7 Communication Protocol

7.1 Brief instruction to Modbus protocol

Modbus protocol is a software protocol and common language which is applied in the electrical controller. With this protocol, the controller can communicate with other devices via network (the channel of signal transmission or the physical layer, such as RS485). And with this industrial standard, the controlling devices of different manufacturers can be connected to an industrial network for the convenient of being monitored.

There are two transmission modes for Modbus protocol: ASCII mode and RTU (Remote Terminal Units) mode. On one Modbus network, all devices should select same transmission mode and their basic parameters, such as baud rate, digital bit, check bit, and stopping bit should have no difference.

Modbus network is a controlling network with single-master and multiple slaves, which means that there is only one device performs as the master and the others are the slaves on one Modbus network. The master means the device which has active talking right to sent message to Modbus network for the controlling and inquiring to other devices. The slave means the passive device which sends data message to the Modbus network only after receiving the controlling or inquiring message (command) form the master (response). After the master sends message, there is a period of time left for the controlled or inquired slaves to response, which ensure there is only one slave sends message to the master at a time for the avoidance of singles impact.

Generally, the user can set PC, PLC, IPC and HMI as the masters to realize central control. Setting certain device as the master is a promise other than setting by a bottom or a switch or the device has a special message format. For example, when the upper monitor is running, if the operator clicks sending command bottom, the upper monitor can send command message actively even it can not receive the message from other devices. In this case, the upper monitor is the master. And if the designer makes the inverter send the data only after receiving the command, then the inverter is the slave.

The master can communicate with any single slave or with all slaves. For the single-visiting command, the slave should feedback a response message; for the broadcasting message from the master, the slave does not need to feedback the response message.

7.2 Application of the inverter

The Modbus protocol of the inverter is RTU mode and the physical layer is 2-wire RS485.

7.2.1 2-wire RS485

The interface of 2-wire RS485 works on semiduplex and its data signal applies differential transmission which is called balance transmission, too. It uses twisted pairs, one of which is defined as A (+) and the other is defined as B (-). Generally, if the positive electrical level between sending drive A and B is among +2~+6V, it is logic“1”, if the electrical level is among -2V~-6V; it is logic“0”.

485+ on the terminal board corresponds to A and 485- to B.

Communication baud rate means the binary bit number in one second. The unit is bit/s (bps). The higher the baud rate is, the quicker the transmission speed is and the weaker the anti-interference is. If the twisted pairs of 0.56mm (24AWG) is applied as the communication cables, the Max. Transmission distance is as below:

Baud rate	Max.transmission distance	Baud rate	Max.transmission distance	Baud rate	Max.transmission distance	Baud rate	Max.transmission distance
2400 BPS	1800m	4800 BPS	1200m	9600 BPS	800m	19200 BPS	600m

It is recommended to use shield cables and make the shield layer as the grounding wires during RS485 remote communication.

In the cases with less devices and shorter distance, it is recommended to use 120Ω terminal resistor as the performance will be weakened if the distance increase even though the network can perform well without load resistor.

7.2.1.1 Single application

Figure 1 is the site Modbus connection figure of single inverter and PC. Generally, the computer does not have RS485 interface, the RS232 or USB interface of the computer should be converted into RS485 by converter. Connect the A terminal of RS485 to the 485+ terminal of the inverter and B to the 485- terminal. It is recommended to use the shield twisted pairs. When applying RS232-RS485 converter, if the RS232 interface of the computer is connected to the RS232 interface of the converter, the wire length should be as short as possible within the length of 15m. It is recommended to connect the RS232-RS485 converter to the computer directly. If using USB-RS485 converter, the wire should be as short as possible, too.

Select a right interface to the upper monitor of the computer (select the interface of RS232-RS485 converter, such as COM1) after the wiring and set the basic parameters such as communication baud rate and digital check bit to the same as the inverter.

