润泽流体 RUNZE FLUID

Key Components for Analytical Instrument
Ecological Closed-loop Supplier

V1.1

SY-03B T-DK ASCII Code Manual

南京润泽流体控制设备有限公司
NANJING RUNZE FLUID CONTROL EQUIPMENT CO.,LTD

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Chapter 1 Product Introduction

1.1 Company Overview

Nanjing Runze Fluid Control Equipment Co., Ltd., established in 2014, is a national high-tech enterprise focusing on R&D and production of fluid accessories for numerous analytical instruments. We engineer, manufacture and market differentiated standard products such as syringe pumps, multiport valves, peristaltic pumps, gastight syringes, plastic fittings, etc. We persevere in providing our customers with best quality and service in the fields of environmental monitoring, biopharmaceuticals, medical equipment, industrial automation and laboratory instruments, etc.

In past years, we have accumulated rich technical and practical experience that bring us honors of ISO9001, National High-tech Enterprise, Jiangsu Province Private Science and Technology Enterprise, 5A Bank Credit Assessment, 44 technical patents and software copyright including 2 invention patents, 27 utility model patents, 13 design patents, 2 software copyright.

1.2 SY03B-T-DK Features at-a-Glance

Congratulations on your purchase of the SY03B-T-DK syringe pump from Runze Fluid Tech Company.

SY03B-T-DK Syringe Pump is a fully programmable, open frame, precision liquid handling pump module, designed for applications in the 25 µL to 25 mL range. It is controlled by an external computer or microprocessor and automates pipetting, diluting, and dispensing functions.

1.3 Notice

1.3.1 Notices and Symbols

Warning Notices Used in this Manual

The triangle warning symbol indicates the possibility of personal injury if the instructions are not followed

Specific symbols indicate the hazard to which a user is exposed. A few examples follow:

Toxic Substance

Chemical or biological hazards can be associated with the substances used or the samples

processed with the SY03B-T-DK . Always be aware of possible hazards associated with these substances.

Explosion and Fire Hazard

Never process explosive or highly flammable liquids with the SY03B-T-DK .

Pinch Point, Mechanical Hazards

Automatically moving parts may cause injuries (crushing, piercing)

Attention

The general "Read This" symbol indicates the possibility of equipment damage, malfunction or incorrect process results, if instructions are not followed.

1. The device needs to be reset with /1ZR to power up for the next command operation; if any abnormality occurs during use, please also use the /1ZR command to reset.

2. the [z] instruction simulates piston initialization, but no mechanical initialization occurs.

This instruction can be used to regain control of the pump after an unexpected power failure of the unit. Using the [z] instruction after recovering from a power failure condition sets the current position to the 0 (Home) position. It is possible to continue to control the pump after using the [z] instruction, but to protect the unit, it is recommended that the initialization instruction Z<N1,N2,N3> or Y<N1,N2,N3> be used to reset the true 0 (Home) position.

3. Please make sure the voltage is compatible with the standard voltage of the instrument.

4. Please use the original serial cable of this product to connect with the power supply.

5. The three communication modes (RS232, RS485, CAN bus) of this product are in non-isolated mode.

6. If there are vacant holes, please use matching plugs and washers to plug tightly, so as to avoid impurities and airflow into the valve body, affecting the normal use. 7.

7. Do not disassemble the parts of the product, torn tamper-evident labels are not warranted. 8.

8. When operating the software, please refer to the software operation instructions and communication protocols, and do not make up unauthorized data input. 9.

9. Please dispose of the instrument according to the regulations on the disposal of instrument and equipment waste, and dispose of the waste after using the machine according to the requirements of national environmental protection. Users should not dispose of them at will.

10. CAUTION: When the SY03B-T-DK is used incorrectly, there is a risk to the user, property and the environment. To ensure proper operation, follow the tips below:

Ensure that liquid flows between the syringe and the valve. Failure to do so can easily damage the sealing surfaces.

Ensure that the instrument is powered off before connecting or disconnecting the pump.

1.3.2 ESD Considerations

SY03B-T-DK is an electronic device that is sensitive to electrostatic discharge (ESD). Static discharge from clothing or other fixtures can damage these components. To prevent premature failure of pump components, use good ESD practices when handling the SY03B-T-DK . These include, but are not limited to:

- Using wrist or ankle strap
- ESD mats or worktables
- ESD wax on the floor

Chapter 2 Product Introduction

2.1 Product Features

- For syringe sizes: 50μl ~ 5ml
- Valve head can be replaced independently, good compatibility
- Communication interface: RS232/RS485/CAN
- Programmable acceleration and deceleration curves
- Programmable gap compensation
- Missing step detection

2.2 Optional Syringe

RUNZE TK-60 Series Syringe（60mm Stroke）

Specification						
50ul	100ul	250ul	500μl	1ml	2.5ml	5ml

2.3 Technical Parameters

Item	Name	Parameter
Piston	Rated stroke	60mm
	Resolution	Standard mode: 6000; Microstep mode: 48000
Syringe	Syringe Configuration	50μL、100μL、250μL、500μL、1ml、1.25ml、2.5ml、5ml
	Liquid volume accuracy	Accuracy ≤1% (rated stroke)
	Liquid volume precision	Repeatability accuracy 0.3%-0.5% (rated stroke)
	Maximum speed	900rpm
	Line speed	0.01-60mm/s
	Rated stroke run time	1s-6000s (Test medium is pure water)
	Control Resolution/Minimum Feed Accuracy	0.01mm/1 step
Solenoid Valve	Valve Type	Three way solenoid valve
	Valve Thread	1/4-28UNF
	Diaphragm Material	FKM
	Valve Body Material	PPS、PEEK
	Maximum pressure	0.2Mpa
Power	Voltage	Rated Voltage: 24V DC±5%

	Current	3.0A
Interface	type	RS-232、RS-485、CAN
		9600/38400(RS232/RS485)
Communication	Address	Up to 15 individual addresses available
	Communication	Data terminal
Firmware	Programmable acceleration/deceleration, termination of movement, programmable piston speed, diagnostic queryable error, programmable gap compensation, absolute or relative position, rapid speed change, programmable non-volatile memory	
Signal input	2-way TTL level input	
Signal output	3-way TTL signal input & one-way MOS output	
Environment	Operating temperature	5-55C°
	Storage temperature	15-65C°
Max. Pressure	0.2Mpa	
Wetted material	Borosilicate glass, FKM, PTFE, PEEK(PPS)	
Actuator	Lead screw	
Weight	3.8kg	

2.4 SyringePump Injection Accuracy & Injection Volume Calculation

Example 1: Take the single-step accuracy (resolution) of a 5ml syringe (stroke 60mm) as an example,

5ml=5000μl

60mm=6000 steps

5000μl÷6000 steps=0.8333μl/step

(Note): One step of the syringe pump corresponds to a capacity of 0.8333μl/step, which is the minimum resolution of a 5ml syringe.

Example 2: Syringe pump needs to aspirate or dispense liquid 3.8ml, and the corresponding calculation should be as follows:

3.8ml=3800μl

3800μl÷0.8333μl/step=4560 steps（rounding off）

It is found that the parameters to be executed for the syringe pump for a 3.8ml volume of liquid is 4560 steps (0x11D0 in hexadecimal).

(Note): The preceding calculations are all in decimal notation. When you use debugging tools or write code, the parameter input should be in hexadecimal notation.

