Chapter 7 Modbus Communications

This chapter specifies the Modbus Communications protocol as RS-232 or RS-485 interface module is installed. Only RTU mode is supported. Data is transmitted as eight-bit binary bytes with 1 start bit, 1 stop bit and optional parity checking (None, Even or Odd). Baud rate may be set to 300, 600, 1200, 2400, 4800, 9600, 14400, 19200, 28800 and 38400.

7-1 Functions Supported

Only function 03, 06 and 16 are available for this series of controllers. The message formats for each function are described as follows:

Function 03: Read Holding Registers

Query (from master)	**Response** (from slave)
Slave address (0-255)	←
Function code (3)	←
Starting address of register Hi (0)	Byte count
Starting address of register Lo (0-61, 128-143)	Data 1 Hi
	Data 1 Lo
No. of words Hi (0)	Data 2 Hi
No. of words Lo (1-22)	Data 2 Lo
CRC16 Hi	⋮
CRC16 Lo	CRC16 Hi
	CRC16 Lo

Function 06: Preset single Register

Query (from master)	**Response** (from slave)
Slave address (0-255)	←
Function code (6)	←
Register address Hi (0)	←
Register address Lo (0-61, 128-143)	←
Data Hi	←
Data Lo	←
CRC16 Hi	←
CRC16 Lo	←

Function 16: Preset Multiple Registers

Query (from master)	**Response** (from slave)
Slave address (0-255)	←
Function code (16)	←
Starting address of register Hi (0)	←
Starting address of register Lo (0-61, 128-143)	←
No. of words Hi (0)	←
No. of words Lo (1-18)	←
Byte count (2-36)	
Data 1 Hi	
Data 1 Lo	
Data 2 Hi	
Data 2 Lo	
⋮	
CRC16 Hi	CRC16 Hi
CRC16 Lo	CRC16 Lo

7-2 Exception Responses

If the controller receives a message which contains a corrupted character (parity check error, framing error etc.), or if the CRC16 check fails, the controller ignores the message.
However, if the controller receives a syntactically correct message which contains an illegal value, it will send an exception response, consisting of five bytes as follows:

slave address +offset function code + exception code + CRC16 Hi + CRC16 Lo

Where the offset function code is obtained by adding the function code with 128 (ie. function 3 becomes H'83), and the exception code is equal to the value contained in the following table:

Exception Code	Name	Cause
1	Bad function code	Function code is not supported by the controller
2	Illegal data address	Register address out of range
3	Illegal data value	Data value out of range or attempt to write a read-only or protected data

7-3 Parameter Modbus Register Mapping Table

Register Address	Parameter Notation	Parameter	Scale Low	Scale High	Notes
0		Reserved			
1	HSP1	High limit set point 1	*1	*1	R/W
2	LSP1	Low limit set point 1	*1	*1	R/W
3	SP2	Set point 2 value for output 2	*1	*1	R/W
4		Reserved			
5		Reserved			
6	PV.HI	Historical max. value of PV	*1	*1	R
7	PV.LO	Historical min. value of PV	*1	*1	R
8		Reserved			
9	INPT	Input type selection	0	65535	R/W
10	UNIT	Process unit	0	65535	R/W
11	RESO	Display resolution	0	65535	R/W
12	IN.LO	Low scale value for linear input	*1	*1	R/W
13	IN.HI	High scale value for linear input	*1	*1	R/W
14	SHIF	PV shift (offset) value	*1	*1	R/W
15	FILT	PV filter time constant	0	65535	R/W
16	T.ABN	Accumulated time during abnormal condition	0	6553.5	R
17	OUT1	Output 1 function	0	65535	R/W
18		Reserved			
19		Reserved			
20	O1.HY	Output 1 hysteresis value	*2	*2	R/W
21		Reserved			
22		Reserved			
23		Reserved			
24		Reserved			
25		Reserved			
26		Reserved			
27		Reserved			
28	HSPL	Lower limit of HSP1	*1	*1	R/W
29	HSPH	Upper limit of HSP1	*1	*1	R/W

