

## LONGER RS485 Protocol for LSP02-1B

### 1. Frame Format: 1start + 8data + 1even parity + 1stop, 1200bps.

This defines the frame format: 1 start bit, 8 data bits, 1 even parity bit, and 1 stop bit. And the baud rate can be 1200bps, 2400bps or 9600bps.

### 2. Command Format: flag+ addr + len + pdu + fcs.

**flag:** E9H is the start **flag** of a command string, takes up 1 byte. Every command string is preceded with the start of E9H (H: hexadecimal).

- In one command string, there is no other E9H except start **flag** E9H. When transmitting, E8H is replaced by E8H 00H, and E9H is replaced by E8H 01H except start **flag**. When receiving, E8H 00H is replaced by E8H, and E8H 01H is replaced by E9H.

**addr:** Pump address expressed in Hex, takes up 1 byte.

- The pump address can be set from 1 to 30. 31(1FH) is broadcast address.
- In a command string from the control computer, if the **addr** is pump address, the corresponding pump will execute the command and respond. And if the **addr** is broadcast address, all the pumps execute the same command, and pumps don't respond.

**len:** Length of **pdu**, expressed in Hex, takes up 1 byte.

**Fcs:** XOR of **addr**, **len** and **pdu**, takes up 1 byte.

**pdu:** application layer code, see below.

### 3. Pdu Format: application layer code format

#### 3.1. Set Syringe Diameter

Control computer command string:



Pump response:



- **C, W, D, Y** are command characters expressed in ASCII, each takes up 1 byte.
- **M or U:** takes up 1 byte. **M** means setting syringe diameter from the table of standard syringes arranged by manufacturer. **U** means setting the internal

diameter of syringe barrel directly.

- **P1, P2:** parameter 1 and parameter 2, each takes up 1 byte.  
When setting mode is **M**, **P1** expresses manufacturer as specified character, **P2** is syringe No. expressed in Hex. See table 1.  
When setting mode is **U**, **P1** and **P2** express the diameter and No of user-defined syringe. The diameter value is from 1 to 5000 and the diameter unit is 0.01mm. **P1** is the least significant byte of diameter. The low 6 bits (i.e. bit5 to bit1) of **P2** is the most significant byte of diameter, and the high 2 bits (i.e. bit7 to bit6) of **P2** is the No of user-defined syringe, 00 for User1, 01 for User2, 10 for User3 and 11 for User4.
- In a command string from the control computer, if the **addr** is one pump's address (1-30), the corresponding pump will respond.

### 3.2. Read Syringe Diameter

Control computer command string:

CRD

Pump response:

RD
M or U (1 byte)
P1 (1 byte)
P2 (1 byte)

- **C, R, D** are command characters expressed in ASCII, each takes up 1 byte.
- The meaning of **M, U, P1** and **P2** is the same as defined in 3.1.
- In a command string from the control computer, if the **addr** is one pump's address (1-30), the corresponding pump will respond.

**Table 1**

Manufacturer of Syringe	Specified Character of Manufacturer (P1)	Syringe No. (P2)	Syringe Size	Syringe Diameter (mm)
Air-Tite	A	1	1ml	4.70
		2	2.5ml	9.70
		3	5.0ml	12.48
		4	10ml	15.89
		5	20ml	20.00
		6	30ml	22.50
		7	50ml	28.90
Becton Dickinson Plastipak	B	1	1ml	4.70
		2	3ml	8.59
		3	5ml	11.99
		4	10ml	14.48
		5	20ml	19.05
		6	30ml	21.59
		7	60ml	26.60

