

Note: This manual applies to the RUNZE protocol (unless otherwise specified, the pump leaves the factory defaulting to the RUNZE protocol).

If unsure about the current protocol used by the pump, please first check P20 for [C Query and Switch Protocol].

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Chapter 1 Overview and Precautions

1.1 Company Overview

Nanjing Runze Fluid Control Equipment Co., Ltd. was established in 2014. It is a national high-tech enterprise specializing as an analytical instrument supplier and focused on the R&D and production of fluid components. Products include syringe pumps, switching valves, high-pressure valves, airtight sample injectors, peristaltic pumps, pipe fittings, and other standard products, covering the entire industry chain from product customization, design R&D, production manufacturing, sales, and after-sales service. We consistently provide high-quality products and services for environmental monitoring, biopharmaceuticals, medical equipment, industrial automation, and laboratory instruments.

Since its establishment, Runze has passed ISO9001 certification and successively obtained certifications such as "National High-Tech Enterprise" and "Jiangsu Provincial Private Sci-Tech Enterprise". It has been rated as a 5A credit user by Bank of Nanjing. Pursuing high and new technologies, through years of R&D investment and accumulation, the company has obtained 48 patent technologies in the fluid field and multiple software copyrights, including 8 invention patents, 17 utility model patents, 13 design patents, and 2 software copyrights.

Runze always focuses on strategy and independent innovation, accurately grasps the major trends in the fluid equipment industry, and has conducted continuous and substantial R&D investments in the core technologies of its product series. This has given the company a significant advantage in the production and sales of analytical instrument accessories, keeping it at the forefront of the industry. The Runze Technology Center possesses a series of advanced processing equipment and testing instruments, including an EMC reliability laboratory, imported white light interferometers, Keyence flat surface rapid detectors, five-axis machining centers, high-precision nano-grinding machines, etc. It adopts leading production processes and technologies, fully implements lean production concepts, and consistently maintains professional, internationally first-class production and manufacturing capabilities.

1.2 Product Overview

The SY-08 vertical syringe pump is a compact, ultra-high precision, stable performance, long-life micro industrial syringe pump independently developed by our company. It receives instructions from an upper computer and converts the stepper motor's clockwise or counterclockwise circular motion into linear motion via a trapezoidal lead screw, enabling the syringe pump piston to move up and down linearly to achieve fluid aspiration and dispensing functions.



5ml 12.5ml 25ml

Product Specifications: 5ml, 12.5ml, 25ml

Product Applications: Used as a core component in laboratory instrument overall solutions, medical in-vitro diagnostic analysis equipment, chromatographic analyzers, automatic biochemical analyzers, blood analyzers, trace element analyzers, electrolyte analyzers, food and beverage detection analysis systems, online water quality analyzers, petroleum testing equipment, biopharmaceutical extraction devices, and other fluid transmission systems requiring high precision and stability for sample introduction.。

1.3 Precautions

1. Please ensure the product is effectively grounded to prevent interference. Refer to section 3.3 Port Definitions for the grounding terminal.
2. The device must be reset with the 0x4F command after power-on before proceeding to the next instruction operation; if any abnormality occurs during use, please also use the 0x4F command to reset.
3. Applicable power supply: DC 24V $\pm$ 10%, 3A. When using a linear power supply, the voltage and current must be adjusted to the corresponding parameter values.
4. When debugging this product with a computer, please use Runze's dedicated debugging software SerialComm.
5. During debugging, fluid must be passed through for testing to avoid dry running of the piston, which affects the lifespan of the injector.
6. When using this product, please connect the ground wire properly to reduce interference from environmental factors.
7. When using this product, do not plug or unplug the power terminals while powered on, to avoid damaging internal components and causing unavoidable damage.
8. When not using this product, promptly clean the inside of the injector with clean water, alcohol, or other cleaning fluids to prevent residual test liquid from staying inside the injector for a long time, which could cause channel blockage or piston damage.
9. When installing this product, please use the existing mounting holes for installation; strictly avoid creating additional holes. If there are special requirements, please consult sales or technical support.
10. Please use the original serial cable and power connection provided with this product.
11. The two communication methods (RS232, RS485 bus) of this product are in non-isolated mode.
12. Do not disassemble product components arbitrarily; warranty is void if the anti-tamper label is removed..
13. When operating the software, please refer to the software operation manual and communication protocol; do not input fabricated data arbitrarily.
14. For instrument disposal, please follow the regulations for the disposal of instrument equipment waste. Dispose of waste generated after using this machine according to national environmental protection requirements. Users should not discard it randomly.
15. When connecting multiple devices using the RS485 bus protocol, please refer to the connection method shown in Figure 1-1 below. However, the resistance value should be determined based on the number of devices connected by the user.

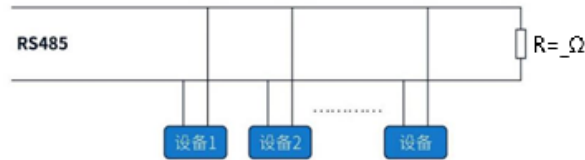


Figure 1-1

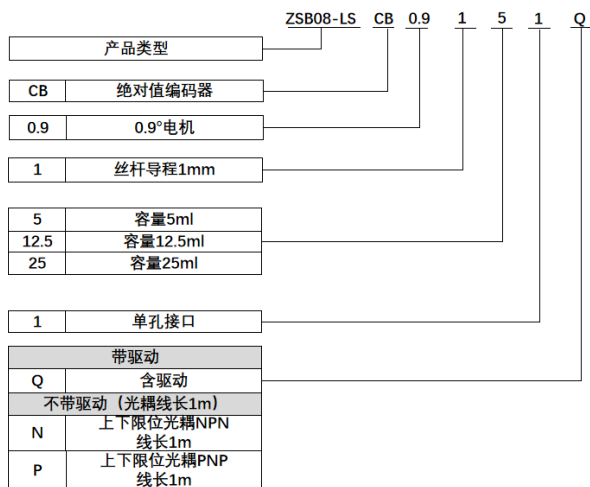
Chapter 2 Main Technologies and Functions

2.1 Product Features

- Compact size, saves installation space, high precision, stable performance, long-life micro industrial syringe pump.
- Fluid-contact materials use high borosilicate glass, PTFE, corrosion-resistant, high-temperature resistant, suitable for various special media.
- Widely used in environmental protection equipment, medical analysis equipment, non-standard high-precision sampling equipment, and various analyzers.

2.2 Naming Rules

Model parameters are as shown in the figure below:



Example: 5ml 0.9-degree stepper motor single hole with driver syringe pump, named: ZSB08-LS-CB-0.9-1-5-1-Q

Example: 5ml 0.9-degree stepper motor single hole without driver, with upper/lower limit photoelectric sensor, NPN, wire length 1m, named: ZSB08-LS-0.9-1-5-1-N

2.3 Syringe Pump Basic Parameters

2.3.1 Product Functions

Product Function	Description
Set Address	Set address via serial port
Set Baud Rate	Can set different baud rates for RS232, RS485

Set Speed	5ml, 12.5ml: 1rpm to 600rpm; 25ml: 1rpm to 500rpm (Differs for gas and liquid, and varies by model)
Reset Internal Data	Restore factory settings
Query Parameters	Can query device address, speed, baud rate
Query Version	Query current firmware version
Motor Control Direction	Can control motor clockwise, counterclockwise rotation
Reset	Return syringe pump piston to zero point position
Force Stop	Stop current syringe pump motor operation
Query Motor Status	Detect current motor status

2.3.2 Technical Parameters

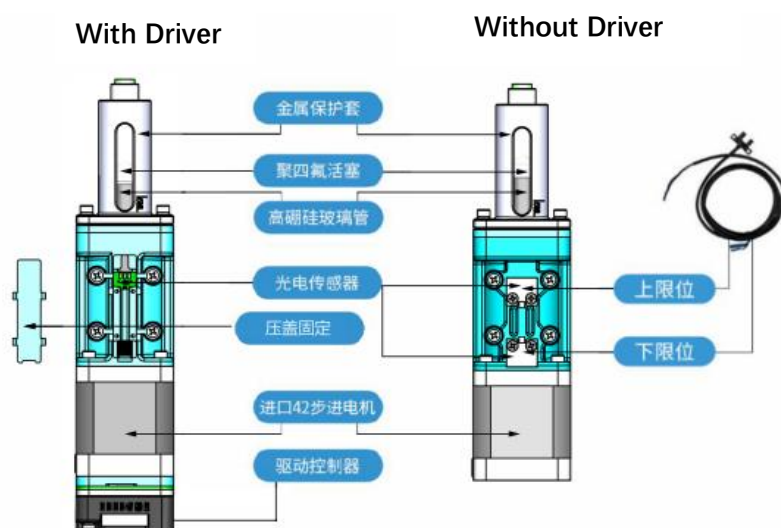
Product Function	Description		
Liquid Volume Accuracy	Error $\leq 1\%$ (rated stroke)		
Liquid Volume Precision	Repeatability Error 0.3%~0.7% (rated stroke)		
Expected Lifespan	3 million cycles leak-free (test medium: pure water)		
Specification	5ml	12.5ml	25ml
Back Pressure (Mpa) ^{注1}	1.32	0.51	0.28
Max Speed	600rpm	600rpm	500rpm
Rated Stroke (Control Steps)	30mm(12000Steps)	30mm(12000Steps)	30mm(12000Steps)
Linear Speed	0.017~10mm/s	0.017~10mm/s	0.017~8.33mm/s
Rated Stroke Run Time	3s~1800s	3s~1800s	3.6~1800s
Control Resolution / Min. Sample Precision	0.0025mm/0.416 μ l	0.0025mm/1.042 μ l	0.0025mm/2.083 μ l
Glass Tube Inner Diameter	14.55mm	23.03mm	32.57mm
Transmission Structure	Trapezoidal lead screw (Lead 1mm)		
Piston Max Driving Force	≥ 100 N		
Fluid-Contact Materials	High borosilicate glass、PTFE、PCTFE、FFKM		
Channel Type	Single Channel		
Tubing Interface	1/4-28UNF internal threaded interface		
Communication Interface	RS232/RS485 bus		
Communication Rate	RS232/RS485 bus: 9600bps、19200bps、38400bps、57600bps、115200bps		
Device Address & Parameter Setting	Communication interface		
Applicable Power Supply	DC24V/3A		
Rated Power	15W		
Operating Environment Temperature	5 ~ 55℃		