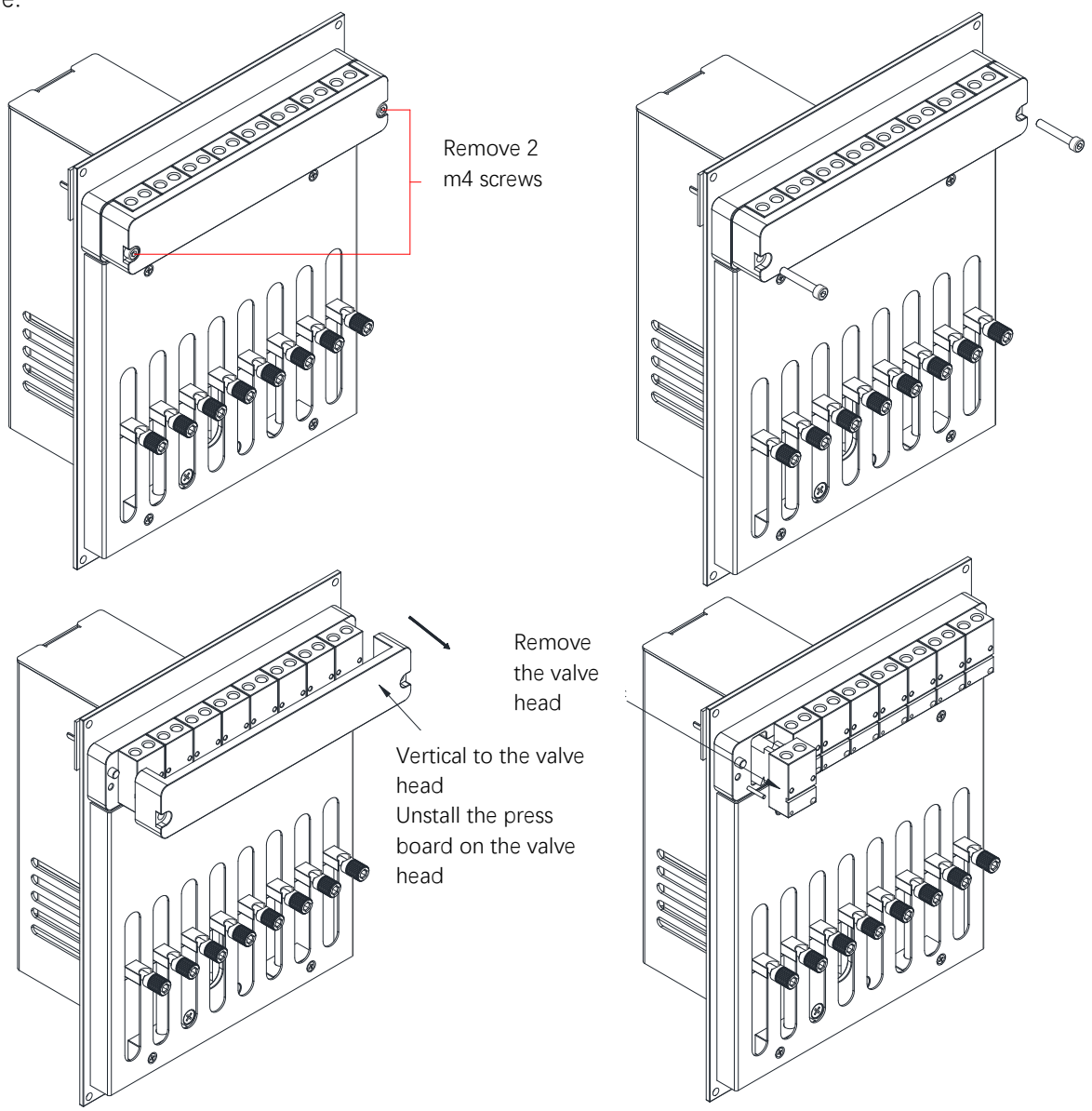
Chapter 3 Hardware Setting

3.1Installing Components

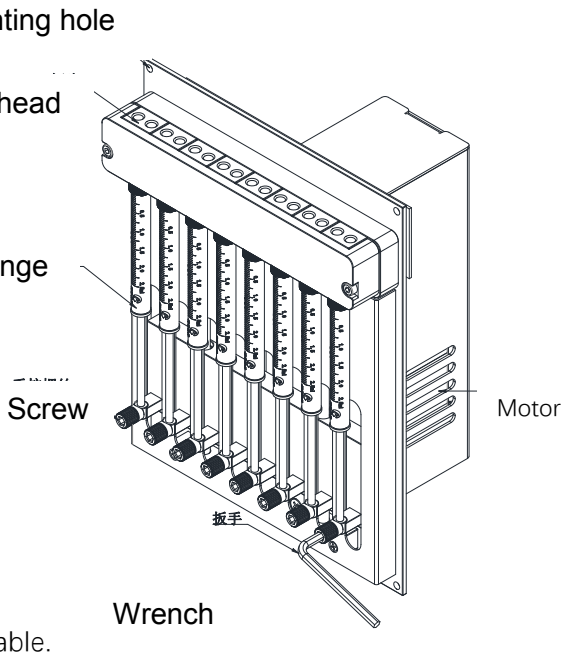
3.1.1 Installing the SY03B-T-DK Valve

Users are supported to replace the valve head assembly manually by themselves, if you need to replace the valve head follow the instructions below.

According to the disassembly procedure, after the replacement of the valve head assembly, re-installed into the product, the installation of the valve head assembly, slowly inserted to ensure that the solenoid valve insert and the control board socket can be aligned to avoid improper installation of the solenoid valve insert damage.



3.1.2 Installing a Syringe



To install a syringe, follow these steps:

1 Remove the plunger lock screw.

2 Send the ZR command first, followed by A6000R, lower the push rod.

Install the syringe as shown, following these steps:

a. Screw the syringe into the threaded hole in the valve head

b. Keeping the actuator seat and actuator at the same level, pull down on the actuator.

c. Pass the hole in the injector through the hole in the actuator seat.

