Golander Peristaltic Pump

MODBUS Communication Instruction

1 Introduction

Golander products including S, L and F series of peristaltic pump, support RS485 MODBUS RTU protocol to communicate with HMI, PC or PLC, etc. The program uses a modular design, stable and reliable. The Modbus communication stack consists of two layers: Modbus application layer and network layer. The product supports the commands shown on the *Table 1* in **Bold** and *Italic*.

Table 1. Currently supported commands

Function code	Command text	Description
0x01	Read coil	Read the status of coil (on/off)
0x02	Read Inputs Discrete	Read Input Status (on/off)
0x03	***Read Holding Registers***	***Read the contents of read/write location***
0x04	***Read Input Registers***	***Read the contents of read only location***
0x05	Write single coil	Force Single Coil
0x06	***Write single register***	***Preset Single Register***
0x0F	Write multiple coils	Force Multiple Coils
0x10	***Write multiple registers***	***Preset Multiple Registers***
0x11	Gateway Target Device Failed to Respond	Specialized use in conjunction with gateways, indicates no response was received from the target device.
0x17	***Read/Write multiple Registers***	***Read/Write multiple Registers at the same time***

2 Modbus Protocol

2.1 Modbus Protocol Model

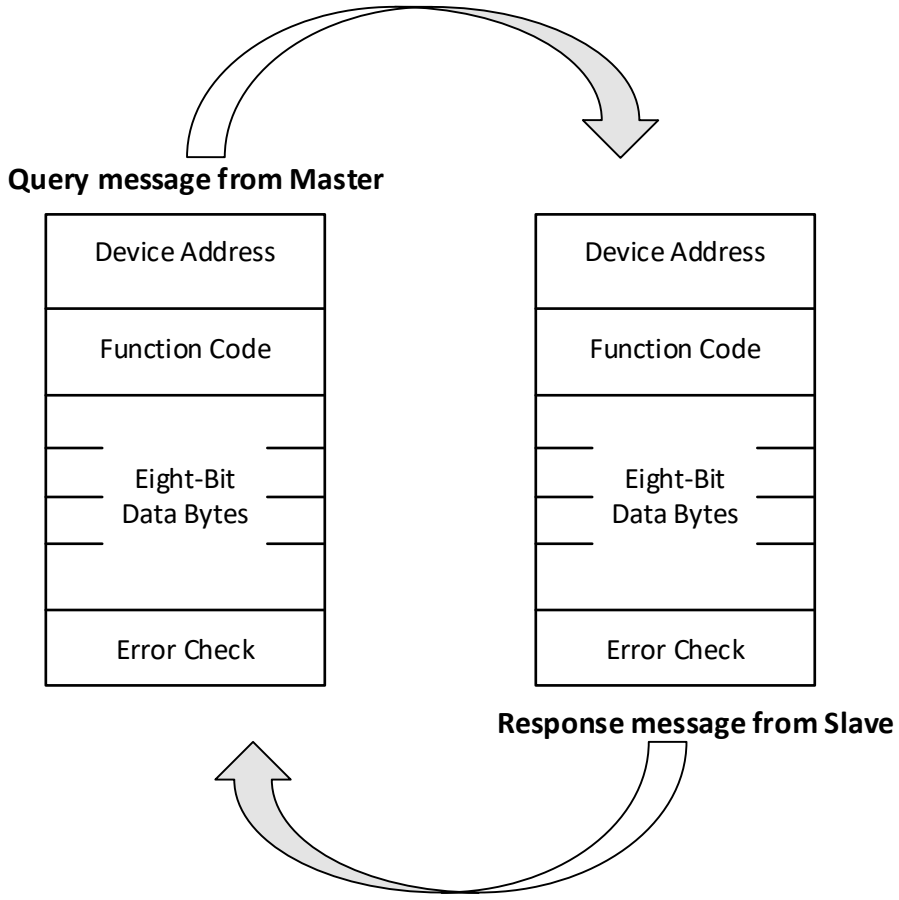

Figure 1. Master–Slave Query–Response Cycle

2.2 Byte Format

- **Coding System**
  8-bit binary, hexadecimal 0-9, A-F. Two hexadecimal characters contained in each 8-bit field of the message.
- **Bits per Byte:**
  1 start bit
  8 data bits, least significant bit sent first
  1 parity bit for even/odd parity; no parity bit for no parity
  1 stop bit if parity is used; 2 stop bits if no parity
- **Error Check Field**
  Cyclical Redundancy Check (CRC)

