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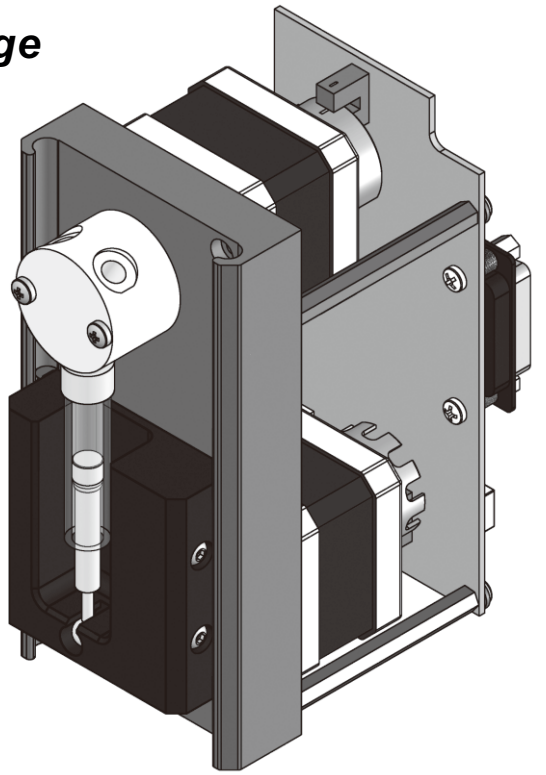
MSP1-D1 Industry syringe pump

LONGER

MSP1-D1

Industrial Syringe Pump



Baoding Longer Precision Pump Co.,Ltd.

A **Halma** company

⚠ **Important information:**

- Please read the operating manual before operation.
- LongerPump reserve the right to revise, improve this device. Please contact the sales if there are any changes on specifications.

⚠ **Warning:**

- This will insult in the spill of liquid if the syringe is damaged, please take caution in order to prevent the injury to operator.
- If liquid spilled on mechanism unit, operator need to turn off the power supply. To re-power up the pump after wiping the pump dry.
- Please contact Longer company or Longer distributor for maintenance if there are any wrong with this equipment. Do not open the case of device by yourself.
- Shut off the power supply and change the power cord if the power cord is worn or damaged.
- Unplug the power plug if there is damage or wear to the power cord or power plug.
- Turn off the power supply before installing peripheral equipment.

⚠ **No warranty is expressed or implied for:**

- Any damage or failure caused by improper installation, storage, maintenance or usage, not in compliance with operating manual.
- Any damage or failure caused by attempts by personnel other than authorized Longer representatives to install, repair, modify or remove the product.
- Damage or failure caused by not returning pumps in original or adequate packaging
- Syringes
- Syringe seals
- Tubing and tubing connections
- Valves

LONGER MSP1-D1 Industry syringe pump

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LONGER MSP1-D1 Industry syringe pump

Figure List

1 Summary

MSP1-D1 is the sister product of MSP1-C1. It broadens the product line of our industry syringe pump. MSP1-D1 has lower accuracy than MSP1-C1, but the mechanical structure of MSP1-D1 is simple and the price is lower to make it widely accepted by the customer. MSP1-D1 can be controlled by computer. It can also run automatically according to pre-saved commands. It is ideal for high automatic field. The materials of the syringe, valve and tube connector are the same with MSP1-C1 and have excellent chemical property.

This chapter includes these topics:

- MSP1-D1 Main Features
- Unpacking the MSP1-D1
- MSP1-D1 Functions
- MSP1-D1 Operation
- Power Supply

Note: MSP1-D1 is a general laboratory module. Since it is not a medical device, it is not subject to FDA regulatory approval.

1-1 MSP1-D1 Main Features:

- Syringe sizes from 500 L to 5 mL
- Accuracy <1.0 % at ⩾30% full stroke
- Full stroke: 30mm (1000 steps)
- Control resolution: 0.03mm (1 step)
- Borosilicate glass, PTFE and PCTFE fluid contact
-
- Communication interface: RS232 and RS485
- Programmable plunger speeds from 2-60 sec/stroke
- Pump diagnostics, self-test, and error reporting
- Auxiliary input and output
- Operates using a single 24VDC power supply

1-2 Unpacking the MSP1-D1

To unpack the module, follow these steps:

1 Remove the pump module(s) and accessories from the shipping cartons.

2 Check the contents against the packing list to make sure that all components are present.

1-2-1 ESD Considerations

MSP1-D1 is an electronic device that sensitive to electrostatic discharge (ESD). Any static discharge can damage sensitive electronic components. To prevent premature failure of pump components, MSP1-D1 should be handled using good ESD practices. These include, but are not limited to:

- Using anti-static gloves or wrist/ankle straps
- Anti-static table or cushion
- Anti-static floor

Prepare an ESD-free work area before the chassis is grounded.

1-3 MSP1-D1 Functions

MSP1-D1 uses a stepper-motor driven syringe and valve design to aspirate and dispense measured quantities of liquid. Both the syringe and the valve are replaceable. The illustrations below show the MSP1-D1:

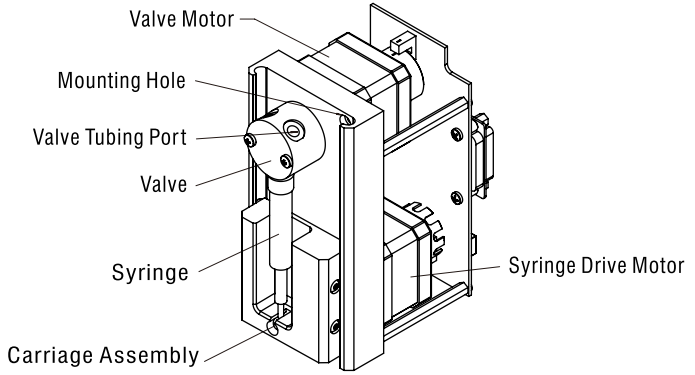


Figure 1-1 MSP1-D1 Syringe Pump

1-3-1 Syringe and Syringe Drive

The full stroke of syringe plunger is 30mm which divide into 1000 steps, resolution is one step.
The base of the syringe plunger is held to the drive by a self-aligning ball that mates to the carriage. The top of the syringe barrel attaches to the pump valve by a 1/4-28" fitting.
Figure 1-2 shows the components of a typical syringe.

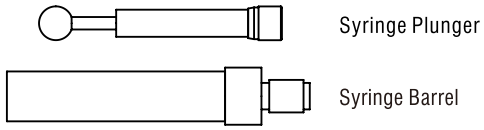


Figure 1-2

Plunger fixup, see Figure 1-3

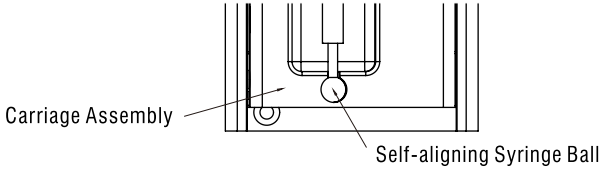


Figure 1-3

Syringes are available in these sizes: 500 μ L, 1.0mL, 2.5mL, 5.0mL. For ordering information, see Appendix A,

1-3-2 Valve and Valve Drive

The valve is made of a Kel-F body and Teflon plug. The valve plug rotates inside the valve body to connect the syringe port to the input or output ports. The valve is turned by a stepper motor coupled to an encoder to provide positioning feedback.

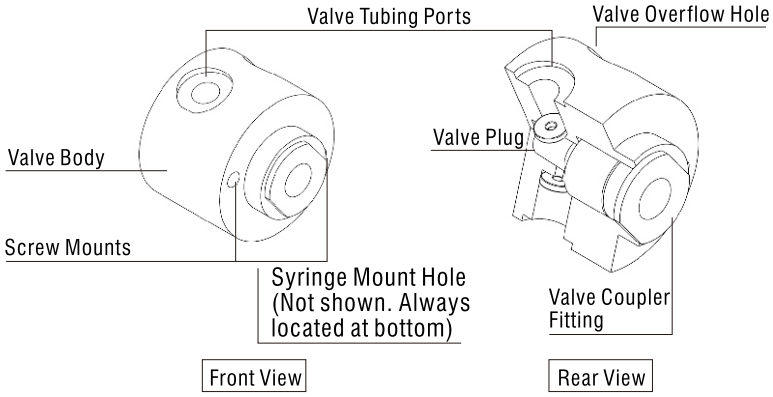
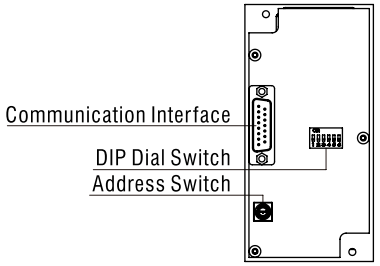


Figure 1-4 3-Port Valve Components

Valve includes input, output and syringe ports, syringe port is a "public port" which is always connected to input or output ports, these three ports are spaced at 120 degree.

1-3-3 Printed Circuit Board

The printed circuit board (PCB) holds the microprocessor and circuitry to control the syringe and valve drives. The PCB provides connectors for the auxiliary input and output, DIP dial switch for configuring different work modes, address setting switch, individual power supply and DB15 external interface. Use DIP dial switch can set different communication modes, for more information about work modes, see chapter 3 "Software Communication".



For more information about more input/output, DIP and address switch, see Chapter 2 "Hardware Setting"

1-3-4 Communication Interfaces

Depending on the pump configuration, MSP1-D1 can communicate single or multi-pump configuration through an RS-232 or RS-485 interface which include power supply. For RS-232 and RS-485 interface, baud rate of 9600 and 38400 are available.

For details on the communications interfaces, see chapter 2, "Hardware Setup".