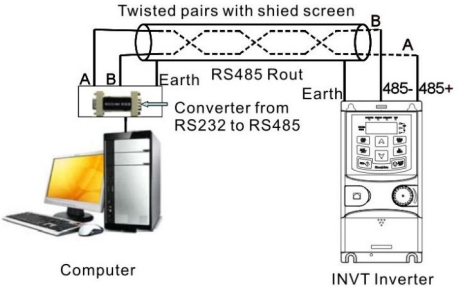


Figure 1 RS485 physical connection in single application

7.2.1.2 Multi-applications

In real multi-applications, the chrysanthemum connection and star connection are commonly used.

Chrysanthemum chain connection is required in the RS485 industrial fieldbus standards. The two ends are connected to terminal resistors of 120Ω which is shown as figure 2.

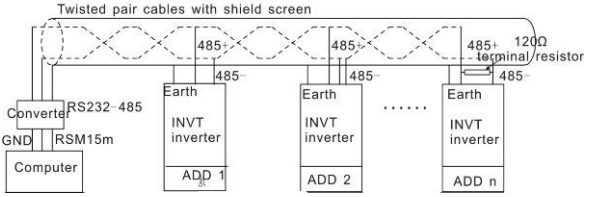


Figure 2 Chrysanthemum connection applications

Figure 3 is the star connection. Terminal resistor should be connected to the two devices which have the longest distance. (1# and 15#device)

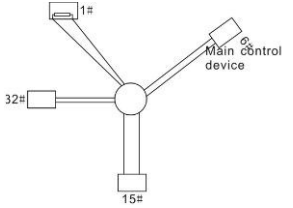


Figure 3 star connection

It is recommended to use shield cables in multiple connection. The basic parameter of the devices, such as baud rate and digital check bit in RS485 should be the same and there should be no repeated address.

7.2.2 RTU mode

7.2.2.1 RTU communication frame format

If the controller is set to communicate by RTU mode in Modbus network every 8bit byte in the message includes two 4Bit hex characters. Compared with ACSII mode, this mode can send more data at the same baud rate.

Code system

- 1 start bit
- 7 or 8 digital bit, the minimum valid bit can be sent firstly. Every 8 bit frame includes two hex characters (0...9, A...F)
- 1 even/odd check bit . If there is no checkout, the even/odd check bit is inexistent.
- 1 end bit (with checkout), 2 Bit(no checkout)

Error detection field

- CRC

The data format is illustrated as below:

11-bit character frame (BIT1~BIT8 are the digital bits)

Start bit	BIT1	BIT2	BIT3	BIT4	BIT5	BIT6	BIT7	BIT8	Check bit	End bit

10-bit character frame (BIT1~BIT7 are the digital bits)

Start bit	BIT1	BIT2	BIT3	BIT4	BIT5	BIT6	BIT7	Check bit	End bit

In one character frame, the digital bit takes effect. The start bit, check bit and end bit is used to send the digital bit right to the other device. The digital bit, even/odd checkout and end bit should be set as the same in real application.

The Modbus minimum idle time between frames should be no less than 3.5 bytes. The network device is detecting, even during the interval time, the network bus. When the first field (the address field) is received, the corresponding device decodes next transmitting character. When the interval time is at least 3.5 byte, the message ends.

The whole message frame in RTU mode is a continuous transmitting flow. If there is an interval time (more than 1.5 bytes) before the completion of the frame, the receiving device will renew the uncompleted message and suppose the next byte as the address field of the new message. As such, if the new message follows the previous one within the interval time of 3.5 bytes, the receiving device will deal with it as the same with the previous message. If these two phenomena all happen during the transmission, the CRC will generate a fault message to respond to the sending devices.