Operating Relative Humidity	$\leq 80\%$ (non-condensing)		
Dimensions (LWH)	42*42*191.5mm	42*42*200mm	42*42*200.7mm
Weight	0.56kg	0.6kg	0.64kg

Chapter 3 Hardware Setup

3.1 Component Installation

3.1.1 Syringe Pump Structure



3.1.1.1 Vertical Syringe Pump Without Driver

For the vertical syringe pump without a driver controller, two dedicated Samron photoelectric sensors (Model: PM-L25) are used. Two photoelectric sensors are installed to control the upper and lower limits, preventing the syringe pump piston from damaging the glass tube or pump head during up/down movement. Photoelectric sensor adjustment method: Rotate the motor to bring the piston to the top dead center position, move the upper sensor, and tighten the fixing screw when the sensor detects the signal. Install the lower sensor at the lowest position and tighten it. Panasonic photoelectric sensors (Model: PM-L25) are optional.

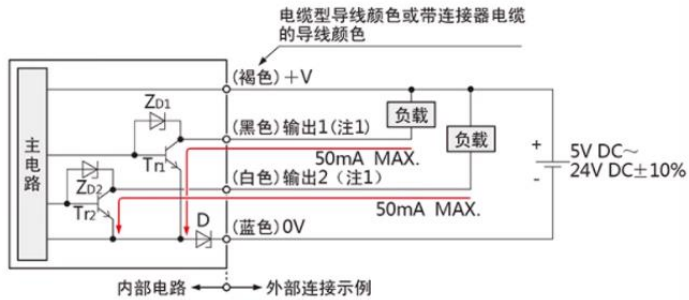
Note: When 24V power is cut off, the step error is 0~60 steps. (The step error is an average value obtained from actual tests.)

Color	Function
Brown Line	Positive (5-24V)

Blue Line	Negative
White line	Normally Open
Black line	Normally Closed

3.1.1.2 Samron Photoelectric Sensor Output Properties and Wiring Differences

3.1.2 Pump Installation



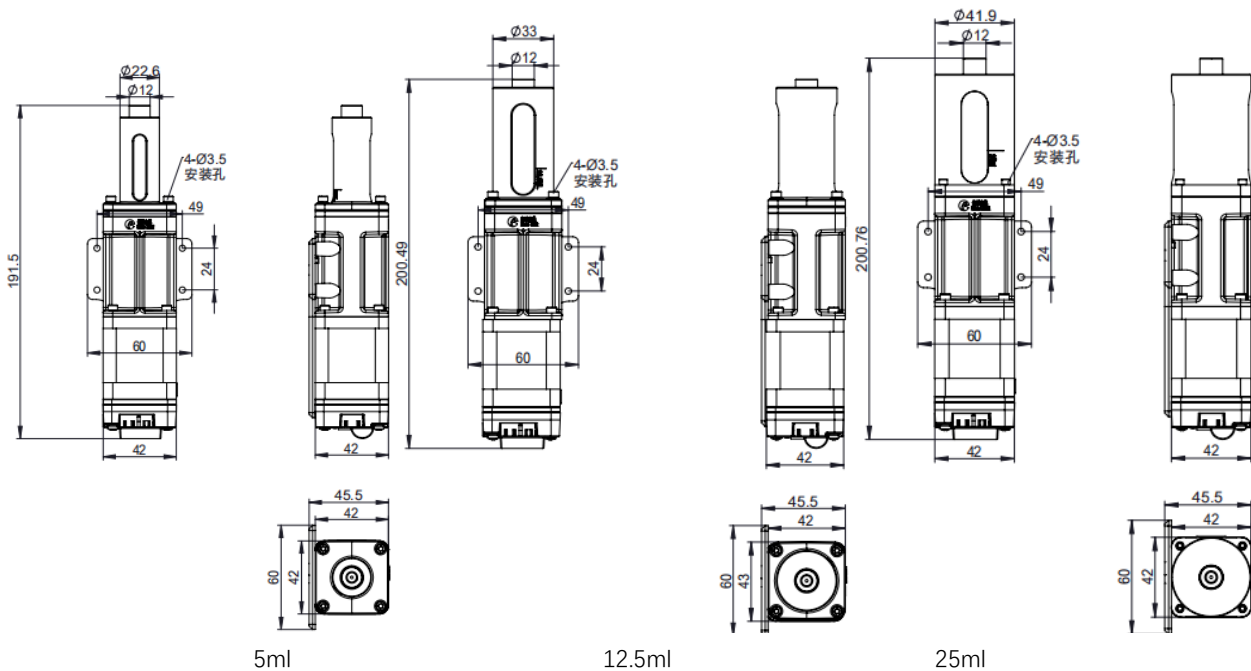
(注)：不使用的输出线请务必进行绝缘处理。

For in
outline dra

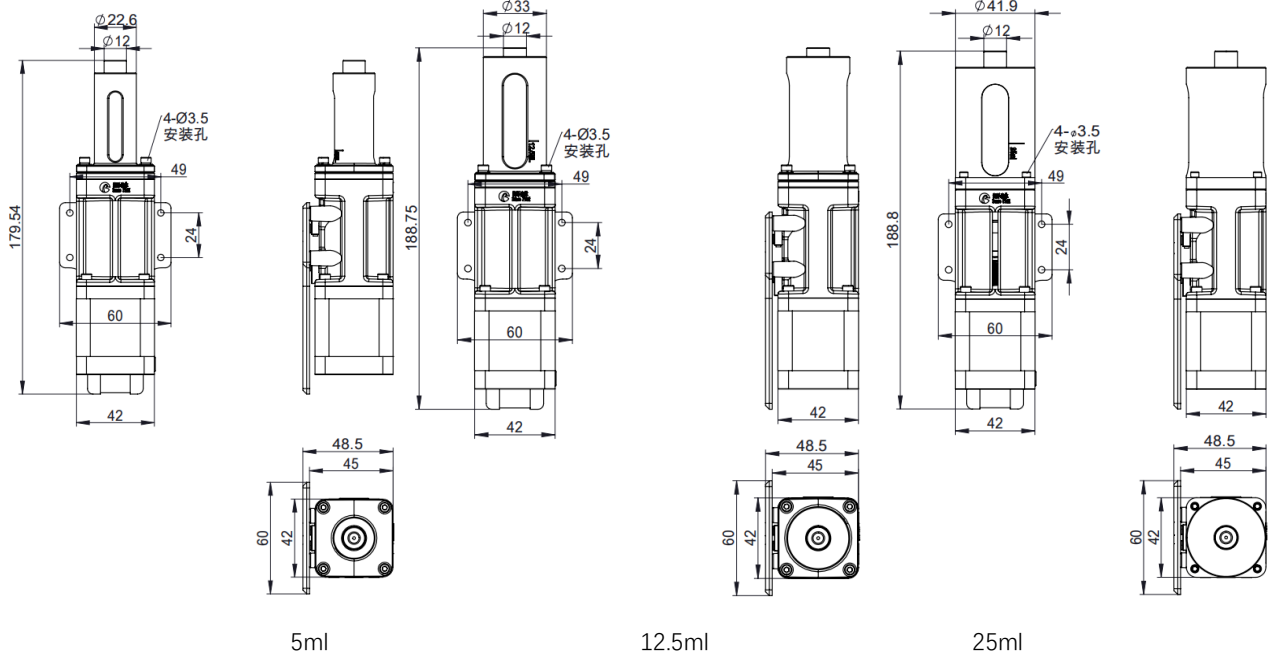
符号... D：电源反向连接保护用二极管
Z_{D1}、Z_{D2}：电涌吸收齐纳二极管
Tr₁、Tr₂：NPN输出晶体管