1-3-5 Multi-Pump Configurations

Up to 15 pieces MSP1-D1 can be connected together in a multi-pump configuration (also called "daisy-chaining"). Within a multi-pump configuration, the RS-485 communications bus required, although the first pump in the chain may receive either RS-232 or RS-485 communications. Each pump can be addressed separately from a single terminal via its unique address, which is set using the address switch on PCB. For more information on setting addresses, see Chapter 2, "Hardware Setup".

1-4 MSP1-D1

For complete information on setting up the MSP1-D1, see Chapter2, "Hardware Setup" and Chapter 3, "Software Communication."

To ensure proper operation, follow these tips:

- Always set up and mount the pump in an upright position. Failure to do so may damage the syringe barrel.
- Always run liquid through the syringe and valve when they are moving. Failure to do so can damage the sealing surfaces.
- Before running any organic solvents through the pump, see Appendix D.
- Keep fingers away from the carriage assembly while the pump is running. Failure to do so can cause injury.
- Always power down the pump when connecting or disconnecting pumps.

1-5 Choosing a Power Supply

1-5-1 Power Supply for Single Pump

MSP1-D1 is powered by a 24VDC power supply via Pin 1 and 10 in Db15 or power supply socket, The 24VDC supply for a single MSP1-D1 should meet the

Following basic requirements:

- Output voltage: 24VDC nominal
- Output voltage tolerance: +/-10% minimum, +/-5% perferred
- Output voltage regulation: +/-1% with varying line (inout voltage) and load
- Output current (not including loads other than a single pump)
  >=1.5A for power supplies with minimal capacitance
  >=850mA for power supplies with internal filter capacitance of at least 1000 F per amp of output current
  >=850mA for power supplies with external capacitance of at lease 1000 F per amp of output current (aluminum electrolytic capacitor preferred)
- Output voltage ripple: 50mV maximum at full load.
- Voltage turn-on and turn-off overshoot: <2 volts

To meet the above basic requirements, the supply must incorporate either linear or switching regulation; it must have adequate output filter capacitance.

A current-limiting power supply is recommended. Current imiting above 1.0 A is acceptable, assuming that no additional equipment is operated from the supply.

1-5-2 Integrating a Power Supply

When a power supply is used to operate more than one MSP1-D1 or other device, it must provide the total average current for all devices. The power supply and filter capacitance together must satisfy the total peak input current for all devices.

For example, if a system incorporates six pieces MSP1-D1 with other equipment that together require 4 amps, a 10A power supply is satisfactory, provided the output filter capacitance in the supply is at lease 10,000 F:
6*0.85=5.1A; 5.1A+4A=9.1A (choose a10A power supply).

If output filter capacitance in power supply is smaller than 10,000 F, need to use external capacitance or 15A power supply.
6*1.5=9.0A; 9.0A+4.0A=13A (choose a 15A power supply).

In this example, it is assumed that all the pumps and other equipment will sometimes operate simultaneously.

External equipment with inadequate bypass capacitance or that is inadequately sourced for current can cause overvoltage transients and sags, and can create unnecessary ripple current in the MSP1-D1. This can result in decreased component life and performance variability. Additionally, it is possible for a regulated power supply to become unstable with certain loads and oscillate if adequate filter capacitance is not present. Some forms of oscillation can cause failures in the MSP1-D1. These issues can be avoided by using a properly designed commercial power supply.

Consideration should also be given to the wiring of the MSP1-D1 and additional devices. Wiring should be of sufficient gauge for the current, and as short as possible. Unless otherwise required by safety requirements, the power supply lines to MSP1-D1 should be 20AWG or heavier. Multiple MSP1-D1 can be daisy-chained, provided that the wire size and the power supply are adequate for the total current. In the example of the six MSP1-D1 above, use 18AWG wire if he units are daisy-

chained. It is best if each pair is twisted or dressed together from the device to the supply.

To control power to the MSP1-D1, switch power to the power supply. Do not use a relay or switch contacts between the 24V supply and the MSP1-D1.

2 Hardware Setup

This chapter includes these sections describing the various parts of hardware setup:

- Power
- Cabling
- Printed Circuit Board Setting and Options
- Installing Components
- Mounting the XE 1000
- Valveless MSP1-D1

2-1 Power

The MSP1-D1 requires a 24VDC power supply with a current rating of at least 500mA, provided through a DB-15 connector. LongerPump recommends using one power cable for every two pumps to provide noise immunity; i.e., power should not be daisy-chained to more than two pumps.

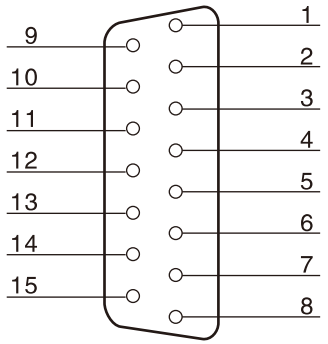
For complete information on choosing a power supply, see Chapter 1, "Getting Started."

2-2 Cabling

A single cable supplies both power and communications to each MSP1-D1. Set a unique address to identify each pump module. For more information, see "Address Setting Swithc", see also Chapter3, " Software Communication."

Table 2-1 Pin Definition of DB15 Interface

Pin	Function	Description
1	DC-24V	Power Supply Input (+)
2	TXD	RS232 Output Data
3	RXD	RS232 Input Data
4	COM	External Control Public End
5	NC1	Floating Pin
6	NC2	Floating Pin
7	IN1	External Control Input Pin 1
8	NC3	Floating Pin
9	GND	Ground-Power and Logic
10	GND	Ground-Power and Logic
11	RS-485 A	RS-485 A Pin
12	RS-485 B	RS-485 B Pin
13	OUT1	External Control Output Pin 1
14	NC4	Floating Pin
15	Nc5	Floating Pin



Igure 2-1 DB-15 Connector Pins

Figure 2-1 shows the pin positions of the DB-15 connector on the circuit board. This is a male connector that requires a female connector on the mating cable.

Communication Interface

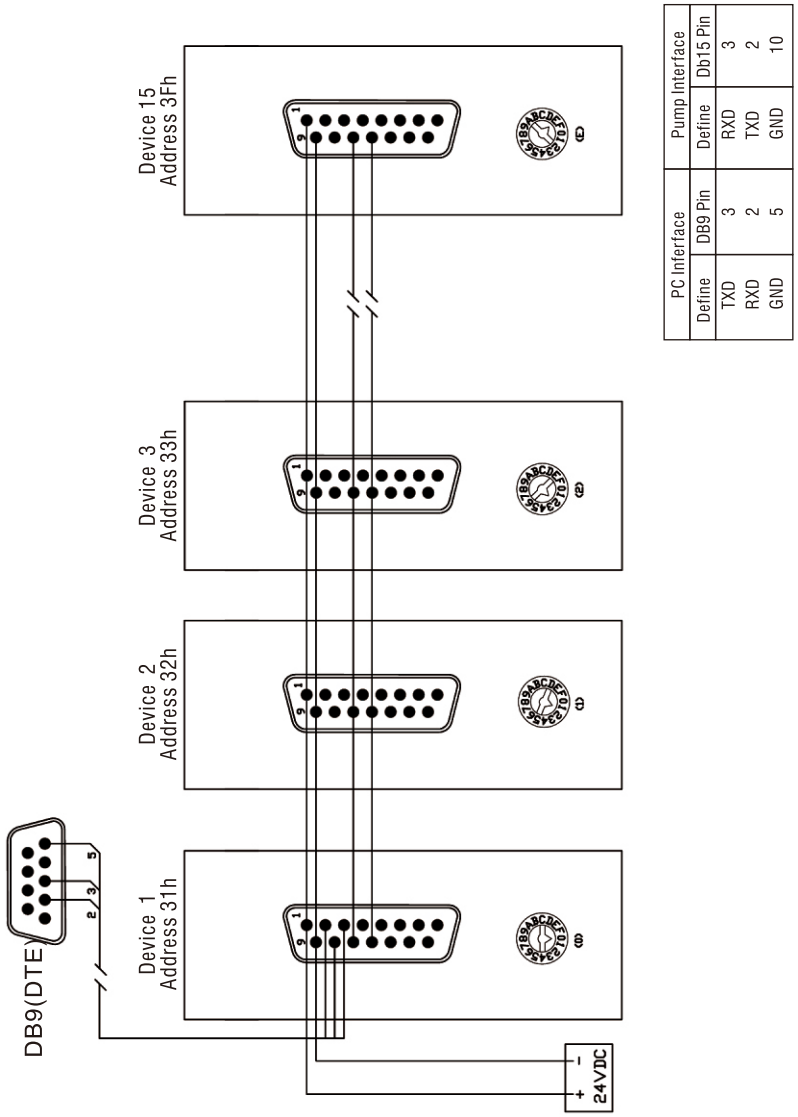
The computer or controller communicates with the MSP1-D1 through an RS-485 interface, RS-232 interface.

> Note: The RS-232 interface does not support hardware handshaking and requires only three lines: RXD, TXD, and Signal Ground.

There are some samples for communication cable wiring in the following pages.

Note: Power off the pump before operation.