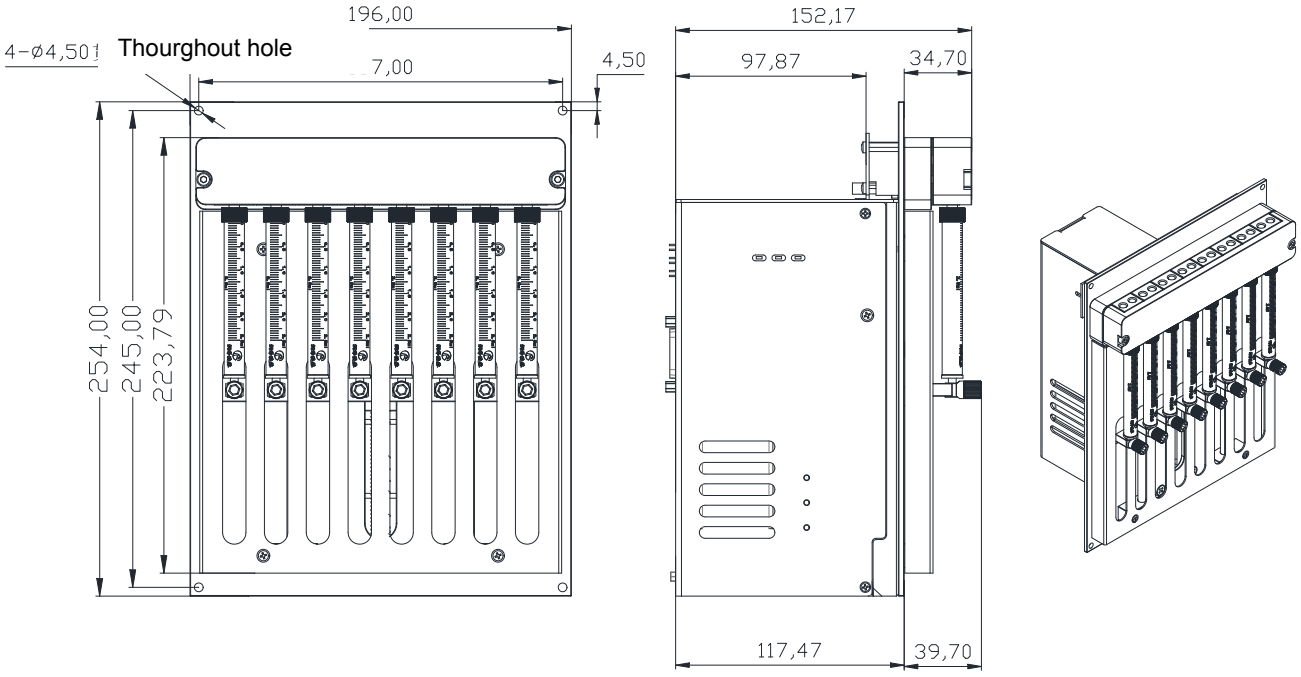
d. Align the two holes and secure with screws.

3 Reinitialize the Pump

NOTE: Make sure the pushrod screws are tight and the pushrod is movable.

3.1.2 Installing pump

For ease of installation, size and location of key mounting holes on SY03B-T-DK outline drawing.



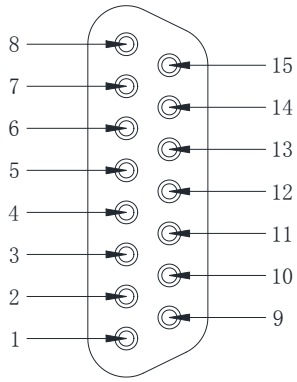
3.2 Power and Electrical Considerations

The 24V DC supply for a single SY03B-T-DK should meet the following basic requirements：

- Output voltage: 24V nominal + 2%
- Well-regulated power supplies are recommended, as operating pumps below 24V will affect performance.
- Current rating of at least 1.5 A
- Conformance to required safety and EMI/RFI specifications
- Current should be limited to 35A or less

3.2.1 Choosing a Power Supply

Power is input through pins 1 and 9 of the DB15 jack, and the definition of the terminals is detailed in the following figure:



PIN	Function	Note
1	24VDC	Power Input Positive
9.10	GND	Power and Logic Ground

3.2.2 Integrating a Power Supply

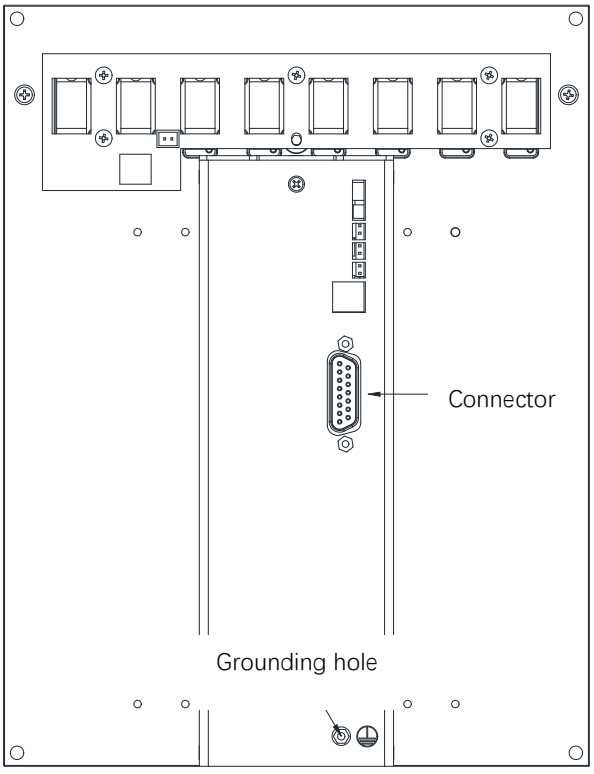
When a power supply is used to operate more than one SY03B-T-DK or other device, it must provide the total peak current for all devices. The power supply and filter capacitance together must satisfy the total peak input current for all devices.

3.2.3 Switching Power Supplies

Each SY03B-T-DK has an external interface that provides power and communication with the pump.

Each pump is set with a unique address, for more information refer to "Address Switch Settings" in this chapter.

Pin	Function	Remarks
1	24v DC	
2	RS-232TxD Line	Output data
3	RS-232RxD Line	Input data
4	Reserved	
5	CAN high signal line	CAN H
6	CAN low signal line	CAN L
7	Auxiliary input #1	TTL level
8	Auxiliary input #2	TTL level
9	Ground	Power and logic
10	Ground	Power and logic
11	RS-485 A Line	Data+
12	RS-485 B Line	Data-
13	Auxiliary output #1	TTL level
14	Auxiliary output #2	TTL level
15	Auxiliary output #3	TTL level