le dimensions and positions on the

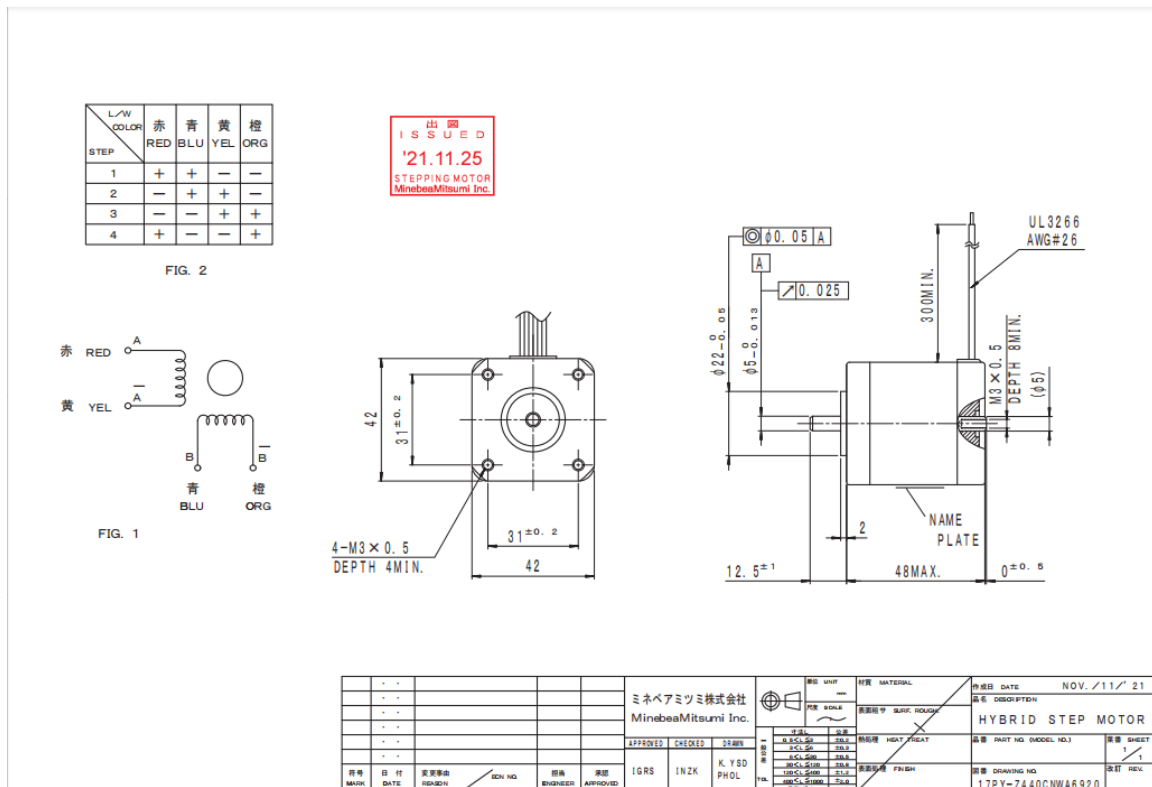
3.1.2.1 Vertical Syringe Pump with Driver Dimensions (Unit: mm)



3.1.2.2 Vertical Syringe Pump Without Driver Dimensions (Unit: mm)



3.2 42 Stepper Motor Manual



6. 信頼性 Reliability

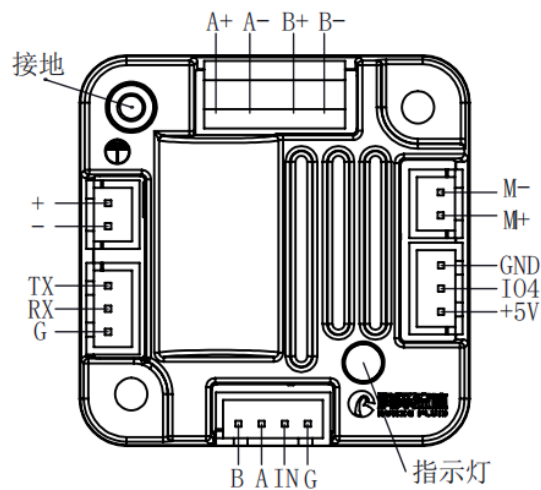
下記条件で試験後、2項の電気的特性、3項の機械的特性を満足するものとする。

The product to be examined in the following condition and satisfy 2.Electrical characteristics and 3.Mechanical characteristics.

No.	試験項目 Item	試験条件 Test condition	参考規格 Reference standard
1	低温放置 Cold (耐寒性)	温度 Temperature : $-40^{\circ}\text{C} \pm 3^{\circ}\text{C}$ 試験時間 Test time : 96 h	JIS C 60068-2-1
2	高温放置 Dry heat (耐熱性)	温度 Temperature : $85^{\circ}\text{C} \pm 2^{\circ}\text{C}$ 試験時間 Test time : 96 h	JIS C 60068-2-2
3	高温高湿放置 Damp heat (耐湿性)	温度 Temperature : $60^{\circ}\text{C} \pm 2^{\circ}\text{C}$ ($40^{\circ}\text{C} \pm 2^{\circ}\text{C}$) 湿度 Humidity : 93 % +2 / -3 % 試験時間 Test time : 96 h	JIS C 60068-2-3
4	冷熱衝撃 Thermal shock (温度変化)	温度 Temperature : 低温側 Cold $-40^{\circ}\text{C} \pm 3^{\circ}\text{C}$ 1 h ↑ ↓ (温度移行時間: 5 min 以内) (Temperature migration time: 5 min MAX.) 高温側 Dry heat $85^{\circ}\text{C} \pm 2^{\circ}\text{C}$ 1 h サイクル数 Number of cycle : 25 cycle	JIS C 60068-2-14
5	振動 Vibration	振動数範囲 Frequency range : 10 Hz ~ 55 Hz ~ 10 Hz 振幅 Amplitude : 1.5 mm 掃引時間 Time coefficient: 1 min 加振方向 Direction of excitation: X, Y, Z 時間 Time : 各方向 Each direction 2 h	JIS C 60068-2-6
6	衝撃 Shock	加速度 Acceleration : 981 m/s ² [100 G] 正弦半波 Half-sine 作用時間 Interaction time: 6 ms 落下方向 Drop direction: $\pm X, \pm Y, \pm Z$ 落下回数 Number of drop : 各3回 Each 3 times	JIS C 60068-2-27

3.3 Port Definitions

The drive control board schematic is shown as below:



Drive Board Port Description:

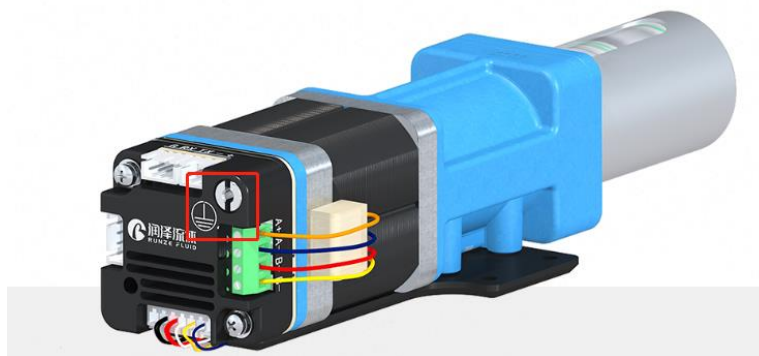
Port Name	Function	Port Name	Function
+	DC24V Positive	A+, A-	Stepper Motor A Phase
-	DC24V Negative	B+, B-	Stepper Motor B Phase

TX	RS232 Negative	I04	I04 Signal
RX	RS232 Data Output	+5V	Power Positive
GND	RS232 Ground	GND	Ground
A	RS485 Communication A	M+	MOS Positive
B	RS485 Communication B	M-	MOS Negative

3.4 Grounding Method Description

1、The ground wire is recommended to be copper with a cross-sectional area not less than 50mm² or galvanized iron wire with a cross-sectional area not less than 100mm².

2、Syringe Pump Grounding Port Location



3、Grounding Method: Unscrew the grounding screw, then screw in the circular washer and tighten the screw. Connect the other end to your equipment's equipotential terminal or the metal casing of the chassis.



Chapter 4 Software Communication

4.1 Address Setting

As part of the communication protocol, the address of each pump must be clearly defined. The user can select one, two (dual devices), four (four devices), or 15 pumps (all devices) by setting the address byte. Each physical address in the address switch corresponds to a hexadecimal value, see the table below.

Address (Hex)	Device
30	Host Address (Main controller, PC, etc.)
31-3F	Device Address, Single Control
41-4F	Device Address, 2 devices simultaneous control
51-5D	Device Address, 4 devices simultaneous control
5F	Device Address, All devices simultaneous control

Table 4-1-1

For example, setting the address of an SY08 device to 0 corresponds to 31H in the RS-232 or RS-485 communication protocol, address 1 corresponds to 32H, etc.

Table 4-1-2, Hexadecimal switch setting addresses (ASCII code), shows the different address switch settings for various devices.

Note: When using the pump: The ASCII code address values from Table 4-1-2 must be used to send commands from the connecting software to the specific device.