RS232 Cabling



PC Interface	
Define	DB9 Pin
TXD	3
RXD	2
GND	5

Pump Interface	
Define	Db15 Pin
RXD	3
TXD	2
GND	10

Figure 2-2 RS-232 Multi-Pump Cabling

RS232 Cabling

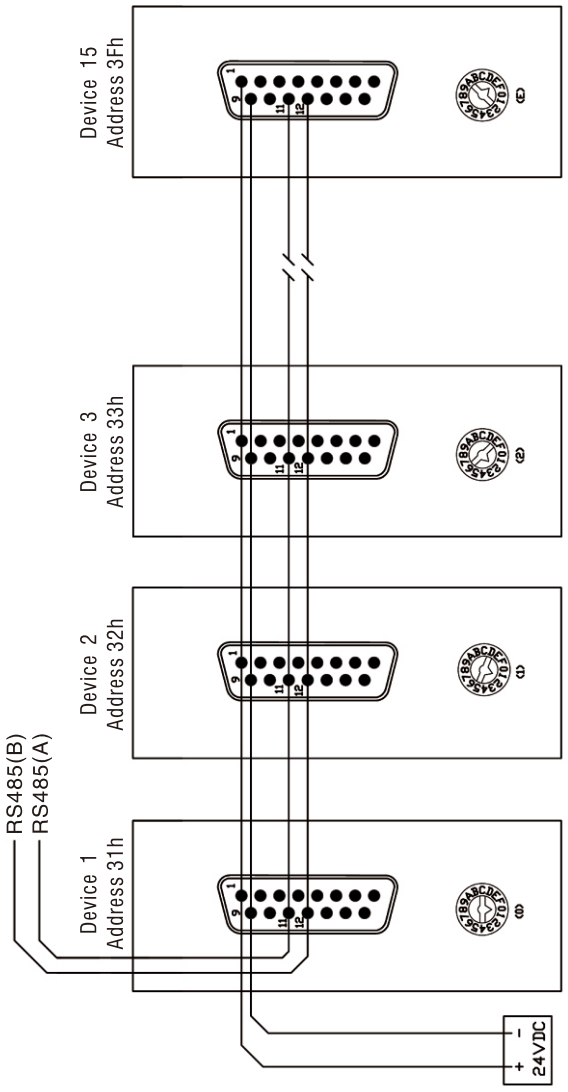


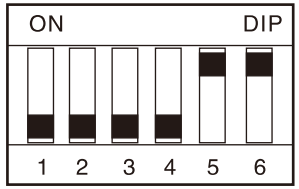
Figure 2-3 RS-485 Multi-Pump Cabling

2-3 Printed Circuit Board Setting and Options

2-3-1 DIP Dial Switch Setting

DIP dial switch is used to configure different work modes, see Figure 2-4,shown DIP dial switch and status.

Figure 2-4 DIP Dial Switch



DIP	Definition	ON	OFF
1	Reserved		
2	Code	Terminal	OEM
3	Baud Rate	38400	9600
4	RS485/RS232	RS232	RS485
5	A	Closed A	Open A
6	B	Closed B	Open B

Figure 2-4 DIP Dial Switch

Note: Always power off the MSP1-D1 before changing either work status.

DIP-1: Function Reserved

DIP-2: Code Selection

Dial switch allows choosing different work modes

- DIP-2 DT Terminal Mode
- DIP-2 OFF OEM Mode (default)

Refer to Chapter 3 "Software Communication" to know more information about communication protocol.

DIP-3: Baud rate selection

There are two kinds of baud rate of 9600/38400 available.

- DIP-3 ON 38400 Baud rate
- DIP-3 OFF 9600 Baud rate (default)

DIP-4: Communication mode selection

This DIP is used for setting RS232/RS485 communication protocol:

- DIP-4 ON RS-232 Protocol
- DIP-4 OFF RS-485 Protocol (default)

DIP-5: RS-485 Wire A

This DIP is used for setting RS-485 A status:

- DIP-5 ON A Closed (default)
- DIP-5 OFF A Open

DIP-6: RS-485 Wire B

This DIP is used for setting RS485 status:

- DIP-6 ON B Closed (default)
- DIP-6 OFF B Open

2-3-2 Address Setting Switch

The address jumpers are located on the rear panel of MSP1-D1. Each pump must be assigned a unique address number from 0 to E (total 16 position and 15 positions of 0 to E are available, F is self-test address, and allow user to send commend to specific pump.

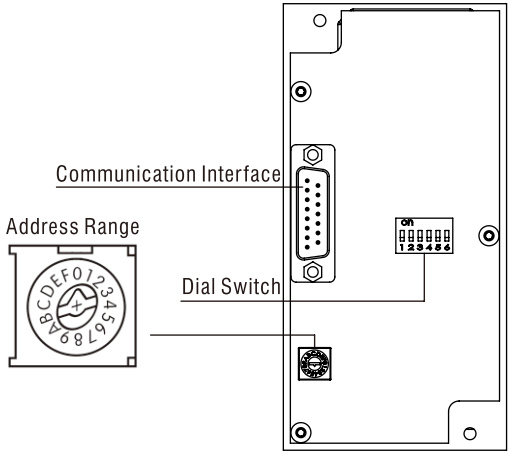


Figure 2-5 Address Setting Switch

Setting Address Switch:
Use a screw driver or similar tool to turn switch to target position (address)

Note: Restart the device after changing the address.

Self-test F address:
Set switch to "F" position, power on pump and run self-test program which includes initialization and plunger at different speed. Pump will stop if there are any error occurs.

Note: Must not dry run the valve and syringe, or it will damage the valve and the seal of syringe.

2-3-3 Input/Output

MSP1-D1 provides one auxiliary input and output that can be accessed through the DB-15 connector. They provide OC gate signal. The output is controlled by the "J" command.

The auxiliary input is located on DB-15 pin 7. It can be read back using report command "?I". Additionally, the input can be used to externally trigger a command sequence using the "H" command. The commands are described in Chapter 3, "Software Communication."

The auxiliary output is located on DB-15, pin 13. It is can be controlled the pin status using "?J".

2-4 Valveless MSP1-D1

Valveless MSP1-01 excludes valve, valve motor and valve encoding disc, its accessories and operation method is same as MSP1-D1, syringe is connected with Kel-F which replace valve of MSP1-D1. There is a "Y" type input/output port (suitable for 1/4-28" or M6) and 1/4"-28 thread. It is same for the operating method of valveless pump and valve pump.

"Y" Type Valve

Connector	1/4"-28 Imperial Fine Thread
Port/Path	3-Port-120
Syringe Installation	1/4"-28 Imperial Fine Thread
Material	PCTFE/PTFE

Figure 2-6 Kel-F Component

Commands of valveless MSP1-D1 and MSP1-D1 with valve are same except initialization command, valve command and valve overload command. For more information about commands see Chapter 3 ″Software Communicaiton.″

2-5 Installing Components

See Chapter 5, "Maintenance," for the procedures for replacing and maintaining components. Below installing instruction is for the 3- ports valve.

2-5-1 Installing Valve

Install MSP1-D1, following below steps:
1. Placing it on the front panel so that the screw holes line up.
2. Adjust encoder flat, let it perpendicular to the right side.
3. Turn valve coupler fitting in the position shown as Figure 2-8.
4. Install valve, mate the valve coupler fitting with the valve motor shaft, let valve tubing ports face up, syringe mount hole face down.
5. Slightly turn valve body, let valve mounting hole and holes in front panel of pump in same position.
6. Insert valve screws. Tighten to 1/4 to 1/2 turn after the screws contact the valve body.

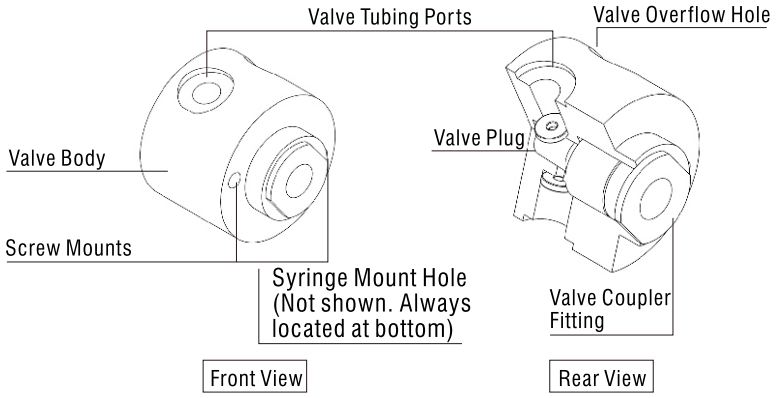


Figure 2-7 MSP1-D1 Valve Installation (3-Port Valve Shown)

2-5-2 Installing a Syringe

To install a syringe, follow these steps:
1. Lower the plunger drive by sending the command "A1000". If power is not applied, the plunger drive can be manually lowered by pushing down on the carriage assembly until it reaches the bottom of travel.
2. To install the syringe, do the following (as shown in Figure 2-8)
3. Place the self-aligning ball on the syringe plunger into the matching space in the carriage assembly.
4. Pull up on the syringe barrel and screw the1/4-28 fitting into the valve until it is finger tight. Using pliers on the syringe 1/4-28 fitting, turn the syringe an additional quarter turn.

Note: Make sure the syringe is securely screwed into the valve.

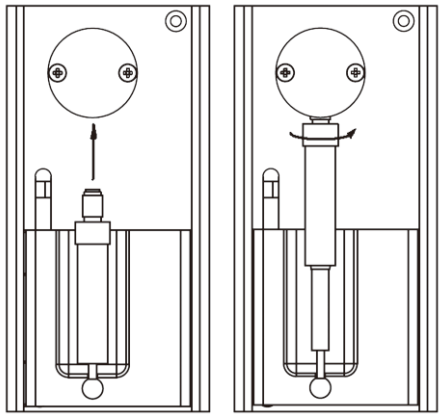


Figure 2-8. Syringe Installation

2-6 Mounting the MSP1-D1

MSP1-D1 contains mounting holes in the top right and bottom left corners of the pump face. It is designed to mount to a panel using two M3 socket head cap screws. Shown as Figure 2-9:

Note: Always mount the pump in an upright position. Failure to do so can cause problems in priming the system.

