Instruction Manual

Supplementary Manual for SYL-2381-S (RS-485/Modbus_RTU)

Version 1.2 (May, 2017)

CAUTION!

This controller is intended to control equipment under normal operating conditions. If failure or malfunction of it could lead to an abnormal operating condition that could cause personal injury or damage to the equipment or other property, other devices (limit or safety controls) or systems (alarm or supervisory) intended to warn of or protect against failure or malfunction of the controller must be incorporated into and maintained as part of the control system.

1. Introductory

This controller is using Modebus_RTU (Remote Terminal Unit) mode for the data transfer. The format for each byte in RTU mode is:

Coding System:
8-bit binary, hexadecimal 0-9, A-F
Two hexadecimal characters contained in each 8-bit field of the message

Bits per Bytes:
Baud rate (bps): 1200, 2400, 4800 and 9600
Stop bit: 1 bit
Data length: 8 bits
Parity check: None
Error Check Field: Cyclical Redundancy Check (CRC-16)

2. RTU Message Frame:

The interval time before transmitting a new message requires 3.5 character times at minimum. The full data frame must be transmitted in once. If the interval time period between two messages is less than 1.5 character times, the receiver unit will clear the current incomplete message, and assume the next byte is the address field for the next new message. Similarly, if a new message has been received during this minimum interval time, the receiving device will assume that message is from the previous incomplete message.

A typical message frame is shown below.

Table 2.1 RTU data frame.

Start	Target Address	Function	Data	CRC-16 (Modbus_RTU)	End
T1-T2-T3-T4	8 Bits	8 Bits	n x 8 Bits	16 Bit	T1-T2-T3-T4

Address field: This field contains 8-bit data (RTU). Its range is 0 - 64 decimal. Address 0 is for broadcasting data to all receiving devices. To contact a slave unit, the master/sender unit will put the address of that slave unit in the address field of the message. When that slave unit replies, it will put its address in the address field of the message as well.

Function field: This field contains 8-bit data. Its range is 1 - 64 decimal. This function field will tell what operations are requested for this data frame. For example, updating the value for set temperature, fetching the current reading temperature, etc.

Data field: This field contains multiple 8-bit data. It contains all the additional information, which is needed to complete the requested function. Such as the target parameter address, or the new set temperature.

CRC: 16-bit or two 8-bit bytes for error checking. Cyclical Redundancy Check (CRC) value is appended to the end of this data frame. Low-order byte will be sent in prior to the high-order byte. For example, if the data frame is 050301640002, and its CRC16 is AC85. So its complete data frame is 050301640002**85AC**.

Note: When you are using the physical keypad on this controller, it is unable to change/overwrite any current parameter values over RS-485 port. But the master unit (like PC or PLC) can still read the parameter value from this controller by RS-485 port.

Valid data types for all the parameters:

Table 2.2 Data type.

Data type #	Data definition	Modbus function codes for read/write
A	Bit	01H/05H
G	32 bits, floating point	03H/10H

3. Parameter set

3.1. Dynamic parameter set

Table 3.1 Dynamic parameter set

#	Parameter Symbol	Description	Starting Address	Data type	Property	Range	Note
1	PV	Process value	0164H	G	Read only	-1999 - 9999	
2	OUT	Output value	0166H	G	Read only	0 - 1.000	
3	AL1_STA	J1 status flag	0005H	A, 1-bit data	Read only	0, 1	
4	CV	Control flag for OUT	016C	G	Read & write	0, 1	See 3.5
5	AT	Flag status	0000H	A, 8-bit data	Read only	0, 1 for every bit	

3.2. Static parameter set

Table 3.2 Static parameter set

#	Parameter Symbol	Description	Starting Address	Data type	Property	Range	Note
1	SV	Set Value	0000H	G	Read & write	-1999-9999	
2	AH1	J1 ON temperature	0002H	G	Read & write	-1999-9999	
3	AL1	J1 OFF temperature	0004H	G	Read & write	-1999-9999	
4	P	Proportional Constant	1000H	G	Read & write	0.1-999.9	
6	I	Integral Time	1002H	G	Read & write	0-9999	
7	d	Derivative Time	1004H	G	Read & write	0-999	
8	bb	Proportional Band Range Limit	1006H	G	Read & write	1-1999	
9	SouF	Damp Constant	1008H	G	Read & write	0.0-1.0	
10	ot	Cycle Rate	100AH	G	Read & write	1-500	
11	FILt	Digital Filter	100CH	G	Read & write	0-3	
12	Inty	Input Sensor Type	2000H	G	Read & write	00-10	See 3.3
13	outy	Control Output Mode	2002H	G	Read & write	0-5	