2.3 MODBUS Message Timing

In RTU mode, messages start with a silent interval of at least 3.5 character times. This is most easily implemented as a multiple of character times at the baud rate that is being used on the network (shown as T1-T2-T3-T4 in the

Table 2). The first field then transmitted is the device address. The allowable characters transmitted for all fields are hexadecimal 0-9, A-F. Devices monitor the network bus continuously, including during the “silent” intervals. When the first field (the address field) is received, each device decodes it to find out if it is the addressed device. If the device determines that it is the one being addressed it decodes the whole message and acts accordingly, if it is not being addressed it continues monitoring for the next message. Following the last transmitted character, a silent interval of at least 3.5 character times marks the end of the message. A new message can begin after this interval. The entire message frame must be transmitted as a continuous stream. If a silent interval of more than 1.5 character times occurs before completion of the frame, the receiving device flushes the incomplete message and assumes that the next byte will be the address field of a new message. Similarly, if a new message begins earlier than 3.5 character times following a previous message, the receiving device will consider it a continuation of the previous message. This will result in an error, as the value in the final CRC field will not be valid for the combined messages. A typical message frame is shown below.

Table 2. RTU Message Frame

START	ADDRESS	FUNCTION	DATA	CRC CHECK	END
T1-T2-T3-T4	8 BTIS	8 BTIS	n x 8 BTIS	16 BITS	T1-T2-T3-T4

2.4 Address Field

The address field of a message frame contains eight bits (RTU). Valid slave device addresses are in the range of 0-247 decimal. The individual slave devices are assigned addresses in the range of 1-247. A master addresses a slave by placing the slave address in the address field of the message. When the slave sends its response, it places its own address in this address field of the response to let the master know which slave is responding. Address 0 is used for the broadcast address, which all slave devices recognize. When Modbus protocol is used on higher level networks, broadcasts may not be allowed or may be replaced by other methods. For example, Modbus Plus uses a shared global database that can be updated with each token rotation.

2.5 Function Field

The function code field of a message frame contains eight bits (RTU). Valid codes are in the range of 1-255 decimal. Of these, some codes are applicable to all xLogic, while some codes apply only to certain models, and others are reserved for future use. When a message is sent from a master to a slave device the function code field tells the slave what kind of action to perform. Examples are to read the ON/OFF states of a group of discrete coils or inputs; to read the data contents of a group of registers; to read the diagnostic status of the slave; to write to designated coils or registers; or to allow loading, recording, or verifying the program within the slave.

When the slave responds to the master, it uses the function code field to indicate either a normal (error–free) response or that some kind of error occurred (called an exception response). For a normal response, the slave simply echoes the original function code. For an exception response, the slave returns a code that is equivalent to the original function code with its most–significant bit set to logic 1. For example, the Read Holding Registers command has the function code

0000 0011 (03H).

If the slave device takes the requested action without error, it returns the same code in its response. However, if an exception occurs, it returns

1000 0011 (83H)

in the function code field and appends a unique code in the data field of the response message that tells the master device what kind of error occurred, or the reason for the exception.

The master's application program must handle the exception response. It may choose to post subsequent retries of the original message, it may try sending a diagnostic query, or it may simply notify the operator of the exception error.