The standard structure of RTU frame:

START	T1-T2-T3-T4(transmission time of 3.5 bytes)
ADDR	Communication address: 0~247(decimal system)(0 is the broadcast address)
CMD	03H:read slave parameters 06H:write slave parameters
DATA (N-1) … DATA (0)	The data of 2*N bytes are the main content of the communication as well as the core of data exchanging
CRC CHK low bit	Detection value:CRC (16BIT)
CRC CHK high bit	
END	T1-T2-T3-T4(transmission time of 3.5 bytes)

7.2.2.2 RTU communication frame error checkout

Various factors (such as electromagnetic interference) may cause error in the data transmission. For example, if the sending message is a logic "1",A-B potential difference on RS485 should be 6V, but in reality, it may be -6V because of electromagnetic interference, and then the other devices take the sent message as logic "0". If there is no error checkout, the receiving devices will not find the message is wrong and they may give incorrect response which cause serious result. So the checkout is essential to the message.

The theme of checkout is that: the sender calculate the sending data according to a fixed formula, and then send the result with the message. When the receiver gets this message, they will calculate anther result according to the same method and compare it with the sending one. If two results are the same, the message is correct. If not, the message is incorrect.

The error checkout of the frame can be divided into two parts: the bit checkout of the byte and the whole data checkout of the frame (CRC check).

Bit checkout of the byte

The user can select different bit checkouts or non-checkout, which impacts the check bit setting of each byte.

The definition of even checkout: add an even check bit before the data transmission to illustrate the number of "1" in the data transmission is odd number or even number. When it is even, the check byte is "0", otherwise, the check byte is"1". This method is used to stabilize the parity of the data.

The definition of odd checkout: add an odd check bit before the data transmission to illustrate the number of "1" in the data transmission is odd number or even number. When it is odd, the check byte is "0", otherwise, the check byte is"1". This method is used to stabilize the parity of the data.

For example, when transmitting "11001110", there are five "1" in the data. If the even checkout is applied, the even check bit is "1"; if the odd checkout is applied; the odd check bit is "0". The even and odd check bit is calculated on the check bit position of the frame. And the receiving devices also carry out even and odd checkout. If the parity of the receiving data is different from the setting value, there is an error in the communication.

CRC check

The checkout uses RTU frame format. The frame includes the frame error detection field which is based on the CRC calculation method. The CRC field is two bytes, including 16 figure binary values. It is added into the frame after calculated by transmitting device. The receiving device recalculates the CRC of the received frame and compares them with the value in the received CRC field. If the two CRC values are different, there is an error in the communication.

During CRC, 0*FFFF will be stored. And then, deal with the continuous 6-above bytes in the frame and the value in the register. Only the 8Bit data in every character is effective to CRC, while the start bit, the end and the odd and even check bit is ineffective.

The calculation of CRC applies the international standard CRC checkout principles. When the user is editing CRC calculation, he can refer to the relative standard CRC calculation to write the required CRC calculation program.

Here provided a simple function of CRC calculation for the reference (programmed with C language):

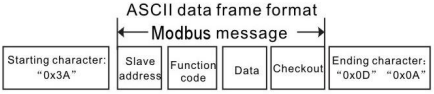
```
unsigned int crc_cal_value(unsigned char *data_value,unsigned char data_length)
{
int i;
unsigned int crc_value=0xffff;
while(data_length--)
{    crc_value^=*data_value++;
                    for(i=0;i<8;i++)
                    {
if(crc_value&0x0001)crc_value=(crc_value>>1)^0xa001;
                    else crc_value=crc_value>>1;
                    }        }
return(crc_value);
}
```

In ladder logic, CKSM calculated the CRC value according to the frame with the table inquiry. The method is advanced with easy program and quick calculation speed. But the ROM space the program occupied is huge. So use it with caution according to the program required space.

