dLSP 501X
Operating Manual

LONGER

dLSP 501X Digital Split-type Syringe Pump

2024.8

Baoding Longer Precision Pump Co.,Ltd.

A **Halma** company

Contents

Statement

- The contents of this manual and the specifications of the pump are subject to change without notice.
- Depending on the pump model and software version you are using, the screenshots or function descriptions in this manual may be different, please refer to the functions of the current software version.
- Before using the pump, please review all relevant documentation concerning safety guidance and proper operation.

1.Precaution

Please read the following safety precautions to ensure proper use of the pump. If the pump is used in an unspecified manner, the protection provided by the pump may be damaged.

(1) Please use a power supply that meets the requirements, voltage: 24VDC

(2) Please use the power cord specified for the pump and ensure the power cord is certified.

(3) Before using the pump, ensure that the ground wire of the power cord is reliably grounded to ensure personal safety.

(4) Fluid may spray from the syringe. Take reasonable practicable measures to ensure the operators' safety.

(5) When liquid overflow into the pump drive occurs, immediately turn off power to the device before cleaning.

(6) Do not disassemble, modify or repair the product by yourself. Contact the distributor or Longer Pump if the product needs repair.

(7) If it is transported in an environment below 0 degrees, please place the device at room temperature (not lower than 0 degrees) before starting.
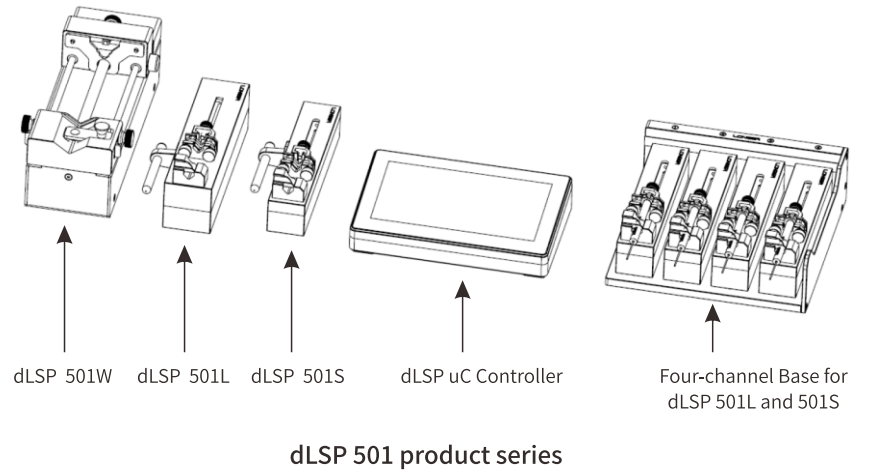
2.Product Introduction

dLSP 501X series are high-precision digital lab syringe pumps. There are three pump drive models: dLSP 501S, dLSP 501L, dLSP 501W, working with different syringe sizes. The pump drive can be controlled via the separate dLSP uC controller, which can control up to 4 drives through a 7-inch touch screen.
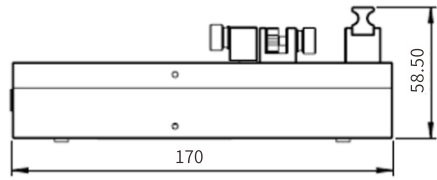
2.1 Technical Specification

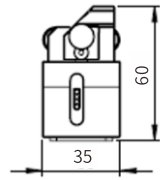| Product model	Drive unit	dLSP 501S	dLSP 501L	dLSP 501W
	Controller	dLSP uC		
Control mode	Touch screen controller	Control 1-4 separated drive units with preset parameters through touch screen controller		
	Computer	Dedicated PC control software can control 10 drive units independently		
	PLC/ other controller	RS485 interface, Modbus RTU, can control 40 drive units independently		
Display		7 inch HD LCD		
Work mode		Infusion only, withdrawal only, infusion/withdrawal, withdrawal/infusion, programming (on PC software)		
Stroke of the drive unit		70mm		95mm
Pusher advance per microstep		0.095um/ustep	0.099um/ustep	0.098um/ustep
Linear speed		0.6096um/min - 182.88mm/min	0.635um/min - 190.5mm/min	0.625 um/min - 143.75mm/min
Linear speed resolution		0.6096um/min	0.635um/min	0.625um/min
Linear travel accuracy		≤±0.35% (when travel≥30% of the stroke)		
Linear travel CV		0.03% (rated travel)		
Linear force (Max.)		15N (can be set 20%-100%)	30N(can be set 20%-100%)	100N (can be set 20%-100%)
Syringe (built-in manufacturer, or user-defined)		0.5uL-250uL	0.5uL-1000uL	5uL-60mL
Flow rate calibrate		Calibrate the user-defined syringe for better flow rate /dispensing volume accuracy and precision		
Parameter method		Up to 100 parameter methods can be stored on the controller, and can be imported/exported to USB flash drive		
Programming function		Parameter configured based on workflow on PC. PC method editor: infusion, withdrawal, delay, repeat. PC control software: constant flow rate, ramp up/down, delay, repeat.		
Screen lock		Prevent misoperation		
User access control		Three levels of user access (administrator, developer, operator), each user can have an exclusive password		
Log record		Record the pump operation history, and can be exported to a USB flash drive		
Electronic signature		There are electronic signatures on the log record for FDA 21CFR Part11 compliance		
Pump state when powered up		The default state is stop, can be set to continue to run through communication commands		
Fast forward/backward		Infuse or withdraw liquid at full speed		
Controller dimensions (L X W X H)		187mm*123mm*39mm		
Controller weight		0.6kg		
Power supply for controller		AC 90V-260V/30W		
Drive unit dimensions (L X W X H)		170mm*35mm*58mm	180mm*45mm*74mm	235mm*103mm*91mm
Drive unit weight		0.31kg	0.51kg	1.65kg
Power supply for drive unit		DC 24V/2W	DC 24V/3.6W	DC 24V/7.5W

Syringe (uL)	Syringe ID (mm)	dLSP 501S	dLSP 501L	dLSP 501W
0.5uL	0.10	0.0048nL/min-1.435uL/min	0.0050nL/min-1.495uL/min	
1uL	0.15	0.0108nL/min-3.230uL/min	0.0112nL/min-3.365uL/min	
2uL	0.20	0.0191nL/min-5.742uL/min	0.0199nL/min-5.982uL/min	
5uL	0.35	0.0586nL/min-17.59uL/min	0.0611nL/min-18.32uL/min	0.0601nL/min-13.82uL/min
10uL	0.50	0.1196nL/min-35.89uL/min	0.1246nL/min-37.39uL/min	0.1227nL/min-28.21uL/min
25uL	0.80	0.3063nL/min-91.88uL/min	0.3190nL/min-95.71uL/min	0.3140nL/min-72.22uL/min
50uL	1.10	0.5790nL/min-173.7uL/min	0.6032nL/min-180.9uL/min	0.5937nL/min-136.5uL/min
100uL	1.46	1.020nL/min-306.0uL/min	1.063nL/min-318.8uL/min	1.046nL/min-240.5uL/min
250uL	2.30	2.531nL/min-759.4uL/min	2.637nL/min-791.1uL/min	2.595nL/min-596.9uL/min
500uL	3.25	-	5.265nL/min-1580uL/min	5.182nL/min-1192uL/min
1000uL	4.61	-	10.594nL/min-3178uL/min	10.43nL/min-2398uL/min
2mL	9.00			39.74nL/min-9.140mL/min
5mL	13.10			84.20nL/min-19.37mL/min
10mL	16.60			135.2nL/min-31.10mL/min
20mL	19.00			177.1nL/min-40.74mL/min
30mL	23.00			259.5nL/min-59.69mL/min
60mL	29.14			416.6nL/min-95.82mL/min

2.2 Dimensions

dLSP 501W   dLSP 501L   dLSP 501S   dLSP uC Controller   Four-channel Base for dLSP 501L and 501S

dLSP 501 product series
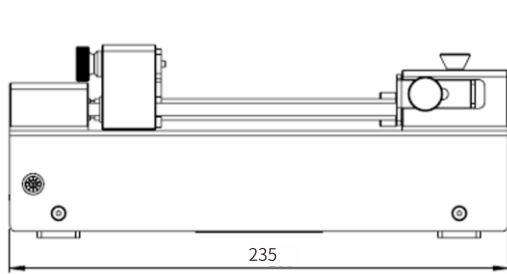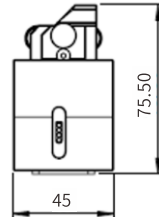
dLSP 501S
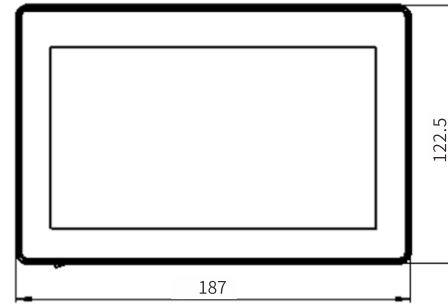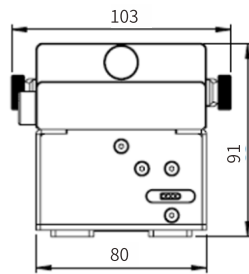
dLSP 501L

dLSP 501W

dLSP uC Controller
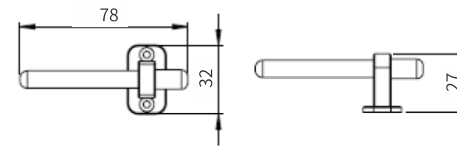
Mounting Hook for dLSP 501S and dLSP 501L
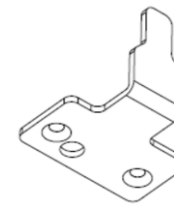
Cable Retainer for
dLSP 501S and dLSP 501L

Cable Retainer for
dLSP 501W

59.50

189

194
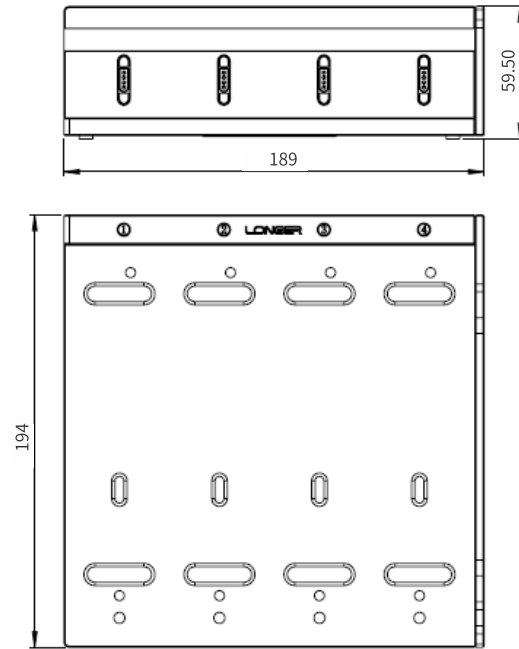
Four-channel Base for dLSP 501S and dLSP 501L

3. Operating Instruction

3.1 Syringe Loading

dLSP 501S、dLSP 501L：

Lock Knob 1

Pusher Block

Back Bracket of Barrel Flange Holder

Barrel Flange Clamp

Lock Knob 2 and 3

Syringe Barrel Clamp

Plunger Flange

Barrel Flange
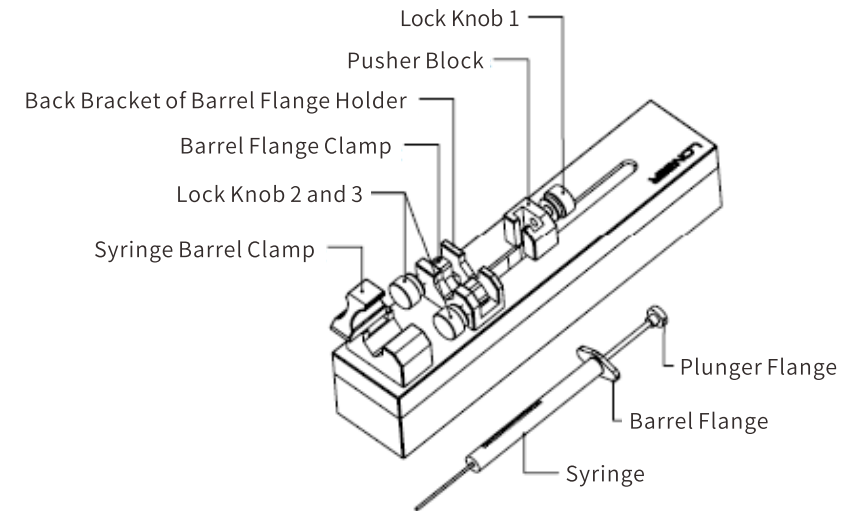
Syringe

Syringe loading process：

1. Release the lock knobs 1, 2 and 3
2. Raise the springe loaded syringe barrel clamp and rotate 90° away from the syringe holder.
3. Use the "Fast Forward" or "Fast Backward" of the controller to position the pusher block, ensuring while placing the syringe plunger flange into the pusher block, the barrel flange can be fit into the barrel flanger holder.
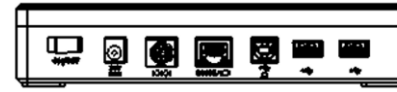4. Place the syringe on the syringe holder, make sure the plunger flange is positioned within the pusher block, and the barrel flange is positioned into the space between the barrel flange clamp and the back bracket of the barrel flange holder.
5. Tighten the lock knob 2 and 3, ensuring the barrel flange contact both with the barrel flange clamp and the back bracket of the barrel flange holder.