2.6 Data Field

The data field is constructed using sets of two hexadecimal digits, in the range of 00 to FF hexadecimal. These can be made from one RTU character, according to the network's serial transmission mode. The data field of messages sent from a master to slave devices contains additional information which the slave must use to take the action defined by the function code. This can include items like discrete and register addresses, the quantity of items to be handled, and the count of actual data bytes in the field. For example, when the master request the slave to read the holding registers (function code 03H), the data includes register address, the quantity of the resisters.

If no error occurs, the data field of a response from a slave to a master contains the data requested. If an error occurs, the field contains an exception code that the master application can use to determine the next action to be taken. The data field can be nonexistent (of zero length) in certain kinds of messages. For example, in a request from a master device for a slave to respond with its communications event log (function code 0B hexadecimal), the slave does not require any additional information.

2.7 CRC Error Checking

Two kinds of error–checking methods are used for standard Modbus networks. The error checking field contents depend upon the method that is being used. When RTU mode is used for character framing, the error checking field contains a 16–bit value implemented as two 8–bit bytes. The error check value is the result of a Cyclical Redundancy Check calculation performed on the message contents.

The CRC field is appended to the message as the last field in the message. When this is done, the low–order byte of the field is appended first, followed by the high–order byte. The CRC high–order byte is the last byte to be sent in the message.

3 Transmit Characters Serially

When messages are transmitted on Modbus serial networks, each character or byte is sent in the order of Least Significant Bit (LSB) to Most Significant Bit (MSB) as outlined below (left to right).

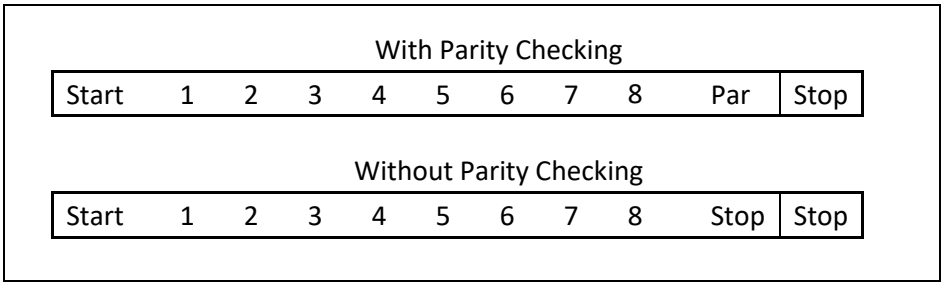

Figure 2. Bit Order (RTU)

4 Parameters and Addresses of S Series Peristaltic Pump

Mode: RTU
Addresses: 1-247 (User Defined)
Baud Rate: 9600
Data Bits: 8
CRC: Even Parity
Stop Bit: 1

Table 3. Input Registers (Read Only)

No.	Address (Decimal)	Name	Function	Data Range	Data Type
1	1000	Reserved			Unsigned Short int (2 bytes)
2	1001	Value of rotating speed timer	The setting that determines current rotating speed	200-65535	Unsigned Short int (2 bytes)
3	1002	Subdivide number	Step numbers for 1 round.	10000	Unsigned Short int (2 bytes)
4	1003	Analog speed control	Speed setting controlled by external analog signal	1-1500 1-3500 1-6000	Unsigned Short int (2 bytes)
5	1018	Manufacturer information	Display manufacturer information	"LeadFluid"	Unsigned Char (10 bytes)
6	1023	Product information	Display product information	"BT100S " "BT300S " “BT600S” ...	Unsigned Char (10 bytes)

Table 4. Holding Register (Lose Setting after Power Off)

No.	Address (Dec)	Name	Function	Data Range	Data Type
1	3000	Key value	Modify key value	0-8	Unsigned Short int (2 bytes)
2	3001	Easy dispense state	Easy dispense is on or not	Normal: 0 Dispense on: 1	Unsigned Short int (2 bytes)
3	3002	Time dispense state	Time dispense is on or not	Normal: 0 Dispense on: 1	Unsigned Short int (2 bytes)

Table 5. Holding Register (Power-off Memory EEPROM)