Switch Setting	Single Device		Two Devices		Four Devices		Fifteen Devices	
	Hex Addr	ASCII Addr	Hex Addr	ASCII Addr	Hex Addr	ASCII Add	Hex Addr	ASCII Add
0	31	1	41	A	51	Q	5F	-
1	32	2						
2	33	3	43	C				
3	34	4						
4	35	5	45	E	55	U		
5	36	6						
6	37	7	47	G				
7	38	8						
8	39	9	49	I	59	Y		
9	3A	:						
A	3B	;	4B	K				
B	3C	<						
C	3D	=	4D	M	5D	]		
D	3E	>						
E	3F	?	4F	O				
F	Device Self-Test							

Table 4-1-2 Hexadecimal (ASCII) Address Setting Switch

The user can connect all pumps on the pump chain via address 5F, for example, to initialize all pumps simultaneously. Afterwards, individual pump operation can be achieved by switching the address to 31 through 3F.

Note: Multiple address commands cannot be used to detect device status or request status

reports. To achieve this, each pump must be assigned an independent address.

4.2 Communication Protocol

Two protocols are available::

- ◆ OEM Communication Protocol
- ◆ Data Terminal (DT) Protocol

4.2.1 Data Terminal (OEM) Protocol

SY-08 firmware automatically detects the communication protocol

Because the DT protocol does not use sequence numbers or checksums, it can pass through ASCII data terminal sequences. For instructions on using the Microsoft Windows terminal emulator, refer to the section "Using the Data Terminal (DT) Protocol with Microsoft Windows" in this chapter.

Note: The SY-08 system recommends using the OEM protocol for RS-232 and RS-485 communication interfaces, as it adds error checking through the use of checksums and sequence numbers. Once the SY-08 detects the OEM or DT protocol, it will ignore other protocols until the next power cycle.

OEM Communication Protocol

OEM communication is a robust protocol that encompasses automatic recovery from transmission errors. As shown in Table 4-2, it details each setting of the OEM protocol.

Parameter	Setting
Character Format	
Baud Rate	9600 or 38400
Data Bits	8
Parity	NO
Stop Bits	1
Command Block (See OEM Protocol Command Sub-protocol for details)	
1	Start of Text (^B Or 02h)
2	Pump Address
3	Sequence Number
3+n	Data Block (length n)
4+n	End of Text (^C or 03h)
5+n	Checksum

Response Block (See OEM Protocol Command Sub-protocol for details)	
1	Start of Text (^B or 02h)
2	Host Address (0 or 30h)
3	Status Code
3+n	Data Block (length n)
4+n	End of Text (^C or 03h)
5+n	Checksum

Table4-2 OEM Command

OEM Protocol Command Block Characters

The command block characters in the OEM communication protocol are described below. All characters outside the command block are ignored.

When developing an analysis algorithm, the programmer should focus on designing the start of the detection module as the starting point and the checksum (end of text character) response module as the end point.

Start of Text (^B or 02h)

The STX character indicates the start of a command.

Pump Address

Each pump has a specific hexadecimal code.

Sequence Number / Repeat Flag

The sequence number is a single byte that serves as a transmittable sequence number (standard values: 0-7) and a bit flag for repeated operation commands due to communication failures. Because each message takes a different sequence number from the previous one (except in case of repetition), the sequence number can alternate between different values (e.g., 1 and 2). However, if the repeat flag is set, the pump will choose whether to execute or not execute the instruction based on previously received and currently received commands.

Note: If the operator chooses not to use this option, the sequence number can be set to a fixed value of 1 (31H).

Data Block (length n)

The data block consists of data or commands sent to the pump or host. (This is an ASCII string). When the pump responds to a move or [Q] command, the data block length is 0 (i.e., no data string is

present).。

ETX

The ETX character indicates the end of a command string.

Checksum

The checksum is the last byte of the message string. All bytes (excluding line sync check) together form an 8-bit checksum, appended as the last character of the data block. The receiver compares the transmitted value with the calculated value. If the two values match, the transmission is assumed error-free; otherwise, an error is assumed.

OEM Communication Protocol Response Block Characters

The OEM communication protocol response block characters are described below.

Only the unique answer block entries are listed in this section. For common command and response block commands (characters), please refer to the previous "OEM Protocol Command Block Characters" section.

Host Address

The host address is the address of the host system. This value is fixed at 30h (ASCII value "0").

Status and Error Codes

Status and error codes define pump status and signal error conditions. For descriptions of status and error codes, refer to "Error Codes and Pump Status" in this chapter.

4.2.2 Data Terminal (DT) Protocol

The DT protocol can be easily used in any terminal or terminal emulator capable of generating ASCII characters at 9600 baud, 8 bits, and no parity.

Parameter	Setting
Character Format	
Baud Rate	9600 or 38400
Data Bits	8
Parity	None
Stop Bits	1
Command Block (See OEM Protocol Command Sub-protocol for details)	
1	Start of Text (ASCII '/' or 2Fh)
2	Pump Address

2+n	Data Block (length n)
3+n	Carriage Return ([CR] or 0Dh)
Response Block (See "DT Protocol Command Block Characters" for details)	
1	Start of Text (ASCII '/' or 2Fh)
2	Host Address (ASCII "0" or 30h)
3	Status Code
3+n	Data Block (length n)
4+n	End (03h)
5+n	Carriage Return (0Dh)
6+n	Line Feed (0Ah)

表4-2-2 DT Protocol

DT Protocol Command Block Characters

The command block characteristics of the DT communication protocol are described below:

Start Character

The start character indicates the beginning of the message block.

Pump Address

The pump address is an ASCII character specific to each pump.

Data Block (length n)

The data block consists of the ASCII data or commands sent to the pump or host.

End Block

The end character indicates the end of a message block.

DT Protocol Answer Block Characters

The answer block characters comprising the DT communication protocol are described below.

Only unique answer block entries are listed in this section. For more information about commands and response block commands (characters), see the previous section, "OEM Protocol Command Block Characters."

Master Address

The master address is the address of the host system. This should always be 30h (ASCII "0").

Status

The status and error codes define pump status and signal error conditions. See the description of the [Q] command in "Error Codes and Pump Status".

Data Block

This is the response from all Report commands with the exception of the [Q] command.

Carriage Return (0dh)/Newline (0AH to 0CH)

This character terminates the feedback block.

4.2.3 Using DT Protocol with Microsoft Windows

The communication protocol of SY08 can be directly set to DT protocol mode through Windows terminal.

To communicate with the SY08 using Windows, follow these steps:

- 1 Connect the SY08 to a communications port of PC.
- 2 Start the SerialCommV1.3.0 application on the PC.
- 3 Select more serial port settings.
- 4 Select the communication port (such as COM1), the baud rate is 9600, 8 data bits, 1 stop bit, no parity, no flow control
- 5 Click OK and then click to open the serial port
- 6 Set the pump address switch to 0.
- 7 Power on the pump.<http://www.runzeliuti.com>
- 19
- 8 Type /1WR to initialize the pump
- 9 To run the pump, see the commands listed in "Using the SY08 Command Set" in this chapter.

4.3 Using the SY08 Command Set

4.3.1 Precautions for Command Execution

To use the commands properly, keep the following in mind:

- ◆ All commands, except Report commands and most Control commands, must be followed by an [R] (Execute) command

- ◆ The pump can accept a single command or string.

For example:

- A single command such as [A6000R] moves the plunger to position 6000.
- A multi-command string such as [IA6000OA0R] moves the plunger to position 6000, and finally returns the plunger to position 0

- ◆ The pump's command buffer holds a maximum of 255 characters. If a command is sent without the [R] (Execution) command, it is placed into the buffer without being executed. If a second command is sent before the first command is executed, the second command overwrites the first command.

- ◆ Once a command is executed, new commands are not accepted until the sequence is completed. Exceptions to this rule include interruptible (see "T Terminate Command" in this chapter) and Report commands.

- ◆ When a command is sent, the pump answers immediately. If an invalid command has been sent in a command string, or there was an invalid parameter in the command, the pump reports an error immediately. This instruction is not executed regardless of the error.

- ◆ The syringe should not run dry, otherwise it will damage the piston seal.

- ◆ Keep your hand away from the narrow slit in the syringe during pump operation to avoid injury

4.3.2 Pump Configuration Commands

SY-08 pumps are preconfigured at the factory to the default settings. The firmware, however, allows the user to configure the pump to meet his or her specific requirements. Configuration options available to the user include resolution, backlash, baud rate, gastight syringe reset stall current and device address.

N <n> Set Microstep Mode Off/On

The [N] command enables or disables microstepping (fine positioning).

The syntax for this command is:

[N<n>]

where <n> = 0 or 1 (0 is the default)

Value of <n>	Description
0	Normal mode: All positions set and reported in half-steps; all speed settings in half steps/sec and all slopes in half-steps/sec 2.
1	Fine positioning mode: All positions set and reported in micro-steps; all speed settings in half-steps/sec and all slopes in half-steps/sec 2. Maximum cutoff frequency limited to 750 half-steps/sec; maximum on- the-fly set velocity limited to 750 half-steps/sec.
2	Subdivision mode /Micro-step mode: All positions set and reported in micro-steps; all speed settings in micro-steps/sec and all slopes in micro-steps/sec 2.

K<n> Backlash Increments [K]命令设置回吸步数。

The [K] command sets the number of backlash increments.