7.2.3 ASCII mode

<table>
<tr><th>Name</th><th>Definition</th></tr>
<tr><td>Coding system</td><td>Communication protocol belongs to hexadecimal system. The meaning of message character in ASCII: “0”…“9”, “A”…”F”, each hex is represented by the ASCII message corresponds to the character.
<table>
<tr><td>Character</td><td>‘0’</td><td>‘1’</td><td>‘2’</td><td>‘3’</td><td>‘4’</td><td>‘5’</td><td>‘6’</td><td>‘7’</td></tr>
<tr><td>ASCII CODE</td><td>0x30</td><td>0x31</td><td>0x32</td><td>0x33</td><td>0x34</td><td>0x35</td><td>0x36</td><td>0x37</td></tr>
<tr><td>Character</td><td>‘8’</td><td>‘9’</td><td>‘A’</td><td>‘B’</td><td>‘C’</td><td>‘D’</td><td>‘E’</td><td>‘F’</td></tr>
<tr><td>ASCII CODE</td><td>0x38</td><td>0x39</td><td>0x41</td><td>0x42</td><td>0x43</td><td>0x44</td><td>0x45</td><td>0x46</td></tr>
</table></td></tr>
<tr><td>Data format</td><td>Starting bit, 7/8 data bit, check bit and stop bit. The data formats are listed as below:
11-bit character frame:
<table>
<tr><td>Starting bit</td><td>BIT1</td><td>BIT2</td><td>BIT3</td><td>BIT4</td><td>BIT5</td><td>BIT6</td><td>BIT7</td><td>BIT8</td><td>Check bit</td><td>Stop bit</td></tr>
</table>10-bit character frame:
<table>
<tr><td>Starting bit</td><td>BIT1</td><td>BIT2</td><td>BIT3</td><td>BIT4</td><td>BIT5</td><td>BIT6</td><td>BIT7</td><td>Check bit</td><td>Stop bit</td></tr>
</table></td></tr>
</table>

In ASCII mode, the frame header is “:” (“0*3A”), frame end is “CRLF” (“0*0D” “0*0A”) by default. In ASCII mode, all the data bytes, except for the frame header and frame end, are transmitted in ASCII code mode, in which four high bit groups will be sent out first and then, four low bit groups will be sent out. In ASCII mode, the data length is 8 bit. As for ‘A’~’F’, its capital letters is adopted for ASCII code. The data now adopts LRC checkout which covers slave address to data information. The checksum equals to the complement of the character sum of all the participated checkout data.



Standard structure of ASCII frame:

START	‘:’ (0x3A)
Address Hi	Communication address:
Address Lo	8-bit address is formed by the combination of two ASCII codes
Function Hi	Function code:
Function Lo	8-bit address is formed by the combination of two ASCII codes
DATA（N-1） … DATA（0）	Data content: nx8-bit data content is formed by combination of 2n (n≤16) ASCII codes
LRC CHK Hi	LRC check code:
LRC CHK Lo	8-bit check code is formed by the combination of two ASCII codes.
END Hi	End character:

END Lo	END Hi=CR (0x0D), END Lo=LF (0x0A)

7.2.3.1 ASCII mode check (LRC Check)

Check code (LRC Check) is the value combined of address and data content result. For instance, the check code of above 2.2.2 communication message is: 0x02+0x06+0x00+0x08+0x13+0x88=0xAB, then take the compliment of 2=0x55. Below is a simple LRC calculation function for user reference (programed with C language):

```
Static unsigned char
LRC(auchMsg,usDataLen)
unsigned char *auchMsg;
unsigned short usDataLen;
{
unsigned char uchLRC=0;
while(usDataLen--)
uchLRC+=*auchMsg++;
return((unsigned char)(~((char)uchLRC)));
}
```

7.3 Command code and communication data illustration

7.3.1 RTU mode

7.3.1.1 Command code:03H

03H（correspond to binary 0000 0011）,read N words（Word）(the Max. continuous reading is 16 words)

Command code 03H means that if the master read data from the inverter, the reading number depends on the “data number” in the command code. The Max. Continuous reading number is 16 and the parameter address should be continuous. The byte length of every data is 2 (one word). The following command format is illustrated by hex (a number with “H” means hex) and one hex occupies one byte.