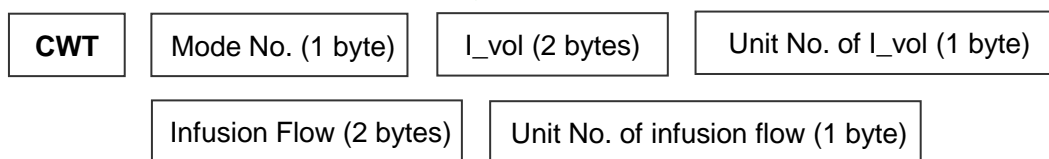
Becton Dickson Glass	C	1	0.5ml	4.64
		2	1ml	4.64
		3	2.5ml	8.66
		4	5ml	11.86
		5	10ml	14.34
		6	20ml	19.13
		7	30ml	22.70
		8	60ml	28.60
Hamilton	H	1	10ul	0.46
		2	25ul	0.73
		3	50ul	1.03
		4	100ul	1.46
		5	250ul	2.30
		6	500ul	3.26
		7	1ml	4.61
		8	2.5ml	7.28
		9	5ml	10.30
		10	10ml	14.57
		11	25ml	23.03
		12	50ml	32.57
Popper&Sons	P	1	0.25ml	3.45
		2	0.5ml	3.45
		3	1ml	4.50
		4	2ml	8.92
		5	3ml	8.99
		6	5ml	11.70
		7	10ml	14.70
		8	20ml	19.58
		9	30ml	22.70
		10	50ml	29.00
Ranfac	R	1	2ml	9.12
		2	5ml	12.34
		3	10ml	14.55
		4	20ml	19.86
		5	30ml	23.20
		6	50ml	27.60
Scientific Glass Engineering	S	1	25ul	0.73
		2	50ul	1.03
		3	100ul	1.46
		4	250ul	2.30
		5	500ul	3.26
		6	1ml	4.61
		7	2.5ml	7.28

		8	5ml	10.30
		9	10ml	14.57
Sherwood-Monojet plastic	M	1	1ml	4.65
		2	3ml	8.94
		3	6ml	12.70
		4	12ml	15.90
		5	20ml	20.40
		6	35ml	23.80
		7	50ml	26.60
Terumo	T	1	1ml	4.73
		2	3ml	9.00
		3	5ml	13.04
		4	10ml	15.79
		5	20ml	20.18
		6	30ml	23.36
		7	60ml	29.45
Unimetrics	U	1	10ul	0.46
		2	25ul	0.73
		3	50ul	1.03
		4	100ul	1.46
		5	250ul	2.30
		6	500ul	3.26
		7	1000ul	4.61

### 3.3. Set Running Parameter

#### 3.3.1. Set Running Parameter of Infusion Mode

Control computer command string:



Pump response:

<b>Y</b>
----------

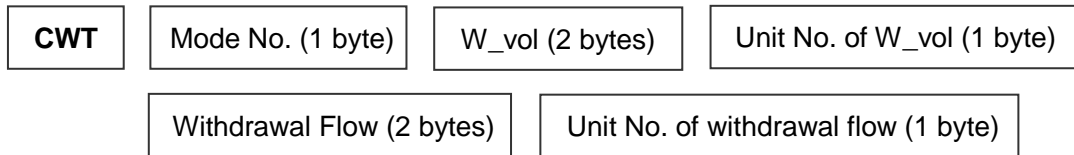
- **C, W, T, Y** are command characters expressed in ASCII, each takes up 1 byte.
- Mode No. expresses infusion mode as 1 in hex, takes up 1 byte.
- I\_vol is from 0 to 9999 in hex, takes up 2 bytes. And the least significant byte is transmitted first and the most significant byte finally.
- Unit No. of I\_vol takes up 1 byte, expressed in hex and defined in table 2.
- Infusion flow is from 1 to 9999 in hex, takes up 2 bytes. And the least

significant byte is transmitted first and the most significant byte finally.

- Unit No. of infusion flow takes up 1 byte, expressed in hex and defined in table 2.
- In a command string from the control computer, if the **addr** is one pump's address (1-30), the corresponding pump will respond.

### 3.3.2. Set Running Parameter of Withdrawal Mode

Control computer command string:



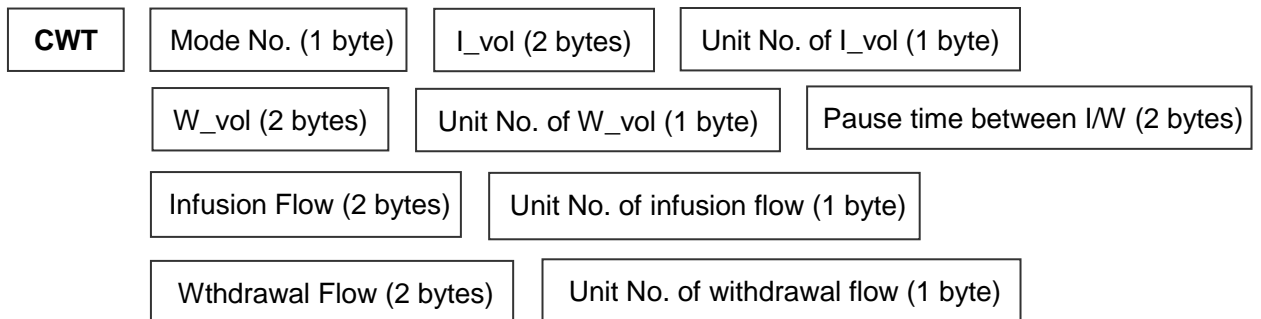
Pump response:



- **C, W, T, Y** are command characters expressed in ASCII, each takes up 1 byte.
- Mode No. expresses Withdrawal mode as 2 in hex, takes up 1 byte.
- W\_vol is from 0 to 9999 in hex, takes up 2 bytes. And the least significant byte is transmitted first and the most significant byte finally.
- Unit No. of W\_vol takes up 1 byte, expressed in hex and defined in table 2.
- Withdrawal flow is from 1 to 9999 in hex, takes up 2 bytes. And the least significant byte is transmitted first and the most significant byte finally.
- Unit No. of withdrawal flow takes up 1 byte, expressed in hex and defined in table 2.
- In a command string from the control computer, if the **addr** is one pump's address (1-30), the corresponding pump will respond.

### 3.3.3. Set Running Parameter of I/W Mode

Control computer command string:



Pump response:



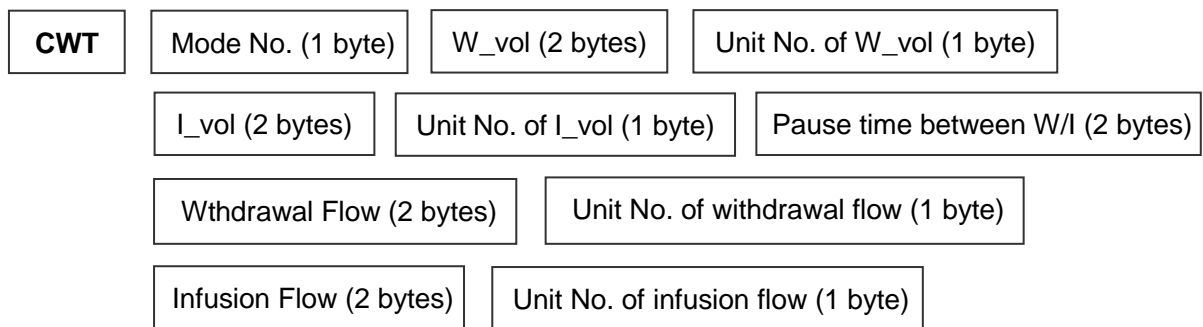
- **C, W, T, Y** are command characters expressed in ASCII, each takes up 1

byte.

- Mode No. expresses Infusion/Withdrawal mode as 3 in hex, takes up 1 byte.
- I\_vol, unit No. of I\_vol, infusion flow and unit No. of infusion flow are the same as defined in 3.3.1
- W\_vol, unit No. of W\_vol, withdrawal flow and unit No. of withdrawal flow are the same as defined in 3.3.2.
- Pause time between infusion and withdrawal takes up 2 bytes. The high 2 bits (i.e. bit15 to bit14) represents time unit, 00 for 0.1s, 01 for 1s. The low 14 bits (i.e. bit13 to bit0) represents pause time value from 0 to 9999 in hex. And the least significant byte is transmitted first and the most significant byte finally.
- In a command string from the control computer, if the **addr** is one pump's address (1-30), the corresponding pump will respond.