The syntax for this command is

[K<n>]

where <n> = 0---800 in full step mode (150 is the default),

and <n> = 0---6400 in fine positioning mode (1200 is the default). When the syringe drive motor reverses direction, the carriage will not move until the backlash due to mechanical play within the system is compensated. To provide this compensation, during aspirating, the plunger moves down additional increments, then backs up the set number of backlash increments. This ensures that the plunger is in the correct position to begin a dispense move.

> Set User Data Command

The [>] command loads a byte of user data into non-volatile memory:

[> <n1>, <n2>], where: <n1> is 0---15 (location in non-volatile memory) and

<n2> is 0---255 (data to load into non-volatile memory).

U<n> Write Pump Configuration to Non-Volatile Memory

The [U] command is used to write configuration information to the non-volatile memory. The pumps are configured during the manufacturing process but can be reconfigured at any time with the following [U] commands:

Value<n>	Description
30	Set Non-Volatile Memory Auto Mode
31	Clear Non-Volatile Memory Auto Mode
41	Set RS-232/RS-485 Baud rate to 9600

47	Set RS-232/RS-485 Baud rate to 38400
200	Set the syringe reset stall current
300	Set device address

Figure4-3-2 Write Pump Configuration Command Values

Note: [U] commands take effect upon the pump's next power-up

4.4 Initialization

4.4.1 Initialization

k <n> Syringe Dead Volume Command / Offset Steps after Reset

The [k] command sets the number of increments that the plunger drive is offset from the top of travel. This is to minimize dead volume.

The syntax for this command is: [k<n>]

where:

n = the offset in increments from top of travel

n = 0~800 in full step modes (80 is the default)

n = 0~6400 in fine positioning and microstep modes (640 is the default)\

Under default initializations, the plunger moves upward until it contacts the top of the syringe, causing a forced stop. The plunger then moves downward, leaving a small gap between the syringe seal and the top of the plunger. This small gap was designed so that the Teflon seal does not hit the top of the plunger each time the syringe moves to the "home" position. This maximizes the life of the syringe seal.

The [k] command must be followed by the Initialization command [W]. Each time the unit is powered down, the "k" value will return to the default condition.

For example, to offset 10 increments away from the top of travel, send the following commands:

- k10R
- WR

4.4.2 Initialization Command

W <n1> Initialize Plunger Drive

The [W] command initializes the plunger drive only (commonly used for valveless pumps). Because the valve can't be initialized, only plunger force and/or speed can be set. The default initialization speed is 1400 pulses per second.

n 1 = Set initialization plunger force/speed

-The parameters are described below

W Parameter	Value	Description
<n>	0	Initializes at full plunger force and at default initialization speed (default)
	1	Initializes at half plunger force and at default initialization speed
	2	Initializes at one-third plunger force and at default initialization speed.
	10...40	Initializes at full force and at speed code <n 1 >. See command <S> for a list of speed codes.

4.4.3 z z Simulation of the Plunger Initialization

The [z] command simulates an initialization of the plunger, however, no mechanical initialization occurs. The current position of the plunger is set as the zero (home) position.

This command can be used after a plunger overload error, to regain control of the pump. After recovering from the overload condition using the [z] command to set the current position to 0, and the pump must be reinitialized using the [W] commands to set the true zero position to protect the device.

4.5 Operating Commands

4.5.1 Plunger Movement Commands

A <n> Absolute Position

The [A] command moves the plunger to the absolute position <n>, where <n> = 0...24000 in standard mode and 0...192000 in fine positioning and micro-steps mode.

Command	<n> Parameter Value	Description
A	0-24000	Absolute position in half increments (N=0)
	0-192000	Absolute position in micro-steps (N=1)
	0-192000	Absolute position in micro-steps (N=2)

For example:

- [A300R] moves the syringe plunger to position 300.
- [A6000R] moves the syringe plunger to position 6000

a <n> Absolute Position (Not Busy)

This is the same as the [A] command, except that the status bit within the reply string indicates that the pump is not busy.

P <n> Relative Pickup

The [P] command moves the plunger down the number of increments commanded. The new absolute position is the previous position plus <n>, where

<n> = 0...24000 in standard mode and

<n> = 0...192000 in fine positioning and micro-steps mode

Command	<n> Parameter Value	Description
P	0-24000	Relative position in half increments (N=0)
	0-192000	Relative position in micro-steps (N=1)
	0-192000	Relative position in micro-steps (N=2)

For example:

The syringe plunger is at position 0. [P300] moves the plunger down 300 increments. [P600] moves the plunger down an additional 600 increments to an absolute position of 900.

The [P] command will return error 3 (invalid operand) if the final plunger position is greater than 24000.

p <n> Relative Pickup (Not Busy)

This is the same as the [P] command, except that the status bit of the reply string indicates that the pump is not busy.

D <n> Relative Dispense

The [D] command moves the plunger upward the number of increments commanded. The new absolute position is the previous position minus <n>, where

<n> = 0...24000 in standard mode and

<n> = 0...192000 in fine positioning and micro-steps mode

Command	<n> Parameter Value	Description
D	0-24000	Relative position in half increments (N=0)
	0-192000	Relative position in micro-steps (N=1)
	0-192000	Relative position in micro-steps (N=2)

For example:

The syringe plunger is at position 3000. [D300] will move the plunger up 300 increments to an absolute position of 2700.

The [D] command will return error 3 (invalid operand) if the final plunger position would be less than 0.

d <n> Relative Dispense (Not Busy)

This is the same as the [D] command, except that the status bit of the reply string indicates that the pump is not busy.

4.5.2 Set Commands (Speed and Acceleration)

Set commands are used to control the speed of the plunger. Plunger movement is divided into three phases:

- Ramping Up. Plunger movement begins with the start speed and accelerates with the programmed slope to the constant or top speed.
- Constant or Top Speed. The plunger moves at the constant or top speed. Plunger speed can be programmed in Hz (half-increments/second) or in preprogrammed Set Speeds. The actual time the plunger travels is dependent on the ramping up and down. If the plunger move is short, it may never reach top speed.
- Ramping Down. The plunger will decelerate based on the programmed slope. To enhance fluid breakoff, the Cutoff command ([c]) can be used to define the end speed of the plunger just before it stops.

Note: The Cutoff command is only active in a dispense move. During aspiration the move will end at the start speed [v].

For each plunger move, the firmware calculates how many increments the plunger must travel during each phase in order to move the total number of increments commanded. If the plunger is moving at a rate less than 900 Hz, the pump automatically micro-steps to reduce the pulsation.

The top speed can be changed on the fly (while the plunger is moving) using the [v] command, providing the top speed is less than or equal to the start speed. Ramps are not included in on-the-fly speed changes; therefore, large speed changes (100 Hz to 1000 Hz) are not recommended.

Note: Unless the top speed is less than or equal to the start or cutoff speed, always program the pump in order of the move: start speed [v], top speed [V], cutoff speed [c].

- **Changing Speed on the Fly**

Speed changes can be made while the syringe plunger is moving. This is called "changing speed on the fly."

Speeds can be decreased or increased between 1 and 12000Hz (i.e., in the fine positioning region)

- **To change speed on the fly:**

1. Issue speed commands with identical start and top speeds (e.g., [v100V100]), followed by a Plunger Move command. Ramping is not allowed in on-the-fly changes.

2. Issue a new top speed in the range 5 to 750 (e.g. [V600]) while the plunger is moving, to change the speed on the fly.

Note: When the move completes, speed values revert to original values (i.e., value sent on-the-fly is temporary).

L <n> Set Slope

During the beginning and end of a move, the plunger speed ramps up and down respectively. The ramp is programmed using the Slope command. It is calculated as $\text{<n>} \times 2.5 \text{ pulses/sec}^2$. The syntax for this command is:

[L<n>]

where <n> = 1...20 (14 is the default)

In normal or fine positioning modes (N0, N1) pulses are in half steps. In micro-step mode (N2) pulses are in micro-steps.

The corresponding slopes in pulses/sec² are listed below.

Slope Code	Pulses/sec ² (KHz)	Slope Code	Pulses/sec ² (KHz)
1	2500	11	27500
2	5000	12	30000
3	7500	13	32500
4	10000	14	35000
5	12500	15	37500
6	15000	16	40000
7	17500	17	42500
8	20000	18	45000
9	22500	19	47500
10	25000	20	50000

v <n> Set Start Speed

The [v] command sets the speed at which the plunger begins its movement, in pulses/sec. The plunger will then ramp up (slope) to the top speed. The start speed should always be less than the top speed

Command	<n> Parameter Value	Default Value	Description
v	1-1000	900	Set start speed in pulses/sec.

V <n> Set Top Speed

The [V] command sets the top speed in pulses/second. This command may be sent while a command string is already executing. (See section on Changing Speed on the Fly, earlier in this chapter.)

Command	<n> Parameter Value	Default Value	Description
V	1-6000	1400	Set top speed in pulses/sec.

Note: According to the different specifications of the syringe, the value can be adjusted, but we can only guarantee that 1-6000 will run perfectly on the syringe we provide. For the speed set higher than V6000, Users must determine the appropriate speeds for their actual applications.

S <n> Set Speed

The [S] command sets a predefined top plunger speed, in pulses/sec. As <n> increases, the plunger speed decreases

Command	<n> Parameter Value	Default Value	Description
S	0-40	11	Set plunger drive speed in pulses/sec.