No.	Address (Dec)	Name	Function	Data Range	Data Type
1	3100	Rotating Speed	Adjust rotating speed	1-1500/1-3500/ 1-6000	Unsigned Short int (2 bytes)
2	3101	Direction	Set rotation direction	Clockwise: 0 Counterclockwise: 1	Unsigned Short int (2 bytes)
3	3102	Running state	Start/stop pump	Stop: 0 Start: 1	Unsigned Short int (2 bytes)
4	3103	Full speed state	Display full speed state	Normal: 0 Full speed: 1	Unsigned Short int (2 bytes)
5	3104	Control mode	External, footswitch, or internal control mode	Internal: 0 External: 1 Footswitch: 2 Logic level: 3	Unsigned Short int (2 bytes)
6	3105	Easy dispense volume	Set easy dispense volume for one micro step	0-4294967295	Unsigned long int (4 bytes)
7	3107	Slave device address	Set Slave device address	1-247	Unsigned Short int (2 bytes)
8	3108	MODBUS mode	Switch MODBUS mode	Computer: 0 PLC: 1	Unsigned Short int (2 bytes)
9	3109	Dispense time	Set dispense time	1-9999 (0.1-999.9 Sec)	Unsigned Short int (2 bytes)

5 Parameters and Addresses of L Series Peristaltic Pump

Mode: RTU
Addresses: 1-247 (User Defined)
Baud Rate: 4800, 9600, 19200, 38400
Data Bits: 8
CRC: Even Parity
Stop Bit: 1

Table 6. Input Register (Read Only)

No.	Address (Dec)	Name	Function	Data Range	Data Type
1	1000	Internal temperature	Check the temperature inside the pump	-100 - +100 Degrees	Signed Short int (2 bytes)
2	1001	Reserved			Unsigned Short int (2 bytes)
3	1002	Rotating speed	Check current rotating speed	0.1-150 0.1-350 0.1-600	Float (4 bytes)

4	1004	Steps has run for current dispense	Check how many steps has run for current dispense	0-4294967295	Unsigned Long int (4 bytes)
5	1006	Required steps for one dispense	Check required steps for one dispense	0-4294967295	Unsigned long int (4 bytes)
6					
7					
8					
9					
10					
11	1016	Value of rotating speed timer	The setting that determines current rotating speed	150-65535	Unsigned Short int (2 bytes)
12	1018	Manufacturer information	Display manufacturer information	"LeadFluid"	Unsigned Char (10 bytes)
13	1023	Product information	Display product information	"BT100L" "BT300L" "BT600L"	Unsigned Char (10 bytes)
14	1028	Touch panel X-coordinate	Display touch panel X-coordinate		Unsigned Short int (2 bytes)
15	1029	Touch panel Y-coordinate	Display touch panel Y-coordinate		Unsigned Short int (2 bytes)
16	1030	Analog speed control	Display the speed controlled by external analog signal	0.1-max speed	Unsigned Long int (4 bytes)
17	1032	Cumulative volume	Check cumulative volume		Float (4 bytes)
18	1034	Unit of cumulative volume	Check unit of cumulative volume	μL: 1 mL: 2 L: 3	Unsigned Short int (2 bytes)
19	1980	Error log (20 groups)	Check error log		Unsigned Short int (2 bytes)

Table 7. Input Register (Read Only)

No.	Address (Dec)	Name	Function	Data Range	Data Type
1	2800	Total on time	Check cumulative time that the pump powered on (seconds)	0-4294967295	Unsigned Long int (4 bytes)
2	2802	Total running time	Check cumulative running time (seconds)	0-4294967295	Unsigned Long int (4 bytes)
3	2804	Total powered on cycles	Check how many cycles the pump powered on	0-4294967295	Unsigned Long int (4 bytes)

Table 8. Holding Register (Lose Setting after Power Off)

No.	Address (Dec)	Name	Function	Data Range	Data Type
1	3000	Switch monitoring screen	Switch monitoring screen	Page 1: 0 Page 2: 1	Unsigned Short int (2 bytes)

Table 9. Holding Register (Power-off Memory FRAM)