### 3.3.4. Set Running Parameter of W/I Mode

Control computer command string:



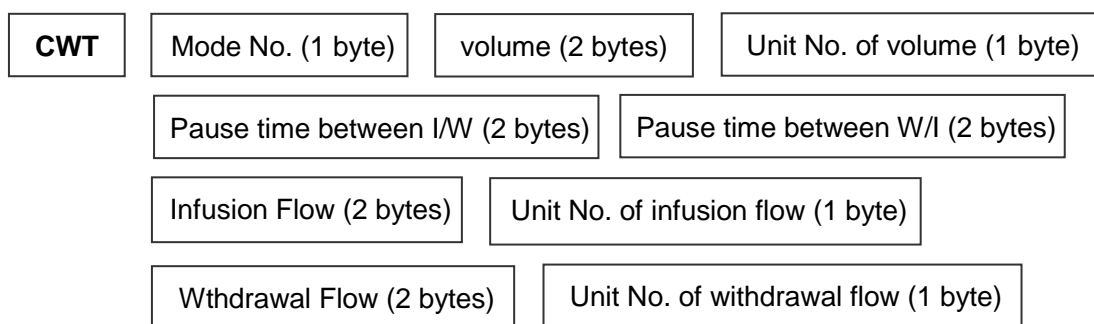
Pump response:



- **C, W, T, Y** are command characters expressed in ASCII, each takes up 1 byte.
- Mode No. expresses Withdrawal/Infusion mode as 4 in hex, takes up 1 byte.
- W\_vol, unit No. of W\_vol, withdrawal flow and unit No. of withdrawal flow are the same as defined in 3.3.2.
- I\_vol, unit No. of I\_vol, infusion flow and unit No. of infusion flow are the same as defined in 3.3.1.
- Pause time between withdrawal and infusion takes up 2 bytes. The high 2 bits (i.e. bit15 to bit14) represents time unit, 00 for 0.1s, 01 for 1s. The low 14 bits (i.e. bit13 to bit0) represents pause time value from 0 to 9999 in hex. And the least significant byte is transmitted first and the most significant byte finally.
- In a command string from the control computer, if the **addr** is one pump's address (1-30), the corresponding pump will respond.

### 3.3.5. Set Running Parameter of Continuous Mode

Control computer command string:



Pump response:

Y

- **C, W, T, Y** are command characters expressed in ASCII, each takes up 1 byte.
- Mode No. expresses Continuous mode as 5 in hex, takes up 1 byte.
- Volume takes up 2 bytes, represents I\_vol and W\_vol, as defined in 3.3.4.
- Unit No. of volume is the same as unit No. of I\_vol or W\_vol.
- Infusion flow and unit No. of infusion flow are the same as defined in 3.3.1.
- Withdrawal flow and unit No. of withdrawal flow are the same as defined in 3.3.2.
- Pause time between I/W is the same as defined in 3.3.3.
- Pause time between W/I is the same as defined in 3.3.4.
- In a command string from the control computer, if the **addr** is one pump's address (1-30), the corresponding pump will respond.

Table 2

Mode No.	Work Mode	Unit No. of Volume	Unit of Volume	Unit No. of Flow	Unit of Flow
1	Infusion	1	0.001ul	1	0.001ul/h
2	Withdrawal	2	0.01ul	2	0.01ul/h
3	Infusion / Withdrawal	3	0.1ul	3	0.1ul/h
4	Withdrawal / Infusion	4	1ul	4	1ul/h
5	Continuous	5	0.01ml	5	0.001ul/min
		6	0.1ml	6	0.01ul/min
		7	1ml	7	0.1ul/min
				8	1ul/min
				9	0.01ml/h
				10	0.1ml/h
				11	1ml/h
				12	0.01ml/min
				13	0.1ml/min
				14	1ml/min

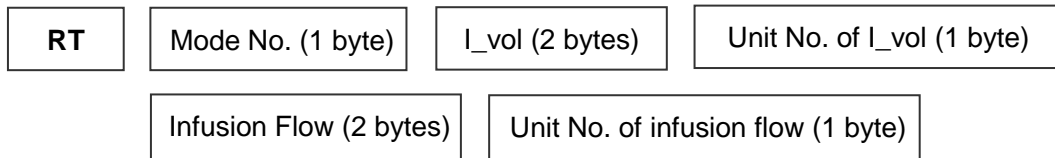
### 3.4. Read Running Parameter

#### 3.4.1. Read Running Parameter of Infusion Mode

Control computer command string:

CRT

Pump response:



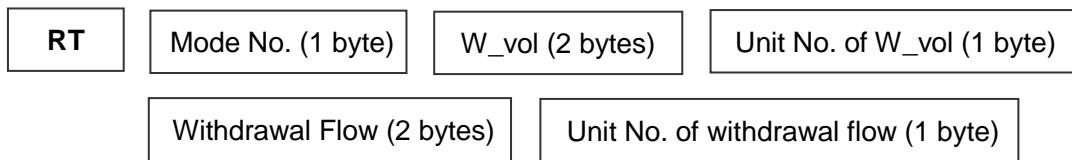
- **C, R, T** are command characters expressed in ASCII, each takes up 1 byte.
- The other parameters are the same as defined in 3.3.1
- In a command string from the control computer, if the **addr** is one pump's address (1-30), the corresponding pump will respond.

#### 3.4.2. Read Running Parameter of Withdrawal Mode

Control computer command string:

CRT

Pump response:



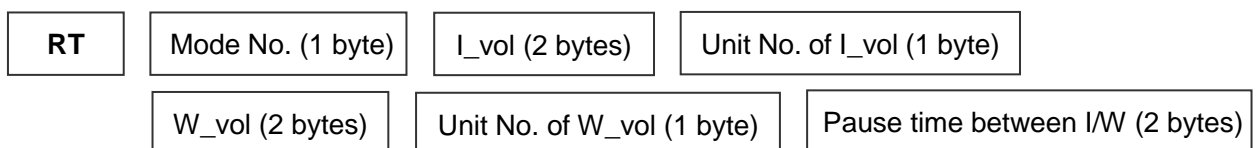
- **C, R, T** are command characters expressed in ASCII, each takes up 1 byte.
- The other parameters are the same as defined in 3.3.2
- In a command string from the control computer, if the **addr** is one pump's address (1-30), the corresponding pump will respond.

#### 3.4.3. Read Running Parameter of I/W Mode

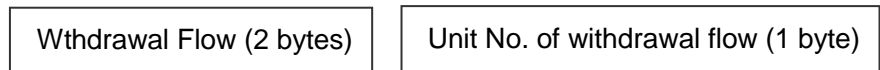
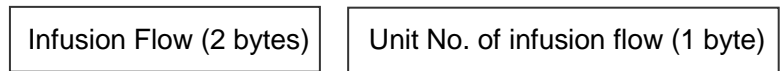
Control computer command string:

CRT

Pump response:







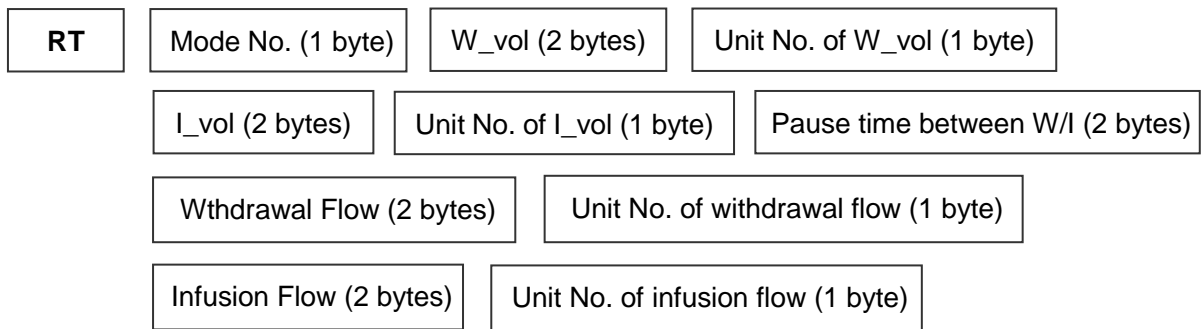
- **C, R, T** are command characters expressed in ASCII, each takes up 1 byte.
- The other parameters are the same as defined in 3.3.3
- In a command string from the control computer, if the **addr** is one pump's address (1-30), the corresponding pump will respond.