14	coty	Main Output Mode	2004H	G	Read & write	0-2	See 3.4
15	Hy	Hysteresis Band	2006H	G	Read & write	0-9999	
16	PSb	Input Offset	2008H	G	Read & write	-1000-1000	
17	rd	Control Function	200AH	G	Read & write	0-1	
18	CorF	Display Unit	200CH	G	Read & write	0 for Celsius, 1 for Fahrenheit	
19	Id	Unit ID	200EH	G	Read & write	1-64	
34	bAud	Baud Rate	2010H	G	Read & write	0-3	

3.3. Range for inty (input sensor type)

Table 3.3 Range for inty.

Value	00	01	02	03	04	05	06	07	08	09	10
Input sensor type	T	R	J	Wre3-Wre5	B	S	K	E	P100	P10.0	CU50

For example, if the controller replies “08” for parameter inty, the current sensor type is set to Pt100. If you want to change its sensor type to type K thermocouple, write “06” for parameter inty.

3.4. Range for coty (main output mode)

Table 3.4 Range for coty.

Value	00	01	02
Control option	SSR	0-20mA	4-20mA

For example, if the controller replies “02”, the current main control option is set to “4-20mA”. If you want to change it to “0-20mA”, write “01” for parameter coty.

3.5. CV, Control flag for OUT

CV controls the function to write/read the parameter OUT. When CV is set to 0 (default), host can only read the value for OUT (power output percentage). When CV is set to 1, host can read and write OUT. It works for both manual mode and PID mode. In PID mode, after you set new output percentage, the controller itself will not change it (like manual mode). To exit, you can either reboot this controller, or set CV back to 0.

3.6. Flag status register parameter (AT)

One 8-bit register can be used to display the status of the controller. Every digit is used for one individual status of the controller, such as alarm status, auto-tune, manual mode, etc.

Table 3.5 Parameters in flag status register

SV	Reserved	AL1	Anomaly	Setting	Heating/ Cooling	A/M	AT
D7	D6	D5	D4	D3	D2	D1	D0

Hi bit Lo bit

D7 = 1: Controller is changing SV right now; D7 = 0: Normal status.
D6 = 0: Reserved parameter.
D5 = 1: Alarm 1 is activated; D5 = 0: Alarm 1 is deactivated.
D4 = 1: Controller is in anomaly status. For example, sensor is not connected and display shows EEEE. D4 = 0: Normal status.

D3 = 1: Controller is in setting mode of static parameters (section 3.2); D3 = 0: Normal status.
D2 = 1: Cooling mode; D2 = 0: Heating mode
D1 = 1: Controller is in manual mode; D1 = 0: Normal status.
D0 = 1: Controller is in the process of auto-tune; D0 = 0: Normal status.

For example, if the controller replied 20H, which is 0010 0000. So D5 = 1, which means alarm 1 is triggered. The rest statuses are deactivated.

3.7. Format for floating point (IEEE 754 standard, 32 bits)

Table 3.6 Data format for floating point number

Address	+0	+1	+2	+3
Contents	SEEE EEEE	EMMM MMMM	MMMM MMMM	MMMM MMMM
	Low			High

S is for sign bit. E is for exponent (8 bits in total). M is for true significand (23 bits in total). You can use this online tool here for this calculation: http://www.binaryconvert.com/convert_float.html

4. Function code examples

Note: Three function codes are available for this controller: 03, 10 and 01. Function code 01 is only available for parameter AT and AL1_STA, whose data type is A (table 2.2). Function code 03 and 10 are available for the parameters whose data type is G (table 2.2). For details, please check ModBus Protocol.

4.1. Function code 03: Read parameter value from the controller

Example: Read the current PV value from the controller:
Data sent by host (hex): 05030164000285AC
Data received from slave (hex): 050304434800002A61

Table 4.1 Example for function code 03

Data sent by host							
Target Address	Function	Parameter Address		Number of words		CRC16	
05	03	Hi	Lo	Hi	Lo	Lo	Hi
		01	64	00	02	85	AC

Data received by slave								
Target Address	Function	Number of bytes	Data				CRC16	
			Hi		Lo		Lo	Hi
05	03	04	43	48	00	00	2A	61

The controller replied that the current PV was 43480000H (200 decimal).