No.	Address （Dec)	Name	Function	Data Range	Data Type
1	4035	Flow factor	Set flow factor		Float (4 bytes)
2	4022	Flow unit	Set flow unit	μL/min: 1 mL/min: 2 L/min: 3	Unsigned Short int (2 bytes)
3	4012	Reverse speed	Reverse speed setting	1-1500/1-3500/ 1-6000	Unsigned Short int (2 bytes)
4					
5	4015	Flow rate	Flow rate	0.001-999.9	Float (4 bytes)
6	4020	Language	Set language	0: English 1: Chinese	Unsigned Short int (2 bytes)
7					
8	4019	Parameter lock	Set parameter lock	Unlock: 0 Lock: 1	Unsigned Short int (2 bytes)
9	4028	Slave address	Set slave address	1-247	Unsigned Short int (2 bytes)
10	4021	Pump head and tubing type	Set installed pump head and tube type	0-20	Unsigned Short int (2 bytes)

11	4000	The leftmost physical coordinate of touch screen	The leftmost physical coordinate of touch screen		Unsigned long int (4 bytes)
12	4002	The rightmost physical coordinate of touch screen	The rightmost physical coordinate of touch screen		Unsigned long int (4 bytes)
13	4004	The uppermost physical coordinate of touch screen	The uppermost physical coordinate of touch screen		Unsigned long int (4 bytes)
14	4006	The down most physical coordinate of touch screen	The down most physical coordinate of touch screen		Unsigned long int (4 bytes)
15	4026	External control mode	Set external control mode	Internal: 0 Footswitch: 1 Voltage: 2 Current: 3	Unsigned Short int (2 bytes)
16	4018	Keypad tone	On/off		Unsigned Short int (2 bytes)
17	4027	Reverse angle	Reverse angle setting	0-720 degrees	Unsigned Short int (2 bytes)
18	4032	Easy dispense volume	Set easy dispense volume for one micro step	0- 4294967295	Unsigned long int (4 bytes)
19	4023	Direction	Set rotating direction	Clockwise: 0 Counterclockwise: 1	Unsigned Short int (2 bytes)
20	4024	Full speed	Running at full speed (clean) or not	Normal: 0 Full speed: 1	Unsigned Short int (2 bytes)
21	4025	Dispense state	Set dispense on/off	Off: 0 On: 1	Unsigned Short int (2 bytes)
22	4126	Running state	Running/Stopped	Stopped: 0 Running: 1	Unsigned Short int (2 bytes)
23	4029	Communication baud rate	Set Communication baud rate	4800bbs: 0 9600bbs: 1 19200bbs: 2 38400bbs: 3	Unsigned Short int (2 bytes)
24	4030	External control signal	Set external control signal type	Pulse: 0 Logic Level: 1	Unsigned Short int (2 bytes)
25					
26	4034	Restore defaults	Restore to factory defaults		Unsigned Short int (2 bytes)
27	4127	MODBUS mode		Computer: 0 PLC: 1	Unsigned Short int (2 bytes)

Table 10. Holding Register (Power-off Memory RAM)

No.	Address (Dec)	Name	Function	Data Range	Data Type
1	4800	Cumulative running cycles	Cumulative running cycles	0- 4294967295	UnSigned Long int (4 bytes)
2	4802	Cumulative running steps	Cumulative running steps (equivalent to cumulative volume)	0- 4294967295	Unsigned Long int (4 bytes)

6 Parameters and Addresses of F Series Peristaltic Pump

Mode: RTU
Addresses: 1-247 (User Defined)
Baud Rate: 4800, 9600, 19200, 38400
Data Bits: 8
CRC: Even Parity
Stop Bit: 1

Table 11. Input Register (Read Only)