The command code is used to read the working stage of the inverter.

For example, read continuous 2 data content from0004H from the inverter with the address of 01H (read the content of data address of 0004H and 0005H), the frame structure is as below:

RTU master command message (from the master to the inverter)

START	T1-T2-T3-T4
ADDR	01H
CMD	03H
High bit of the start address	00H
Low bit of the start address	04H
High bit of data number	00H
Low bit of data number	02H
CRC low bit	85H
CRC high bit	CAH
END	T1-T2-T3-T4

T1-T2-T3-T4 between START and END is to provide at least the time of 3.5 bytes as the leisure time and

distinguish two messages for the avoidance of taking two messages as one message.

ADDR = 01H means the command message is sent to the inverter with the address of 01H and ADDR occupies one byte

CMD=03H means the command message is sent to read data from the inverter and CMD occupies one byte

"Start address" means reading data from the address and it occupies 2 bytes with the fact that the high bit is in the front and the low bit is in the behind.

"Data number" means the reading data number with the unit of word. If the "start address' is 0004H and the "data number" is 0002H, the data of 0004H and 0005H will be read.

CRC occupies 2 bytes with the fact that the high bit is in the front and the low bit is in the behind.

RTU slave response message (from the inverter to the master)

START	T1-T2-T3-T4
ADDR	01H
CMD	03H
Byte number	04H
Data high bit of address 0004H	13H
Data low bit of address 0004H	88H
Data high bit of address 0005H	00H
Data low bit of address 0005H	00H
CRC CHK low bit	7EH
CRC CHK high bit	9DH
END	T1-T2-T3-T4

The meaning of the response is that:

ADDR = 01H means the command message is sent to the inverter with the address of 01H and ADDR occupies one byte

CMD=03H means the message is received from the inverter to the master for the response of reading command and CMD occupies one byte

"Byte number" means all byte number from the byte(excluding the byte) to CRC byte(excluding the byte). 04 means there are 4 byte of data from the "byte number" to "CRC CHK low bit", which are "digital address 0004H high bit", "digital address 0004H low bit", "digital address 0005H high bit" and "digital address 0005H low bit".

There are 2 bytes stored in one data with the fact that the high bit is in the front and the low bit is in the behind of the message, the data of data address 0004H is 1388H,and the data of data address 0005H is 0000H.

CRC occupies 2 bytes with the fact that the high bit is in the front and the low bit is in the behind.

7.3.1.2 Command code:06H

06H(correspond to binary 0000 0110), write one word(Word)

The command means that the master write data to the inverter and one command can write one data other than multiple dates. The effect is to change the working mode of the inverter.

For example, write 5000 (1388H) to 0004H from the inverter with the address of 02H, the frame structure is as below:

RTU master command message (from the master to the inverter)

START	T1-T2-T3-T4
ADDR	02H
CMD	06H
High bit of writing data address	00H
Low bit of writing data address	04H
High bit of data content	13H
Low bit of data content	88H
CRC CHK low bit	C5H
CRC CHK high bit	6EH
END	T1-T2-T3-T4

RTU slave response message (from the inverter to the master)

START	T1-T2-T3-T4
ADDR	02H
CMD	06H
High bit of writing data address	00H
Low bit of writing data address	04H
High bit of data content	13H
Low bit of data content	88H
CRC CHK low bit	C5H
CRC CHK high bit	6EH
END	T1-T2-T3-T4

Note: section 10.2 and 10.3 mainly describe the command format, and the detailed application will be mentioned in 10.8 with examples.

7.3.1.3 Command code 08H for diagnosis

Meaning of sub-function codes

Sub-function Code	Description
0000	Return to inquire information data

For example: The inquiry information string is same as the response information string when the loop detection to address 01H of driver is carried out.