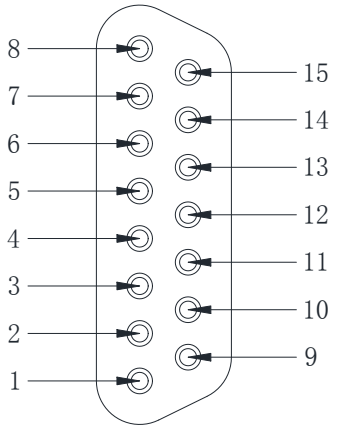


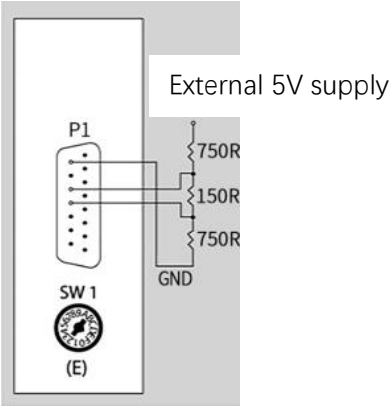
Figure 3-2-3 DB15 connector

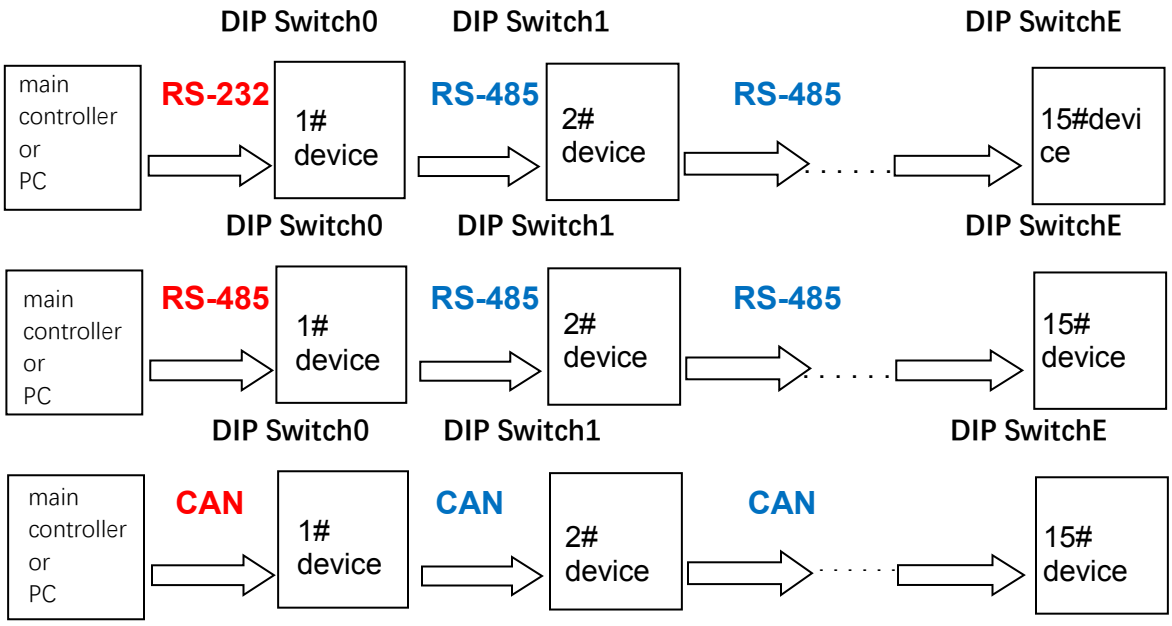
3.3 Communication Interfaces

Depending on the configuration of the pumps, the RS232 or RS485 interface enables control of a single pump or multiple pumps simultaneously. For the RS232 and RS485 interfaces, baud rates of 9600 and 38400 are supported.

Up to 15 units can be connected in multi-pump configuration mode. The first unit can enable RS232 or RS485, but RS485 communication is used internally in the multi-pump configuration.

Terminal Resistor Installation: P1 jumper is installed at the last device terminal or the terminal device is connected to an external resistor.





3.4 Settings and Options

3.4.1 Address Switch Settings

The address switch is located near the top of the SY03B-T-DK electronic circuit board. It is used to give each SY03B-T-DK in a multi-pump configuration a unique or specific address, allowing the user to direct commands to specific pumps. The address switch has sixteen positions (numbered 0 through F). Fifteen positions (addresses 0 through E) are valid pump addresses. F is the self-test address. Set the address switch to rotate the switch to the target position (address) using a flat screw. For example, when the switch goes to 0, the address is 31H and so on.

3.4.2 Self-Test

The "F" address switch position is used to activate the SY03B-T-DK self-test. Self-test causes the SY03B-T-DK to initialize, then cycle repeatedly through a series of plunger movements. The self-test cycles through speed codes 5 to 40(add 5 in turn). If an error condition occurs, the pump stops moving.

To run the self-test, set the address switch to position "F." Then supply power to the pump.

Caution! Always run liquid through the syringe and valve. Failure to do so can damage the valve and syringe seal.

3.4.3 P11 Inputs/Outputs

The SY03B-T-DK provides two auxiliary inputs and three auxiliary outputs that can be accessed through the DB-15 connector, P11. They provide TTL level signals. The outputs are controlled by the [J] command.

The auxiliary inputs are located on P11, pins 7 and 8. They can be read back using report commands ?13 and ?14. Additionally, the inputs can be used to externally trigger a command sequence using the [H] command. The commands are described in Chapter 3, "Software Communication".

The auxiliary outputs are located on P11, pins 13, 14, and 15.

Chapter 4 Software Communication

4.1 SY03B-T-DK Addressing Scheme

As part of the communication protocol, an address for each pump must be specified. The user has the option of addressing a single pump, two pumps (dual device), four pumps (quad device), or all 15 pumps (all devices), depending on the address byte used. Each physical address in the address switch corresponds to a hexadecimal value, as shown in Table 3-1, Hexadecimal Addressing Scheme.

Address (hex)) RS-232/RS-485	Device
30	Master Address (master controller, personal computer, etc.)
31···3F	Addresses single device
41···4F	Addresses two devices at a time (dual device)
51···5D	Addresses four devices at a time (quad device)
5F	Addresses all devices on the bus

Table 4-1 *Hexadecimal Addressing Scheme*

For example, an SY03B-T-DK with address switch set to 0 is addressed as device "31h" in the RS-232 or RS-485 communication protocol, hardware address 1 is addressed as device "32h," and so on.

Table 4-2, Address Switch Settings in Hex (ASCII), shows the different address switch settings for each of these configurations

Note: *When using the Pump: Link software to send commands to a device, use the ASCII address values in Table 4-2*

Switch Setting	Single Device		Dual Device		Quad Device		All Devices	
	Hex Address	ASCII Address	Hex Address	ASCII Address	Hex Address	ASCII Address	Address	Value to Send
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	Self Test							

Table 4-2 Address Switch Settings in Hex (ASCII)

The user can communicate with all pumps in the chain by using address "5fh," for example to initialize all pumps at once. Then each pump can be controlled independently by using addresses "31h" to "3Fh."

Note: Multiple address commands cannot be used to determine device status or to request reports. Each device must be queried separately to gather status or generate a report..

4.2 Communication Protocols

Two communication protocols are available: :

OEM communication protocol

Data Terminal (DT) protocol

CAN protocol

SY03B-T-DK firmware automatically detects the communication protocol.

The DT protocol can be run via an ASCII data terminal because no sequence numbers or checksums are used. For instructions on using a Microsoft Windows Terminal Emulator, see "Using DT Protocol with Microsoft Windows" in this chapter.

Note: SY03B-T-DK Systems recommends using the OEM protocol for RS-232 and RS-485 interfaces. It provides increased error checking through the use of checksums and sequence numbers.

Once the SY03B-T-DK detects either the OEM or DT protocol, it will ignore the other protocol until the next power cycle.

4.2.1 OEM Communication Protocol

OEM communication is a robust protocol that includes automatic recovery from transmission errors.

Table 3-3, OEM Protocol describes each setting within the OEM communication protocol.

Parameter	Setting
Character Format	
Baud rate	9600 or 38400
Data bits	8
Parity	None
Stop bit	1
Command Block (see "OEM Protocol Command Block Characters" for details)	
1	STX (^B or 02h)
2	Pump address
3	Sequence number
3+n	Data block (length n)
4+n	ETX (^C or 03h)
5+n	Checksum

Answer Block (see "OEM Protocol Answer Block Characters" for details)	
1	STX (^B or 02h)
2	Master address (0 or 30h)
3	Status code
3+n	Data block (length n)
4+n	ETX (^C or 03h)
5+n	Checksum

Table 4-2-1, *OEM Protocol*

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 a parsing algorithm, the programmer should key on the STX as the beginning of the answer block and the checksum (character after the ETX) as the end of the answer block.

STX (^B or 02h)

The STX character indicates the beginning of a command

Pump Address

The pump address is a hexadecimal number specific for each pump

Sequence Number/Repeat Flag

The sequence number is a single byte that conveys both a sequence number (legal values: 0 to 7) and a bit-flag indicating that the command block is being repeated due to a communications breakdown. The sequence number is used as an identity stamp for each command block. Since it is only necessary that every message carry a different sequence number from the previous message (except when repeated), the sequence number may be toggled between two different values (e.g., "1" and "2") as each command block is constructed. During normal communication exchanges, the sequence number is ignored. If, however, the repeat flag is set, the pump compares the sequence number with that of the previously received command block to determine if the command should be executed or merely acknowledged without executing.