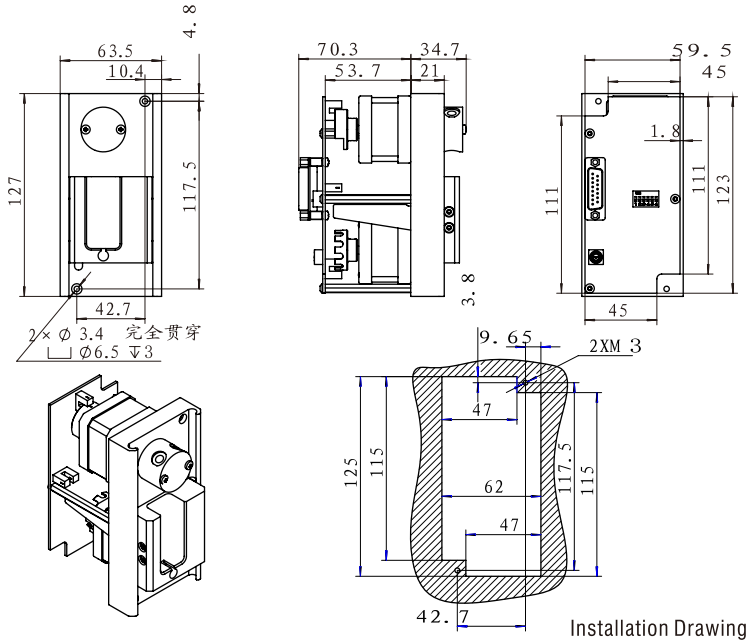


Figure 2-9 MSP1-D1 Outline Drawing

3. Software Communication

This chapter describes how to communicate with the MSP1-D1 through an RS232, RS-485 interface.

This chapter includes these topics:

- Address setting
- Communication Protocol
- Command Set
- Error Codes and Pump Status

3-1 Address Setting

As part of communication protocol, each pump must have an individual address number.

Table 3-1. Address Setting Table (16 Hex)

Address 16 Hex RS-232/RS-485	Device
30	Host Address (Main controller, computer, etc.)
31-3F	Pump Address
5F	Broadcasting Address (that means this address is available for all the pumps)

For example, set pump address switch at "0" position, then communication address is "31h"; set at "1" position, then communication address is "32", and so on.

In multi-pump connection, Host can communication all the pumps when use "5F" broadcasting address, for example, initialize all the pumps at same time. And use individual pump address to control individual pump through communication.

Note: Commands sent through broadcasting address can not inquire the pump status, and it can not affect report command. if want to check the work status of each pump then individual pump address must be used.

3-2 Communication Protocol

Two communication protocol are available:

- OEM Communication Protocol
- DT (Data Terminal) Protocol

DT is data terminal protocol which use non-check code ASCII to transfer, more detail refer to "Using DT Protocol with Microsoft Windows" in this chapter.

Note: Longerpump recommends using OEM protocol. It provides increased error checking, i.e., checksums and sequence numbers are used.

3-2-1 OEM Communication Protocol

OEM communication is a robust protocol. Table 3-3 describes each setting in this protocol.

Table 3-1 OEM 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")	
1	STX(^B or 02h)
2	Pump Address

Parameter	Setting
3	Sequence Number/Repeat Flag
3+n	Data Block (Length n)
4+n	ETX(^C or 03h)
5+n	Checksum
Command Block (see "OEM Protocol Command Block Characters")	
1	STX(^B or 02h)
2	Master Dress (“0” or 30h)
3	Status Code
3+n	Data Block
4+n	ETX(^C or 03h)
5+n	Checksum

OEM Procotol Command Block Characters

The command block characters in the OEM commnication 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. It also also automatically spefifies that the pump is using OEM protocol.

Pump Address: "0" - "E" (31h-3Fh)

Sequence Number/Repeat Flag: Fixed value "1" (31h)

Data Block (Length n): The data block consist of the data or commands sent to the pump or host (this is an ASCII string).

For example, A1000, five bits, display as 41 31 30 30 30.

ETX (^ C or 03h): Block end (The ETX character indicates the end of a command string.)

Checksum: The checksum is the last byte of the message string. All bytes are data from STX to ETX (including STX and ETX).

OEM Protocol Answer Block Characters

The answer block in OEM communication procotol 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 Charaters."

Mater 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" in this chapter.

3-2-2 Data Terminal (DT) Protocol

Table 3-4 DT Protocol

Parameter	Setting
Data Transfer Character	
Baud Rate	9600 or 38400
Data Bits	8
Parity	None
Stop Bits	1
Command Block (see "OEM Protocol Command Block Characters")	
1	“/” (2Fh)
2	Pump address
2+n	Data Block (length n) Carriage
3+n	Return ([CR] OR 0Dh)
Answer Block (see "DT Protocol Answer Block Characters")	
1	“/” (2Fh)
2	Host 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)

DT Protocol Command Block Characters

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

Start Block "/": The start block indicates the beginning of a message block. It also automatically specifies that the pump is using DT protocol.

Pump Address: "0" to "E" (31h-3Fh), The pump address is an ASCII character specific to each pump.

Data Block (length n): The data block consist of the ASCII data or commands sent to the pump which displayed by ASCII data, big digits are front, and small digits are behind.

For example: A1000 five bits, which display as 51 31 30 30 30.

Carriage return: ODH is end block, the end character indicates the end of a message block.

DT Protocol Answer Block Characters

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

Only unique answer block entries are listed in this section. For information on command and answer block command (characters), see the previous section, "DT Protocol Command block characters.˝

Host Address: The host address is the address of the host system. This should always be 30h (SCII "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.

Enter Byte: 0Dh is end block.

Line Feed (0Ah): This is the last byte in data string, that means to terminate the block.

Using DT Protocol with Microsoft Windows

The MSP1-D1 can be controlled in DT protocol mode directly from the Microsoft Windows terminal accessory.

To communicate with the MSP1-D1 using Windows, follow these steps:

1. To connect the MSP1-D1 to a communication ports on the PC, first select the **Start** menu and choose **Run**.
2. In the Run Dialog box, type **Hyperterm.exe** or **click Start-Accessory-Hyperlink**. The Connection Description dialog box appears.
3. Enter a name for the connection and select an icon, then click **OK**. The Phone Number dialog box appears.
4. Select the following in the fields provided:
   Connect using: Direct to <communication port> (usually COM1 or COM2)
   Click **OK**. The COM Propertis dialog box appears.
5. Select the following in the fields provided, then click OK:
   Bits per second: 9600
   Data bits: 8
   Parity: None
   Stop bits: 1
   Flow control: None
   Click **OK**
6. Select the File menu, and choose Properties, the Properties dialog box appears.
7. Select the Setting tab, and enter or select these options:
   - Function, arrow, and Control keys act as:
     Select "Terminal keys"
   - Emulation:
     Select "Autodetect"
     Enter "500" in Backscroll buffer lines
   - Click the ASCII Setup button. The ASCII Setup dialog box appears.
8. Enter or select these options:
   Select "Send line ends with line feed"
   Select "Echo typed characters locally"
   Enter a Line delay of "0"
   Enter a Character delay of "0"
   Select "Wrap lines that exceed terminal width"
9. Click OK to close the ASCII Setup dialog box, then click OK to close Properties Dialog box.
10. Set the pump address to 1 or the appropriate address.

11. Set DIP dial switch: DIP-2 means ON, DIP-3 means OFF, i.e. to choose terminal mode, baud rate is 9600.
12. Power on the pump and initialize it by typing /1ZR and pressing Enter. To run the pump, see the commands listed in "Using the XE1000 Command Set" in this chapter.

3-3 Commands System

MSP1-D1 features a robust command set which allows a wide range of parameters to be defined by the user. Many of the commands have default values; however, the default values may not provide the optimal settings for your application. Take a moment to familiarize yourself with each command in order to obtain the best performance for your application.

For a quick summary of all commands, see Appendix G, "Command Quick Reference."

When problems are detected, the XE1000 sends an error code. The error codes are described in "Error Codes" at the end of this chapter.

3-3-1 Command Execution Guiderlines

To use the commands properly, keep following in mind:

- All commands, except Report commands and Enquiry Commands, must be followed by an [R] (Execute) command.
- Single or multiple command strings can be sent to the pump.
  For example:
  A single command such as [A1000R] moves the plunger to position 1000.
  A multi-command string such as [IA1000oA0R] turns the valve the input position, moves the plunger to position 1000, turns the valve to the output position, and finally returns the plunger to position 0.
- The pump's command buffer holds a maximum of 128 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.
- Always run liquid through the syringe and valve then issuing a Move command. Failure to do so may damage the valve and syringe seal.
- Keep fingers away from the carriage assembly while the pump is running. Failure to do so can result in injury.
  Command Syntax
  The syntax for each command in the command set is:
  <n> Numerical value within a given range
  0..30,000 Range of numerical values allowed
  (n) Default value

Note: Square brackets, [], are used to distinguish commands and should not be sent as part of the command strings.

3-3-2 Control Commands

R Execute Command Or Program String

The [R] command tells the pump to execute a previously sent command or program string.

Commands containing an [R] at the end of the string will execute immediately. If the command or program string is sent without the [R], it is 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 or Program String

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

G<n> Repeat Command Sequence

The [G] command repeats a command or program string the specified number of times. The syntax for this command is : [G<n>], where <n> = 0 to 30,000, zero means unlimited cycle.

For example: [g1000A0G10R] moves the syringe plunger to position 1000 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).

For example: [A0GP50gP100G10G5R] command string perform as following:

A0	Moves the plunger to absolute position 0.
g	Marks the beginning of a repeat sequence.
P50	Move the plunger down 50 steps
g	Marks the beginning of a repeat sequence.
P100	Move the plunger down 100 steps
D100	Move the plunger up 100 steps
G10	Closes the loop and commands the pump to repeat the commands from the [g] a total of 10 times.
G5	
R	Execute command string.

Note: if <n>=0, it means unlimited cycle, send a command [T] to stop it.