These speed settings do not cover the full range of speeds the plunger can travel. They are commonly used speeds provided for the convenience of the user. All times are approximate and will vary with different ramp speeds and cutoffs. For information on determining timing for specific applications, see Appendix B, "Plunger Information".

The [S] command sets top speed without changing start speed, slope, and cutoff speed, except under the following conditions:

- If the start speed is higher than the (new) top speed, start speed is changed to equal the top speed.
- If the cutoff speed is higher than the (new) top speed, cutoff speed is changed to equal the top speed.

Speed codes, the Hz (pulses/second) equivalent, and seconds per stroke are listed below.

Seconds/stroke values are based on default ramping

Speed Code	Value (pulses/sec)	Seconds/stroke (N=0, N=1)	Seconds/stroke (N=2)
0	6000	1.25	8.25
1	5600	1.30	8.80
2	5000	1.39	9.79
3	4400	1.52	11.1
4	3800	1.71	12.8
5	3200	1.97	15.1
6	2600	2.37	18.5
7	2200	2.77	21.9
8	2000	3.03	24.0
9	1800	3.36	26.7
10	1600	3.77	30.0
11	1400	4.30	34.3
12	1200	5.00	40.0

13	1000	6.00	48.0
14	800	7.50	60.0
15	600	10.00	80.0
16	400	15.00	120
17	200	30.00	240
18	190	31.58	253
19	180	33.33	267
20	170	35.29	282
21	160	37.50	300
22	150	40.00	320
23	140	42.86	343
24	130	46.15	369
25	120	50.00	400
26	110	54.55	436
27	100	60.00	480
28	90	66.67	533
29	80	75.00	600
30	70	85.71	686
31	60	100.00	800
32	50	120.00	960
33	40	150.00	1200
34	30	200.00	1600
35	20	300.00	2400
36	18	333.33	2667
37	16	375.00	3000
38	14	428.00	3429
39	12	500.00	4000
40	10	600.00	4800

Note: To achieve maximum stroke time of 80 minutes for N=0, N=1 or 640 minutes for N=2, At this time, the [S] speed code is not available, and the [V1] instruction is required for programming.

c <n> Cutoff Speed in Pulses/Second

The [c] command sets the speed at which the plunger ends its movement, in pulses/sec. The plunger will ramp down (slope) from the peak speed. The [c] command overwrites the [C] command.

Command	<n> Parameter Value	Default Value	Description
c	1-5400	900	Set cutoff speed in half-steps/sec (N=0, N=1)
	1-1500	900	Set cutoff speed in micro-steps/sec (N=2)

Note: [c] is only valid in a dispense move. During aspiration, [c] = [v]

4.5.3 Control Commands

R Execute Command

The [R] command tells the pump to execute a new or previously loaded but unexecuted command string. This command will also cause the resumption of a halted ("H") or terminated ("T") command string.

Commands containing [R] at the end of the string will execute immediately. If the command or program string is sent without the [R], it is placed in the command buffer.

Sending the [R] alone will execute the last unexecuted command in the buffer. Sending another [R] will not repeat the program string (i.e., the string has been executed).

X Execute the Last Command

The [X] command repeats the last executed command or program string.

G <n> Repeat Command Sequence

This command repeats a command or program string the specified number of times. If a GR or a GOR is sent, the sequence is repeated until a Terminate command [T] is issued. The G command can be used to nest up to 10 loops and can be repeated up to 48,000 times.

The syntax for this command is:

[G<n>]

where <n> = 0...48000

For example, [A3000A0G10R] moves the syringe plunger to position 3000 then back to position 0. This sequence is repeated 10 times.

g Mark the Start of a Repeat Sequence

The [g] command is used in conjunction with the [G] command. The [g] command marks the beginning of a repeat sequence (loop) that occurs within a program string (i.e., the entire string is not repeated). Both the [g] and [G] commands can be used to nest up to 10 loops.

Table 3-5, Example Program String, shows the various segments of the command string [A0gP50gP100D100G10G5R].

Command Segment	Description
A0	Move plunger to position 0
g	Outer loop start
P50	Move plunger down 50 increments.
g	Inner loop start
P100	Move plunger down 100 increments
D100	Move plunger up 100 increments.
G10	Inner loop, repeat 10 times.
G5	Outer loop, repeat 5 times

R	Execute command string
---	------------------------

Figure 3-5 Example Program String

M <n> Delay Command Execution

The [M] command delays execution of a command in milliseconds to the closest multiple of five. This command is typically used to allow time for liquid in the syringe and tubing to stop oscillating, thereby enhancing precision. The syntax for this command is:

[M<n>]

where <n> = 0...30,000 milliseconds (5 is the default)

H <n> Halt Command Execution

The [H] command is used within a program string to halt execution of the string. To resume execution, an [R] command or TTL signal must be sent.

The syntax for this command is:

[H<n>]

where <n> = 0...2

Two TTL inputs are available, input 1 (P11 pin 7) and input 2 (P11 pin 8). They control execution as follows:

<n> = 0 Waits for [R] or either input 1 or 2 to go low

<n> = 1 Waits for [R] or input 1 to go low

<n> = 2 Waits for [R] or input 2 to go low

Note: If the value of <n> is not specified, <n> defaults to 0.

The status of the TTL input lines can also be read by using [?13] and [?14]. These commands are described in "Report Commands" later in this chapter

T Terminate Command

The [T] command terminates plunger moves in progress ([A], [a], [P], [p], [D] and [d]), control loops, and delays [M].

Note: The [T] command will not terminate Valve Move commands. The [T] command will terminate both single commands and program strings. If a program string is terminated before completion, the [R] (Execution)

command will resume the program string. If the command was terminated due to a problem or error, the pump must be reinitialized.

Caution! When a plunger move is terminated, lost increments may result. Reinitialization is recommended following termination.

For "H" command and "T" command: In the string containing "H" command, the execution of the string will stop when the execution command encounters the "H" command, and the "R" command should be sent to execute the following instructions of the "H" command. When the subsequent instructions are executed, sending the "R" command will re-execute this instruction containing the "H" command; For a command that is being executed, sending the "T" command will terminate the movement being executed, and then send "R" command will re-execute the remaining string command.

J <n> External Control Output

The [J] command sets the TTL output lines.

The syntax for this command is:

[J<n>]

where <n> = 0...7 (0 is the default)

DB15 provides three external control outputs on P11 (pins 13, 14, and 15) that correspond to outputs 1, 2, and 3. They are controlled as shown in the following table:

Command	Output 1 (pin 13)	Output 2 (pin 14)	Output 3 (pin 15)
J0	0	0	0
J1	1	0	0
J2	0	1	0
J3	1	1	0
J4	0	0	1
J5	1	0	1
J6	0	1	1
J7	1	1	1

0 = low; for example, GND

1 = high; for example, +5V DC

U200 Set Reset Stall Current

[U200] command sets the reset stall current

[U200<n>] where <n> = 1...31

U300<n> Set Device Address

[U300] command set device address. This instruction can not be queried after setting the address.

[U300, <n>] where <n>=1...15

4.5.4 Non-Volatile Memory (EEPROM)

The non-volatile memory in the SY08 can store a program string thus providing the user with the option of computer-free operation. The pump can be configured to run stored programs using the U<30>

command. See “Pump Configuration Commands” earlier in this chapter.

s < n > Load Program String into Non-Volatile Memory

The [s] command is placed at the beginning of a program string to load the string into the non-volatile memory. The syntax for this command is:

[s<n>]

where <n> = 0…14

Up to 15 program strings (numbered 0 through 14) can be loaded into the non-volatile memory. Each string can use up to 128 characters.

For example, [A3000A0R] requires 8 bytes.

Example Program String: [s8WS1gA3000A0GR]

Command Segment	Description
s8	Loads string into program 8 of non-volatile memory (Address switch position 8)
W	Initializes pump
S1	Sets plunger speed
g	Marks start of loop
A3000	Moves plunger to position 3000
A0	Moves plunger to position 0
G	Endlessly repeats loop
R	Executes command string

e < n > Execute Non-Volatile Memory Program String

Non-volatile memory command strings are executed by sending an [e] command. The executing program string can be terminated using the [T] command.

[e<n>]

where <n> = 0…14 (the string number)

Note: An Initialization command should always be included in the non-volatile memory command string if the pump will be used in standalone mode.

U30 Set to Run in Non-Volatile Memory Auto Mode

The [U30] command sets the “Run in Non-Volatile Memory Auto Mode” flag in the non-volatile memory and begins operating the pump in standalone mode. The pump will run one of 15 command strings <n>.

where <n> = 0…E

U31 Clear Running in Non-Volatile Memory

The [U31] command clears the “Run in Non-Volatile Memory Auto Mode” flag in the EEPROM and begins operating in the default mode.

Linking Program Strings in the Non-Volatile Memory

Non-volatile memory program strings can be linked by ending one program string with an [e] command that refers to a second program string.

Example Program Strings:

[s1WgA3000A0G5e2R]

[s2gA3000gHD300G10GR]

The first string loads an initialization and prime sequence into program 1 of the non-volatile memory (address switch position 1). It then links to string 2 in the non-volatile memory.

