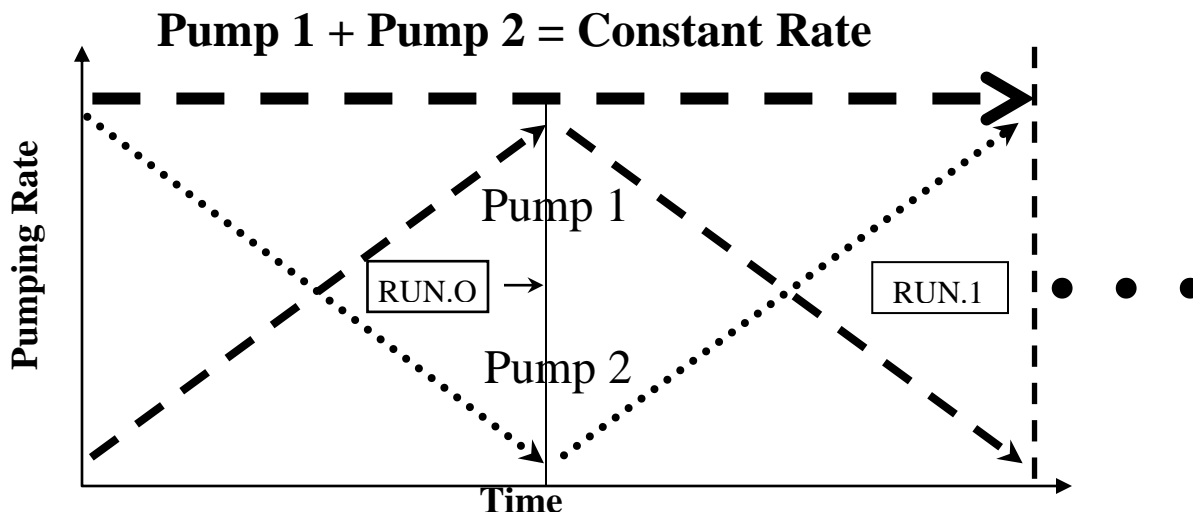
To load the default program: On the Master pump, while turning on power:

Press and hold the “Volume”/”Program Function” key until [Cont] is displayed. Press the “Volume” button again to enter the selection.

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 set to Continuous: [Cont]					

Dual Pumps Inverse Gradient Pumping Mode

'X Firmware Version Only



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. 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

Requirement:

- 1) 2 Pumps from the NE-1000 syringe pump series with 'X firmware upgrades.
- 2) CBL-DUAL-3 dual pump communications cable.

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 pressing the "Volume / Program Function" key.
 - Use any up-arrow key to select Gradient Mode, displayed as: G r A d
 - Press the Volume key to select, or wait for the time out.
- 3) Set the syringe diameter on the Master pump. Both pumps will use the same diameter. (Default program assumes at least a 14.43 mm diameter).
- 4) Press Start on the Master pump to start the dual pump Gradient pumping program.

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

- 1) Attach the dual pump cable, CBL-DUAL-3, to the “To Computer” port on both pumps.
 - 2) Select Gradient communications mode:
 From the Setup menu (Press and hold “Diameter / Setup” key), select Gradient communications Mode (displayed as Grad). When Ad:00 (or other communications mode) is displayed, use the left-most arrow key to select.
 - 3) Set the syringe diameter.
 - 4) Enter a Linear function pumping program as a 2 Phase Pumping Program:
 Phase 1: Linear function starting rate, and [hours:minutes] portion of pumping time.
 Phase 2: Linear function ending rate, and [seconds:tenths] portion of pumping time.
 - 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.

Operation

When the Master pump is started, the Linear function will be expanded to a 3 or 5 Phase Pumping program, depending on mode, representing 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 be virtually constant.

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.

Default Gradient Pumping Program

To load the default program: On the Master pump, while turning on power, press and hold the “Volume”/“Program Function” key until [Cont] is displayed, then use any up arrow key until [GrAd] is displayed. Press the “Volume” key again to enter the selection.

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.					