M<n> Delay Command Execution

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

[M<n>], where <n>=5..30,000 milliseconds

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>]

There are two TTL input available, at JP3-7. It controls execution as follows:

<n> =0 Wait for [R] or input to go high.
<n> =1 Wait for [R] or input to go low.

Note: <n> default as 0 if there are no digits with it.

T Terminate Command

The [T] command terminates plunger moves in progress ([A], [P], [D], and delays [M]) as well as program strings. It is designed to be an emergency stop.

Note: The [T] command will not terminate Valve Move commands.

The [T] command terminates single command and command string.

When a plunger move is terminated, lost steps may result. Reinitialization is recommended following termination.

J<n> Auxiliary Outputs

The [J] command sets the TTL output line.

The syntax for this command is:

[J<n>], where <n>=0..1 (0 is the default)

The DB15 provides one TTL output on pin 13, It is controlled as follows:

MSP-D1 Commands	Output 1 (Pin 13)
J0	0
J1	1

3-3-3 Initialization Commands

Initialization commands for valve

Z <n> Initialize Plunger (Set Input at left port, output at right port)

The Z<n> command initializes the plunger and valve. It defines the left port as the input port (from which fluid is drawn into the syringe) and the right port as the output port (from which fluid is dispensed).

Command	Data	Description
Z<n>	<n>=2 ~ 20	Initialization Plunger

Y<n> Initialize Plunger (Sets input at right port, output at left port)

The [Y] command initializes the plunger and valve. It defines the right port as the input port (from which fluid is drawn into the syringe) and the left port as the output (from which fluid is dispensed).

Command	Parameters	Description
Y<n>	<n>=2～20	Initialization Plunger

3-3-4 Plunger Movement Commands

A<n> Absolute Position

The [A] command moves the plunger to the absolute position <n>, where <n>=0..1000.

For example:[A300] moves the syringe plunger to position 300.

P<n> Relative Pickup

The [P] command moves the plunger down the number of steps commanded. The new absolute position is the previous position +<n>, where <n>=0..1000.

For example:The syringe plunger is at position 0. [P300] moves the plunger down 300 steps. [600] moves the plunger down an additional 600 steps to an absolute position of 900.

The [P] command will return error 3 (invalid operand) if the final plunger position would be greater than 1000.

D<n> Relative Dispense:

The [D] command moves the plunger upward the number of steps commanded. The new absolute position is the previous position -<n>, where <n>=0..1000.

For example:The syringe plunger is at position 1000. [300] will move the plunger up 300 steps to an absolute position of 700.

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

P Prime:

The [P] command orders the pump to perform two complete aspiratin/dispense cycles of the full syringe volume.

3-3-5 Valve Commands

Note: It is unavailable if valve command uses to non valve pump.

I Move Valve to Input Position

The [I] command move the valve on the MSP1-D1 to the input position set by the [Y] and [Z] commands, the valve will be open to the syringe on the left side (as viewed from the front of the pump). The input position will pull fluid into the syringe.

O Move Valve to Output Position:

The [O] command moves the valve on the MSP1-D1 to the output position set by the [Y] and [Z] commands.

For example: If the [O] command is sent after the [Z] command, the valve will be open to the syringe side (as viewed from the front of the pump). The output position will dispense fluid out of the syringe.

The illustration below shows the positions of the valves in relation to the initialization command and valve movement used.

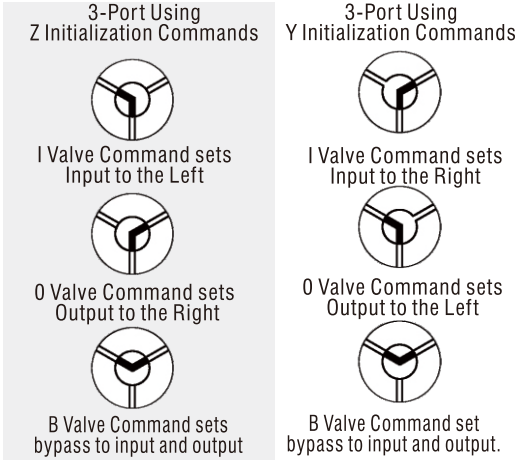


Figure 3-1 Valve Positions

B Move Valve to Bypass (Throughput Position)

The [B] command connects the input and output positions, bypassing the syringe.

3-3-6 Set Commands

S<n> Set Speed:

The [S] command sets the plunger speed. This parameter specifies the approximate time required for one full stroke (plunger travel in a singel direction). The syntax for this command is:

[S<n>], where <n>=20..600 (40 is the default)

K<n> Backlash Steps:

The [K] command sets the number of backlash steps. The syntax for this command is:

[K<n>], where <n> is the moving steps, <n>=0..80

In initialization, plunger move to "0" point, plunger move down "n" steps to make sure there are small gap between syringe seal and the top of plunger. This gap ensure the plunger will not to strike the syringe barrel and this will enlarge the life of syringe seal.

3-3-7 Report Commands

? Report commands do not require an [R] command.
[?] command reports the position of the plunger in steps [0…1000].

?S Reports Current Speed Setting
The [?S] command reports the current speed setting in [S] command format: tenth of second/stroke [20..600].

F Reports Buffer Status
The [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.

?I Reports Status of Auxiliary Input (JP3, PIN7)
0=LOW
1=HIGH

3-3-8 Error Codes and Pump Status

The [Q] command reports error codes and pump status (ready or busy).

Table 3: Error Codes and ASCII and Hexadecimal Values.

Status Byte	Hex# 如果 Bit5 =		Dec# 如果Bit 5 =		Error Code	
76543210	0	Or 1	0	Or 1	Number	Error
01X00000	40h	60h	64	96	0	Initialization
01X00001	41h	61h	65	97	1	Invalid Command
01X00010	42h	62h	66	98	2	Invalid Operand
01X00011	43h	63h	67	99	3	
01X00100	44h	64h	68	100	4	Keep
01X00101	45h	65h	69	101	5	Keep
01X00110	46h	66h	70	102	6	Keep
01X00111	47h	67h	71	103	7	Device not Initialized
01X01001	49h	69h	73	105	9	Plunger Move Not Allowed
01X01010	4Ah	6Ah	74	106	10	Valve Overload
01X01011	4Bh	6Bh	75	107	11	Plunger Move Not Allowed
01X01111	4Fh	6Fh	79	111	15	Command Overflow

The [Q] command 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: The query command [Q] is the best method of obtaining status.

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

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.

During the move command [A], [P] and [D] process, the [Q] command reports the status of pump is busy, multi-pump must be check the status individually.

Note:Other return bits can not confirm the status of pump. Only [Q] command is available if pump is busy. The error information or return status bits is available.

Error Code

Error codes describe problem conditions that may be detected in the MSP1-D1 (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 next command causes an error #3, the status byte reflects the error #3 (invalid operand). For more information, see table 4 below:

Error Code	Description
0(00h)	Error free condition.
1(01h)	Initialization error. This error occurs when the pump fails to initialize.
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.
4(04h)	Reserved
5(05h)	Reserved
7(07h)	Device not initialized. This error occurs when the pump is not initialized or has lost its positional information, i.e., as stall occurs, but a move command has been issued. To clear the error, initialize the pump.
9(09h)	Plunger overload. This error occurs when movement of the syringe plunger is blocked by excessive back pressure. 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 steps. 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.
15(0Fh)	Command overflow. This error occurs when the command string contains too many characters. Commands in the buffer must be executed before more commands can be sent.

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), "Invalid Command Sequence" (error 4), and "Plunger Move Not Allowed" (Error11). 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.

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 indicateds 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.

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 a successful initialization has not occured, an initialization error is returned.

Command Overflow Error. This is error 15, and it occurs if the command string contains more than 128 characters. The pump ignores the command and issues an error 15. The [Q] command allows the controller to determine when the complete and the pump is ready to accept new commands.

Error Reporting Examples

[A4000R] Does not return an error immediately after the command, but when queried ([Q] command), returns an "Invalid Parameter" error.

[A1000A3500R] Moves to position 1000, then stops. A [Q] command returns an error.

[X1000R] Return an invalid command error immediately. The pump status is "Not Busy."

[A1000x1000R] Return an invalid command error immediately. The pump status is "Not Busy."

Valve in Bypass [A1000R] Does not return an error immediately, but when queried ([Q] command), returns a "Plunger Move Not Allowed" error.

4 Setting Up the MSP1-D1 for Your Application

The MSP1-D1 is capable of providing precision pumping in a wide variety of hardware and fluid systems. The interplay of fluid viscosity, aspiration and dispense speeds, and system geometry [syringe size, tubing inner diameter (I.D.)

4-1 Glossary

Air Gap: A small volume of air at the end of the output tubing or sandwiched between two fluids in the pump system tubing. Air gaps may be created by aspirating air (programmed air gaps) or by the spring action of the fluid system (inertial air gaps).

Aspirate/dispense tubing: Connects the valve output port to a sample source and destination. To ensure good breakoff, aspirate/dispense tubing tends to have a smaller I.D. than reagent tubing, and a necked-down or tapered end.

Backlash: Mechanical play in the syringe drive created by accumulated mechanical clearances. To maintain accuracy and precision when the syringe drive changes direction, the MSP1-D1 incorporates programmable back lash compensation.

Backpressure: The pressure which must be exceeded to move fluid through tubing. Backpressure is created by a combination of fluid inertia, flow path restrictions and friction.

Breakoff: Describes how the last droplet of fluid exits the end of the output tubing following a dispense. Rapid or sharp breakoff means that the droplet exits cleanly with high inertia.

Breakup: Undesired air gaps generally created by overly rapid aspiration.

Carryover: Contamination of a volume of fluid by residual fluid from a previous aspiration or dispense. Carryover causes variability in final volume and concentration.

Cavitation: Formation of air bubbles due to rapid pressure changes.

Dilution Effect: Reduction in sample or reagent concentration, caused by contact with system fluid or residual fluid from a previous aspiration or dispense.