No.	Address (Dec)	Name	Function	Data Range	Data Type
1	1000	Internal temperature	Check the temperature inside the pump	-100 - +100 Degrees	Signed Short int (2 bytes)
2	1001	Reserved			Unsigned Short int (2 bytes)
3	1002	Rotating speed	Check current rotating speed	0.1-150/0.1-350/0.1-600	Float (4 bytes)
4	1004	Steps has run for current dispense	Check how many steps has run for current dispense	0-4294967295	Unsigned Long int (4 bytes)
5	1006	Required steps for one dispense	Check required steps for one dispense	0-4294967295	Unsigned long int (4 bytes)
6	1008	Elapsed time for current dispense	Check elapsed time for current dispense	0-4294967295	Unsigned long int (4 bytes)
7	1010	Volume has dispensed for current dispense	Check volume has dispensed for current dispense	0-4294967295	Unsigned long int (4 bytes)

8	1012	Current dispense cycles has run	Check current dispense cycles has run	0-4294967295	Unsigned long int (4 bytes)
9					
10					
11	1016	Value of rotating speed timer	The setting that determines current rotating speed	150-65535	Unsigned Short int (2 bytes)
12	1018	Manufacturer information	Display manufacturer information	"LeadFluid"	Unsigned Char (10 bytes)
13	1023	Product information	Display product information	"BT100F" "BT300F" "BT600F"	Unsigned Char (10 bytes)
14	1028	Touch panel X-coordinate	Display touch panel X-coordinate		Unsigned Short int (2 bytes)
15	1029	Touch panel Y-coordinate	Display touch panel Y-coordinate		Unsigned Short int (2 bytes)
16	1030	Analog speed control	Display	0.1-max speed	Unsigned Long int (4 bytes)
17	1032	Cumulative volume	Check cumulative volume		Float (4 bytes)
18	1034	Unit of cumulative volume	Check unit of cumulative volume	μL: 1 mL: 2 L: 3	Unsigned Short int (2 bytes)
19	1980	Error log (20 groups)	Check error log		Unsigned Short int (2 bytes)

Table 12. Input Register (Read Only)

No.	Address (Decimal)	Name	Function	Data Range	Data Type
1	2800	Total on time	Check cumulative time that the pump powered on (seconds)	0-4294967295	Unsigned Long int (4 bytes)
2	2802	Total running time	Check cumulative running time (seconds)	0-4294967295	Unsigned Long int (4 bytes)
3	2804	Total powered on times	Check how many times the pump powered on	0-4294967295	Unsigned Long int (4bytes)

Table 13. Holding Register (Lose Setting after Power Off)

No.	Address (Dec)	Name	Function	Data Range	Data Type
1	3000	Switch monitoring	Switch monitoring screen	Page 1: 0 Page 2: 1	Unsigned Short int (2 bytes)

		screen			

Table 14. Holding Register (Power-off Memory FRAM)

No.	Address (Dec)	Name	Function	Data Range	Data Type
1	4035	Flow factor	Set flow factor		Float (4 bytes)
2	4022	Flow unit	Set flow unit	μL/min: 1 mL/min: 2 L/min: 3	Unsigned Short int (2 bytes)
3	4012	Reverse speed	Set reverse speed	1-1500/1-3500/1-6000	Unsigned Short int (2 bytes)
4	4008	Selected preset dispense parameter group	Choose dispense parameter group	Group one: 0 Group two: 1 Group three: 2 Group four: 3	Unsigned short int (2 bytes)
5	4015	Flow rate	Set flow rate	0.001-999.9	Float (4 bytes)
6	4020	Language	Set language	0: English 1: Chinese	Unsigned Short int (2 bytes)
7	4017	Working mode	Set working mode	Flow: 0 Volume dispense: 1 Time dispense: 2 Copy dispense: 3	Unsigned Short int (2 bytes)
8	4019	Parameter lock	Parameter lock setting	Unlocked: 0 Locked: 1	Unsigned Short int (2 bytes)
9	4028	Slave address	Set slave address	1-247	Unsigned Short int (2 bytes)
10	4021	Pump head and tubing type	Set installed pump head and tube type	0-20	Unsigned Short int (2 bytes)
11	4000	The leftmost physical coordinate of touch screen	The leftmost physical coordinate of touch screen		Unsigned long int (4 bytes)
12	4002	The rightmost physical coordinate of touch screen	The rightmost physical coordinate of touch screen		Unsigned long int (4 bytes)
13	4004	The uppermost physical coordinate of touch screen	The uppermost physical coordinate of touch screen		Unsigned long int (4 bytes)
14	4006	The down most physical coordinate of touch screen	The down most physical		Unsigned long int (4 bytes)