6. Raise and rotate the syringe barrel clamp onto the syringe barrel gently to avoid syringe damage.

7. Tap the "Fast Backward" of the controller, ensuring the plunger flange contact with the pusher block. Then tighten the lock knob 1.

Note: Tighten all three lock knobs gently until the contact surfaces have adequate clamping force. Do not overtighten, as this will make disassembly difficult.

dLSP 501W:

Lock Knob 1 — Pusher Block
Plunger Flange Clamp
Barrel Flange Clamp — Half Nut Button
Handle
Lock Knob 2 and 3
Syringe Barrel Clamp
Pusher Block Assembly
Limit block
Plunger Flange
Barrel Flange
Syringe Holder
Syringe
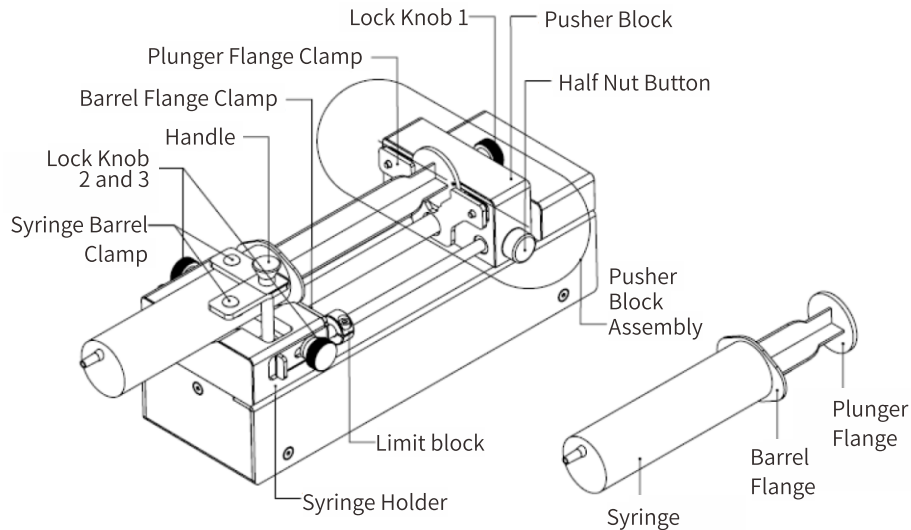
Syringe loading process:

1. Press the half nut button, or use the "Fast Forward"/"Fast Backward" of the controller, to move the pusher block to the appropriate position, ensuring the syringe plunger flange and barrel flange can be both retained by their respective flange clamps at the same time.

2. Release the lock knobs 1, 2 and 3 to release the flange clamps.

3. Raise the springe loaded syringe barrel clamp and rotate 90° away from the syringe holder.

4. Place the syringe on the syringe holder. Position the plunger flange into the space between the plunger flange clamp and the pusher block, and position the barrel flange into the space between the barrel flange clamp and the syringe holder. Tighten the lock knobs 2 and 3 to retain the barrel flange firmly. Raise and rotate the syringe barrel clamp onto the syringe barrel gently. Press the half nut button to move the pusher block to contact the plunger flange. Tighten the lock knob 1 to retain the plunger flange firmly. Tap the "Fast Forward"/"Fast Backward" of the controller to move the pusher block and ensure it meshes well with the lead screw.

Note:

- When using the half nut button to move the pusher block manually, the pusher block may not mesh with the lead screw very well after releasing the button. Continue to move the pusher block back and forth with a very short distance to ensure the button can fully pop out.

- The limit block is used to prevent damage to the syringe caused by the overstroke of the pusher block. Release the screw of the limit block, then it can move freely along the guide rod. Tighten the screw to place the limit screw to a proper position. Then the pusher block can not move forward any more when it contact the limit block.

3.2 Mounting and Wiring Instruction

dLSP uC controller :

F1
F2
F3
F4   F5   F6   F7
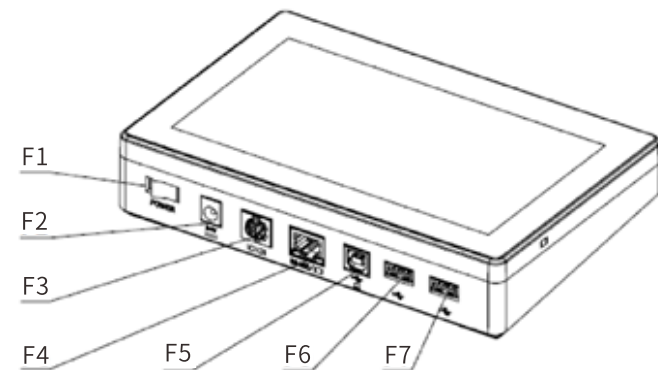
F1: Power switch
F2: DC24V power input
F3: S port to connect the pump drive
F4: RJ45 port: reserved
F5: USB_B: communication port to host controller
F6 and F7: USB_A, for software/ firmware upgrade and data export

Pump Drive:

dLSP 501S、dLSP 501L Magnetic Terminal

dLSP 501W Magnetic Terminal
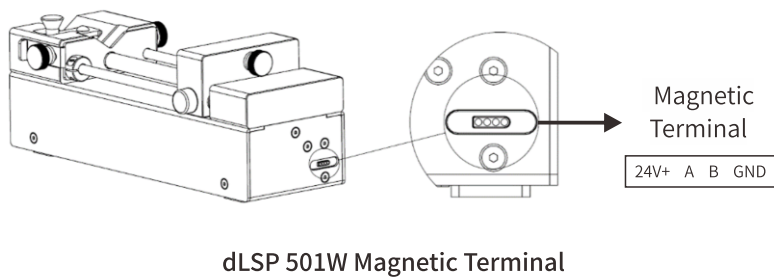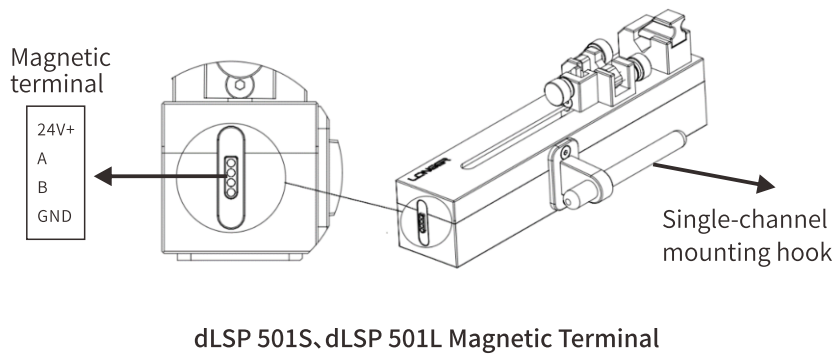
dLSP 501S and dLSP 501L magnetic terminal pins definition: from top to bottom, 24V+, 458_A, 485_B, GND
dLSP 501W magnetic terminal pins definition: from left to right, 24V+, 458_A, 485_B, GND

The single-channel mounting hook can also be mounted in rear-direction as below:

Single-channel hook mounting position
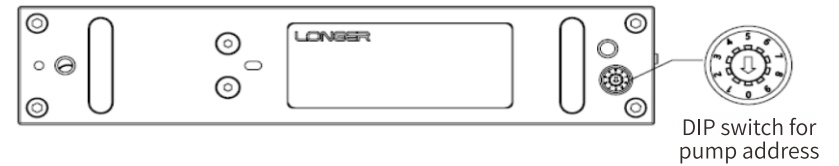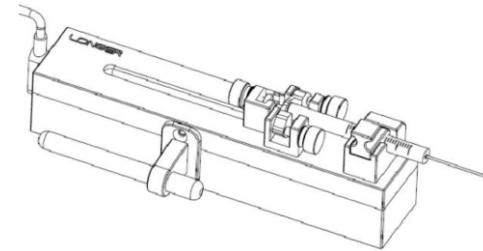
dLSP 501S, dLSP 501L DIP switch for pump address
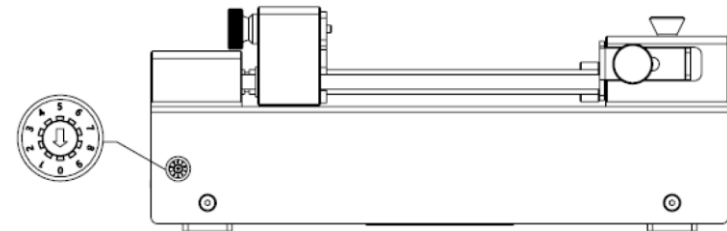
dLSP 501W DIP switch for pump address

The physical address DIP switch can be set from 0-9 corresponding to 10 physical addresses. DIP switch set 0 represents pump address 1, and DIP switch set 9 represents pump address 10.

Wiring instructions for single pump drive to dLSP uC controller:

- Connect the pump drive to the controller via a magnetic cable. The cable can be fixed onto the pump drive by a cable retainer accessory.
- Plug the DC24V power adapter to the controller, then power on.
- Turn on the power switch of the controller.