I.D. ("inner diameter"): Inside diameter of the fluid path orifice.

Priming: Completely filling the pump tubing and syringe with bubble-free fluid to allow sustained, reproducible pumping action. The air in an unprimed line acts as a spring, adversely affecting accuracy and precision.

Reagent Tubing: Connects the valve (1/4-28 thread) input ports to a reagent source. Reagent tubing is used to fill the pump syringe; it tends to have a larger I.D. than aspirate/dispense tubing, and a blunt-cut end which extends into the reagent.

System Fluid: A fluid used to prime the pump system that does not act as sample or reagent. Typically the system fluid is deionized water or a wash buffer and is isolated from sample or reagent fluid by an air gap to avoid intermixing.

4-2 Optimizing MSP1-D1 Performance

CAUTION! Run the pump only in the upright position. Do not move the pump valve or syringe plunger without first wetting or priming the pump.

For command details, see chapter3, "Software Communication."

To optimize MSP1-D1 performance, follow these steps:

1 Check chemical compatibility.

Check the chemical compatibility chart in Appendix D, "Chemical Resistance Chart," to determine if the fluids in your application are compatible with the MSP1-D1 syringe and valve materials. If not, a system fluid is required. Complete the optimization procedure with the fluids you will use in your final system.

Note that the system fluid is used to prime the syringe and tubing from inlet to outlet. After the tubing is primed (and before any sample or reagent is aspirated), and air gap must be taken into the aspirate/dispense tubing to separate the system fluid from subsequently aspirated sample or reagent. Air gaps should be aspirated fluid - or at least 10 micro liters - to avoid any dilution effect. Similar air gaps should separate each aspirated fluid when performing multiple aspirates with no intervening dispenses, in order to prevent premature mixing and/or contamination. In addition, the aspirate/dispense tubing must be long enough to hold the total aspirate volume without coming in contact with the valve or syringe.

2 Select syringe size.

Determine your volume and flowrate requirements. Select a syringe that accommodates the smallest and largest volumes to be dispensed without refill, as well as the desired flowrate (see Table 4-1). While smaller syringes allow better accuracy and precision, a larger syringe allows more aliquots when multiple aspirations or multiple dispenses are required, and they allow better breakoff and longer seal life.

Table 4-1. Flowrate Ranges

Syringe Size	Minimum Flowrate (mL/min)	Maximum Flowrate (mL/min)
500 μ L	0.5 mL/min	15 mL/min
1mL	1 mL/min	30 mL/min
2.5mL	2.5 mL/min	75 mL/min
5mL	5 mL/min	150 mL/min

3 Select tubing

In tubing selection, the general rule is that smaller syringes work best with smaller I.D. tubing and larger syringes with larger I.D. tubing. Most MSP1-D1 valve styles have an internal I.D. of 0.059" (approx. 1/16"). For aspirate/dispense tubing a thermal-drawn tip or tapered tip is most common, providing good breakoff and excellent accuracy and precision for most applications. A necked-down tip may be used when aspiration very small volumes of sample, i.e., 5 L. A blunt-cut tip is better suited for large volume applications. For tubing recommendations, see Table 4-2; for a description of the various types of tubing, see Appendix A, "Ordering Information."

Table 4-2 Tubing Recommendations

Suitable tubing for MSP1-D1	
Part Number	Detailed Description
008T16-050	1.6mm (1/16") O.D.×0.5mm (.02") I.D.
008T16-100	1.6mm (1/16") O.D.×1.0mm (.039") I.D.
008T32-150	3.2mm (1/8") O.D.×1.5mm (.059") I.D.

4 Make pump connections.

Connect power and communications cables to the pump, install syringe and tubing. Place the end of the input tubing in a reservoir of particle-free fluid; place the end of the output tubing in a waste reservoir.

5 Check communications to the pump.

a) Open the pump to start the program.
b) Send the command [Z2R] to communicate the pump, pump will be initialized.

Possible errors:
No response. Check for loose or incorrectly connected cables or connection to the wrong computer COM port. Retry.

6 Initialize pump and set initialization speed.

The following information assumes that your input tubing connects to the right valve port. If your input tubing connects to the left valve port, exchange [Y] for all instance of [Z] in the following commands.
Send the command [ZR] to initialize the pump. Successful initialization will move the syringe plunger to the position "0" (fully dispensed) and return a "Ready" status.

7 Prime the syringe.

a) Send the command [IA1000R], to pull fluid through the valve input position and into the syringe.
b) Inspect the pump tubing syringe for bubbles and re-prime until all bubbles are completely gone.
If bubbles remain after several priming strokes, disassemble the syringe and clean it with alcohol. Also check to ensure that the tubing fitting and syringe are screwed in tightly.
c) Re-prime.

Possible errors: Error 9 (plunger overload). See step 8.

8 Check aspirate/dispense.

Send the command [IAI1000OA0R] to aspirate a full syringe stroke (1000 steps) from input and dispense it to output. Successful execution will move the syringe plunger to position "1000" then back to "0," then it will return a "Ready" status.

Possible errors:

Error 9 (plunger overload). The stepper motor is unable to move the syringe plunger, probably because of excessive back pressure caused by excessive flowrate, narrow tubing I.D., or valve or tubing blockage. Note whether the error occurred during aspiration or dispensing. To differentiate between blockage and flowrate limitation, reduce syringe plunger speed by sending the command [S20IA1000OA0R]. Repeat with decreasing plunger speed (increase "S_" value) until the pump aspirates and dispenses succeffully.

4-3 Helpful Hints

To maintain pump performance, keep the following in mind when operating the MSP1-D1:

- Wipe up all spills immediately.
- Pumping cold fluids may cause leaks, the result of differing coefficients of expansion of Teflon and glass. Leaks may occur when pumping fluids that are at or below 15 C (61F).

- Use organic solvents in the MSP1-D1 with caution. Using organic solvents may reduce tubing, valve ans syringe life.

5. Maintenance

Although required maintenance may vary with your application, the following procedures are recommended for optimal performance and maximum life of the MSP1-D1.

Perform manitenance tasks in these intervals:

- Daily
- Weekly
- Periodically

5-1 Daily Maintenance

To ensure proper operation of the MSP1-D1, perform these tasks daily:

- Inspect the pump (s) for leaks, and correct any problems.
- Wipe up all spills on and around the pump.
- Flush the pump (s) thoroughly with distilled or deionized water after each use and when the pump is not in use. Failure to do so can result in crystallization of reagents. Crystals can damage the syringe seal and valve plug resulting in leakage.

Note: Do not allow the pump(s) to run dry for more than a few cycles.

5-2 Weekly Maintenance

The fluid path of the MSP1-D1 must be cleaned weekly to remove precipitates such as salts, eliminate bacterial growth, and so on. Any of the three following cleaning procedures can be used:

- Weak detergent
- Weak acid and base
- 10% bleach

The procedures using these solutions are described in the sections that follow.

5-2-1 Weak Detergent Cleaning

To clean the pump with weak detergent, follow these steps:

1 Prime the pump with a weak detergent solution (e.g. 2% solution of CONTRAD, RoboScrub, or flo-kleen) and allow the solution to remain in the pump with the syringe fully lowered for 30 minutes.

2 After the 30 minutes period, remove the reagent tubing from the detergent and cycle all the fluid from the syringe and tubing into a waste container.

3 Prime the pump a minimum of 10 cycles with distilled or deionized water. Leave the fluid pathways filled for storage.

5-2-2 Weak Acid-Base-Sequence Cleaning

To clean the pump with weak acid and base, follow these steps:

1 Prime the pump with 0.1N NaOH and allow the solution to remain in the pump(s) for 10 minutes with the syringes fully lowered.

2 Flush the pump with distilled or deinized water.

3 Prime the pump with 0.1 N HCl, and allow the solution to remain in the pump for 10 minutes with the syringes fully lowered.

4 After a 10 minute period, remove the reagent tubing from 0.1 N HCl solution and cycle all the fluid from the syringes and tubing into a waste container.

5 Prime the pump a minimum of 10 cycles with distilled or deionized water.

5-2-3 10% Bleach Cleaning

To clean the pump with 10% bleach, follow these steps:

1 Make a solution of 10% bleach by adding one part of commercial bleach to nine parts of water.

2 Prime the pump with the 10% bleach and allow the solution to remain in the pump with the syringes fully lowered for 30 minutes.

3 After the 30-minute period, remove the reagent tubing from 10% bleach solution and cycle all the fluid from the syringes and tubing into a waste container.

4 Prime the pump a minimum of 10 cycles with distilled or deionized water.

5-3 Periodic Maintenance

Tubing, syringe seals, and valves require periodic maintenance. If they become worn, you are likely to notice these symptoms:

- Poor precision and accuracy
- Variable or moving air gap
- Leakage

If any of these symptoms occurs and it is not obvious which component is causing the problem, it is easiest and most economical to replace one component at a time in the following order:

- Input and output tubing
- Plunger seal
- Valve

The frequency of replacement will depend on the duty cycle, fluids used, and instrument maintenance.

5-3-1 Quality Control Assurance

Check the accuracy and precision of the MSP1-D1 on a regular basis.

Recommends checking both accuracy and precision gravimetrically, using a calibrated analytical balance with the capability to measure to 0.1 mg. Gravimetric measurements should be corrected for the specific gravit of water at the ambient temperature.

The syringe can be checked by programming in the desired volume and determining the weight of fluid dispensed.

To determine precision and accuracy, run a minimum of 20 replicateds. The Mean, Standard Deviation and Coefficient of Variation (see formula below) can then be calculated. The calculations to determine accuracy must take into account the specific

gravity of water, which is dependent upon temperature. In addition, to prevent a false reading caused by fluid adhering to the tip of the aspirate tubing, a small amount of surfactant should be added to the water (e.g., Fluoard at a 0.01% concentration).

