

SPC Series syringe pump with communication

MODBUS Communication Protocol

Note: The hexadecimal numbers are expressed by 'XXXXH' or 'XXH' in the below description.

1. MODBUS-RTU standard communication format

This communication use MODBUS RTU mode, message frame as below: :

Slave address	Function code	Data area	CRC Check (Cyclic Redundancy Check)	
1 Byte	1 Byte	0 or up to 252 bytes	2 Bytes	
			CRC low	CRC high

- (1) **Slave address:** Host control peristaltic pump address No. The pump address No. should not be same when they are in the same 485 line. The address No. range is 1~32, 0 means broadcast.
- (2) **Function code:** The protocol use 2 common function codes which defined by MODBUS protocol.
 - 03H:** Read holding registers
 - 06H:** Write single register
 - 10H:** Write multiple registers
- (3) **Data area:** The detailed information command that the peristaltic pumps need to follow, such as start/stop, change direction, increase/decrease speed..and so on
- (4) **CRC check:** CRC code is 2 bytes, 16 check codes. Use CRC-16(which used in American binary synchronous system).

Polynomial: $G(X)=X^{16}+X^{15}+X^2+1$.

CRC check C language code please refer to Appendix 1.

2. Communication Setting

- (1) **Communication boudrate:** 1200, 2400, 4800, 9600 optional
- (2) **Byte structure:** 1 start bit + 8 data bits +1 parity bit + 1 stop bit
- (3) **Bit serial sending order:** The least significant big(LSB)..... The most significant bit (MSB)

Start	1	2	3	4	5	6	7	8	Check	Stop
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- (4) **Data transferring format:**

Integer (2 bytes):

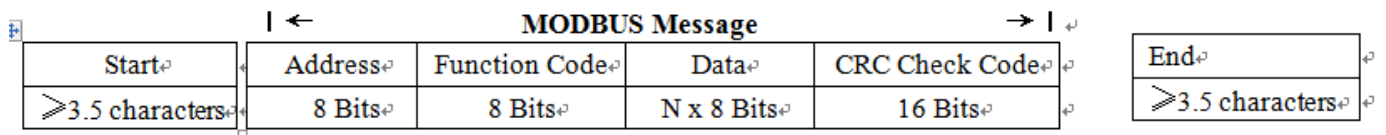
Data: The second byte The first byte
 Send: The second byte The first byte
 For example: 1234H send 12H 34H

Long integer and Float (4 bytes):

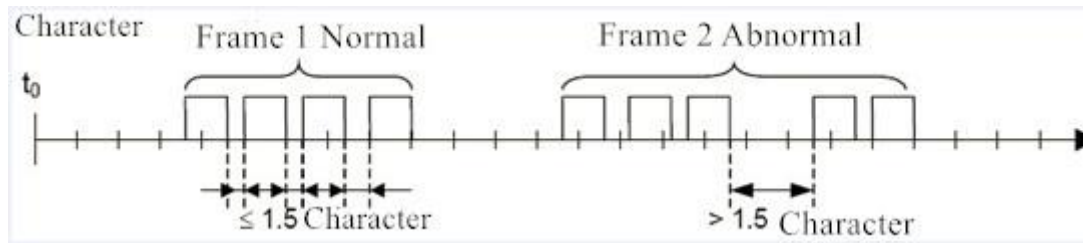
Data: The fourth byte The third byte The second byte The first byte
 Send: The second byte The first byte The fourth byte The third byte
 For example: 8.9 send 41H 0EH 66H 66H

3. MODBUS Message RTU Frame Format

In RTU mode, The message frame is distinguished by an idle interval of at least 3.5 characters.As below:



The entire message frame must be sent in a continuous stream of characters. If the idle space between two characters is greater than 1.5 character times, the message frame is considered as incomplete, should be discarded by receiving node. As below:



4. Abnormal reaction

When host sending request data, slave receiving data abnormal, it should have abnormal reaction. If the address code sent from host is wrong, there is no this address code between slaves or the data received by slave is wrong when CRC check, no abnormal code return, the host should have super reaction process.

Function code area: Abnormal reaction function code is normal reaction function code +80H.

Data area: Return abnormal code, define as below.。

Chart 1: Abnormal code definition

Code	Name	Meaning
01H	Illegal function code	The function code received by peristaltic pump except 03H/06H/10H.
02H	Illegal data address	This abnormal code means the register address is not allowed data which received by peristaltic pump.
03H	Illegal data value	Written data does not meet the operating range.
06H	Slave(peristaltic pump) busy	The current state of the peristaltic pump conflict with the command received, unable to complete the command.

5. Holding register address and content

Address (Decimal)	Name	Range	Data Type
0010	Start All	0: Stop 1: Running	unsigned short int (2 Bytes)

Note: When sending this command, the filling units under the same controller will start/stop at same time.