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 the data or commands sent to the pump or host (this is an ASCII string). When the pump is responding to a move or [Q] command, the data block length is 0 (i.e., no data string exists).

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 synchronization and checksums) are XORed to form an 8-bit checksum. This is appended as the last character of the block. The receiver compares the transmitted value to the computed value. If the two values match, an error free transmission is assumed; otherwise, a transmission error is assumed.

OEM Protocol Answer Block Characters

The answer block characters in the OEM communication protocol are described below.

Only the unique answer block entries are listed in this section. For common commands and answer 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 value "0").

Status and Error Codes

The status and error codes define pump status and signal error conditions. For a description of status and error codes, see "Error Codes and Pump Status".

4.2.2 Data Terminal (DT) Protocol

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

Character Format	
Parameter	Setting
Baud rate	9600 or 38400
Data bits	8
Parity	None
Stop bit	1
Command Block (see "DT Protocol Command Block Characters" for details)	
1	Start command (ASCII "/" or 2FH)
2	Pump address
2+n	Data block (length n)
3+n	Carriage Return ([CR] or 0DH)
Answer Block (see "DT Protocol Answer Block Characters" for details)	
1	Start answer (ASCII "/" or 2FH)
2	Master address (ASCII "0" or 30H)
3	Status character
3+n	Data block (length n)
4+n	ETX (03H)
5+n	Carriage return (0DH)
6+n	Line feed (0AH)

Table 3-4 DT Protocol

DT Protocol Command Block Characters

The command block characters in the DT communication protocol are described below:

Start Block

The start character indicates the beginning of a 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 information on command and answer 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 Character

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)/Line Feed (0AH to 0CH)

This character terminates the reply block

4.2.3 Using DT Protocol with Microsoft Windows

The SY03B-T-DK can be controlled in DT protocol mode directly from the Microsoft Windows terminal accessory.

To communicate with the SY03B-T-DK using Windows , follow these steps:

1 Connect the SY03B-T-DK to a communications port of the PC.

2 From the Microsoft Program Manager window, start the SerialCommV1.0 application.

3 Select more serial port Settings.

4 Select a baud rate of 9600, 8 data bits, 1 stop bit, no parity, communications port connector (for example,COM1), and no flow control.

5 Click OK and click again to start the serial port

6 Set the pump address switch to 0.

7 Power on the pump.

8 Type /1ZR to initialize the pump.

9 To run the pump, see the commands listed in "Using the SY03B-T-DK Command Set" in this chapter.

4.2.4 CAN Interface Communication

CAN Controller Area Network is a two-wire, serial communication bus. It eliminates polling sequence that verify task completion. Using CAN, the pump asynchronously report to the maste or host when they have finished the current task

Note: all HMD use CAN controller chips compatible with Philips semiconductor CAN rCAN bus specification, version 2.0. When using the CAN interface, termination resistors (120ohm)are necessary at both ends of the bus.The pump does not provide CAN termination resistors.

4.2.4.1 CAN Messages

CAN messages consist of frames. Each frame has an 11 – bit Message Identifier (MID) and a 4-bit length identifier. The bits: Indlicate to which device on the bus the message is directed

Identify the message type

Show the direction of the message (toor from the master device)

Represent the length of the data block. Data blocks can be from zero to eight bytes in length. Any message that requires more than eight bytes must be sent in a series of multi-frame messages. The receiving unit then assembles the separate frames into one long string.

4.2.4.2 CAN Message Construction

Each message frame begins with the Message ID (MID). The data block (up to 8 bytes in length) follows the MID and length information. The MID makes up three nibbles that are transmitted first in a message frame. The bits are grouped asshown in Figure 3-1, CAN Message Structure"

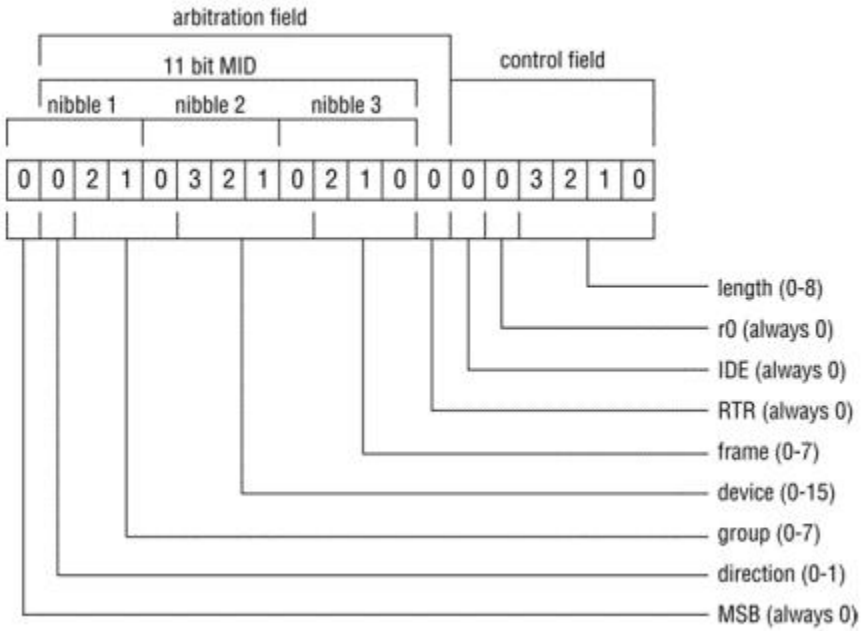


Figure 3-1 CAN Message Structure

Direction

This is the direction bit. It lets the devices on the bus know whether the current message is to or from the master. "O" means that the message is from master to slave; "|" means the message is from the slave to the master.

Note: Peer-to-peer messaging is not supported.

Group

This is the group number (0 - 7). Each type device on the CAN bus has a group assignment. HMD is assigned to group 2. The group number "1" is reserved for the boot request procedure.

Device

This is the address of the module in the particular group. Each group can have up to 16 devices. The address value is 0 - 15.

Frame

This lets the device know what type of message is coming. See "CAN Frame Types" in this chapter.

RTR

This bit is not used in HMD CAN implementation and should always be set to 0.

IDE

This will always be set to O for standard format frames.

r0

Reserved bit. set to 0.

Length

This is the length of the data block in the message. Data blocks can be from zero to eight bytes in length.

CAN Frame Types

The frame types allow each device to know what type of command is coming in and enables faster processing of commands. Pumps respond to the frame types described below:

Action Frames, Type 1

This frame type is used for action commands, such as Initialization commands, Movement commands, Valve commands, or to set pump operating parameters. All "task-type" commands are sent in this type message frame. When multi-frame messages are used to send an action command, this frame is the end message sent to the pump.

Common Commands, Type 2

This frame type is used for commands that are common to every device on the bus. The frame type is set to 2 and the command is a single ASCII character in the data block. The sinqle ASCII character is described below.

Command	Command
0	Reset mode. This resets the pump and beqins the boot request procedure.
1	Start loaded command. Just like sending an [R] command after a string has been loaded.
2	Clear loaded command. This clears out the command buffer.
3	Repeat last command. This command does the same thing as the (X] command,
4	Stop action immediately. This acts like a [T] command.

Multi-Frame Start Message, Type 3

This frame type lets the pump know that the next message will be longer than the 8-byte maximum for each frame. Subsequent frames will follow to complete the message.