The magnetic connector also can used to connect the four-channel base with the controller

Connect to the S port of the controller

S1 S2 S3

S5
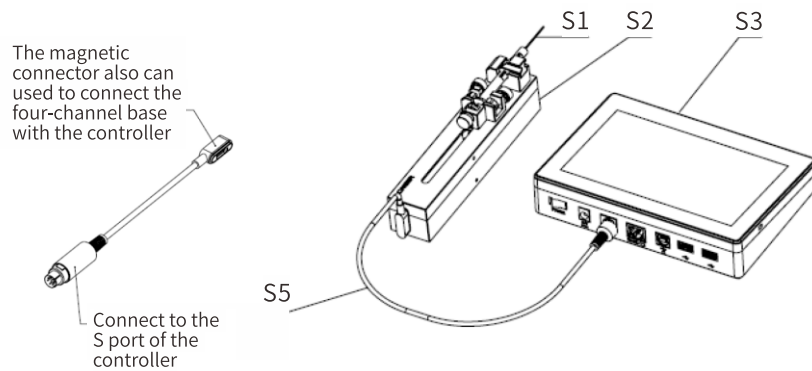
Single Pump Drive Wiring

S1：Syringe
S2：Pump Drive
S3：Controller
S5：Magnetic cable

2 screws M3x5 to mount the cable retainer   dLSP 501S   dLSP 501L   Cable Retainer

2 screws M3x8 to mount the cable retainer

Cable Retainer

2 screws M3x5 to mount the cable retainer
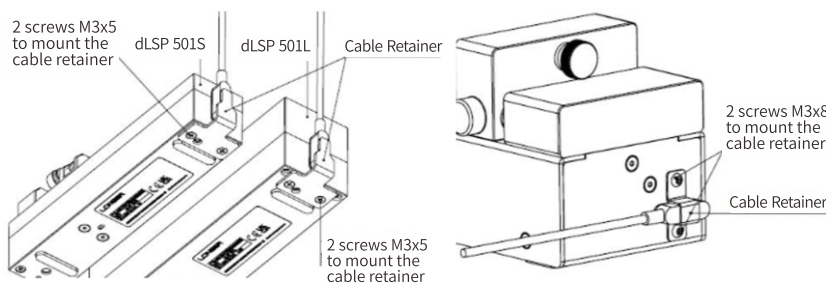
Cable Retainer Mounting

12

Wiring instructions for the pump to PC or other controllers:

Use the USB cable or RS485 cable to connect the pump drive to the PC or other controllers. The power supply for the pump is DC24V 7.5W

RS485 Cable:

Red White Green Black
24V+ A B GND

Magnetic connector to pump drive
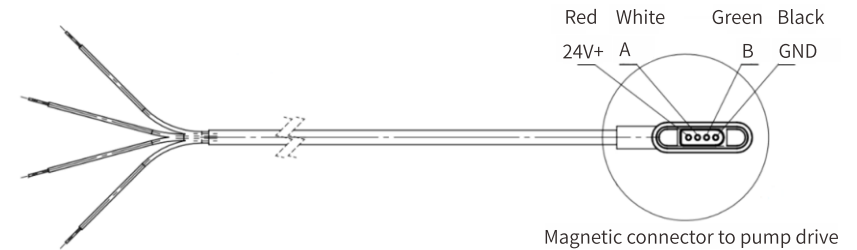
USB Cable (1 to 10 channels):

Magnetic connector to pump drive

USB-A Interface (Rs485 serial communication)

5.5-2.1 Interface (DC24V)

13
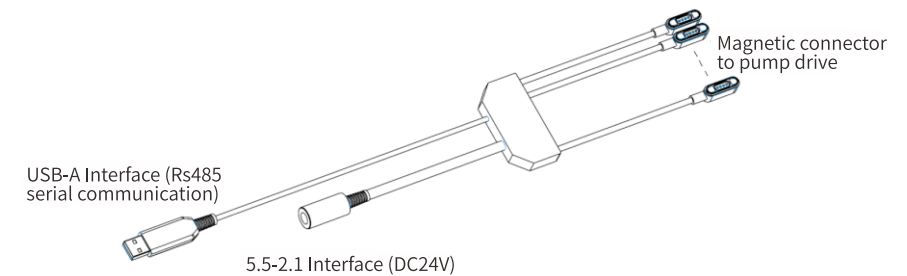
Wiring instruction for the four-channel base:

- Place the pump drive unit onto the four-channel base, ensuring the magnetic terminal of drive contact well with the magnetic terminal of the four-channel base.
- Fix the pump drive to the base with 2 fixing screws.
- Connect the four-channel base with the controller via a magnetic cable.
- Plug the DC24V power adapter to the controller, then power on.
- Turn on the power switch of the controller.

The magnetic connector also can used to connect the four-channel base with the controller

Magnetic terminal

Connect to the S port of the controller

Fixing screws

Fixing screws

Syringe

Pump drive unit
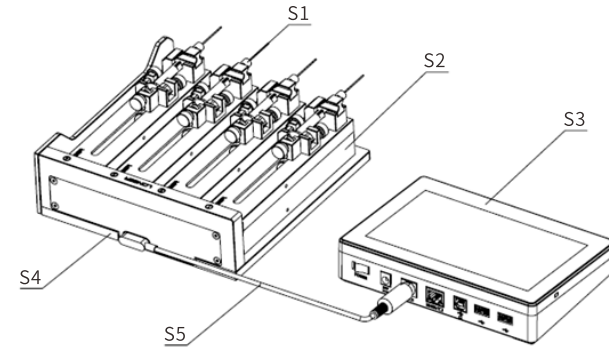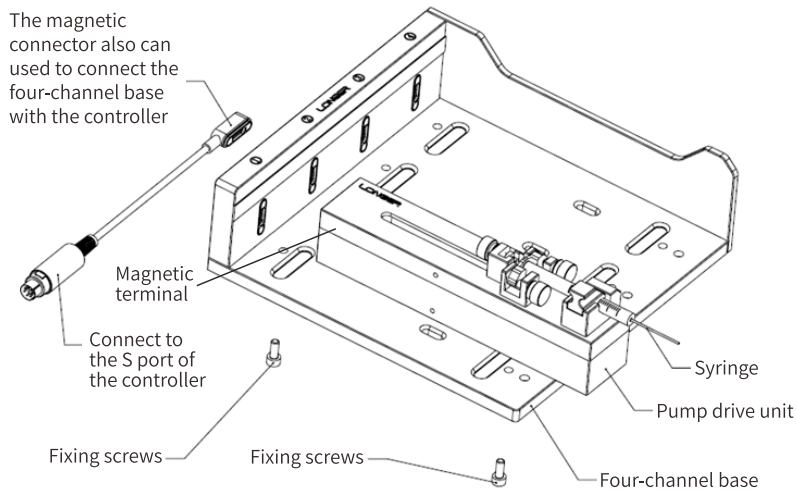
Four-channel base

Four-channel Base Wiring

S1：Syringe
S2：Syringe pump drive (dLSP 501S or 501L)
S3：dLSP uC controller
S4：Four-channel base
S5: Magnetic cable

Note: The four-channel base is optional accessory, suitable for dLSP 501S and dLSP 501L pump drive, and can be connected to 1-4 pump drives. If you want to control 2 to 4 dLSP 501W with a single controller, you can use a multi-channel cable.

3.3 Pump Running Status Description

dLSP 501S and dLSP 501L can indicate the pump running status by indicator light.
Blue: Standby, running interval status
Green: Running (including the pause status during Running)
Red: Fault status, indicating motor stall or hardware failure

3.4 Controller Operation

3.4.1 Login

After powering up the controller, it enters the Login screen.
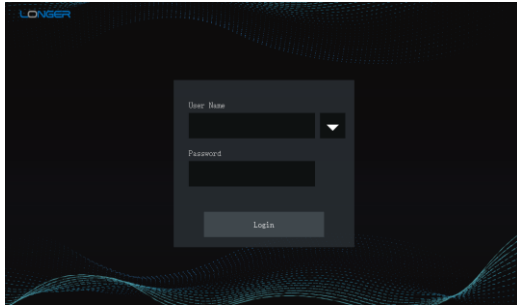
Default user name : admin
Initial password: 123456

3.4.2 Running Screen

After login, the running screen will be displayed. When another screen is displayed, tap [Home] to enter the running screen. There will be no active recipe when enter the running screen for the first time.
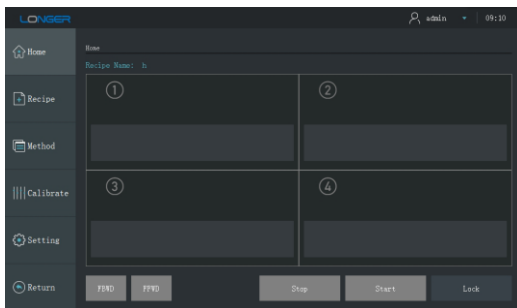
Refer to Chapter 3.4.3 or 3.4.4 to activate one recipe or method. Then the running screen will display the activated recipe or method.

16
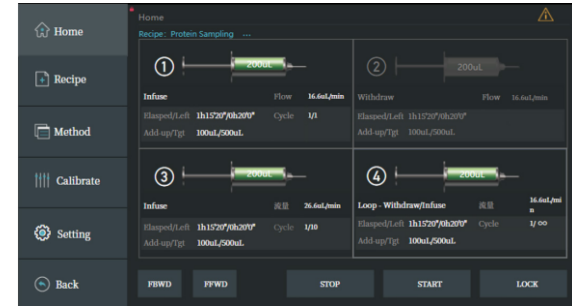
Running Screen (Standby Status)

Description of the status:

The current active recipe is named "h", and the parameters or method description of the current recipe can be reviewed by tapping the recipe/method name

In above screen example:

Channels ① and ③ are connected to the controller and enabled in the current active recipe.

Channel ② is not connected to the controller

Channel ④ is connected to the controller but not enabled in the current active recipe.

The enable channel in the recipe is displayed with white icons, and the disabled or off-line(not connected) channel is displayed with gray icons

17
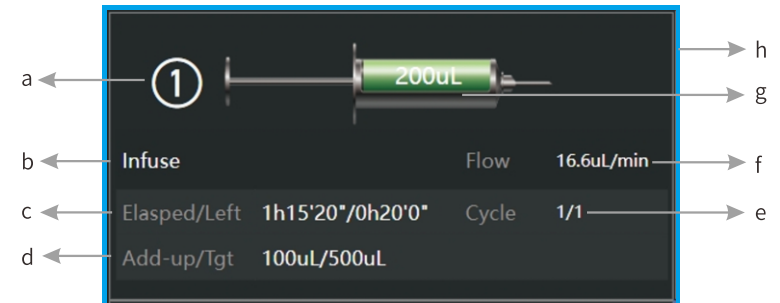
Description of each channel status:

a: the physical address of the channel (pump drive): 1 to 4 address corresponding to the DIP switch set of 0 to 3

b: the work mode of the current channel

c: the elapsed time and remaining time. In the advanced method, the times are only for the current step.

d: the total volume delivered for the current work mode, and the target volume for one cycle.

e: the total cycles already finished and total target cycles to run. This data will display in the mode of infusion only with multiple dispensing, the mode of infusion/withdrawal, and the mode of withdrawal/infusion.

f: the current flow rate when the pump is running.

g: the dynamic display of the plunger movement. The number on the syringe means the total volume of the syringe used on the pump drive.

h: the channel selection area allows you to select or deselect a channel by tapping its display area. When selected, the area has a blue border; when not selected, it has a gray border. In standby mode, multiple channels can be selected simultaneously, allowing fast forward and fast backward operations for all selected channels. When the pump is running any normal recipe (not an advanced method), a single channel can be selected, and the flow rate of the selected channel can be adjusted during the pump running.

Button function:

➢ **[Lock]**

Tap the [Lock] button to lock the screen. Tap again to unlock the screen. When the screen is locked, only the [Unlock] button can be operated.

➢ **[Start]**

Tap the [Start] button to run the pump with the current recipe. Then the [Start] button will change to [Pause].

➢ **[Pause]**

When the pump is running, tap the [Pause] to pause the pump running.Then the [Pause] button will change to [Continue].

➢ **[Continue]**

Then pump is paused, tap [Continue] to continue the rest of the current recipe.

➢ **[Stop]**

When the pump is running or paused, tap the [Stop] button to stop the current recipe.

➢ **[Fast Forward]**

When the pump is on standby, one or several channels can be selected by tapping each channel's display area. Then there is a blue border for each selected channel's display area. When press and hold the [Fast Forward] button, all selected channels will run at full speed with the infusion direction.

➢ **[Fast Backward]**

When the pump is on standby and one or several channels are selected, press and hold the [Fast Backward] button to run all channels at full speed with the withdrawal direction.

➢ **[Flow Adjustment]**

When the pump is running a normal recipe (not an advanced method), the [Fast Forward] and [Fast Backward] buttons change to [Flow Adjustment]. Select one channel, the flow rate can be adjusted by tapping the [Flow Adjustment] button.

Note:
- The pump is running an advanced method, the pump can not be paused or continued, only can be stopped. And the flow rate can not be adjusted.
- The flow adjustment function is only available during the recipe running and when only one channel is selected

3.4.3 Recipe Configuration

Tap **[Recipe]** in the left navigation bar to enter the recipe screen.

All existing recipes are displayed, and up to 100 recipes can be stored.

No.: the recipes are displayed in reverse chronological order

Name: the name of the recipe

Protected: show whether the recipe is protected or not. The protected recipe can not be edited.