Register Address	Parameter Notation	Parameter	Scale Low	Scale High	Notes
30	LSP.L	Lower limit of LSP1	*1	*1	R/W
31	LSP.H	Upper limit of LSP1	*1	*1	R/W
32		Reserved			
33		Reserved			
34	AOFN	Analog output function	0	65535	R/W
35	OUT2	Output 2 function	0	65535	R/W
36		Reserved			
37		Reserved			
38		Reserved			
39	COMM	Communication function	0	65535	R/W
40	ADDR	Address	0	65535	R/W
41	BAUD	Baud rate	0	65535	R/W
42	PARI	Parity bit	0	65535	R/W
43	AOLO	Analog output scale low	*1	*1	R/W
44	AL.FN	Alarm function	0	65535	R/W
45	AL.MD	Alarm mode	0	65535	R/W
46	AL.HY	Alarm hysteresis value	*2	*2	R/W
47	AL.FT	Alarm failure transfer	0	65535	R/W
48	EIFN	Event input function	0	65535	R/W
49	DISP	Normal display format	0	65535	R/W
50	AOHI	Analog output scale high	*1	*1	R/W
51	AD0	mV calibration low coefficient	-1999.9	4553.6	R/W
52	ADG	mV calibration high coefficient	-1999.9	4553.6	R/W
53	CJTL	Cold junction calibration low coefficient	-199.99	455.36	R/W
54	CJG	Cold junction calibration high coefficient	-1999.9	4553.6	R/W
55	REF	RTD calibration low coefficient	-1999.9	4553.6	R/W
56	SR	RTD calibration high coefficient	-1999.9	4553.6	R/W
57		Reserved			
58	DATE	Manufacturing date of the product	0	65535	R/W
59	NO	Serial number of the product	0	65535	R/W
60	HOUR	Working hours of the product	0	65535	R/W
61	HRLO	Fractional value of hour	0	65535	R/W

Register Address	Parameter Notation	Parameter	Scale Low	Scale High	Notes
128	PV	Process value	*1	*1	R
129	HSP1	High limit set point 1	*1	*1	R
130	LSP1	Low limit set point 1	*1	*1	R
131	T.ABN	Accumulated time during abnormal condition	0	6553.5	R
132	ALM	Output 1 status *4	0	65535	R
140	PROG	Program code *3	0.00	655.35	R
142	CMND	Command code	0	65535	R/W
143	JOB	Job code	0	65535	R/W

*1: The scale high/low values are defined in the following table for the parameters HSP1, LSP1, SP2, PV.HI, PV.LO, IN.LO, IN.HI, SHIF, HSP.L, HSP.H, LSP.L, LSP.H, PV, AOLO and AOHI:

Conditions	Non-linear input	Linear input RESO = 0	Linear input RESO = 1	Linear input RESO = 2	Linear input RESO = 3
Scale low	-1999.9	-19999	-1999.9	-199.99	-19.999
Scale high	4553.6	45536	4553.6	455.36	45.536

*2: The scale high/low values are defined in the following table for the parameters O1.HY and AL.HY :

Conditions	Non-linear input	Linear input RESO = 0	Linear input RESO = 1	Linear input RESO= 2	Linear input RESO = 3
Scale low	0.0	0	0.0	0.00	0.000
Scale high	6553.5	65535	6553.5	655.35	65.535

*3: The PROG code is defined by 5.XX, where XX denotes the software version number. For example : PROG=5.10 means the product is L41 with software version 10.

*4: The least significant bit (LSB) of ALM shows the status of output 1. LSB=1 if output 1 is ON (normal condition). The second bit of ALM shows the status of output2.

7-4 Data Conversion

The word data are regarded as unsigned (positive) data in the Modbus message. However, the actual value of the parameter may be negative value with decimal point. The high/low scale values for each parameter are used for the purpose of such conversion.