4.2. Function code 10: Write new parameter value to the controller

Example #1: Write 60.5 decimal as new SV value to the controller. 60.5 = 42720000H
Data sent by host (hex): 0510000000020442720000052FC
Data received from slave (hex): 051000000002404C

Table 4.2.1 Example 1 for function code 10.

Data sent by host											
Target Address	Function	Parameter Address		Data length			Value				CRC16	
05	10	Hi	Lo	Number of words		Number of bytes	42	72	00	00	52	FC
		00	00	00	02	04						
Data received from slave												
Target Address	Function	Parameter Address		Number of words			Value				CRC16	
05	10	00	00	00			02				40	4C

Example #2: Change temperature unit to Celsius degree
Date sent by host (hex): 0510200C000204000000007F0B
Data received from slave (hex): 0510200C00028B8F

Table 4.2.2 Example 2 for function code 10.

Data sent by host											
Target Address	Function	Parameter Address		Data length			Value				CRC16	
05	10	Hi	Lo	Number of words		Number of bytes	00	00	00	00	7F	0B
		20	0C	00	02	04						
Data received from slave												
Target Address	Function	Parameter Address		Number of words			Value				CRC16	
05	10	20	0C	00			02				8B	8F

4.3. Function code 01: Read the flag status (AT)
Date sent by host (hex): 0501000000083C48
Date received from slave (hex): 050101205160

Table 4.3 Example for function code 01.

Data sent by host							
Target Address	Function	Address of status flag		Number of bits		CRC16	
05	01	Hi	Lo	Hi	Lo	Lo	Hi
		00	00	00	08	3C	48
Data received from slave							
Target Address	Function	Number of bytes		Data		CRC16	
05	01	01		20		51	60

The controller replied 20H as the value of status flag register. 20 is 0010 0000, which means AL1= 1 (Alarm 1 is activated).

Note: Termination resistors for RS-485 communication.
Termination resistors are required for the transmission-line effects, for high frequencies and long distances transmission. That resistance is determined by the characteristic impedance of the cable, not by the length of the cable. The range of the resistance is 100 to 140 Ohms. The typical value is 120 Ohms. For capacitor, the typical value is 0.1 Uf (104). Please check the following diagram for the recommended wiring.

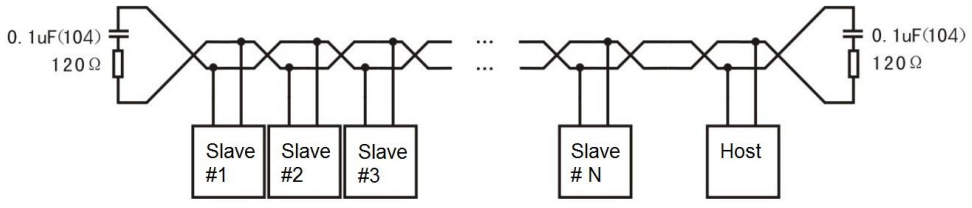

Figure 5. Resistor wiring example.

Appendix 1: Tutorial for Simply Modbus Software

Simply Modbus Master is a software for Modbus testing. It functions as Modbus RTU master, and it can be connected to RTU slave unit (like SYL-2381-mA-S) using Modbus protocol. You can download its demo program here. Demo mode allows sending and receiving six messages. The programs can always be restarted to reset the demo, and send & receive more messages. For more information regarding this software, please check http://www.simplymodbus.ca/.