Activate: the activated recipe has a checkmark. When entering the running screen, the pump will run the activated recipe.
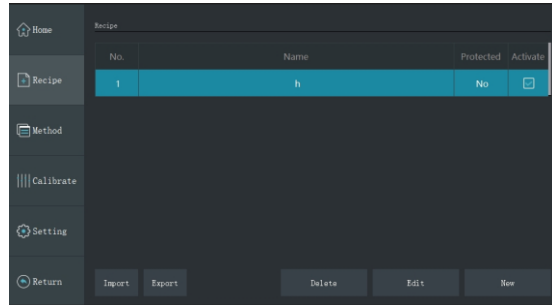
Button function:

➢ **[Import]**

Insert the USB flash drive with the recipe file into the USB port of the controller, tap [Import], then import one or several recipes to the controller. The recipe file storage path in the USB flash drive: USB flash drive > Longer/dLSP501Recipe.

➢ **[Export]**

After inserting the USB flash drive, tap [Export], the selected one or several recipes can be exported to the USB flash drive. The export path: USB flash drive> Longer/dLSP501Recipe.

➢ **[Delete]**

Delete the selected recipe (The background color of the selected recipe is blue).

➢ **[Edit]**

To edit the parameters of the selected recipe: tap [Edit], and the recipe edit screen will be displayed.

➢ **[New]**

To create a new recipe: tap [New], and the recipe edit screen will be displayed as below.
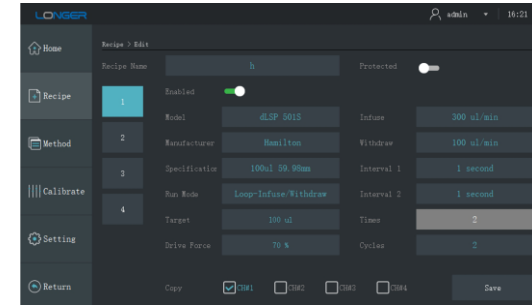
Channel selection: 1, 2, 3, and 4 on the left are the channel selection areas, corresponding to the channel with the physical address 1,2,3,4 (DIP switch is 0 to 3)

Recipe Name: Tap the edit area to enter the recipe name through the pop-up keyboard, which supports numbers, letters, underscores, and up to 20 characters

Protected: enable the protection function by tapping the icon to protect the recipe. Once the recipe is protected, the parameters can be reviewed but can not be edited. Default set is not protected.

Channel Enabled: enable the channel by tapping the icon. The enabled channel can be controlled on the running screen.

Pump drive model: select the correct pump drive model for each channel. Tap the drop-down button "√" to select the model and the pump drive can be recognized automatically. The wrong model setting will prompt error information and the pump can not be controlled.

Syringe manufacturer, syringe specification: tap the drop-down icon "√" to select the syringe manufacturer and spec. The wrong syringe setting may result in actual flow rate and volume differing significantly from the set values.

Work mode: tap the drop-down button "√" to select the work mode: infuse (including multiple dispensing), withdraw, loop- withdraw / infuse, loop- infuse / withdraw.

a. Infuse: The syringe plunger only moves forward according to the set parameters. And the pump will stop automatically when the target volume is achieved. When the dispensing Times is more than 1, the pump will dispense multiple times with Intervals 1. And each dispensing volume = Target volume/ Times.

b. Withdraw: The syringe plunger only moves backward according to the set parameters. And the pump will stop automatically when the target volume is achieved.

c. Loop- infuse/withdraw: The pump will first perform an infusion according to the set parameters. Once the target volume is reached, the pump will pause. After the Interval 2 has elapsed, the pump will automatically reverse direction and perform a withdrawal. When the target volume is reached again, the pump will pause, completing one cycle. If the Cycles is more than 1, After the Interval 1 has elapsed, the pump will automatically start the second cycle of infuse/withdraw. The pump will automatically stop when all cycles have been finished.

d. Loop- withdraw/infuse: The pump will first perform an withdrawal according to the set parameters. Once the target volume is reached, the pump will pause. After the Interval 1 has elapsed, the pump will automatically reverse direction and perform a infusion. When the target volume is reached again, the pump will pause, completing one cycle. If the Cycles is more than 1, After the Interval 2 has elapsed, the pump will automatically start the second cycle of withdraw/infuse. The pump will automatically stop when all cycles have been finished.

Target volume: For the mode of Infuse, the target volume is the total volume to be infused. If the dispensing times is more than 1, the each dispensing volume = target volume/ dispensing times.

For the mode of Withdraw, the target volume is the total volume to be withdrawn.

For the modes of loop-infuse/withdraw and loop-withdraw/infuse, the target volume is the volume to be infused or withdrawn in one cycle.

Tap the edit area and enter value through the pop-up keyboard, the maximum value can not exceed the syringe volume.

Driving force: Indicates the driving force of the pump drive, tap the edit area and enter the value through the pop-up keyboard, the value range 20-100, corresponding to 20%-100% of max. linear force.

Infuse flow: the pump flow rate when infuse, tap the edit area and enter the value through the pop-up keyboard. The flow rates for different pump drive models and syringes are different, and there is a range prompt on the input screen.

Withdraw flow: the pump flow rate when withdraw, tap the edit area and enter the value through the pop-up keyboard. The flow rates for different

pump drive models and syringes are different, and there is a range prompt on the input screen.

Interval 1: In the infuse mode, the Interval 1 means the pause time between each dispensing. So the Interval 1 can not be edited when the dispensing Times is 1. In the Loop work mode, the Interval 1 represents the pause time from withdraw to infuse. Tap the edit area and enter the value through the pop-up keyboard, the range is 1s-1000h.

Interval 2: In the Loop work mode, the Interval 2 represents the pause time from infuse to withdraw. Tap the edit area and enter the value through the pop-up keyboard, the range is 1s-1000h.

Times: The dispensing times in the infuse mode.

Number of cycles: The number of repeated cycles in Loop work mode. Such as Loop- infuse/withdraw mode, 1 cycle represents 1 infusion-withdrawal run. Tap the edit area and enter value through the pop-up keyboard, the set range is 0-3000, where 0 means unlimited cycles.

Parameter Copy To: Recipe parameters can be copied to other channels.

[Save]: After setting the parameters, tap [Save] to store the parameters.

Note: When one recipe is activated, the driving force for fast-forward and fast-backward operation will be according to the driving force set in the recipe. When no recipe or advanced method is activated, the driving force for fast-forward and fast-backward operation will be 50% of max. linear force.

3.4.4 Advanced Method

Tap [Method] in the left navigation bar to enter the Advanced Method screen.
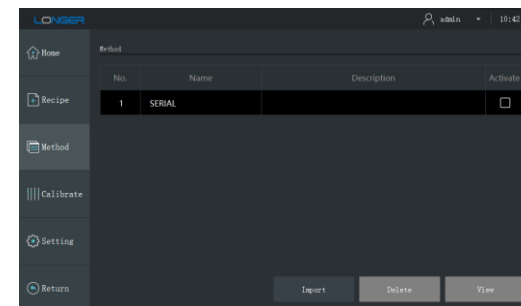
All advanced methods can be displayed after being imported to the controller, and up to 100 methods can be stored.

No.: the methods are displayed in reverse chronological order

Name: the name of the method, which was saved when the method was created.

Description: the description of the method, which was saved when the method was created.

Activate: the activated method has a checkmark. When entering the running screen, the pump will run the activated method.

Button function:

➢ **[Import]:** Insert the USB flash drive with the method file into the USB port of the controller, tap [Import], then import the method to the controller. The method file storage path in the USB flash drive: USB flash drive > Longer/dLSP501Method. Only one method can be imported at a time.

➢ **[Delete]:** to delete the selected method (The background color of the selected method is blue).

➢ **[View]:** to view the parameters of the selected method, including the pump drive model for each channel, the syringe spec, the driving force, and the parameters for each step.

An advanced method can be created via the PC method editor, and imported to the dLSP uC controller through the USB flash drive. Only one method can be imported at a time. Select the method and enter the method running screen.

Note: When one advanced method is activated, the driving force for fast-forward and fast-backward operation will be according to the driving force set in the method. When no advanced method is activated, the driving force for fast-forward and fast-backward operation will be 50% of max. linear force.

3.4.5 PC Method Editor Introduction

After editing the advanced method on the PC method editor, save the method to a USB flash drive with the specified patch: Longer/dLSP501Method > the USB flash drive. Then insert the USB flash drive to the controller and import the method to the controller through the advanced method import function.

Instructions of using the PC Method Editor:

1. Install the Software

Installation requirements: Windows 10 or higher operating system

Save the installation package to your computer, double-click the .exe installation file, and follow the prompts to install.

2. Run the Software

After the software installation is complete, double-click the created shortcut or navigate to the installation directory dLSP510MethodEditor and double-click file └ dLSP501 MethodEditor.exe to open the software.

3. Edit a Method

After running the software, edit the method.
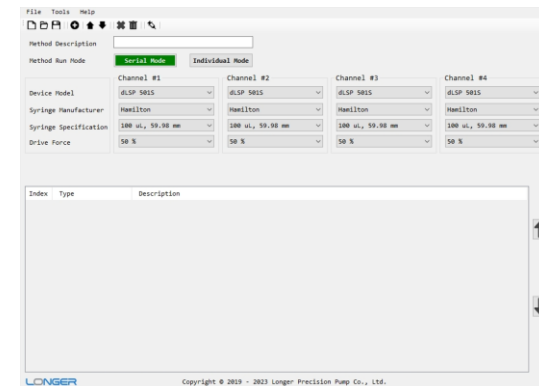
📄 📂 💾 :to create a new method, open a method, save a method. The method names can only be in English and do not support names with spaces or special characters.

When saving a method, please save the method file to the specified path: USB flash drive > Longer/dLSP501Method. Afterwards, you can directly import it from the USB flash drive to the controller. When saving to the local hard drive, ensure it is saved within a folder path with an English name, as saving elsewhere may lead to editing errors.

➕ :Add a step to the method, which can be a constant flow rate (multiple dispensing), time delay, and repeat mode.
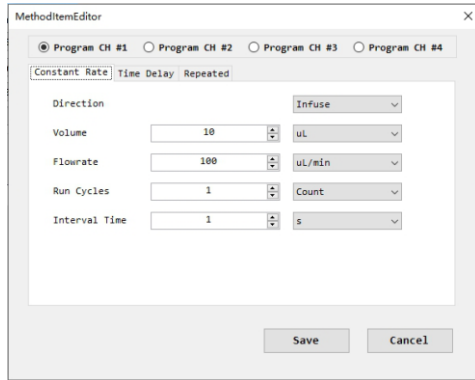
a. Constant flow rate

Direction: can be set as infuse or withdraw.

Volume: can be set to a volume value that is smaller than the current syringe volume.

Flow rate: can be set to a flow rate suitable for the current syringe spec.

Run cycles: Number of cycles based on the above set volume and flow rate.

Interval time: The interval time between each cycles, range: 1-3600s

b. Time Delay

Set the delay time between steps, ranging from 1 to 3600 seconds

c. Repeated

Repeat the cycle from the defined Start Step to the current step of "Repeated".

The "Start Step" can be set to any step before the current Repeated step.

The Total Loops means the repeat times, excluding the first run. Set range: 1-9999.
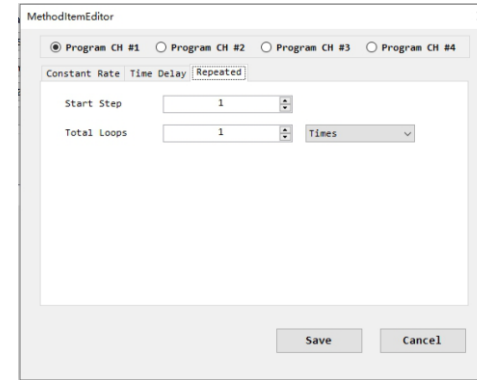
⬆⬇ :Move the selected step forward or backward.

✖ :Delete the selected step.

🗑 :Delete the whole method.

🔧 :Custom syringes. Tap this icon to display all existing custom syringes.

The existing syringes can be deleted or edited. And a new syringe can be created.
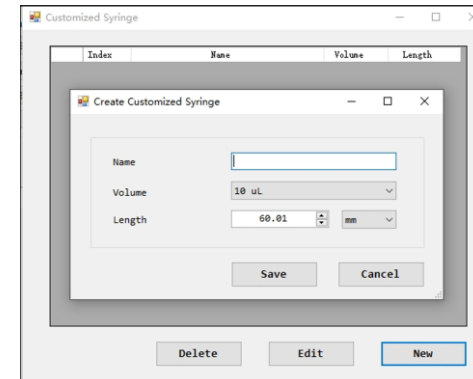
Name: Supports characters such as English letters, numbers, and underscores

Volume: can be selected by drop-down box, 0.5ul-60ml

Length: range 25-60mm, different syringe volume may support different length.