Multi-Frame Data, Type 4

This frame type is used to identify a frame in the middle of a multi-frame message. The last frame of a multi-frame message for action commands must be type 1. The last frame of a multi-frame message response from the pump for report commands will be type 6.

Note: There is no type 5 frame.

Report/Answer Commands, Type 6

This frame type is used to get information back from the pump. It is similar in operation to the query

commands (i.e., (?]) used in the OEM and DT protocols. The report command is one byte long and consists of one or more ASCII characters in the data block. Report commands in ASCII format are:

Command	Command
0	Report absolute plunger position
1	Report start speed
2	Report top speed
3	Report cutoff speed
6	Report current valve position
10	Report buffer status
12	Report pump backlash increment
13	Report status of input #1
14	Report status of input #2
15	Report the number of pump initializations
16	Report the number of plunger movements
17	Report the number of valve movements
18	Report the number of valve movements since last report
23	Report current software version
24	Report the number of reset offset steps
29	Report device status
76	Report pump configuration
200	Verify conf file
201	Query log
202	Query the serial number
203	Query encoder values
300-314	Query program strings in s0-s14
*	Query voltage
<	Report user data

When the pump responds to a query, the first two bytes of the data block are the status bytes. The first byte contains an error code (same error codes used with he RS-232 and RS-485 protocols) added to Ox20h. The second byte contains the value Ox60h and is not used. The remaining six bytes are for the response in ASCII. If the pump is only reporting Current status, the message is only two bytes long. If the reply consists of more than six bytes, multi-frame messages are used.

CAN Data Block

The data block tells the pump what to do. Pump commands are sent in ASCII just like in RS-232 or RS-485. For command strings that are more than eight bytes in length, multi-frame messages are used. This permits long program strings to be sent as with the other communications interfaces (remember that the SY-01C buffer size is 255 characters).

Handling of Pump Boot Requests

When the pump is first powered up or receives a system reset command (frametype 2, command 0), the

pump notifies the host of this condition by sending a boot request message at 100 millisecond intervals until it receives a proper response. The group number is 1 for the boot request message. The frame type is 2 when the pump sends messages to the host, and the frame type must be 0 when the host replies to the boot request.

Example 1. The pump is set to address 0

Pump sends:

Direction	Group	Device	Frame	RTR	Length
1	001	0000	010	0	0000

Host acknowledges ;

Direction	Group	Device	Frame	RTR	Length	Node ID	Slave ID
0	001	0000	000	0	0010	0010 0000	001 00000

Host acknowledges the boot request with:

Direction	0	Host to slave
Group	1	Boot request response group
Device	0	Always 0 in boot response
Frame	0	Boot request response frame
RTR	0	Always 0
Length	2	Two data bytes in return message
Node ID		Node ID (2) +Pump Address (6)　00h must respond with Group & Address
Slave ID		Same as Node ID 20 in hex 00h

Example 2. The pump is set to address 6

Pump sends:

Direction	Group	Device	Frame	RTR	Length
1	001	0110	010	0	0000

Host acknowledges:

Direction	Group	Device	Frame	RTR	Length	Node ID	Slave ID
0	001	0000	000	0	0010	0010 0110	0010 0110

Host acknowledges the boot request with:

Direction	0	Host to slave
Group	1	Boot request response group
Device	0	Always 0 in boot response
Frame	0	Boot request response frame
RTR	0	Always 0
Length	2	Two data bytes in return message
Node ID		Node ID (2) +Pump Address (6)　“&”　26 in hex
Slave ID		Slave ID same as Node ID 26 in hex

The pump will save the Node ID to use for message filter Group ID.

Note: The slave ID does not have to be the same as the node ID. The pump can be assigned any number between 0 and Ox7F (127) for the slave ID.

CAN Host and Pump Exchanges

When a slave pump receives a command, finishes a command, encounters an error condition, or responds to a query, it sends an answer frame to the host using the same frame type as the command it belongs to. The answer frame format is device dependent. Generally, it will have the following format:

<MID><DLC><Answer>

<MID>

11-bit message identifier. The direction bit is 1. The group number and the frame type are the same as received. Device ID is the slave message ID assigned by the host.

<DLC>

4-bit data length code

<Answer>

Data bytes block. The first byte of the data block is always the status byte, which is an error code (same error codes used with the RS232 and RS485 protocols) added to Ox20h. The second byte is always Ox60h. The remaining bytes contain the response in ASCII format. If the reply consists of more than six bytes, the multi-frame messages are used.

Note: Only one command of a given frame type can be in progress at any one time; e.g., after issuing a command to a slave pump with frame type = 1, the master must wait for the answer with frame type = 1 before issuing the next command with frame type = 1. If the user insists on sending the command, a command overload status results. Several commands with different frame types can be in progress at the same time; e.g., an action command and a query command. Following are typical exchanges between the host and slave for action commands, multi-frame commands, common commands, and query commands.

Action Command

The host commands (ZR] to a pump, and the pump is set to address 0

Host sends:

0	XXXXXXX	001	0	0010	ZR
Direction	Slave ID	Frame Type	RTR	DLC	Data bytes

Pump acknowledges:

0	XXXXXXX	001	0	0010
Direction	Slave ID	Frame Type	RTR	DLC

After executing the command, pump reports status:

0	XXXXXXX	001	0	0010	<20h><60h>
Direction	Slave ID	Frame Type	RTR	DLC	Data bytes

Note: The mixed formats ASCII and hexadecimal are used in the data bytes block. The hexadecimal number is bracketed (<>). The rest of the fields are displayed in binary format.

Multi-Frame Command

The host commands [Z2S5glA30000gHD300G10G5R] to a pump, and the pump is set to address 0.

Host sends:

0	XXXXXXX	011	0	1000	Z2S5glA3
Direction	Slave ID	Frame Type	RTR	DLC	Data bytes
0	XXXXXXX	100	0	1000	000OgHD3
Direction	Slave ID	Frame Type	RTR	DLC	Data bytes
0	XXXXXXX	001	0	1000	00G10G5R
Direction	Slave ID	Frame Type	RTR	DLC	Data bytes

Pump acknowledges:

1	XXXXXXX	001	0	0000
Direction	Slave ID	Frame Type	RTR	DLC

After executing the command, pump reports status:

1	XXXXXXX	001	0	0010	<20h><60h>
Direction	Slave ID	Frame Type	RTR	DLC	Data bytes

Note: For multi-frame commands, the pump only acknowledges the last frame.

Common Command

After the host has sent command [A1000A0] to the pump, it sends command 1 of frame type 2 to a pump and makes the pump move. The pump is set to address 0.

Host sends:

0	010	0000	010	0	0001	1
Direction	Slave ID	Frame Type	RTR	DLC	Data bytes	Direction

Pump acknowledges:

1	XXXXXXX	002	0	0000
Direction	Slave ID	Frame Type	RTR	DLC

After executing the command, pump reports status:

1	XXXXXXX	002	0	0010	<20h><60h>
Direction	Slave ID	Frame Type	RTR	DLC	Data bytes

Query Command

The host commands 29 of frame type 6 to a pump, and the pump is set to address 1

Host sends:

0	XXXXXXX	110	0	0010	29
Direction	Slave ID	Frame Type	RTR	DLC	Data bytes

Pump acknowledges:

1	XXXXXXX	110	0	0010	<20h><60h>
Direction	Slave ID	Frame Type	RTR	DLC	

Note: For query commands, no acknowledge frame is needed

Report Command

The host commands 23 of frame type 6 to a pump, and the pump is set to address 1

0	XXXXXXX	110	0	0010	23
Direction	Slave ID	Frame Type	RTR	DLC	Data bytes

Pump reports：

1	XXXXXXX	011	0	1000	<20h><60h><727920>
Direction	Slave ID	Frame Type	RTR	DLC	
1	XXXXXXX	110	0	0110	<20h>Rev<20h>A
Direction	Slave ID	Frame Type	RTR	DLC	Data bytes

Note: For multi-frame replies, the starting frame is type 3, the middle frame is type 4 and the last frame is type 6.