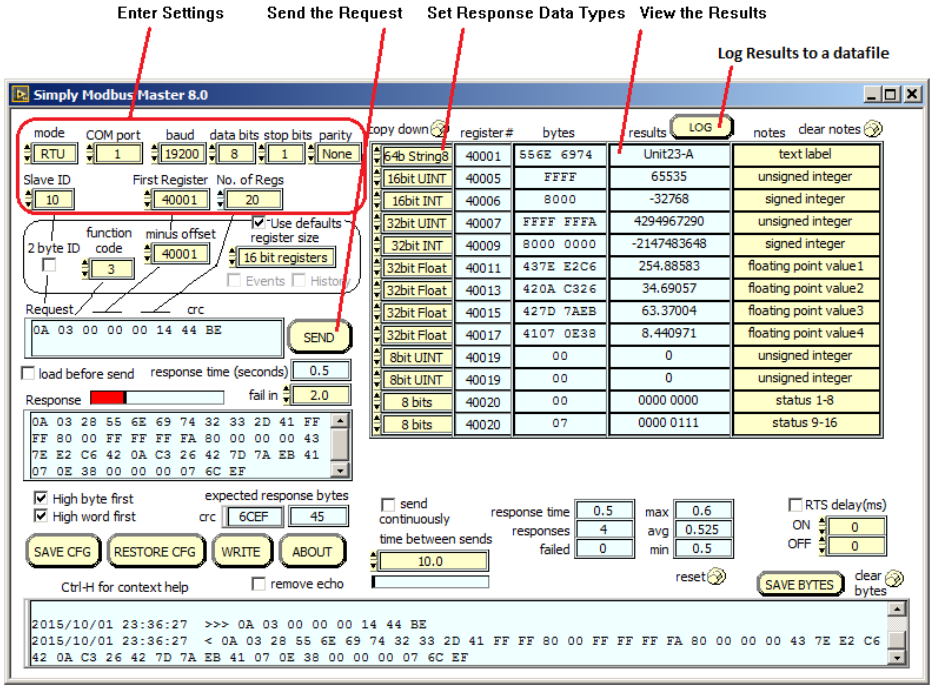

Figure 6. Simply Modbus Master. (Picture from http://www.simplymodbus.ca/RTUmaster.htm)

Example:
1. Function code 03: read parameter

Data sent by host: 05 03 01 64 00 02 85 AC (read PV value)

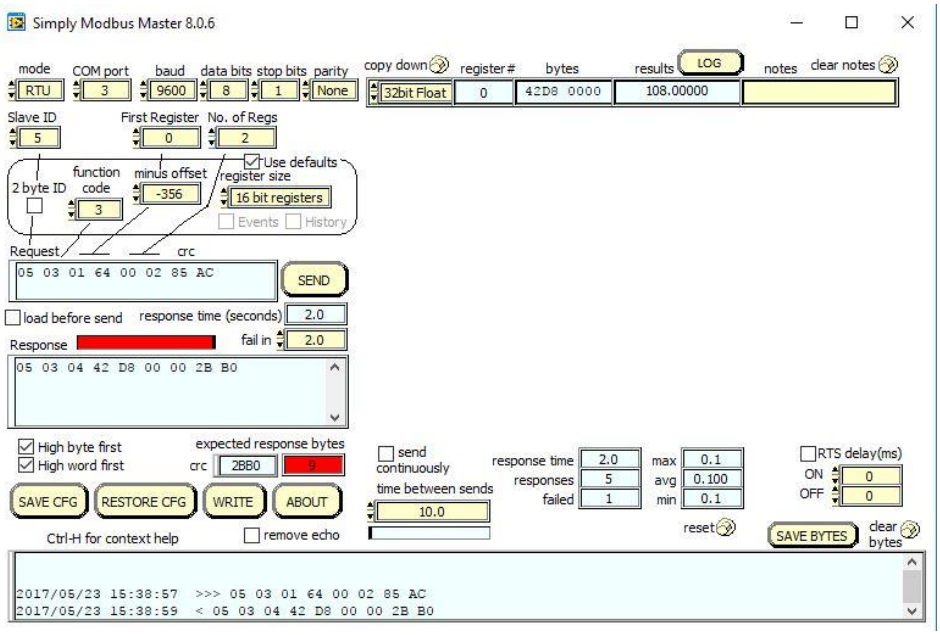

Figure 7. Example for function code 03

Set function code as “3”, change the register address for the target parameter to 0164H (by “first register” and “minus offset”), change the register size to 16 bit registers with 2 registers, then change the response data type (on the right top) to 32bit Float data. Press SEND to send the data to controller.

From figure 7, the response data is “05 03 04 42 D8 00 00 2B B0”. The responded parameter value (PV) will be also displayed on the right top (108 degree).