### 3.4.4. Read Running Parameter of W/I Mode

Control computer command string:



Pump response:



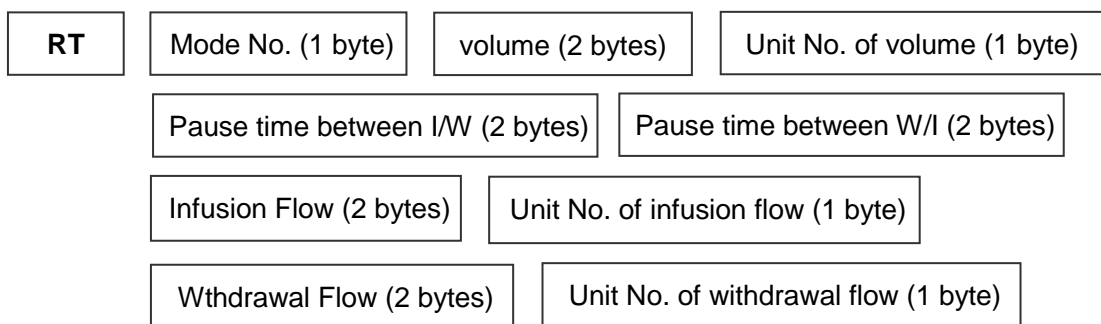
- **C, R, T** are command characters expressed in ASCII, each takes up 1 byte.
- The other parameters are the same as defined in 3.3.4
- In a command string from the control computer, if the **addr** is one pump's address (1-30), the corresponding pump will respond.

### 3.4.5. Read Running Parameter of Continuous Mode

Control computer command string:



Pump response:



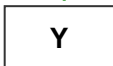
- **C, R, T** are command characters expressed in ASCII, each takes up 1 byte.
- The other parameters are the same as defined in 3.3.5
- In a command string from the control computer, if the **addr** is one pump's address (1-30), the corresponding pump will respond.

### 3.5. Set Running Status

Control computer command string:



Pump response:



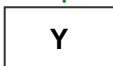
- **C, W, X, Y** are command characters expressed in ASCII, each takes up 1 byte.
- **R\_status** takes up 1 byte, expresses running status as number in hex.  
0 for stopping pump if running, otherwise is ignored.  
1 for starting pump running to present settings, if already running command is ignored.  
2 for pausing the pump if running, otherwise is ignored.
- In a command string from the control computer, if the **addr** is one pump's address (1-30), the corresponding pump will respond.

### 3.6. Change Direction

Control computer command string:



Pump response:



- **C, W, F, Y** are command characters expressed in ASCII, each takes up 1 byte.
- Available only in I/W mode for reversing direction.
- In a command string from the control computer, if the **addr** is one pump's address (1-30), the corresponding pump will respond.

### 3.7. Read Running Status

Control computer command string:



Pump response:



- **C, R, X** are command characters expressed in ASCII, each takes up 1 byte.

- R\_status takes up 1 byte, expresses running status as number in hex.  
0 means pump is stopped.  
1 means pump is running.  
2 means pump is paused.
- In a command string from the control computer, if the **addr** is one pump's address (1-30), the corresponding pump will respond.

### 3.8. Read Direction Status

Control computer command string:

CRF

Pump response:

RF    D\_status

- C, R, F are command characters expressed in ASCII, each takes up 1 byte.
- D\_status takes up 1 byte, expresses infusion as character 1 in ASCII, and expresses withdrawal as character 0 in ASCII.
- In a command string from the control computer, if the **addr** is one pump's address (1-30), the corresponding pump will respond.

### 3.9. Read Error Information

Control computer command string:

?E

Pump response:

?E    E\_info

- ?, E are command characters expressed in ASCII, each takes up 1 byte.
- E\_info takes up 1 byte, expresses error information as number in hex, described as follows.  
0 = no errors  
1 = stall
- In a command string from the control computer, if the **addr** is one pump's address (1-30), the corresponding pump will respond.

## 4. Examples

Read running parameter of pump 1 (address):

Control computer command string:

E9 01 03 43 52 54 47

Pump response:

E9 01 09 52 54 01 32 00 07 0A 00 0E 3E

<b>Flag</b>	<b>addr</b>	<b>len</b>	<b>pdu</b>	<b>fcs</b>
-	The above pump response indicates that pump 1 works in infusion mode, infusion volume (i.e. I_vol) is 50ml, infusion flowrate is 10ml/min.			

## **Appendix**

### **ASCII Chart of Codes for US Characters**