The second string loads an aspirate and dispense sequence into program 2 of the non-volatile memory. The second non-volatile memory program string fills the syringe, then performs 10 dispenses of 300 increments each. The dispenses are triggered by an [R] command. This string is repeated endlessly until the pump is powered down.

On power-up the pump will automatically initialize, prime and perform the multiple dispenses until it is again powered down.

4.5.5 Report Commands

Report commands do not require an [R] command.

? Report Absolute Plunger Position

The [?] command reports the absolute position of the plunger in half-steps[N0] or in micro-steps [N1, N2].

? 1 Report Start Speed

The [?1] command reports the start speed in pulses/sec [1…1000]

? 2 Report Top Speed

The [?2] command reports the top speed in pulses/sec [1…12000]

? 3 Report Cutoff Speed

The [?3] command reports the cutoff speed in pulses/sec [1…5400]

? 4 Report Actual Position of Plunger

The [?4] command reports the plunger encoder position in increments.

? 10 or F Report Command Buffer Status

The [?10] or [F] command reports the command buffer status. If the buffer is empty, the pump returns

status code 0. If the buffer is not empty, the pump returns a 1. If a program string is sent to the pump without an [R] command, the string is loaded into the buffer and the buffer status becomes 1. An [R] command will then execute the command stored in the buffer.

0 = empty

1 = commands in buffer

? 12 Report Number of Backlash Increments

The [?12] command reports the number of backlash increments as set by the "K" command.

?13 Report Status of Auxiliary Input #1 (DB15, Pin 7)

0 = low

1 = high

?14 Report Status of Auxiliary Input #2 (DB15, Pin 8)

0 = low

1 = high

? 15 Report Number of Pump Initializations

Command [?15] reports the number of pump initializations. This value cannot be reset.

? 16 Report Number of Plunger Movements

Command [?16] reports the number of plunger moves. This value cannot be reset.

? 24 Report the steps to reset the stall /Zero Gap increments

The [?24] command reports the value set by the "k" command. The value reported is in half steps (N=0) or in micro-steps (N=1, N=2).

? 25 Report Slope Code Setting

The [?25] command reports the slope code setting as set by the "L" command.

? 28 Report Current Mode

The [?28] command reports the current mode as set by the "N" command (normal, fine positioning, or micro-steps).

? 29 or Q Report the Device Status

The [?29] command reports device status (error code).

? 76 Report Pump Configuration

The [?76] command reports pump configuration in ASCII text.

? 200 Verify conf file

[?200] Query conf file checksum, and the same specification of the product checksum must be exactly the same.

? 201 Query log

[?201]log is used to record the current device status, The log can be queried only when there is an error again, normally, the log is 0.

? 202 Query sequence number

[?202] can be used to query the sequence number of the current device, and the sequence number of each device is unique.

?203 Query encoder

[?203] value= $n / (2 \times 200) \times 920$ n: The value of the plunger from the zero point.

? 300-? 314 Query the program string of s0-s14

[?300] Query the program string written in s0

* Report Voltage

The [*] command reports the value of the device power supply. The value is multiplied by 10. For example, if $V = 24.0$ VDC, the * command reports 240

< Report User Data

The [<] command returns the value of user data stored in the EEPROM. The value <n> is between 0 and 15; 0 is the default.

4.6.1 Report Command

Bit 5 is the status bit. It indicates when the pump is busy or not busy. The designations for bit 5 are listed below.

Status Bit 5	Description
$X = 1$	Pump is ready to accept new commands.
$X = 0$	Pump is busy and will only accept Report and Terminate commands.

In response to uppercase Move commands ([A], [P] and [D]), the [Q] command reports that the pump is busy. In response to lowercase Move commands ([a], [p] and [d]), the [Q] command reports that the pump is not busy. Additionally, commands addressed to multiple pumps at once cannot be used to obtain pump status; pumps must be queried separately.

Note: Although the answer block for other commands contains a status bit, it should not be used for determining pump status. A [Q] command is the only valid method to determine if the pump is busy. The error information in the status byte of the answer block is always valid.

4.6.2 Error Codes

Error codes describe problem conditions that may be detected in the SY-08 (excluding error code

0). Error codes are returned in the least significant four bits of the status byte. If an error occurs, the pump stops executing commands, clears the command buffer, and inserts the error code into the status byte.

Some errors continue to appear, such as syringe overloads, until they are cleared by the Initialization command. On a plunger overload, the device will not execute another valve or syringe Move command until it is reinitialized. The last error has precedence in the status byte. For example, if a command overflow occurs, an error 15 results. If the next command causes an error #3, the status byte reflects the error #3 (invalid operand).

Error Code	Description
0 (00h)	Error Free Condition.
1 (01h)	Initialization error. This error occurs when the pump fails to initialize. Check for blockages and loose connections before attempting to reinitialize. The pump will not accept commands until it has been successfully initialized. This error can only be cleared by successfully initializing the pump.
2 (02h)	Invalid Command. This error occurs when an unrecognized command is issued. Correct the command and operation will continue normally
3 (03h)	Invalid Operand. This error occurs when an invalid parameter (<n>) is given with a command. Correct the parameter and pump operation will continue normally
6 (06h)	EEPROM Failure. This error occurs when the EEPROM is faulty. If you receive this error, please call SY08 Systems Technical Service.
7 (07h)	Device Not Initialized. This error occurs when the pump is not initialized. To clear the error, initialize the pump.
8 (08h)	Internal failure. If this error occurs, please call SY08 Systems Technical Services.
9 (09h)	Plunger Overload. This error occurs when movement of the syringe plunger is blocked by excessive backpressure. The pump must be reinitialized before normal operation can resume. This error can only be cleared by reinitializing the pump.
11 (0Bh)	Plunger Move Not Allowed. When the remaining value of the plunger is less than the value to be sent, the Plunger Movement commands are not allowed.
12 (0Ch)	Internal failure. If this error occurs, please call SY-08 Systems Technical Services.
14 (0Eh)	A/D converter failure. This error occurs when the internal A/D converter is faulty. If this error occurs, please call SY08 Systems Technical Services.
15 (0Fh)	Command Overflow. This error occurs when action commands are sent to the pump before it has completed the current action. Commands in the buffer must be executed before more commands can be sent.

4.6.3 Error Types

The pump handles errors differently, depending on the error type. There are four

error types, which are described below.

Immediate Errors

These include “Invalid Command” (error 2), “Invalid Operand” (error 3). After the command is sent, the answer block immediately returns an error. Once a valid command is sent, the pump will continue to function normally. Since the [Q] command is a valid command, the pump will not return an error. In this case, the [Q] command is not required.

***Note:** There is no need to reinitialize the pump following this error type.*

Initialization Errors

These include “Initialization errors” (error 1) and “Device not Initialized” (error 7). If the pump fails to initialize or if an Initialization command has not been sent, subsequent commands will not be executed.

To ensure that the pump initializes successfully, send a [Q] command after the Initialization command.

- If the [Q] command indicates both a successful initialization and that the pump is ready, subsequent Move commands can be sent.
- If the [Q] command indicates the pump has not initialized, the pump must be reinitialized until the [Q] command indicates successful initialization.
- If initialization is not successful, a “Device Not Initialized” error is returned as soon as the next Move command is sent. A successful reinitialization must be executed before subsequent commands can be sent.

Overload Errors

It means the “Plunger Overload” error (errors 9). If the pump returns a plunger overload, the pump must be reinitialized before continuing. If another command is sent without reinitializing the pump, another overload error will be returned when the next Move command is issued. The [Q] command clears the error; however, if a successful initialization has not occurred, an initialization error is returned.

Command Overflow Error

This is error 15, and it occurs if a Move command or Set command (except [V]) is sent while the plunger is moving. The pump ignores the command and issues an error 15. The [Q] command allows the controller to determine when the command is complete and the pump is ready to accept new commands.

***Note:** There is no need to reinitialize the pump following this error type.*

Report commands, Control commands, and the Top Speed command [V] will not return an error 15. Report and Control commands are considered valid commands during a Move. Because the pump can change speed while the plunger is moving in the 1-12000 pulses/sec range, the [V] commands will not return a “Command Overflow” error.

***Caution!** All errors reported by the pump should be captured by the user software and the physical cause corrected before continuing operation. Failure to do so may result in damage to the pump or adversely affected pump performance, and void the warranty.*

Status Byte	Hex # if Bit 5 =		Dec # if Bit 5 =		Error Code	Status Byte
7 6 5 4 3 2 1 0	0	or 1	0	or 1	Number	Error
0 1 X 0 0 0 0 0	40H	60H	64	96	0	No Error
0 1 X 0 0 0 0 1	41H	61H	65	97	1	Initialization
0 1 X 0 0 0 1 0	42H	62H	66	98	2	Invalid Command
0 1 X 0 0 0 1 1	43H	63H	67	99	3	Invalid Operand
0 1 X 0 0 1 1 0	46H	66H	70	102	6	EEPROM Failure
0 1 X 0 0 1 1 1	47H	67H	71	103	7	Device not Initialized
0 1 X 0 1 0 0 1	49H	69H	73	105	9	Plunger Overload
0 1 X 0 1 0 1 1	4BH	6BH	75	107	11	Plunger Move Not Allowed
0 1 X 0 1 1 0 0	4CH	6CH	76	108	12	Internal Failure
0 1 X 0 1 1 1 0	4EH	6EH	78	110	14	A/D converter failure
0 1 X 0 0 0 0 0	4FH	6FH	79	111	15	Command Overflow

Error Reporting Examples	
[A7000R]	Does not move the plunger and reports a “No Error” status; when queried ([Q] command), returns error. A second try returns error 3 (67)
[P6000P600R]	Moves to position 6000, then stops. A [Q] command returns an error.
[t2000R]	Returns an invalid command error immediately. The pump status is “Not Busy”
[A6000t2000R]	Returns an invalid command error immediately. The pump status is “Not Busy.”