When a method includes custom syringes, importing the method into the controller automatically adds these custom syringes to the controller's custom syringe list. If a custom syringe name in the method duplicates an existing name in the controller's custom syringe list, you will receive an overwrite prompt.

Method Description: A brief description of the method you created, which will appear in the Description column of the controller's advanced method.

Method Run Mode: Serial Mode or Individual Mode

a. Serial mode: different channel operations can be set at different steps, and the method will be run step by step. The max step number is 16.

Example: The following method uses serial mode. The pump will run channel 1 at step 1. After the step 1 is completed, the pump will run channel 2 at step 2. Then channel 3 at step 3.
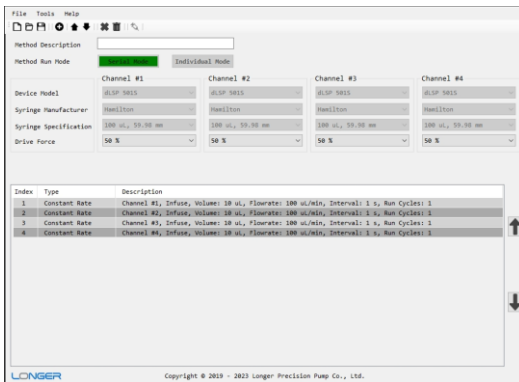
b. Individual mode: each channel runs independently according to its step list, there is no association between channels, and the max step number for each channel is 16.

When creating a method, each channel step list can be reviewed by tapping on the "View Channel #x".
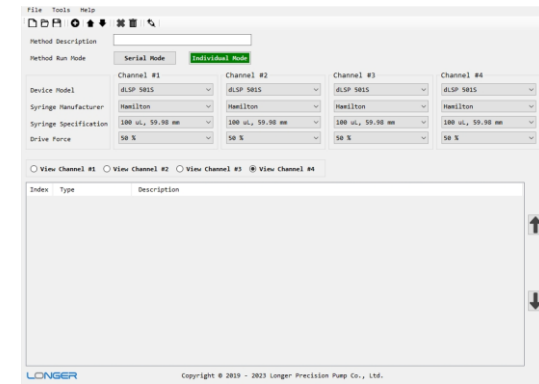
3.4.6 Flow Rate Calibration

For syringe pumps, the actual flow rate may not match the input flow rate in the recipe if the syringe ID specified in the recipe does not match the actual value. dLSP 501X provides the calibration function for custom syringes.
Tap [Calibrate] in the left navigation bar to enter the calibration screen.
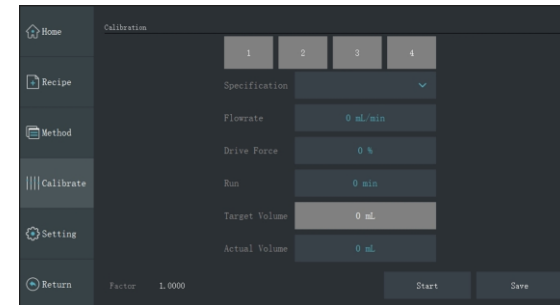
Channel selection: The channel to be calibrated can be selected through the upper 1, 2, 3, and 4 buttons, and cannot be selected when the channel pump drive is not connected to the controller.

Syringe Specification: select a custom syringe to calibrate by tapping "√" on the right. It will display no option if there is no custom syringe. Refer to Chapter 3.4.7.1 for setting customer syringes.

Infuse Flow Rate: Set the flow rate to be calibrated. Tap the edit area to enter the value through the pop-up keyboard. Different syringe volumes may have different setting ranges, and there will be a range prompt on the input screen.

Drive force: Set the driving force of the pump drive, tap the edit area and enter the value through the pop-up keyboard, the value range 20-100, corresponding to 20%-100% of max. linear force.

Running time: Set the pump running time, and the pumping volume during this time will be used to calibrate the flow rate. Tap the edit area and enter the value through the pop-up keyboard. The total infusing volume should not exceed the volume of the syringe.

Target volume: the theoretical pumping volume calculated based on flow rate and running time, target volume = flow rate * running time, not editable.

Actual volume: After the pump runs, measure the actual pumping volume and enter the measured value here. The actual pumping volume during the running time can also be entered directly without starting the pump. Tap the edit area and enter the value through the pop-up keyboard. An error message will be displayed if the measured actual volume is less than 0.8 times or greater than 1.2 times the theoretical target volume.

Calibration Factor: Last calibration factor * measured volume / theoretical volume. Range 0.8-1.2

The calibration factor is specific to the calibrated custom syringe and is not related to the pump drive model. The calibration factor will reset to 1 after restoring the factory default setting.

Button function:

➢ **[Start]:** Tap [Start] to run the selected channel according to the setting parameters, and [Start] will change to [Stop].

➢ **[Stop]:** Tap [Stop] to stop the selected channel.

➢ **[Save]:** After entering the measured actual volume, tap the [Save] button to calibrate the syringe and flow rate. The calibration factor will be updated. If the calibration factor exceeds the range, an error will occur when saving, and the calibration is invalid.

3.4.7 System Settings

Tap [Setting] in the left navigation bar to enter the system settings screen.
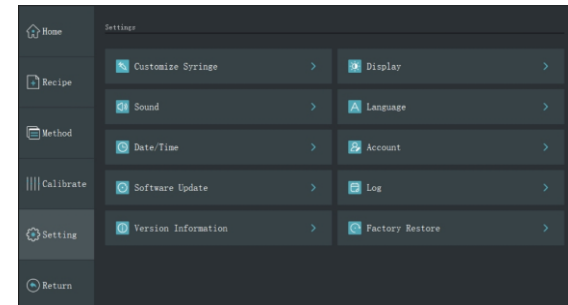
3.4.7.1 Custom Syringes

Tap [Customize Syringe] to enter the custom syringe list screen.
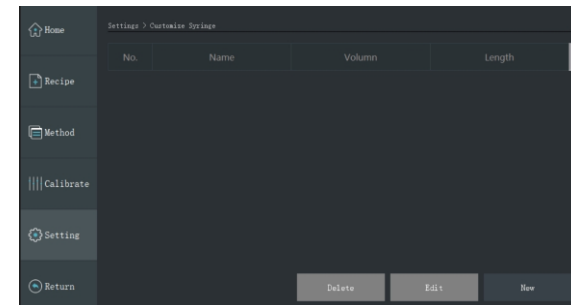
Serial number: Display the syringe list in alphanumeric order by name.

Name: Displays the syringe name when created.

Volume: Displays the syringe volume.

Length: Displays the stroke of the syringe pump plunger.

Button function:

➤ **[New]:** Create a new custom syringe, and up to 25 custom syringe can be stored.
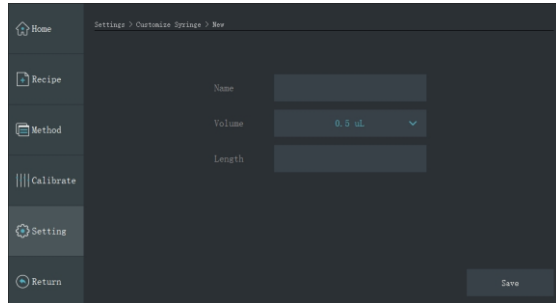
Name: Tap the edit area and enter the syringe name through the pop-up keyboard, which supports numbers, letters and underscores, and up to 20 characters

Volume: Tap the drop-down button "√" to select the syringe volume, from 0.5 uL to 60 mL

Length: Tap the edit area and enter the length through the pop-up keyboard, the range is 25mm-60mm.

After setting the custom syringe, tap [Save] button to save the setting and return to the custom syringe list screen.

➤ **[Edit]:** Edit the existing custom syringe. The syringe name can not be edited, but volume and length can be modified.

➤ **[Delete]:** Delete the existing custom syringe.

3.4.7.2 Display

Tap [Display] to enter the display setting screen.

Screen brightness adjustment: can be set to 30%-100%.

Screen brightness adjustment: the screen brightness can be adjusted by 30%-100%;

Screen saver enablement: when enabled, if there is no operation on the controller for 5 minutes, it enters screen saver mode with the screen brightness automatically adjusted to 40%.
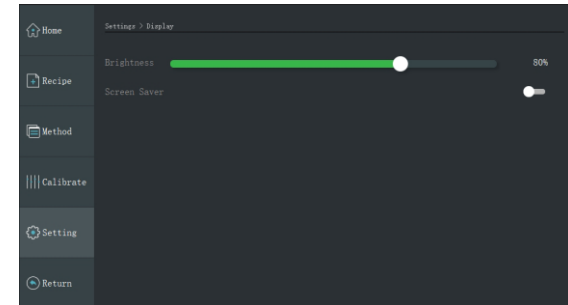
3.4.7.3 Sound

Tap [Sound] to enter the sound settings screen.

Key Click Sound: Enable or disable key click sound. When enabled, all key clicks will produce a sound.

Run Completion Prompt: Enable or disable the completion sound. When enabled, there will be a sound notification after a recipe run completes.
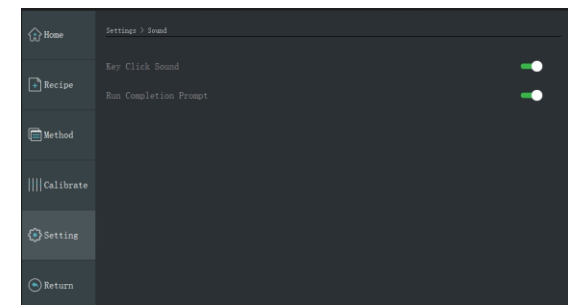
3.4.7.4 Language
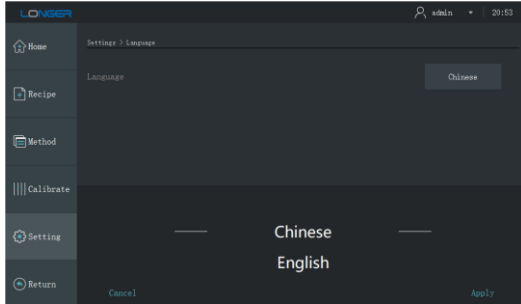
Tap [Language] to enter the language setting screen. The language of the controller can be set to Chinese or English, and changes take effect immediately upon setting.

3.4.7.5 Date/Time

Tap [Date/Time] to enter the date/time setting screen. The date and time of the controller will be the information record time.
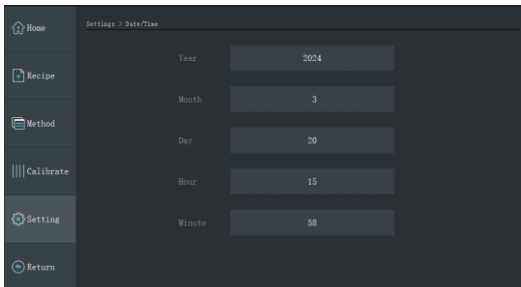
3.4.7.6 Account

Tap [Account] to enter the account setting screen.
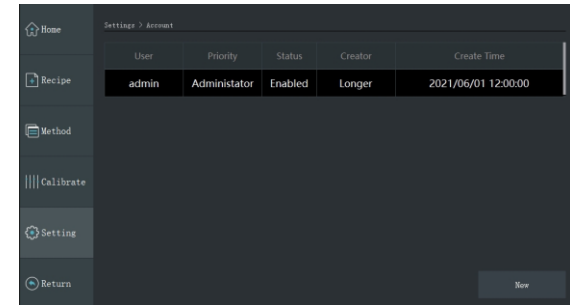
The controller supports three levels of user access, including administrator, technician, operator. Please refer to Appendix A for the specific user permissions.