% Coefficient of Variation=(Standard Deviation/Mean) *100

$$\%CV = \left(\frac{\sqrt{\frac{1}{n-1}\sum_{i=1}^{n}(X_i - \bar{X})^2}}{\bar{X}} \right) *100$$

$$\%Accuracy = \left[\frac{|\frac{\bar{X}}{sg}|*100}{Vol_{expected}} \right] -100$$

Where:

sg = density of H2O @ 25&*&& = 0.99707
Vol = expected volume to be dispensed
N = number of replicates
$\bar{X}$ = inividual result
"X = mean of all results

5-3-2 Repalceing Dispense or Reagent Tubing

To replace dispense or reagent tubing, follow these steps:

1 Unscrew the fittings and remove the tubing.

2 To install new tubing, insert the fitting into the valve and tighten it finger tight.

5-3-3 Replacing a syringe

To replace a syringe, follow these steps:

1 Remove the liquid from the syringe.

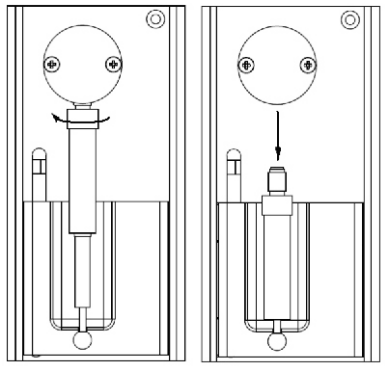
2 Unscrew the tighten screw to plunger.

3 Lower the plunger drive by sending the [A1000R] command.

4 Unscrew the syringe from the valve.

5 To install the syringe, do the following:
a Connect syringe and valve (Pull the syringe up and screw it into the valve).
b Place the self-aligning ball on the bottom of plunger into the carriage.
c Screw the syringe plunger into place.

6 Re-initialize the pump.



5-3-4 Repalcing the MSP1-D1 Valve

To replace the MSP1-D1 valve, follow these steps:

1 Remove the fluid from the pump.

2 Initialize the pump using the [ZR] command so that the motor shaft is in the correct position.

3 Remove the syringe and tubing.

4 Remove the two head screws on the front of the valve, then remove the valve from the pump.

5 Install the valve by placing it in the front panel so the screw holes line up. The valve coupler fitting should be in the correct position.

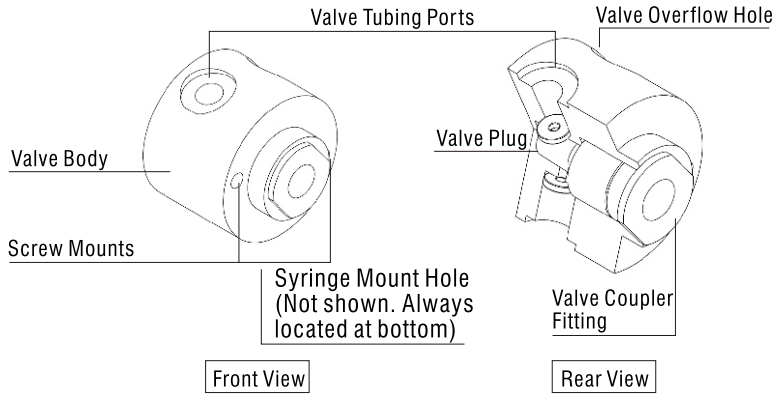


Figure 5-2 Valve Replacement (3-Port Valve Shown）

6 Replace the valve screws. Tighten 1/4 to 1/2 turn after the screws contact the valve body.

5-4 On-Site Replacements

5-4-1 Replacing the Printed Circuit Board (PCB)

To replace the printed circuit board, follow these steps:

1 Power off the pump.

2 Remove the three screws holding the PCB to the standoffs.

3 Note the cable connection locations and unplug the cable from the board.

4 Plug the cables into the new board.

5 Install the new board and screw it into place.

6 Power on and reinitialize the pump.

6. Technical Service

For information or questions regarding ordering or operating the MSP1-D1, please send email to LongerPump: longer@longerpump.com.

Or by phone

Tel: 0086-312-3110087

Fax: 0086-312-3168553

Https://www.longerpump.com

The mailing address is:

Baoding Longer Precision Pump Co., Ltd

3rd/4th Floor, Building 6B, University Science Park Baoding National, High - Tech Industrial Development Zone Baoding, Hebei, China 071051

When calling for technical service, have the following information ready:

- Part number
- Model type
- Operating environment- ambient environment and relative liquid.
- Description of the problem

Appendix A Order Information

Appendix A-1 Configuration and Accessories

Standard Configuration Table

Number	Name	Type	Quantity	Remark
1	Syringe Pump	MSP1-D1	1	
2	Valve	VY32	1	Installed
3	Valve Gasket		3	In valve
4	Operation Manual		1	
5	QA Pass		1	

Spare Parts Configuration A-1-1

Number	Name	Type	Quantity	Remark
1	Syringe	See table A-1-1		
2	Fitting	See table A-1-2	2set	Installed
3	PEFE Tubing	See table A-1-3		In valve
4	SMPS	24V 1.5A		
5	Data Cable	RS232 or RS485		
6	RS232/RS485 Converter			
7	Power Cord	0.5mm2, 1.5m Power cord	1	Based on the requirement of customer.
		0.5mm2 power cord-Europe type	1	
		0.5mm2, 1.5m power cord-USA type	1	

Syringe Table A-1-2

Industries Syringe Pump MSP1-D1 Syringe			
Syringe compatible with CavroXP3000	Heavy Load Syringe PTFE-Seals	Improved Syringe PTFE-Seals	Low-Friction Syringe PE-Seals
500 μl	2607915	2647917	2647918
1ml	2607015	2647017	2647018
2.5ml	2607035	2647037	2647038
5ml	2607075	2647077	2647078
Character	Suitable for working under pressure, good chemical resistance	Own longer life than SYRH, good chemical resistance	Longer life, but chemical resistance is poor

Tubing Fitting Table A-1-3

Industries Syringe Pump MSP1-D1 Fitting		
Tubing Fitting	Tubing OD	Tubing Blunt End
2144 PEEK	1/16"	1544/1544S PTFE
2244 PEEK	1/8"	1545/1545S PTFE

Tubing A-1-4

Industries Syringe Pump MSP1-D1 Tubing	
Part Number	Description
008T16-050	1.6mm (1/16") O.D.×0.5mm (.02") I.D.
008T16-100	1.6mm (1/16") O.D.×1.0mm (.039") I.D.
008T32-150	3.2mm (1/8") O.D.×1.5mm (.059") I.D.

Testing Software

LongerPump can provide relative communication protocol and Demo testing software according to customers' requirement. We also can write relative operation software if customers have special requirement.

Appendix A-2 LongerPump Other Products

Peristaltic pump serial: Basic type, Flow Rates type, Industries type, Batch Transferring type, etc.

Precision syringe pump: Laboratorial Syringe Pump, Industries Syringe Pump.

OEM products: Peristaltic pump tubing, OEM peristaltic pump.

Appendix-B

Plunger Force
Plunger Force: 6.8kgf.

Moving Speed
Plunger speed range: S20-S60, which means one full stroke, will be finished between 2 seconds to 60 seconds.

Appendix C ASCII Chart

Decimal	Hexadecimal	Character or Function
0	00	none
1	01	SOH
2	02	STX
3	03	ETX
4	04	EOT
5	05	ENQ
6	06	ACK
7	07	BEL
8	08	BS
9	09	HT
10	0A	LF
11	0B	VT
12	0C	FF
13	0D	CR
14	0E	SO
15	0F	SI
16	10	DLE
17	11	DC1
18	12	DC2
19	13	DC3
20	14	DC4
21	15	NAK
22	16	SYN
23	17	ETB
24	18	CAN
25	19	EM
26	1A	SUB
27	1B	ESC
28	1C	FS
29	1D	GS
30	1E	RS

Decimal	Hexadecimal	Character or Function
31	1F	US
32	20	SP
33	21	!
34	22	"
35	23	#
36	24	$
37	25	%
38	26	&
39	27	'(apostrophe)
40	28	(
41	29	)
42	2A	*
43	2B	+
44	2C	,(comma)
45	2D	-(en dash)
46	2E	.(Period)
47	2F	/
48	30	0
49	31	1
50	32	2
51	33	3
52	34	4
53	35	5
54	36	6
55	37	7
56	38	8
57	39	9
58	3A	:
59	3B	;
60	3C	<
61	3D	=
62	3E	>
63	3F	?

Decimal	Hexadecimal	Character or Function
64	40	@
65	41	A
66	42	B
67	43	C
68	44	D
69	45	E
70	46	F
71	47	G
72	48	H
73	49	I
74	4A	J
75	4B	K
76	4C	L
77	4D	M
78	4E	N
79	4F	O
80	50	P
81	51	Q
82	52	R
83	53	S
84	54	T
85	55	U
86	56	V
87	57	W
88	58	X
89	59	Y
90	5A	Z
91	5B	[
92	5C	\(backslash)
93	5D	]
94	5E	^ （control）
95	5F	- （emdash）

Decimal	Hexadecimal	Character or Function
96	60	` (tick)
97	61	a
98	62	b
99	63	c
100	64	d
101	65	e
102	66	f
103	67	g
104	68	h
105	69	i
106	6A	j
107	6B	k
108	6C	l
109	6D	m
110	6E	n
111	6F	o
112	70	p
113	71	q
114	72	r
115	73	s
116	74	t
117	75	u
118	76	v
119	77	w
120	78	x
121	79	y
122	7A	Z
123	7B	{ (Left brace)
124	7C	| (Vertical bar)
125	7D	} （Rightbrace）
126	7E	~ （Tilde）
127	7F	DEL

Appendix D Chemical Resistance Chart

Table D-1, which starts on the following page, provides a summary of chemical compatibility information provided by the manufacturers of components in the MSP1-D1 fluid path. LongerPump recommends that you use this information as a guideline only, and that you test each application fluid for chemical compatibility.