Let M = Value of Modbus message
A = Actual value of the parameter
SL = Scale low value of the parameter
SH = Scale high value of the parameter

The conversion formulas are as follows:

$$M = \frac{65535}{SH\text{-}SL} \bullet (A - SL)$$

$$A = \frac{SH\text{-}SL}{65535} \bullet M + SL$$

7-5 Communication Examples :

Example 1: Down load the default values via the programming port

The programming port can perform Modbus communications regardless of the incorrect setup values of address, baud, parity, stop bit etc. It is especially useful during the first time configuration for the controller. The host must be set with 9600 baud rate, 8 data bits, even parity and 1 stop bit.

The Modbus message frame with hexadecimal values is shown as follows:

(1) Unlock the controller

	06	00	8E	68	2C	HI	LO
Addr.	Func.	Reg. Addr.		CMND=26668		CRC16	

(2) Preset the first group of the parameters

	10	00	09	00	07	0E	00	01	00	00
Addr.	Func.	Starting Addr.		No. of words		Bytes	INPT=1		UNIT=0	

00	01	4E	1F	52	07	4E	1F	00	02	HI	LO
RESO=1		IN.LO=0		IN.HI=100.0		SHIF=0.0		FILT=2		CRC16	

(3) Preset the second group of the parameters

	10	00	01	00	03	06	52	07	4E	1F	51	A3	HI	LO
Addr.	Func.	Starting Addr.		No. of words		Bytes	HSP1=100.0		LSP1=0.0		SP2=90.0		CRC16	

(4) Preset the third group of the parameters

	10	00	11	00	13	26	00	02	00	00	00	00	00	01
Addr.	Func.	Starting Addr.		No. of words		Bytes	OUT1=2		Reserved		Reserved		O1.HY=0.1	

00	00	00	00	00	00	00	00	00	00	00	00	00	00	4E	1F
Reserved		Reserved		Reserved		Reserved		Reserved		Reserved		Reserved		HSP.L=0	

75	2F	4A	37	4E	1F	00	00	00	00	00	00	00	02	HI	LO
HSP.H=1000.0		LSP.L=-100.0		LSP.H=0		Reserved		Reserved		AOFN=0		OUT2=2		CRC16	

(5) Preset the rest parameters

	10	00	27	00	0C	18	00	01	00	01	00	05	00	00
Addr.	Func.	Starting Addr.		No. of words		Bytes	COMM=1		ADDR=1		BAUD=5		PARI=0	

4E	1F	00	06	00	00	00	01	00	01	00	00	00	00
AOLO=0		AL.FN=6		AL.MD=0		AL.HY=0.1		AL.FT=1		EIFN=0		DISP=0	

52	07	HI	LO
AOHI=100.0		CRC16	

Example 2: Read the process value (PV)

Send the following message to the controller via the COMM port or the programming port :

Query

	03	00	80	00	01	HI	LO
Addr.	Func.	Starting Addr.		No. of words		CRC16	

Example 3: Perform reset function (same effect as pressing RESET key):

Query

	06	00	8E	68	25	HI	LO
Addr.	Func.	Starting Addr.		CMND=26661		CRC16	

Example 4: Read 22 parameters at most one time

Query

	03			00	16	HI	LO
Addr.	Func.	Starting Addr.		No. of words		CRC16	

Example 5: Modify the calibration coefficient

Preset the CMND register with 26665 before attempting to change the calibration coefficient.

	06	00	8E	68	29	HI	LO
Addr.	Func.	Register Addr.		CMND=26665		CRC16	

Table A.1 Error Codes and Corrective Actions

Error Code	Display Symbol	Error Description	Corrective Action
10	Er 10	Communication error: bad function code	Correct the communication software to meet the protocol requirements.
11	Er 11	Communication error: register address out of range	Don't issue an over-range register address to the slave.
14	Er 14	Communication error: attempt to write a read-only data or a protected data	Don't write a read-only data or a protected data to the slave.
15	Er 15	Communication error: write a value which is out of range to a register	Don't write an over-range data to the slave register.
39	SEnb	Input sensor break, or input current below 1 mA if 4-20 mA is selected, or input voltage below 0.25V if 1 - 5V is selected	Replace input sensor.
40	AdEr	A to D converter or related component(s) malfunction	Return to factory for repair.