Basic parameter setting

Address (Decimal)	Name	Range	Data Type
n000	Manufacturer No.	Table 1	unsigned short int (2 bytes)
n001	Syringe specs	Table 1	unsigned short int (2 bytes)
n002	Retreat steps	0-6400	unsigned short int (2 bytes)
n003	Start/stop	1: Start 0: stop	unsigned short int (2 bytes)
n004	Working mode	0: withdraw 1: infuse 2: withdraw-infuse 3: infuse-withdraw	unsigned short int (2 bytes)
n005	Repeat numbers	0-9999times 0 is infinite	unsigned short int (2 bytes)
n006	Fast forward and retreat	1: Start 0: stop	unsigned short int (2 bytes)
n007	Fast forward and retreat direction	1: withdraw direction 0: infuse direction	unsigned short int (2 bytes)
n008	Delayed start time	0-9999 min	float (4 bytes)
n010	First group volume	0.1-99999 uL	Float (4 bytes)
n012	First group time	0.1-99999 (s)	Float (4 bytes)
n014	Single interval time	0.5-9999 (s)	Float (4 bytes)
n016	Second group volume	0.1-99999 uL	Float (4 bytes)
n018	Second group time	0.1-99999 (s)	Float (4 bytes)
n020	Repeat interval time	0.5-9999 (s)	Float (4 bytes)

Note: 1. The fast forward and retreat function can be enabled only when the unit stop working. Otherwise reminding error.

- 2.The fast forward and retreat direction function can be enabled only when the unit stop working. Otherwise reminding error.。
3. Independent operation parameters can be set only when the operation mode is independent mode.
4. When the independent operation parameter setting exceeds the set number of allocation groups, the setting is invalid and an error is returned. Example: The number of allocation groups is 1 group (withdraw mode or infuse mode), and it is invalid when any one of the register addresses 1016-1020 is set.
5. Please set the register parameters separately according to the table, not receive one instruction to set multiple registers consecutively.
6. The value range of nis 1-8,represents the 8 filling units controlled by the controller.
7. Start delay in minutes and cannot be changed.

Parameters when calibration

Address (Decimal)	Name	Range	Data type
n100	Start testing	1: start 0: stop	unsigned short int (2 个字节)
n101	Real volume	0-99999uL	float (4 个字节)
n103	Back to initial	1: restore initial	unsigned short int (2 个字节)
n104	Fine-tuning	1: add 0: minus	unsigned short int (2 个字节)
n105	Choose filling groups	0-2	unsigned short int (2 个字节)

Table 1

Syringe pump manufacturer	Manufacturer code	Syringe No.	Syringe specification	Syringe diameter (mm)
Air-Tite (plastic)	0	11	1ml	4.70
		12	2.5ml	9.70
		13	5.0ml	12.48
		14	10ml	15.89
		15	20ml	20.00
		16	30ml	22.50
		17	50ml	28.90
Becton Dickinson Plastipak	1	11	1ml	4.70
		18	3ml	8.59
		19	5ml	11.99
		20	10ml	14.48
		21	20ml	19.05
		22	30ml	21.59
		23	60ml	26.60

Baoding Shenchen Precision Pump CO.,Ltd

Becton Dickson Glass	2	24	0.5ml	4.64
		25	1ml	4.64
		26	2.5ml	8.66
		27	5ml	11.86
		28	10ml	14.34
		29	20ml	19.13
		30	30ml	22.70
		31	60ml	28.60
Hamilton	3	32	10ul	0.46
		33	25ul	0.73
		34	50ul	1.03
		35	100ul	1.46
		36	250ul	2.30
		37	500ul	3.26
		38	1ml	4.61
		39	2.5ml	7.28
		40	5ml	10.30
		41	10ml	14.57
		42	25ml	23.03
		43	50ml	32.57
Popper&Sons	4	44	0.25ml	3.45
		45	0.5ml	3.45
		46	1ml	4.50
		47	2ml	8.92
		48	3ml	8.99
		49	5ml	11.70
		50	10ml	14.70
		51	20ml	19.58
Popper&Sons		52	30ml	22.70
		53	50ml	29.00
Ranfac	5	54	2ml	9.12
		55	5ml	12.34
		56	10ml	14.55
		57	20ml	19.86
		58	30ml	23.20
		59	50ml	27.60
Scientific Glass Engineering	6	33	25ul	0.73
		34	50ul	1.03
		35	100ul	1.46
		36	250ul	2.30
		37	500ul	3.26
		38	1ml	4.61
		39	2.5ml	7.28
		40	5ml	10.30
		41	10ml	14.57
Sherwood-Monojet plastic	7	60	1ml	4.65
		60	3ml	8.94
		62	6ml	12.70
		63	12ml	15.90

		64	20ml	20.40
		65	35ml	23.80
		66	50ml	26.60
Terumo	8	67	1ml	4.73
		68	3ml	9.00
		69	5ml	13.04
		70	10ml	15.79
		71	20ml	20.18
		72	30ml	23.36
		73	60ml	29.45
Unimetrics	9	32	10ul	0.46
		33	25ul	0.73
		34	50ul	1.03
		35	100ul	1.46
		36	250ul	2.30
		37	500ul	3.26
		38	1000ul	4.61

6. Appendix 1—CRC Check C Language Code

CRC generation process:

1. Put one 16 bits register into hexadecimal FFFF(all 1), we call it CRC register.
2. Make the first 8 bytes with 16 CRC register low bytes XOR, the result put in CRC register.
3. Move CRC register 1 bit to right, MSB zeroing. Extraction and detection of LSB.
4. (If LSB is 0): Repeat Step 3 (another shift).
(If LDB is 1): XOR register for CRC polynomial value 0xA001 (1010 0000 0000 0001).
5. Repeat Step 3 and 4, until finish 8 shifts. After finish this operation, will finish the complete operation for 8 Bytes.
6. Repeat Step 2 to Step 5 for the next Bytes in message. Continue this operation till all the message be deal with finished.
7. The final content in CRC register is CRC value.
8. When put CRC value in message, high and low Bytes must be exchanged