			coordinate of touch screen		
15	4026	External control mode	Set external control mode	Internal: 0 Footswitch: 1 Voltage: 2 Current: 3	Unsigned Short int (2 bytes)
16	4018	Key tone	On/off		Unsigned Short int (2 bytes)
17	4027	Reverse angle	Reverse angle setting	0-720 degrees	Unsigned Short int (2 bytes)
18	4032	Simple subpacking	Set simple subpacking (unit: micro step)	0-4294967295	Unsigned long int (4 bytes)
19	4023	Direction	Set rotating direction	Clockwise: 0 Counterclockwise: 1	Unsigned Short int (2 bytes)
20	4024	Full speed	Running at full speed (clean) or not	Normal: 0 Full speed: 1	Unsigned Short int (2 bytes)
21	4025	Dispense state	Set dispense on/off	Off: 0 On: 1	Unsigned Short int (2 bytes)
22	4126	Running state	Running/Stopped	Stopped: 0 Running: 1	Unsigned Short int (2 bytes)
23	4029	Communication baud rate	Set Communication baud rate	4800bbs 0 9600bbs 1 19200bbs 2 38400bbs 3	Unsigned Short int (2 bytes)
24	4030	External control signal	Set external control signal type	Pulse: 0 Logic Level: 1	Unsigned Short int (2 bytes)
25	4031	Infrared	Turn on/off infrared remote	Off: 0 On: 1	Unsigned Short int (2 bytes)
26	4034	Restore defaults	Restore to factory defaults		Unsigned Short int (2 bytes)
27	4127	MODBUS mode		Computer: 0 PLC: 1	Unsigned Short int (2 bytes)
28	4128	Volume dispense data structure	Volume dispense parameter setting	(4128+8xN): Flow rate, 4 bytes Float (4130+8xN): Volume, 4 bytes Float (4132+8xN): Stop time, 2 bytes unsigned (4133+8xN): Times, 2 bytes unsigned (4134+8xN): Volume unit, 2 bytes unsigned	16*5bytes 40 words

				(μL: 1, mL: 2, L: 3) (4135+8xN): Flow rate unit, 2bytes unsigned (μL/min: 1, mL/min: 2, L/min: 3) N is an integer from 0 to 4	
	4168	Time dispense data structure	Time dispense parameter setting	(4168+6xN): Flow rate, 4 bytes Float (4170+6xN): Running time, 2bytes unsigned (4171+6xN): Stop time, 2 bytes unsigned (4172+6xN): Times, 2 bytes unsigned (4173+6xN): Flow rate unit, 2bytes unsigned (μL: 1, mL: 2, L: 3) N is an integer from 0 to 4	12*5bytes 30 words
	4198	Copy dispense data structure	Copy dispense parameter setting	(4198+8xN): Flow rate, 4 bytes Float (4200+8xN): Cumulative volume, 4 bytes Float (4202+8xN): Stop time, 2 bytes unsigned (4203+8xN): Times, 2 bytes unsigned (4204+8xN): Cumulative volume unit, 2bytes unsigned (μL: 1, mL: 2, L: 3) (4205+8xN): Flow rate unit, 2bytes unsigned (μL/min: 1, mL/min: 2, L/min: 3) N is an integer from 0 to 4	16*5bytes 40 words

Table 15. Holding Register (Power-off Memory RAM)

No.	Address (Decimal)	Name	Function	Data Range	Data Type
1	4800	Cumulative running times	Cumulative running times	0- 4294967295	UnSigned Long int (4 bytes)

2	4802	Cumulative running steps	Cumulative running times (equivalent to cumulative volume)	0- 4294967295	Unsigned Long int (4 bytes)

7 RS485 Interface (DB15)

7.1 Use external 24V DC Power Supply

Connect the positive of the external +24V DC power supply to pin 4 (VCC_W) of the DB15 connector, connect the negative to pin 8 (com).