New users can be added under the administrator account.
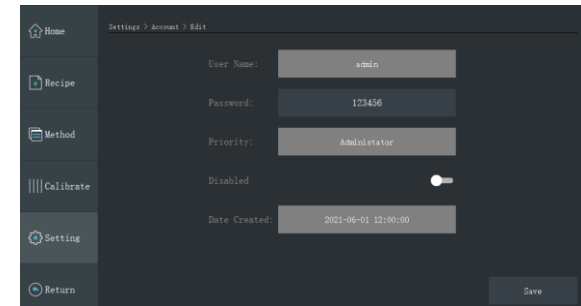
3.4.7.7 Software Update

Tap [Software Update] to enter the software update screen.
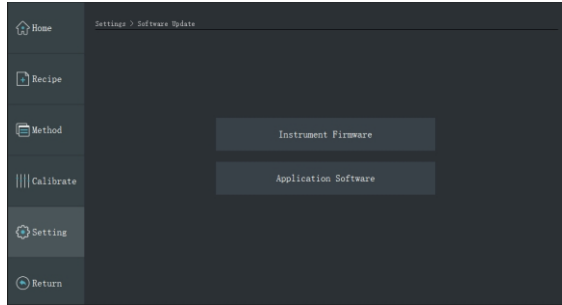
The firmware of the pump drive and the application software of the controller can be updated.

➢ Ensure that the latest firmware (in .bin format) and controller application software (in .tgz format) are placed in the root directory of the USB drive.

➢ During the software updating process, the controller must not be powered off.

➢ When the system has more than 1 pump drive units and needs to update the firmware of all units at the same time, ensure each pump drive in the system has a unique physical addresses and is connected to the controller well, otherwise some units may not be updated successfully.

➢ If no new version was found on the USB flash drive during the update, you can reinsert the USB flash drive and try again.

➢ If the message "Channel firmware cannot be updated" is displayed after the update, you can retry the update process again.

3.4.7.8 Log

Tap [Log] to enter the log review screen, and you can select the logs by checking the box and export them to the designated directory of the USB flash drive, and export the path：Longer/dLSP501Log

The information in below table will be recorded:

Functional module	Record Information	Note
Main screen	1) When an alarm occurs on the main screen, a log is recorded to record the error code information 2) Event record: 1. Record the start time and recipe name when start the pump 2. Pause time 3. Stop time 4. Fast forward, fast backward operation 5. Flow rate adjustment	Alarm: The content of the alarm
Recipe	1. Record the creating time and recipe name when creating a new recipe. 2. Record the recipe name, event and time when import, export or delete a recipe. 3. Record alarms.	Alarm: The content of the alarm
Advanced method	Same method, no method import record	
Calibration	1. Record the change of Calibration factor (the factor before calibration, and factor after calibration), custom syringe spec, calibration time 2. Record alarms	Alarm: The content of the alarm
System	1. Custom syringe: record the syringe name, spec, and model when creating, editing and deleting a custom syringe. 2. Software update: record the old and new version information and update time when updating software and firmware. 3. Account: record the user name, access level, password, enable or disable, creating time when creating or editing a new user. 4. Log: record when the logs are exported 5. Time/Date: record the date and time when modifying. 6. Factory reset: record the time when resetting factory settings. 7. Record alarms	Alarm: The content of the alarm

Refer to Appendix C for the alarm information.

3.4.7.9 Version Information

Tap [Version Information] to enter the version information screen.

Set the Device to Controller or Channel No. to review the version information of the controller or pump drive.
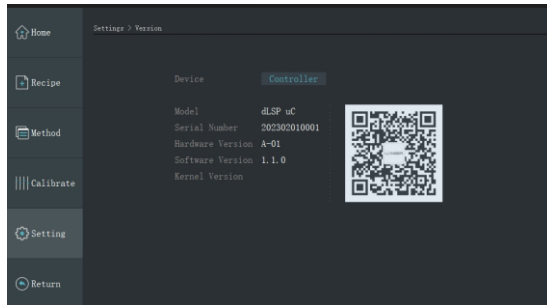
Controller version information: model, product serial number, hardware version, software version, and kernel version

Pump drive version information: model, product serial number, hardware version, firmware version

3.4.7.10 Factory Restore

Tap [Factory Restore] to enter the factory restore screen.
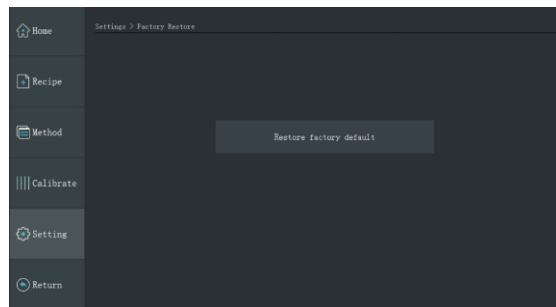
Refer to Appendix D for the factory default settings.

3.4.8 Return

Tap [Return] to return to th previous screen. Not valid in the running screen.

4. Error Messages and Troubleshooting

1) After creating a recipe, fail to start the recipe on the running screen.

1. Check whether the channel model in the recipe matches the actual pump drive model

2. If it is a multi-channel system (more than one pump drive unit), check that each pump drive has a unique physical address (DIP switch setting at the bottom of the pump drive)

2) The running recipe is not the desired recipe

   Tap [Recipe] in the left navigation bar to check if the desired recipe has been activated.

3) The imported recipes or advanced methods are not displayed on the controller.

   Check whether the recipe and method directories meet the path requirements

   Advanced methods path: USB flash drive >Longer/dLSP501Method

   Recipes path: USB flash drive >Longer/dLSP501Recipe

4) When the software is updating, it prompts "No USB flash drive or no new version found in USB flash drive"

   Check whether there is a new version software in the root directory of the USB flash drive, and if so, reinsert the USB and try again, or replace the USB port and try again.

Appendix A Three-Level of User Accesses

Functional Modules	Category	Administrator	Technician	Operator
Main Screen	Start and stop recipe	✓	✓	✓
	Fast forward and backward	✓	✓	✓
	Lock screen	✓	✓	✓
	View the recipe parameters	✓	✓	✓
	Run advanced method	✓	✓	✓
Recipe configuration	Create a new recipe	✓	✓	✕
	Edit a existing recipe	✓	✓	✕
	Import/export recipes	✓	✓	✕
	Delete recipes	✓	✕	✕
	Activate a recipe	✓	✓	✓
Advanced method	Import an advanced method	✓	✓	✕
	Activate an advanced method	✓	✓	✓
	Review an advanced method	✓	✓	✓
	Delete advanced methods	✓	✕	✕
Calibration	Run calibration	✓	✓	✕
System settings	Custom syringes	✓	✓	✕
	Language	✓	✓	✕
	Screen	✓	✓	✓
	Sound	✓	✓	✓
	Account	✓	✕	✕
	Software Update	✓	✕	✕
	Version information	✓	✓	✓
	Log	✓	✓	✕
	Date/Time	✓	✓	✕
	Factory Restore	✓	✕	✕

Appendix B Modbus RTU Protocol

Parameter type	Function	Variable	Register Address	Data Type	Read / write	Default Setting	Description
Multi-channel common parameters	System	Channel enable settings	0x0000	uint_16	R/W	1	Channel enable/disable: 0 – disable to start, 1 – enable to start, valid for all starting command. When the channel is disabled to start, the parameters can be set and read.
	System	Start	0x0001	uint_16	R/W	0	Start/Stop: 0 - Stop, 1 - Start
	System	Running at full speed	0x0008	uint_16	R/W	0	Fast forward and backward 0: Stop 1 infuse at full speed; 2 withdraw at full speed
	System	Pause/Resume	0x000D	uint_16	W	0	Pause/Resume: 1 - Pause 2 – Resume. The default setting is 0. Not valid for Advanced Methods programmed by PC method editor.
	System	Device address (modbus slave address)	0x0010	uint_16	R/W	1	Can be set to: 1~247. Take effect after the system restart. The default setting is 1
	System	Baud rate	0x0011	uint_16	R/W	5	Take effect immediately after setting 0->2400 1->9600 2->19200 3->38400 4->57600 5->115200. The default setting is 115200bps
	System	Parity	0x0012	uint_16	R/W	0	Take effect immediately after setting 0->Non, 1->ODD, 2->EVEN. The default setting is 0.
	System	Stop bit	0x0013	uint_16	R/W	0	Take effect immediately after setting 0->1 bit 1->2 bits. The default setting is 0.
	System	Pump status when power up	0x0020	uint_16	R/W	0	1 - Pump will resume to the same status as power off. (not valid for the advanced method) 0 - Pump will stop. The default setting is 0.

Multi-channel common parameters	Basic mode	Work mode	0x0060	uint_16	R/W	0	0-Infuse 1-Withdraw 2-infuse-> withdraw 3-withdraw-> infuse The default setting is 0.
	Basic mode	Syringe volume	0x0061	uint_16	R/W	100	1~9999 The default setting is 100.
	Basic mode	Syringe volume unit	0x0062	uint_16	R/W	100 (S/L) 101(W)	Refer to "Volume Unit Conversion Table"
	Basic mode	Syringe cross-sectional area value	0x0063	uint_16	R/W	1667	1~9999 The default setting is 1667.
	Basic mode	Syringe cross-sectional area unit	0x0064	uint_16	R/W	97(S\L) 98 (W)	Refer to "Section Area Unit Conversion Table"
	Basic mode	Flow volume/ linear speed selection	0x0067	uint_16	R/W	0	0- flow rate or volume 1- linear speed or travel
	Basic mode	Infusion or Withdrawal volume	0x0068	uint_16	R/W	100	1~9999
	Basic mode	Volume unit	0x0069	uint_16	R/W	100	Refer to "Volume Unit Conversion Table"
	Basic mode	Infusion flow rate	0x006A	uint_16	R/W	1	1~9999
	Basic mode	Infusion flow rate unit	0x006B	uint_16	R/W	102	Refer to "Flow Rate Unit Conversion Table"
	Basic mode	Withdrawal flow rate	0x006C	uint_16	R/W	1	1~9999
	Basic mode	Withdraw flow rate unit	0x006D	uint_16	R/W	102	Refer to "Flow Rate Unit Conversion Table"
	Basic mode	Driving force	0x006E	uint_16	R/W	50	20-100 Means "20%-100%"
	Basic mode	Number of assignments	0x006F	uint_16	R/W	1	1-9999 (only for multiple infusion mode)

Multi-channel common parameters	Basic mode	Interval time 1	0x0070	uint_16	R/W	1	Multiple infusion mode: interval time 1 means the time between each infusion. Cycle model: interval time 1 means the time switching from withdrawal to infusion
	Basic mode	Unit for the interval time 1	0x0071	uint_16	R/W	100	Refer to "Time Unit Conversion Table"
	Basic mode	Interval time 2	0x0072	uint_16	R/W	1	Cycle model: interval time 2 means the time switching from infusion to withdrawal.
	Basic mode	Unit for the interval time 2	0x0073	uint_16	R/W	100	Refer to "Time Unit Conversion Table"
	Basic mode	Number of cycles	0x0074	uint_16	R/W	1	1 - 65535, 0 - Unlimited
	Basic mode	Linear travel- most significant byte	0x0079	uint_16	R/W	0x393 (W)	Linear travel of the pluger= "Linear travel-most significant byte" * 65536 + "Linear travel-least significant byte" , unit is 0.0001um
	Basic mode	Linear travel- least significant byte	0x007A	uint_16	R/W	0x5568 (W) 0X56C8 (S\L)	
	Basic mode	Linear speed- most significant byte	0x007B	uint_16	R/W	0x393	The linear speed of the pluger= "Linear speed-most significant byte" * 65536 + "Linear speed-least significant byte" /(10^-7) Unit is 10^-7 mm/min The maximum speed depends on the pump drive model S->182.88mm/min L->190.5mm/min W-> 143.75mm/min
	Basic mode	Linear speed- least significant byte	0x007C	uint_16	R/W	0x5628 (W) 0x 5764 (S\L)	
	Basic mode	Withdraw the line velocity High position	0x007D	uint_16	R/W	0x393	
	Basic mode	Withdraw line velocity Low position	0x007E	uint_16	R/W	0x5628 (W) 0x 5764 (W)	
	Running at full speed	The driving force at full speed	0x00F0	uint_16	R/W	50	Percentage of driving force operating in full speed mode
	System status	The running step - most significant byte	0x00FC	uint_16	R	0x0000	Steps (or speed)= most significant byte *65536 + least significant byte
	System status	The running step- least significant byte	0x00FD	uint_16	R	0xFA00	In multiple infusion mode: the step value is the amount of single infusion
	System status	The operating speed value is high	0x00FE	uint_16	R	0x002D	In cycle mode: the step value is the amount of 1 infusion or withdrawal
	System status	The operating speed value is low	0x00FF	uint_16	R	0xC6C0	The speed is the current running direction, and the display value /10000 to get the RPM