Caution: Failure to test chemicals used in individual applications with the MSP1-D1 may result in damage to the pump and/or test results.

The materials listed in Table D-1 are used in the following areas of the MSP1-D1:

PTFE	Tubing, Valve Plug, Seal
PCTFE	Valve Body
PEEK	Fitting for Tubing

The codes and symbols in Table D-1 are as follows:

–	No Data
0	No effect – excellent
1	Minor effect – good
2	Moderate effect – fair
3	Severe effect – not recommended
*	Polypropylene – Satisfactory to 22 ℃ (72°F)
**	Polypropylene – Satisfactory to 49 ℃ (120°F)

Table D-1 Plastic Materials Used in MSP1-D1

Solvent	Teflon	Kel - F	PEEK
Acetaldehyde	0	0	0
Acetates	-	0	-
Acetic Acid	0	0	0
Acetic Anhydride	-	0	-
Acetone	0	0	0
Acetyl Bromide	0	-	-
Ammonia	0	-	-
Ammonium Acetate	0	-	-
Ammonium Hydroxide	0	0	0
Ammonium Phosphate	-	0	-
Ammonium Sulfate	-	0	0
Amyl Acetate	0	-	0
Aniline	0	0	-
Benzene	0	3	0
Benzyl Alcohol	0	0	-
Boric Acid	0	0	-
Bromine	0	0	3
Butyl Alcohol	0	0	0
Butyl Acetate	0	-	-
Carbon Sulfide	0	-	-
Carbon Tetrachloride	0	1	0
Chloracetic Acid	0	0	-
Chlorine	0	1	-
Chlorobenzene	-	-	0
Chloroform	0	-	0
Chromic Acid	0	0	0
Cresol	0	-	-
Cyclohexane	0	-	0
Ethers	0	-	-
Ethyl Acetate	0	-	0
Ethyl Alcohol	0	-	0
Ethyl Chromide	0	1	-
Formaldehyde	0	0	0

Table D-1 Plastic Materials Used in MSP1-D1

Solvent	Teflon	Kel - F	PEEK
Formic Acid	0	0	0
Freon	0	2	-
Gasoline	0	0	0
Glycerin	0	0	0
Hydrochloric Acid	0	0	0
Hydrochloric Acid (conc)	0	0	0
Hydrofluoric Acid	0	0	3
Hydrogen Peroxide	0	0	0
Hydrogen Peroxide (conc)	0	0	0
Hydrogen Sulfide	0	0	0
Kerosene	0	0	-
Methyl Ethyl Ketone (MEK)	0	-	-
Methyl Alcohol	0	-	0
Methylene Chloride	0	0	-
Naptha	0	1	-
Nitric Acid	0	0	0
Nitric Acid	0	0	0
Nitrobenzene	0	-	0
Phenol	0	-	-
Pyridine	0	-	-
Silver Nitrate	0	-	-
Soap Solutions	0	-	0
Stearic Acid	0	-	-
Sulfuric Acid	0	0	-
Sulfuric Acid (conc)	0	0	-
Sulfurous Acid	0	0	-
Tannic Acid	-	0	-
Tanning Extracts	0	-	-
Tartaric Acid	0	-	-
Toluene	0	1	0
Trichloroethylene	0	3	0
Turpentine	0	0	-
Water	0	0	0
Xylene	0	0	0

Appendix E Technical Specifications

Plunger

Principle	Direct rack and pinion drive with encoder and home flag.
Rated Stroke	30mm corresponding to 1000 steps.
Plunger Speed	0.5mm/s to 15mm/s (variable from 2-60 secs/stroke)
Control Resolution	One step or 0.03mm
Travel control Precision	⩽0.5% CV at ⩾30% full stroke
Plunger Force	Plunger force⩾6.8kg
Syringe	500μL, 1ml, 2.5ml, 5ml

Valve

Valve Type	3-Port Y type valve at 120°
Turn Time	≤280 ms between adjacent ports (3-port valve)
Valve Drive	Stepper motor with optical encoder for positioning feedback.
Valve Material	Plug material: Virgin Teflon; Body material: Kel-F
Valve Fitting	Tubing and syringe fitting: 1/4”-28 fitting

Communication

Communication	RS485: Baud Rate 9600 and 38400 available RS232: Baud Rate 9600 and 38400 available
External Input	One TTL input with isolation used for the start/stop when pump is in paused status.
External Output	One TTL output with isolation.
Address	Set pump address manual through BCD Dial Switch.
Parameters Jumper	Reserve 6 external jumper to select parameter (baud rate selection, communication mode selection)

Main Function of Software

Initialization Commands	Initialize the valve and syringe through commands
Set Commands	Set speed, “0” position, backlash, etc. through different commands.
Valve Commands	Move valve to different position
Plunger Movement Commands/Status Bit Reports	Precisely move the plunger to different position.
Control Commands	Command, command string or last saved command string can be halted terminated or performed one time, multi-time or delayed implementation,
Report Command	Monitor valve position, plunger position, plunger force, plunger speed.

Outline Dimensions	Height	254mm
	Width	65mm
	Depth	140mm
Power Supply	Voltage	24V (DC)
	Current	⩽1.5A
Operating Environment	Temperature	15-40℃
	Humidity	20-95% @ 40℃

Appendix F Industries Syringe Pump MSP1-D1 Command Quick Reference

Control Commands

Command	Parameters <n>	Value	Parameters Description	Command Description
R				Executes command or command strings
X				Repeat last command string
G<n>	0～30000	1	0=Infinite loop 1-30000=Repeat loops	Repeats command sequence
G				Marks start of a repeat sequence
M<n>	5～30000		Delayed time 5-30000ms	Delay in milliseconds for current commands.
H<n>	0～1	0	0=Wait command [R] or external input 1 to continue performance. 1=Wait command [R] or external input 1 to continue performance.	Halts command execution.
T			Terminate current command or command string	Terminate command
J<n>	0～1	0	0=Output low TTL 1=Output high TTL	Set state of output line

Initialization Command

Command	Parameters <n>	Value	Parameters Description	Command Description
Z<n>	2-20	20	Plunger move at different speed during initialization	Initializes the plunger and sets the valve input at left port and output at right port.
Y<n>	2-20	0	Plunger move at different speed during initialization	Initializes the plunger and sets the valve input at left port and output at right port.

Plunger Movement Commands

Command	Parameters <n>	Value	Parameters Description	CommandDescription
A<n>	0-10000	0	Absolute displacement	Move valve to input position
P<n>	0-10000	0	Relative displacement	Relative aspirate displacement
D<n>	0-10000	0	Relative displacement	Relative aspirate displacement
p			Prime	Repeat full stroke two times

Valve Commands

Command	Parameters <N>	Value	Parameters Description	Command Description
I			Absolute displacement	Move valve to input position
P<n>			Absolute displacement	Move valve to output position
D<n>			Relative displacement	Move valve to bypass position

Set Commands

Command	Parameters <n>	Value	Parameters Description	Command Description
K<n>	0-20	0	Back displacement	Set backlash
S<n>	20-600	11	Speed range	Set speed
	(0.1 seconds)		(refer speed sheet)	

Report Commands

Command	Parameters <n>	Value	Parameters Description	Command Description
Q<n>	Status code		See table 3	Query, status and Error bytes
?			Absolute plunger position	Report absolute Plunger position
?S			Plunger speed	Report plunger speed
F			0=Buffer free 1=Buffer busy	Report the status of buffer area.
?J			Output status	Reports status of input
?I			Input status	Reports status of output

Error Code

Error Code	Description
0(00h)	Error free condition
1(01h)	Initialization error, reinitialize pump before resuming normal operation.
2(02h)	Invalid command
3(03h)	Invalid operand
4(04h)	Reserved
5(05h)	Reserved
6(06h)	Reserved
7(07h)	Device not initialized
9(09h)	Plunger overload, reinitialize pump before resuming normal operation.
10(0Ah)	Valve overload, reinitialize pump before resuming normal operation.
11(0Bh)	Plunger move not allowed.
15(0Fh)	Command overflow.

Error Codes and Status Byte

Status Byte	Hex # if Bit 5=		Dec # ifBit 5=		Error Code	
76543210	0	Or 1	0	Or 1	Number	Error
01X00000	40h	60h	64	96	0	No error
01X00001	41h	61h	65	97	1	Initialization error
01X00010	42h	62h	66	98	2	In Invalid command
01X00011	43h	63h	67	99	3	Invalid command seq
01X00100	44h	64h	68	100	4	Reserved
01X00101	45h	65h	69	101	5	Reserved
01X00110	46h	66h	70	102	6	Reserved
01X00111	47h	67h	71	103	7	Device not initialized
01X01001	49h	69h	73	105	9	Plunger Overload
01X01010	4Ah	6Ah	74	106	10	Valve overload
01X01011	4Bh	6Bh	75	107	11	Plunger move not allowed
01X01111	4Fh	6Fh	79	111	15	Command overflow

DB-15 Connector Pin Assignments

Pin	Function	Description
1	DC-24V	Power Supply Input (+)
2	TXD	RS232 Output Data
3	RXD	Rs232 Input Data
4	COM	External Control Public End
5	NC	Floating Pin
6	NC	Floating Pin
7	IN1	External Control Input Pin 1
8	NC	Floating Pin
9	GND	Ground-Power and Logic
10	GND	Ground-Power and Logic
11	RS-485 A	RS-485 A Pin
12	RS-485 B	RS-485 B Pin
13	OUT	External Control Output Pin 1
14	NC	Floating Pin
15	NC	Floating Pin