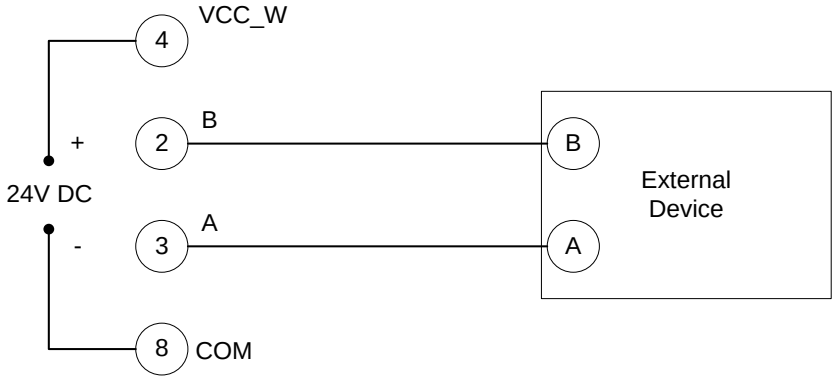

Figure 3. RS485 External 24V DC Power Supply

7.2 Use internal 12V DC Power Supply

Jump a wire from pin 10 (+12V) to pin 4 (VCC_W) of the DB15 connector, and jump another wire from pin 11(GND) to pin 8 (com).

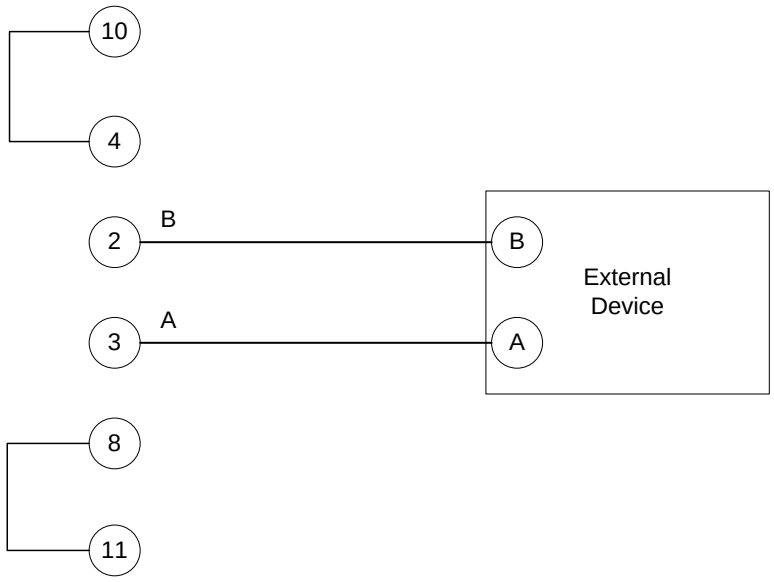

Figure 4. RS485 Internal 12V Power Supply

8 Instruction of data transmission format

8.1 Integer (2 bytes)

Data format: 2nd byte + 1st byte
Send: 2nd byte, then 1st byte
For example:
Data: 0x1234, send 12 34

8.2 Long integer and float (4 bytes)

1) PC mode
   Data: 4th byte + 3rd byte + 2nd byte + 1st byte
   Send: 2nd byte 1st byte 4th byte 3rd byte
   For example:
   Data: 0x12345678, send 56 78 12 34
2) PLC mode
   Data: 4th byte + 3rd byte + 2nd byte + 1st byte
   Send: 4th byte 3rd byte 2nd byte 1st byte
   For example:
   0x12345678, send 12 34 56 78