Category		Name	Address	Type	R/W	Default	Description
Multi-channel common parameters	System status	Error status	0x0100	uint_16	R	0	bit0-motor stall bit1- high temperature of microcontroller bit2-power-off (standby) bit3-too many micro-steps bit4-too small micro-steps bit5- speed is too high bit6- speed is too low bit7-abnormal motor bit8-TMC chip temperature is too high When the error happened, the corresponding bit is 1.
	System status	Running status	0x0101	uint_16	R	501S 0x0003 501L 0x1003 501W 0X2003	bit12=0 bit13=0 bit14=0 bit15=0 ->501S bit12=1 bit13=0 bit14=0 bit15=0 -> 501L bit12=0 bit13=1 bit14=0 bit15=0 ->501W B3-B0: 0-standby (Reserved) 1-Run(0001) 2-Pause(0010) 3-Stop(0011) 4-Dispensing Interval (0100) (Interval 1 infuse/ withdraw Interval and Multiple infusion Interval) LED Status: Blue - > Stop, Green -> Run, Red - > Stall or other errors There is no pause for the advanced method, others apply
	System status	Real-time infusion flow rate	0x0102	uint_16	R	0	
	System status	Real-time infusion flow rate	0x0103	uint_16	R	100	
	System status	Real-time cumulative infusion volume	0x0104	uint_16	R	0	
	System status	Real-time cumulative infusion volume unit	0x0105	uint_16	R	100	
	System status	Real-time withdrawal flow rate	0x0106	uint_16	R	0	
	System status	Real-time withdrawal flow rate unit	0x0107	uint_16	R	100	
	System status	Real-time cumulative withdrawal volume	0x0108	uint_16	R	0	
	System status	Real-time cumulative withdrawal volume unit	0x0109	uint_16	R	100	
	System status	Direction	0x010A	uint_16	R	2	0-No action (reserved) 1-infuse 2-withdraw
	System status	Complete %	0x010B	uint_16	R	0	
	System status	Counts for multiple infusion or cycles (most significant byte)	0x010C	uint_16	R	0	Cumulative number of running cycles
	System status	Counts for multiple infusion or cycles (least significant byte)	0x010D	uint_16	R	0	
	Program system status	The number of step currently running in advanced method	0x010E	uint_16	R	0	
	Linear speed mode	Linear speed-most significant byte	0x010F	uint_17	R	0	The linear speed of the plunger= "Linear speed-most significant byte" * 65536 + "Linear speed- least significant byte" /(10^-7) Unit is 10^-7 mm/min Max speed: S-> 182.88mm/min, L->190.5mm/min, W->143.75mm/min Example: 190.5mm/min->190.5*10^7*10^-7mm/min= 1 905 000 000 *10^-7mm/min->0x718BFE40 Most significant byte: 0x718B Least significant byte: 0xFE40
	Linear velocity mode	Linear speed-least significant byte	0x0110	uint_18	R	0	

Multi-channel common parameters	Programming patterns are universal	Syringe volume	0x0230	uint_16	R/W	10	1~9999
	Programming patterns are universal	Syringe volume unit	0x0231	uint_16	R/W	100	Refer to "Volume Unit Conversion Table"
	Programming patterns are universal	Syringe cross-sectional area value	0x0232	uint_16	R/W	1667	1~9999
	Programming patterns are universal	Syringe cross-sectional area units	0x0233	uint_16	R/W	97	Refer to "Section Area Unit Conversion Table"
	Programming patterns are universal	Driving force	0x0236	uint_16	R/W	100	20-100 Means "20%-100%"
	Programming patterns are universal	Total number of steps	0x0242	uint_16	R	0	Count from 0, if you edit a total of 3 steps, 2 will be displayed Max steps is 16 which will display 15.
	Programming patterns are universal	Start the programming sequence run	0x0245	uint_16	R/W	0	1-Start 0-Stop
	Programming patterns are universal	End the programming sequence run	0x0246	uint_16	R/W	0	1-stop, same as set 0 to register of 0x0245
	Programming mode - constant speed	Step index	0x0250	uint_16	R/W	0	Index of this constant speed mode step.
	Programming mode - constant speed	Direction	0x0251	uint_16	R/W	0	0 - ineffective 1 – infuse 2 - withdraw
	Programming mode - constant speed	Infusion of withdrawal volume	0x0252	uint_16	R/W	0	0-9999
	Programming mode - constant speed	Volume unit	0x0253	uint_16	R/W	0	1nL, 10nL, 100nL, 1uL, 10uL, 100uL, 1mL, 10mL, 100mL, 1L

Multi-channel common parameters	Programming mode - constant speed	Flow rate	0x0254	uint_16	R/W	0	0~9999
	Programming mode - constant speed	Flow rate unit	0x0255	uint_16	R/W	0	0.001nL/min 1nL/min 1u/min 1mL/min
	Programming mode - constant speed	Number of repetitions	0x0257	uint_16	R/W	0	1~99
	Programming mode - constant speed	Interval time	0x0258	uint_16	R/W	0	1~3600s
	Programming mode - constant speed	interval time unit	0x0259	uint_16	R/W	0	Unit index value, 97-1ms, 98-10ms, 99-0.1s, 100-1s, 101-0.1min,102- 1min, 103-0.1h, 104-1h,
	Programming Mode - Time Delay	Step index	0x029A	uint_16	R/W	0	The step number of the delay mode. And the parameters in 0x029B and 0x029C are for this step.
	Programming Mode - Time Delay	Delay time	0x029B	uint_16	R/W	0	1s-3600s
	Programming Mode - Time Delay	Delay time unit	0x029C	uint_16	R/W	0	Unit index value, 97-1ms, 98-10ms, 99-0.1s, 100-1s, 101-0.1min,102- 1min, 103-0.1h, 104-1h,
	Programming mode - process restart	Step index	0x02A2	uint_16	R/W	0	The step number of the restart mode. And the parameters in 0x02A3 and 0x02A4 are for this step.
	Programming mode - process restart	Getting started	0x02A3	uint_16	R/W	0	All the steps from the this step number to the restart step will be restarted.
	Programming mode - process restart	Number of repetitions	0x02A4	uint_16	R/W	0	Repeat cycles: 1-9999.
Channel 1 parameters		Start address	0x2000	uint_16	R/W		The parameter definition is the same as that of the public area, but the register address is different

Channel 1 parameters	End address	0x23FF	uint_16	R/W	
Channel 2 parameters	Start address	0x2400	uint_16	R/W	The parameter definition is the same as that of the public area, but the register address is different
	End address	0x27FF	uint_16	R/W	
Channel 3 parameters	Start address	0x2800	uint_16	R/W	The parameter definition is the same as that of the public area, but the register address is different
	End address	0x2BFF	uint_16	R/W	
Channel 4 parameters	Start address	0x2C00	uint_16	R/W	The parameter definition is the same as that of the public area, but the register address is different
	End address	0x2FFF	uint_16	R/W	
Channel 5 parameters	Start address	0x3000	uint_16	R/W	The parameter definition is the same as that of the public area, but the register address is different
	End address	0x33FF	uint_16	R/W	
Channel 6 parameters	Start address	0x3400	uint_16	R/W	The parameter definition is the same as that of the public area, but the register address is different
	End address	0x37FF	uint_16	R/W	
Channel 7 parameters	Start address	0x3800	uint_16	R/W	The parameter definition is the same as that of the public area, but the register address is different
	End address	0x3BFF	uint_16	R/W	
Channel 8 parameters	Start address	0x3C00	uint_16	R/W	The parameter definition is the same as that of the public area, but the register address is different
	End address	0x3FFF	uint_16	R/W	

The unit conversions are as follows：

Volume Unit	92	0.01pl	1.00E-08
	93	0.1pl	1.00E-07
	94	pl	1.00E-06
	95	0.01nl	1.00E-05
	96	0.1nl	1.00E-04
	97	nl	1.00E-03
	98	0.01ul	0.01
	99	0.1ul	0.1
	100	ul	1
	101	10ul	10
	102	100ul	100
	103	ml	1.00E+03
	104	10ml	1.00E+04
	105	100ml	1.00E+05
	106	l	1.00E+06

		min			s			h	
Flow Rate Unit	94	pl/min	1.00E-06	194	pl/s	1.00E-06	294	pl/h	1.00E-06
	95	10pl/min	1.00E-05	195	10pl/s	1.00E-05	295	10pl/h	1.00E-05
	96	100pl/min	1.00E-04	196	100pl/s	1.00E-04	296	100pl/h	1.00E-04
	97	nl/min	1.00E-03	197	nl/s	1.00E-03	297	nl/h	1.00E-03
	98	10nl/min	0.01	198	10nl/s	0.01	298	10nl/h	0.01
	99	100nl/min	0.1	199	100nl/s	0.1	299	100nl/h	0.1
	100	ul/min	1	200	ul/s	1	300	ul/h	1
	101	10ul/min	10	201	10ul/s	10	301	10ul/h	10
	102	100ul/min	100	202	100ul/s	100	302	100ul/h	100
	103	ml/min	1.00E+03	203	ml/s	1.00E+03	303	ml/h	1.00E+03
	104	10ml/min	1.00E+04	204	10ml/s	1.00E+04	304	10ml/h	1.00E+04
	105	100ml/min	1.00E+05	205	100ml/s	1.00E+05	305	100ml/h	1.00E+05
	106	l/min	1.00E+06	206	l/s	1.00E+06	306	l/h	1.00E+06

	97	millisecond	1.00E-03
	98	0.01second	0.01
	99	0.1second	0.1
Time Unit	100	second	1
	101	0.1minute	6
	102	minute	60
	103	0.1hour	360
	104	hour	3600

	96	0.0001rpm/s	1.00E-04
	97	0.001rpm/s	1.00E-03
	98	0.01rpm/s	0.01
Speed Unit	99	0.1rpm/s	0.1
	100	rpm/s	1
	101	10rpm/s	10
	102	100rpm/s	100
	94	$10^{-6}mm^2$	1.00E-06
	95	$10^{-5}mm^2$	1.00E-05
Cross-sectional area unit	96	$10^{-4}mm^2$	1.00E-04
	97	$10^{-3}mm^2$	1.00E-03
	98	$0.01mm^2$	1.00E-02
	99	$0.1mm^2$	1.00E-01
	100	$1mm^2$	1.00E+00

- Advice: the input values of the recipe parameters in the registers are within the valid range of the controller

Appendix C Error Codes

No.	Fault	Error Code in Log
1	Motor stall	0x0001
2	The controller temperature is too high	0x0002
3	Motor status abnormal	0x0080
4	The motor driver chip temperature is too high	0x0100

Appendix D Factory Default Setting

Refer to the below tables for the parameter settings after restoring to factory defaults.