Note: In this example, the returned data has been actualised.

4.3 Using the SY03B-T-DK Command Set

4.3.1 Command Execution Guidelines

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) comman
- Single or multiple command strings can be sent to the pump.

  For example:

  – A single command such as [A6000R] moves the plunger to position 6000.

  – A multi-command string such as [IA6000OA0R] moves the valve to the input position, moves the plunger to position 6000, turns the valve to the output position, 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
- (i.e., the first command string is erased).
- 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. In the case of a [Q] (Query) command, the error is read back to the host computer.
- Always run liquid through the syringe and valve when issuing a Move command. Failure to do so may damage the valve and syringe seal.
- Keep fingers out of the syringe slot while the pump is running. Failure to do so can result in injury.

4.3.2 Pump Configuration Commands

SY03B-T-DK 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, valve type, and baud rate.

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 speedsettings 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	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

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

and <n> = 0..6400 in fine positioning mode

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
U200	Set the syringe pump blocking current (1-31)

Table 4-3-1 *Write Pump Configuration Command Values*

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

k<n> Backlash Increments after reset

k <n> Syringe Dead Volume Command

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

n = 0···6400 in fine positioning and microstep modes

Under default initializations, the plunger moves upward until it contacts the top of the syringe, causing a forced stall initialization. The plunger then moves downward and upward, 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 [Z], [Y], or[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

– ZR

4.4 Initialization

4.4.1 Z <n > Initialize Plunger (valve input port to NO)

The [Z] command initializes the plunger drive and set to open input port

The parameters are described below:

Z 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	nitializes 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.

4.4.2 Y < n> Initialize Plunger (valve output port to NC)

The [Y] command initializes the plunger drive and open the output port of solenoid valve.

The parameters are described below.

Y 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 <n > Initialize Plunger

The [z] command simulates an initialization of the plunger drive, 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, the pump must be reinitialized using the Z or Y commands to set the true home position.

Caution! *Incorrect use of this command can damage the device.*

4.5 Operating Commands

4.5.1 Valve Commands

I Open valve to input port position (NO)

O Open valve to output port position (NC)

B Open valve to bypass port position

Commands to open all ports to the bypass port position. NOTE: This option is only available for pumps

configured for three-port valves.

/B<n> Binary Valve Control Instructions

The [B] command provides independent control of each valve using a binary format. The valves are controlled in left-to-right order as viewed from the front of the pump.

The parameter table is shown below:

<n>value	Description
0, 1	0=Close 1=open

For example, sending a control command B0101010101R for an 8-channel, single 3-way valve will set the first valve from the left to close, the second valve to open, the third valve to close, and so forth. The number of digits in the parameter is related to the number of valves installed on the pump, e.g., if there are 4 valves installed on the pump, the parameter range is 0000-1111 When the number of digits of the parameter is not enough, it will be made up with 0 from the left, e.g., for a 4-valve configuration, the actual execution is the same as that of B0001R when B1R is entered, and B11R is the same as that of B0011R when B11R is entered.

/ E<n> Hexadecimal Valve Control Command

The [E] instruction uses the hexadecimal form to control each valve independently. When viewed from the front of the pump, the valves are controlled in the order that the leftmost valve is the highest position and the rightmost valve is the lowest position.

For example, sending a control command E15R for an 8-channel single 3-way valve, the binary representation of 0x15 would be 00010101, so it would set the first valve from the left to be closed, the second to be closed, the third to be closed, the fourth to be open, and so on.

4.5.2 Plunger Movement Commands

A <n> Absolute Position

The [A] command moves the plunger to the absolute position <n>,

where<n> = 0.6000 in standard mode

0..48000 in fine positioning and microstep mode.

Command	<n> Parameter Value	Description
A	0-6000	Absolute position in half increments (N=0)
	0-48000	Absolute position in microsteps (N=1)
	0-48000	Absolute position in microsteps (N=2)

For example:

– [A300R] moves the syringe plunger to position 300.

– [A6000R] moves the syringe plunger to position 6000.

a <n> Absolute Position (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 (Busy)

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..7640 in standard mode and

<n> = 0..61120 in fine positioning and micro step mode.

Command	<n> Parameter Value	Description
P	0-6000	Relative position in half increments (N=0)
	0-48000	Relative position in microsteps (N=1)
	0-48000	Relative position in microsteps (N=2)

For example:

The 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 6000.

p <n> Relative Pickup (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> / d <n> Relative Dispense (Busy)

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..6000 in standard mode and

<n> = 0..48000 in fine positioning and microstep mode.

Command	<n> Parameter Value	Description
D	0-6000	Relative position in half increments (N=0)
	0-48000	Relative position in microsteps (N=1)
	0-48000	Relative position in microsteps (N=2)

For example:

The 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 (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.

4.5.3 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 microsteps 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 5 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 <n> x 2.5 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/sec 2 are listed below.

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

19	47500
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 piston pump, the value can be adjusted to 12000, but we can only ensure that 1-6000 piston pump perfect operation, for want to set the speed of more than V6000, the user needs to be properly adjusted according to their actual situation and experience

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.

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	Speed Code	Value
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 100 minutes for N=0, N=1 or 800 minutes for N=2. In this case, the [S] speed code cannot be used 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]

4.5.4 Interaction of Set Commands

The Start Speed [v], Top Speed [V], and Cutoff Speed [c] commands interact according to the following rules:

[v]≤[c]≤[V]

1 Start Speed should always be less than or equal to Top Speed. Changing the Start Speed will change the Cutoff Speed if Cutoff Speed is less than the Start Speed set. If the Start Speed [v] is greater than the Top Speed, the Start Speed will be set equal to the Top Speed.

2 Top Speed should always be greater than or equal to the Start Speed and Cutoff Speed. Changing the Top Speed will modify the Cutoff Speed and Start Speed if they were improper, but will not modify the stored Start Speed. For instance, values of 750, 100 and 1200 will cause the pump to run simply at the top speed of 100.

3 Cutoff Speed [c] should always be less than or equal to Top Speed [V] and greater than or equal to Start Speed [v]. Changing the Cutoff Speed will not modify the Start Speed or Top Speed. However, if Cutoff Speed is greater than Top Speed it will be ignored and the Cutoff Speed will be set equal to the Top Speed. And if the Cutoff Speed is set less than Start Speed, it will be ignored and the Cutoff Speed will be set equal to the Start Speed.

4.5.5 Control Commands

R Execute Command or Program String

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.

G <n> Repeat Command Sequence

This command repeats a command or program string the specified number of times. If a GR or a G0R 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 3-7, 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

Figure3-7 *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 piston pump 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)

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 encouters 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 string command.

J <n> Auxiliary Outputs

The [J] command sets the TTL/MOS output lines.