2. Function code 01: read flag status

Data sent by the host: 05 01 00 00 00 08 3C 48 (read 8-bit flag status register)

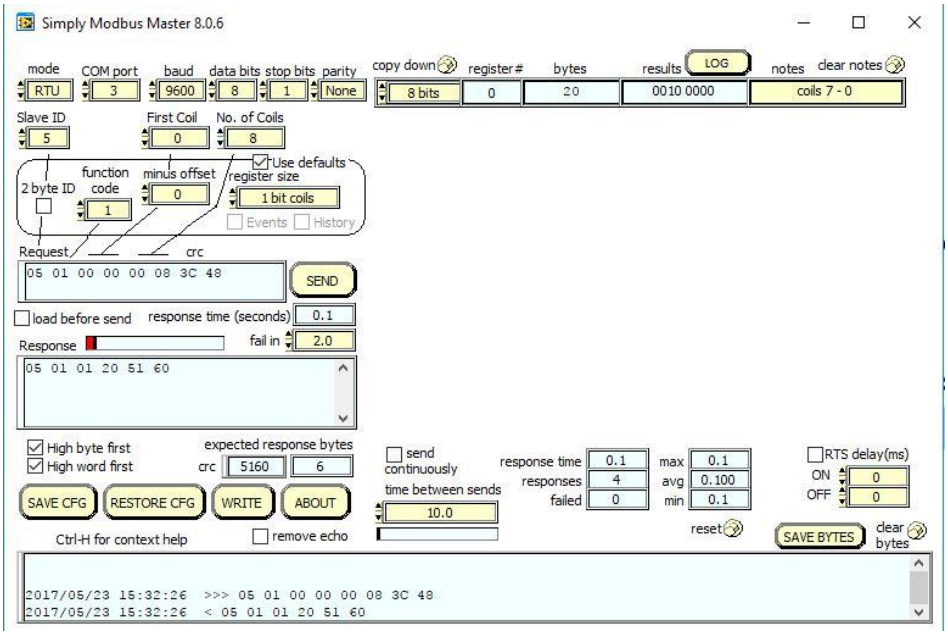

Figure 8. Example for function code 01

Set function code as “1”, change the register address for the target parameter to 0 (by “first register” and “minus offset”), change the register size to 1-bit coil with 8 coils, then change the response data type (on the right top) to 8-bit data. Press SEND to send the data to controller.

From figure 8, the response data is “05 01 01 20 51 60”. The responded flag register value is 0010 0000 (AL1 alarm is triggered).

3. Function code 10: write parameter

Data sent by the host:05 10 00 00 00 02 04 42 72 00 00 52 FC (write 60.5 to SV)

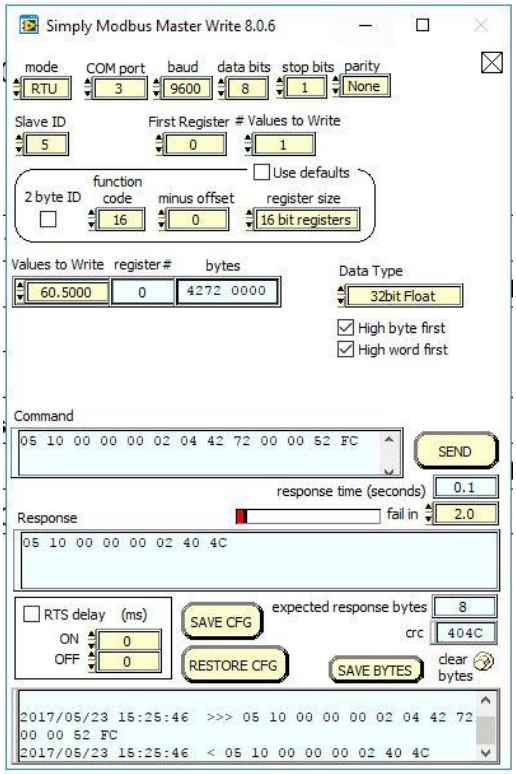

Figure 9. Example for function code 10

Click on yellow “WRITE” button on the left bottom of the main screen, then “WRITE” screen will pop out. Uncheck “Use defaults” box below the serial port settings, then change function code to 16 (which is 10H). Change “register size” to 16 bit registers and “Data Type” to 32bit Float. Enter 60.5 to “Values to Write”. Then press SEND.

From figure 9, the response data is “05 10 00 00 00 02 40 4C”.

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