Chapter 5 Common Problems & Solutions

1	Not working when powered on	The working voltage is not in the acceptable range	Check whether the actual voltage deviates from the rated voltage
		The connection is loose or disconnected	Manually check whether the connection is good, or check the line with a multimeter
2	Unable to aspirate or aspirate properly	The pipe system is not tightly sealed	Check whether the joint is tight
		The aspirating pipe is blocked	Clean and dredge the pipe
		The aspirating valve or the dispensing valve is blocked by debris	Clear the debris
3	Bubbles	Air leakage in aspirating pipe	Find the leak and eliminate it
		The inlet and outlet pipe joints are not tightly sealed	Replace the gasket and tighten the pipe joint

		Gasket broken	Replace the gasket
		Excessive fluid pipe diameter variation	The diameter of the fluid path should be as consistent as possible
4	Pump stuck	Optocoupler is not triggered	Check the optocoupler wiring (refer to the optocoupler wiring method)
		Optocoupler is burned out	Replace optocoupler
		Reverse connection of motor wires	Switch any phase of the motor wires
5	Motor overheated	Drive voltage is too large	Adjust voltage
		Drive current is too large	Adjust current
6	Abnormal sound of pump operation	Motor running speed is too high or too low	Adjust the motor speed to a suitable value
		There are crystals in the pump head	Cleaning steps are required after the machine runs or before it starts
7	Poor sampling accuracy	The pipe system is not tightly sealed	Check whether the joint is tight
		There are bubbles in the pipe	Refer to troubleshooting method of above point 3

Chapter 6 Quick Command

A Communication Commands

Command Type	Command	Valid/Invalid
Initialization	W	Valid
Initialization	Z	Valid
Plunger Movement	A, a, P, p, D, d	Valid
Set	S, V, v, c, L, K, k	Valid
Command for Firmware micro-steps operation	N	Valid
Control	G, g, M, H	Valid
Control	X	Valid

Control	R	Valid
Control	T	Valid
Control	Clear loaded command	Valid
Control	J, s, e, U	Valid
Report	?0 through ?314	Valid
Report	F	Valid
Report	&	Valid
Report	Q	Valid
Report	#	Valid
Report	%	Valid
Report	*	Valid

B Command Quick Reference

B.1 Pump Configuration Commands

Command	Values of <n>	Description
N	0 = fine positioning mode off	Enables or disables micro-stepping or fine positioning mode
	1 = fine positioning mode on	
	2 = micro-step mode on	
U	30 = Set Non-Volatile Memory Auto Mode	Writes configuration information to non-volatile memory
	31 = Clear Non-Volatile Memory Mode	
	41 = Set RS baud rate to 9600	
	47 = Set RS baud rate to 38400	
	200= Set piston reset stall current (1-31, default 5)	
	300= Set device address (1-15, default 1)	
K	0...800 in full step mode (default 150)	Sets number of backlash increments.
	0...6400 in fine positioning mode (default 1200)	

B.2 Initialization Commands

Command	Values of <n>	Description
W	<n1>	Initializes the plunger drive only (commonly used for valveless pumps).
	0 = initializes at full plunger force	
	1 = initializes at half plunger force	
	2 = initializes at one-third plunger force	
	10-40 = initializes at the defined speed	

Z		Simulates initialization and sets the current position of the plunger as the home position
K	0...800 in standard mode (80 default)	Set zero gap (stall steps after reset)
	0...6400 in fine positioning or micro-step mode (640 default)	

B.3 Plunger Movement Commands / Status Bit Report

Command	Value of <n>	Description	Status
A <n>	0-6000, 0-48,000 in fine positioning or micro-step mode	[A] Absolute Position	Busy
a <n>	0-6000, 0-48,000 in fine positioning or micro-step mode	[a] Absolute Position	Ready
P <n>	0-6000, 0-48,000 in fine positioning or micro-step mode	Relative [P] pickup	Busy
p <n>	0-6000, 0-48,000 in fine positioning or micro-step mode	Relative [p] pickup	Ready
D <n>	0-6000, 0-48,000 in fine positioning or micro-step mode	Relative [D] dispense	Busy
d <n>	0-6000, 0-48,000 in fine positioning or micro-step mode	Relative [d] dispense	Ready

B.4 Non-Volatile Memory (EEPROM) Commands

Description	Value of <n>	Description
s <n>	0...14	Loads command string in Non-Volatile Memory
e <n>	0...14	Executes Non-Volatile Memory command string
U31		Clears "Run from Non-Volatile Memory" flag.
U30		Sets "Run from Non-Volatile Memory" flag

B.5 Report Command

Command	Description
Q	Query, Status and Error Bytes
?	Report absolute plunger position
?1	Report start speed
?2	Report top speed
?3	Report cutoff speed

?4	Report actual position of plunger
?10 或 F	Report command buffer status
?12	Report number of backlash increments
?13	Report status of input #1 (P11, Pin7)
?14	Report status of input #2 (P11, Pin 8)
?15	Report number of pump initializations
?16	Report number of plunger movements
?20 或#	Report firmware checksum
?23 或&	Report firmware version
?24	Report number of backlash increments
?29	Same as Q (query, status and error bytes)
?76	Report pump configuration
*	Report supply voltage
< <n>	Report user data (0...15)

B.6 Error Codes and Status Byte

Status Byte	Hex # if Bit 5 =		Dec # if Bit 5 =		Error Code	Status Byte
7 6 5 4 3 2 1 0	0	or 1	0	or 1	Number	Description
0 1 X 0 0 0 0 0	40h	60h	64	96	0	No error
0 1 X 0 0 0 0 1	41h	61h	65	97	1	Initialization
0 1 X 0 0 0 1 0	42h	62h	66	98	2	Invalid command
0 1 X 0 0 0 1 1	43h	63h	67	99	3	Invalid operand
0 1 X 0 0 1 1 0	46h	66h	70	102	6	EEPROM failure
0 1 X 0 0 1 1 1	47h	67h	71	103	7	Device not initialized
0 1 X 0 1 0 0 1	49h	69h	73	105	9	Plunger overload
0 1 X 0 1 0 1 1	4Bh	6Bh	75	107	11	Plunger move not allowed
0 1 X 0 1 1 0 0	4Ch	6Ch	76	108	12	Internal failure
0 1 X 0 1 1 1 0	4Eh	6Eh	78	110	14	A/D converter failure
0 1 X 0 1 1 1 1	4Fh	6Fh	79	111	15	Command overflow

C Switching Protocol

SY08 has two protocols, RUNZE and ASCII protocol. If you need to switch protocols, you can refer to the following steps (both need to be powered off after switching)

1.1 Burn-in Protocol

1.1.1 If the default programmed command is the ASCII command, it will query the following return code

Send→ 91 EB 07 00 00 00 00 00 00 D5 28 FF F8

Receive← 91 EB 0A 01 00 02 C4 47 0B 00

0A parameter definition: 0A stands for ASC II

1.1.2 If the default programmed command is the RUNZE command, it will query the following return code

Send→ 91 EB 07 00 00 00 00 00 00 D5 28 FF F8

Receive← 91 EB 02 01 00 63 D7 F6 AB 00

02 parameter definition: 02 stands for RUZNE

1.2 Switching protocol (must use RS232 port to switch the address, and must be powered off after switching)

1.2.1 If RUNZE command is required, the following code can be used to switch the address

Set the address to 0x0802 (RUNZE)

Send→ 91 EB 03 00 00 02 08 00 00 0C 0A 69 69

Receive← 91 EB 00 01 00 0D 5A 8A 40 00

The values queried after the setting are as follows.

Send→ 91 EB 07 00 00 00 00 00 00 D5 28 FF F8

Receive← 91 EB 02 01 00 63 D7 F6 AB 00

1.2.2 If ASC II command is required, the following code can be used to switch the address

Send→ 91 EB 03 00 00 0A 08 00 00 6D 19 D8 C9

Receive← 91 EB 00 01 00 0D 5A 8A 40 00

The values queried after the setting are as follows.

Send→ 91 EB 07 00 00 00 00 00 00 D5 28 FF F8

Receive← 91 EB 0A 01 00 02 C4 47 0B 00

Chapter 7 Version Description

Version	Description	Release Date
V1.0	Initial Version	
V1.2	Change of cover	2022.6.24
V1.3	Add version description and change technical support contact	2022.6.27
V1.4	Replace the motor manual	2022.7.27
V1.5	Delete CAN communication Add grounding instructions	2023.05.23

	Add back pressure test data	
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Chapter8 Technical Services

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