The RTU request command is:

START	T1-T2-T3-T4
ADDR	01H
CMD	08H
High bit of sub-function code	00H
Low bit of sub-function code	00H
High bit of data content	12H
Low bit of data content	ABH
CRC CHK low bit	ADH

CRC CHK high bit	14H
END	T1-T2-T3-T4

The RTU response command is:

START	T1-T2-T3-T4
ADDR	01H
CMD	08H
High bit of sub-function code	00H
Low bit of sub-function code	00H
High bit of data content	12H
Low bit of data content	ABH
CRC CHK low bit	ADH
CRC CHK high bit	14H
END	T1-T2-T3-T4

7.3.1.4 Command code: 10H, continuous writing

Command code 10H means that if the master writes data to the inverter, the data number depends on the "data number" in the command code. The Max. continuous reading number is 16.

For example, write 5000(1388H) to 0004H of the inverter whose slave address is 02H and 50(0032H) to 0005H, the frame structure is as below:

The RTU request command is:

START	T1-T2-T3-T4 (transmission time of 3.5 bytes)
ADDR	02H
CMD	10H
High bit of write data	00H
Low bit of write data	04H
High bit of data number	00H
Low bit of data number	02H
Byte number	04H
High bit of data 0004H	13H
Low bit of data 0004H	88H
High bit of data 0005H	00H
Low bit of data 0005H	32H
Low bit of CRC	C5H
High bit of CRC	6EH
END	T1-T2-T3-T4 (transmission time of 3.5 bytes)

The RTU response command is:

START	T1-T2-T3-T4 (transmission time of 3.5 bytes)
ADDR	02H

CMD	10H
High bit of write data	00H
Low bit of write data	04H
High bit of data number	00H
Low bit of data number	02H
Low bit of CRC	C5H
High bit of CRC	6EH
END	T1-T2-T3-T4 (transmission time of 3.5 bytes)

7.3.2 ASCII mode

7.3.2.1Command code: 03H (0000 0011), read N words (Word) (max. number for continuous reading is 16 words)

For instance: As for the inverter whose slave address is 01H, the starting address of internal storage is 0004, read two words continuously, the structure of this frame is listed as below:

ASCII master command message (the command sent from the master to the inverter		ASCII slave response message (the message sent from the inverter to the master)	
START	':'	START	':'
ADDR	'0'	ADDR	'0'
	'1'		'1'
CMD	'0'	CMD	'0'
	'3'		'3'
High bit of starting address	'0'	Byte number	'0'
	'0'		'4'
Low bit of starting address	'0'	High bit of data address 0004H	'1'
	'4'		'3'
High bit of data number	'0'	Low bit of data address 0004H	'8'
	'0'		'8'
Low bit of data number	'0'	High bit of data address 0005H	'0'
	'2'		'0'
LRC CHK Hi	'F'	Low bit of data address 0005H	'0'
LRC CHK Lo	'6'		'0'
END Hi	CR	LRC CHK Hi	'5'
END Lo	LF	LRC CHK Lo	'D'
		END Hi	CR
		END Lo	LF

7.3.2.2 Command code: 06H (0000 0110), write one word (Word)

For instance: Write 5000 (1388H) to the 0004H address of the inverter whose slave address is 02H, then the structure of this frame is listed as below:

ASCII master command message (the command sent by the master to the inverter)		ASCII slave response message (the message sent by the inverter to the master)	
START	':'	START	':'
ADDR	'0'	ADDR	'0'
	'2'		'2'
CMD	'0'	CMD	'0'
	'6'		'6'
High bit of write data	'0'	High bit of write data	'0'
	'0'		'0'
Low bit of write data	'0'	Low bit of write data	'0'
	'4'		'4'
High bit of data content	'1'	High bit of data content	'1'
	'3'		'3'
Low bit of data content	'8'	Low bit of data content	'8'
	'8'		'8'
LRC CHK Hi	'5'	LRC CHK Hi	'5'
LRC CHK Lo	'9'	LRC CHK Lo	'9'
END Hi	CR	END Hi	CR
END Lo	LF	END Lo	LF