The syntax for this command is:

[J<n>]

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

PS-10 provides three TTL 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<n> Setting the stalling current

The [U200] command sets the syringe pump blocking current.

The syntax of this command is:

[U200<n>]

where <n>=1...31

4.5.6 Non-Volatile Memory (EEPROM) Commands

The non-volatile memory in the SY03B-T-DK 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, [IA3000OA0R] requires 10 bytes.

Example Program String: [s8ZS1gIA3000OA0GR]]

Command Segment	Description
s8	Loads string into program 8 of non-volatile memory (Address switch position 8)
Z	Initializes pump
S1	Sets plunger speed
g	Marks start of loop
I	Turns valve to input position
A3000	Moves plunger to position 3000
O	Turns valve to output position
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 Run from Non-Volatile Memory Auto Mode

The [U30] command sets the "Run from Non-Volatile Memory Auto Mode" flag in the non-volatile memory and begins operating the pump in stand alone mode. The pump will run one of 15 command strings <n> as selected by the address switch,

where <n> = 0..E

U31 Clear Run From Non-Volatile Memory

The [U31] command clears the "Run from 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:

[sIZgIA3000OA0G5e2R]

[s2gIA3000OgHD300G10GR]

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.

4.5.7 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 microsteps [N1, N2].

? 1 Report Start Speed

The [?1] command reports the start speed in pulses/sec [50..1000]

? 2 Report Top Speed

The [?2] command reports the top speed in pulses/sec [5..12000]

? 3 Report Cutoff Speed

The [?3] command reports the cutoff speed in pulses/sec [50..5400]

? 4 Report Actual Position of Plunger

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

? 6 Report Valve Position

The [?6] command reports the valve position in mnemonics (i = input, o =output, e = extra, and b = bypass for non-distribution valves.

For distribution valves, the [?6] command reports ASCII values 1..X, where X is the number of distribution valve ports.

? 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 (P11, Pin 7)

0 = low

1 = high

? 14 Report Status of Auxiliary Input #2 (P11, 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.

? 17 Report Number of Valve Movements

Command [?17] reports the number of valve movements. This value cannot be reset

? 18 or % Report Number of Valve Movements (Since Last Report)

The [?18] or [%] command reports the number of valve movements since the last [?18] or [%] command.

? 24 Report the 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 microsteps (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 microstep).

? 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]

? 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*200)*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 Error Codes and Pump Status

The [Q] command is used for serial communications and reports error codes and pump status (ready or busy). The user should send a [Q] command before sending a program string or individual command to ensure that the pump has completed the previous command successfully.

Note: [Q] is the only valid method for obtaining pump status in serial mode.

Note: [Q] command (the status byte) provides two items of information: Pump status (bit 5) and error code (bits 0-3).

4.6.1 Status Bit

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 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 SY03B-T-DK 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 Runze Technical Services.
9 (09H)	Plunger Overload. This error occurs when 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.
10 (0AH)	Valve Overload. This error occurs when the valve drive loses increments by blockage or excess backpressure. The pump must be reinitialized before normal operation can resume. Sending another Valve command reinitializes the valve and sets it to the correct location. Continual valve overload errors are an indication the valve should be replaced.
11 (0BH)	Plunger Move Not Allowed. When the valve is in the bypass or throughput position, Plunger Movement commands are not allowed.
12 (0CH)	Internal failure. If this error occurs, please call Runze 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 Runze 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

These include the "Plunger Overload" and "Valve Overload" errors (errors 9 and 10). If the pump returns either a plunger or valve 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, Set command (except [V]), or Valve command is sent while the piston 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 1-6000 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	
7 6 5 4 3 2 1 0	0	or 1	0	or1	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 0	4AH	6AH	74	106	10	Valve 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 is “Not Busy.”
Valve in Bypass [A1000R]	Returns an error immediately; when queried ([Q] command),does not return an error.

Chapter 5 Common Problems & Solutions

Item	Fault	Reason	Troubleshooting method
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	The aspirating pipe is blocked by by debris	Clear the debris

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 microstepping or fine positioning mode
	1 = fine positioning mode on	
	2 = microstep 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	
K	0..31 in full step mode (default 12)	Sets number of backlash increments.
	0..248 in fine positioning mode (default 96)	

B.2 Initialization Commands

Command	Values of <n>	Description
Z	<n1>	Initializes the plunger drive and homes the valve in a clockwise direction
	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	
	<n2>	Sets initialization input port
	0 =Set initialization input port to Port 1	
	1 x =Set initialization input port for distribution valves, where X is the number of ports on the valve	
	<n3>	Sets initialization output port
	0 =Set initialization output port to Port X	
	1 x = Set initialization output port for distribution valves, where X is the number of ports on the valve	
Y	<n1>	Initializes the plunger drive and homes the valve in a counterclockwise direction.
	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	
	<n2>	Sets initialization input ports
	0 =Set initialization input port to Port 1	
	1 x =Set initialization input port for distribution valves, where X is the number of ports on the valve	
	<n3>	Sets initialization output port
	0 =Set initialization output port to Port X	
	1 x =Set initialization output port for distribution valves, where X is the number of ports on the valve	
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	
w	<n1> 1...x =Set initialization port where X is the number of ports on the valve	Initializes the valve drive only
	<n2>0 =Valve homes in a clockwise direction; valve	nitializes the valve drive only.

	ports numbered in a clockwise direction.	
	1 =Valve homes in a counterclockwise direction; valve ports numbered in a counterclockwise direction.	
z		Simulates initialization and sets the current position of the plunger as the home position
k	0..800 in standard mode (50 default)	Set zero gap (increments)
	0..6400 in fine positioning or microstep mode (400 default)	

B.3 Valve Commands

Command	Description
I	Moves valve to input position
O	Moves valve to output position
B	Moves valve to bypass position
E	Moves valve to extra position

B.4 Plunger Movement Commands/Status Bit Reports

Command	Value of <n>	Description	Status
A <n>	0-6000, 0-48,000 in fine positioning or microstep mode	[A] bsolute Position	Busy
a <n>	0-6000, 0-48,000 in fine positioning or microstep mode	[a] bsolute Position	Ready
P <n>	0-6000, 0-48,000 in fine positioning or microstep mode	Relative [P]ickup	Busy
p <n>	0-6000, 0-48,000 in fine positioning or microstep mode	Relative [p]ickup	Ready
D <n>	0-6000, 0-48,000 in fine positioning or microstep mode	Relative [D]ispense	Busy
d <n>	0-6000, 0-48,000 in fine positioning or microstep mode	Relative [d]ispense	Ready

B.5 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.6 Report Commands

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
?6	Report valve position
?10 or 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
? 17	Report number of valve movements
? 18 or %	Report number of valve movements (since last report)
? 20 or #	Report firmware checksum
? 23 or &	Report firmware version
? 24	Report zero gap increments
?29	Same as Q (query, status and error bytes)
?76	Report pump configuration
*	Report supply voltage
< <n>	Report user data (0..15)

B.7 Error Codes and Status Byte

Status Byte	Hex # if Bit 5 =		Dec # if Bit 5 =		Error Code	
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 0	4Ah	6Ah	74	106	10	Valve 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

Chapter 7 Version Description

Version	Description	Release Date
V1.0	Initial Version B.E command invaild	2022.11.24
V1.1	Add precautions for solenoid valves	2024.1.30

Chapter8 Technical Services

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