Running screen	No recipe
Recipe list	No recipe
Create a new recipe	If there is an online pump drive, the default parameters in the new recipe will be the default parameters of the online pump drive. If there is no online pump drive, the default parameters in the new recipe will be the default parameters of dLSP 501S.
Advanced method	No method
Calibration	No parameters
Custom syringes	No syringe
Screen brightness	80%
Screen saver	Disabled
Key click sound	Enabled
Run completion prompt	Enabled
Language	Restore the language selection screen
Account	Administrator user name: admin The default password of administrator: 123456 If the administrator password has been changed, save the updated password. Other created accounts (user name and password) will be saved.
Version information	Retain version information prior to restoration
logs	Retain log information prior to restoration
Date & Time	Retain date and time prior to restoration

Default Parameter	dLSP 501S	dLSP 501L	dLSP 501W
Syringe manufacturer spec	Hamilton/100ul	Hamilton/100ul	Hamilton/1ml
Work mode	Infuse	Infuse	Infuse
Flow rate	100ul/min	100ul/min	1ml/min
Target volume	100ul	100ul	1ml
Driving force	70%	50%	30%
Interval 1	-	-	-
Interval 2	-	-	-
Number of dispensing	1	1	1
Number of cycles	-	-	-

Appendix E List of Syringes

Product model	Syringe manufacturer	Syringe size (uL)	Length (mm)	ID (mm)	Cross-sectional area (mm²)
dLSP 501S	Hamilton	0.5	60.01	0.103	0.0083
	Hamilton	1	59.73	0.146	0.0167
	Hamilton	2	60.01	0.206	0.0333
	Hamilton	5	54.11	0.343	0.0924
	Hamilton	10	54.13	0.485	0.1847
	Hamilton	25	59.9	0.729	0.4174
	Hamilton	50	60.01	1.030	0.8332
	Hamilton	100	59.98	1.457	1.6672
	Hamilton	250	59.96	2.304	4.1694
	Popper&sons	250	26.74	3.450	9.3493
	SGE	5	54.11	0.343	0.0924
	SGE	10	54.13	0.485	0.1847
	SGE	25	60.06	0.728	0.4163
	SGE	50	60.01	1.030	0.8332
	SGE	100	59.98	1.457	1.6672
	SGE	250	60.02	2.303	4.1653
	Shanghai Gaoge	0.5	63.69	0.100	0.0079
	Shanghai Gaoge	1	56.62	0.150	0.0177
	Shanghai Gaoge	2	63.69	0.200	0.0314
	Shanghai Gaoge	5	51.97	0.350	0.0962
	Shanghai Gaoge	10	50.93	0.500	0.1963
	Shanghai Gaoge	25	49.74	0.800	0.5026
	Shanghai Gaoge	50	52.61	1.100	0.9504
	Shanghai Gaoge	100	49.74	1.600	2.0105

Product model	Syringe manufacturer	Syringe size (uL)	Length (mm)	ID (mm)	Cross-sectional area (mm²)
dLSP 501S	Shanghai Gaoge	250	60.17	2.300	4.1549
	Unimertrics	10	60.17	0.460	0.1662
	Unimertrics	25	59.73	0.730	0.4186
	Unimertrics	50	60.01	1.030	0.8332
	Unimertrics	100	59.73	1.460	1.6742
	Unimertrics	250	60.17	2.300	4.1549
dLSP 501L	Air-Tite	1000	57.88	4.690	17.2771
	Becon Dickinson	1000	57.66	4.699	17.3430
	Becon Dickinson (G)	500	29.57	4.640	16.9090
	Becon Dickinson (G)	1000	59.14	4.640	16.9090
	Hamilton	0.5	60.01	0.103	0.0083
	Hamilton	1	59.73	0.146	0.0167
	Hamilton	2	60.01	0.206	0.0333
	Hamilton	5	54.11	0.343	0.0924
	Hamilton	10	54.13	0.485	0.1847
	Hamilton	25	59.9	0.729	0.4174
	Hamilton	50	60.01	1.030	0.8332
	Hamilton	100	59.98	1.457	1.6672
	Hamilton	250	59.96	2.304	4.1694
	Hamilton	500	60.05	3.256	8.3264
	Hamilton	1000	59.96	4.608	16.6778
	Popper&sons	250	26.74	3.450	9.3493
	Popper&sons	500	53.49	3.450	9.3475
	Popper&sons	1000	62.88	4.500	15.9033
	SGE	5	54.11	0.343	0.0924
	SGE	10	54.13	0.485	0.1847

	SGE	50	60.01	1.030	0.8332
	SGE	25	60.06	0.728	0.4163
	SGE	100	59.98	1.457	1.6672
	SGE	250	60.02	2.303	4.1653
	SGE	500	60.01	3.257	8.3319
	SGE	1000	60.02	4.606	16.6611
	Shanghai Gaoge	0.5	63.69	0.100	0.0079
	Shanghai Gaoge	1	56.62	0.150	0.0177
	Shanghai Gaoge	2	63.69	0.200	0.0314
	Shanghai Gaoge	5	51.97	0.350	0.0962
	Shanghai Gaoge	10	50.93	0.500	0.1963
	Shanghai Gaoge	25	49.74	0.800	0.5026
	Shanghai Gaoge	50	52.61	1.100	0.9504
dLSP 501L	Shanghai Gaoge	100	49.74	1.600	2.0105
	Shanghai Gaoge	250	60.17	2.300	4.1549
	Shanghai Gaoge	500	60.27	3.250	8.2960
	Shanghai Gaoge	1000	59.91	4.610	16.6917
	Sherwood Monojet	1000	58.88	4.650	16.9837
	Terumo	1000	56.91	4.730	17.5716
	Unimertrics	10	60.17	0.460	0.1662
	Unimertrics	25	59.73	0.730	0.4186
	Unimertrics	50	60.01	1.030	0.8332
	Unimertrics	100	59.73	1.460	1.6742
	Unimertrics	250	60.17	2.300	4.1549
	Unimertrics	500	59.9	3.260	8.3472
	Unimertrics	1000	59.91	4.610	16.6917
	XinHuaYiLiao	1000	57.15	4.720	17.4978

	Air-Tite	1000	57.88	4.690	17.2771
	Air-Tite	2500	34.18	9.650	73.1422
	Air-Tite	5000	41.07	12.450	121.7434
	Air-Tite	10000	50.36	15.901	198.5703
	Air-Tite	20000	63.34	20.051	315.7562
	Air-Tite	30000	72.84	22.900	411.8616
	Air-Tite	50000	74.66	29.201	669.7027
	Becon Dickinson	1000	57.66	4.699	17.3430
	Becon Dickinson	3000	51.83	8.585	57.8815
	Becon Dickinson	5000	44.29	11.989	112.8923
	Becon Dickinson	10000	61.17	14.427	163.4788
	Becon Dickinson	20000	70.17	19.050	285.0221
dLSP 501W (Disposable syringes)	Becon Dickinson	30000	81.95	21.589	366.0769
	Becon Dickinson	50000	90.01	26.595	555.4938
	Becon Dickinson (G)	1000	59.14	4.640	16.9090
	Becon Dickinson (G)	3000	50.93	8.660	58.9044
	Becon Dickinson (G)	5000	45.26	11.860	110.4728
	Becon Dickinson (G)	10000	61.92	14.340	161.4987
	Becon Dickinson (G)	20000	69.58	19.131	287.4389
	Becon Dickinson (G)	30000	74.13	22.700	404.6945
	Becon Dickinson (G)	60000	93.4	28.599	642.3983
	Hamilton	1000	59.96	4.608	16.6778
	Hamilton	1250	59.98	5.151	20.8403
	Hamilton	2500	59.98	7.285	41.6806
	Hamilton	5000	60.01	10.300	83.3194
	Hamilton	10000	60	14.567	166.6667

	Hamilton	25000	60	23.033	416.6667
	Hamilton	50000	60.01	32.571	833.1945
	Popper&sons	1000	62.88	4.500	15.9033
	Popper&sons	2000	32	8.921	62.5000
	Popper&sons	3000	47.26	8.990	63.4786
	Popper&sons	5000	46.51	11.699	107.5038
	Popper&sons	10000	58.92	14.700	169.7217
	Popper&sons	20000	66.42	19.580	301.1141
	Popper&sons	30000	74.13	22.700	404.6945
	Popper&sons	50000	75.7	29.000	660.5020
	Ranfac	2000	30.62	9.119	65.3168
	Ranfac	5000	41.81	12.340	119.5886
dLSP 501W (Disposable syringes)	Ranfac	10000	60.14	14.550	166.2787
	Ranfac	20000	64.56	19.860	309.7893
	Ranfac	30000	70.97	23.199	422.7138
	Ranfac	50000	83.57	27.600	598.3008
	Shanghai Gaoge	1000	59.91	4.610	16.6917
	Sherwood Monojet	1000	58.88	4.650	16.9837
	Sherwood Monojet	3000	47.79	8.940	62.7746
	Sherwood Monojet	6000	47.36	12.701	126.6892
	Sherwood Monojet	12000	60.44	15.899	198.5440
	Sherwood Monojet	20000	61.19	20.400	326.8508
	Sherwood Monojet	35000	78.67	23.800	444.8964
	Sherwood Monojet	50000	89.97	26.601	555.7408
	SGE	1000	60.02	4.606	16.6611
	SGE	2500	59.99	7.284	41.6736

	SGE	5000	60	10.301	83.3333
	SGE	10000	60	14.567	166.6667
	SGE	25000	60.17	23.000	415.4894
	SGE	50000	84.18	27.500	593.9653
	Terumo	1000	56.91	4.730	17.5716
	Terumo	3000	47.16	9.000	63.6132
	Terumo	5000	37.44	13.040	133.5470
	Terumo	10000	51.07	15.790	195.8097
	Terumo	20000	62.53	20.180	319.8465
dLSP 501W (Disposable syringes)	Terumo	30000	70	23.360	428.5714
	Terumo	60000	88.08	29.450	681.1989
	Unimertrics	1000	59.91	4.610	16.6917
	XinHuaYiLiao	1000	57.15	4.720	17.4978
	XinHuaYiLiao	2000	27.04	9.704	73.9645
	XinHuaYiLiao	5000	37.1	13.099	134.7709
	XinHuaYiLiao	10000	46.21	16.599	216.4034
	XinHuaYiLiao	20000	70.54	19.000	283.5271
	XinHuaYiLiao	30000	72.21	22.999	415.4549
	XinHuaYiLiao	60000	89.97	29.139	666.8890
	Air-Tite	1000	57.88	4.690	17.2771
	BeconDickinson	1000	57.66	4.699	17.3430
	Becon Dickinson (G)	500	29.57	4.640	16.9090
dLSP 501W (Glass injector)	Becon Dickinson (G)	1000	59.14	4.640	16.9090
	Hamilton	5	54.11	0.343	0.0924
	Hamilton	10	54.13	0.485	0.1847
	Hamilton	25	59.9	0.729	0.4174

	Hamilton	50	60.01	1.030	0.8332
	Hamilton	100	59.98	1.457	1.6672
	Hamilton	250	59.96	2.304	4.1694
	Hamilton	500	60.05	3.256	8.3264
	Hamilton	1000	59.96	4.608	16.6778
	Popper&sons	250	26.74	3.450	9.3493
	Popper&sons	500	53.49	3.450	9.3475
	Popper&sons	1000	62.88	4.500	15.9033
	SGE	5	54.11	0.343	0.0924
	SGE	10	54.13	0.485	0.1847
	SGE	50	60.01	1.030	0.8332
	SGE	25	60.06	0.728	0.4163
dLSP 501W (Glass injector)	SGE	100	59.98	1.457	1.6672
	SGE	250	60.02	2.303	4.1653
	SGE	500	60.01	3.257	8.3319
	SGE	1000	60.02	4.606	16.6611
	Shanghai Gaoge	5	51.97	0.350	0.0962
	Shanghai Gaoge	10	50.93	0.500	0.1963
	Shanghai Gaoge	25	49.74	0.800	0.5026
	Shanghai Gaoge	50	52.61	1.100	0.9504
	Shanghai Gaoge	100	49.74	1.600	2.0105
	Shanghai Gaoge	250	60.17	2.300	4.1549
	Shanghai Gaoge	500	60.27	3.250	8.2960
	Shanghai Gaoge	1000	59.91	4.610	16.6917
	Sherwood Monojet	1000	58.88	4.650	16.9837
	Terumo	1000	56.91	4.730	17.5716

	Unimertrics	10	60.17	0.460	0.1662
	Unimertrics	25	59.73	0.730	0.4186
	Unimertrics	50	60.01	1.030	0.8332
dLSP 501W (Glass injector)	Unimertrics	100	59.73	1.460	1.6742
	Unimertrics	250	60.17	2.300	4.1549
	Unimertrics	500	59.9	3.260	8.3472
	Unimertrics	1000	59.91	4.610	16.6917
	XinHuaYiLiao	1000	57.15	4.720	17.4978