7.3.2.3 Command code: 08H (0000 1000), diagnose function

Meaning of sub function code:

Sub function code	Instruction
0000	Return inquiry message data

For instance: carry out circuit detection on drive address 01H, the content of inquiry message word string is the same with response message word string, its format is listed as below:

ASCII master command message (the command sent by the master to the inverter)		ASCII slave response message (the message sent by the inverter to the master)	
START	':'	START	':'
ADDR	'0'	ADDR	'0'
	'1'		'1'
CMD	'0'	CMD	'0'
	'8'		'8'
High bit of write data address	'0'	High bit of write data address	'0'
	'0'		'0'
Low bit of write data address	'0'	Low bit of write data address	'0'
	'0'		'0'
High bit of data content	'1'	High bit of data content	'1'
	'2'		'2'

ASCII master command message (the command sent by the master to the inverter)		ASCII slave response message (the message sent by the inverter to the master)	
Low bit of data content	‘A’	Low bit of data content	‘A’
	‘B’		‘B’
LRC CHK Hi	‘3’	LRC CHK Hi	‘3’
LRC CHK Lo	‘A’	LRC CHK Lo	‘A’
END Hi	CR	END Hi	CR
END Lo	LF	END Lo	LF

7.3.2.4 Command code: 10H, continuous writing function

Command code 10H means the master write data to the inverter, the number of data being written is determined by the command “data number”, the max. number of continuous writing is 16 words.

For instance: Write 5000 (1388H) to 0004H of the inverter whose slave address is 02H, write 50 (0032H) to 0005H of the inverter whose slave address is 02H, then the structure of this frame is listed as below:

ASCII master command message (the command sent by the master to the inverter)		ASCII slave response message (the message sent by the inverter to the master)	
START	‘:’	START	‘:’
ADDR	‘0’	ADDR	‘0’
	‘2’		‘2’
CMD	‘1’	CMD	‘1’
	‘0’		‘0’
High bit of starting address	‘0’	High bit of starting address	‘0’
	‘0’		‘0’
Low bit of starting address	‘0’	Low bit of starting address	‘0’
	‘4’		‘4’
High bit of data number	‘0’	High bit of data number	‘0’
	‘0’		‘0’
Low bit of data number	‘0’	Low bit of data number	‘0’
	‘2’		‘2’
Byte number	‘0’	LRC CHK Hi	‘E’
	‘4’	LRC CHK Lo	‘8’
High bit of data 0004H content	‘1’	END Hi	CR
	‘3’	END Lo	LF
Low bit of data 0004H content	‘8’		
	‘8’		
High bit of data 0005H content	‘0’		
	‘0’		
Low bit of data 0005H content	‘3’		
	‘2’		

ASCII master command message (the command sent by the master to the inverter)		ASCII slave response message (the message sent by the inverter to the master)	
LRC CHK Hi	'1'		
LRC CHK Lo	'7'		
END Hi	CR		
END Lo	LF		

7.4 The definition of data address

The address definition of the communication data in this part is to control the running of the inverter and get the state information and relative function parameters of the inverter.

7.4.1 The rules of parameter address of the function codes

The parameter address occupies 2 bytes with the fact that the high bit is in the front and the low bit is in the behind. The range of high and low byte are: high byte—00~ffH; low byte—00~ffH. The high byte is the group number before the radix point of the function code and the low byte is the number after the radix point. But both the high byte and the low byte should be changed into hex. For example P05.05, the group number before the radix point of the function code is 05, then the high bit of the parameter is 05, the number after the radix point 05, then the low bit of the parameter is 05, then t he function code address is 0505H and the parameter address of P10.01 is 0A01H.

Function code	Name	Detailed instruction of parameters	Setting range	Default value	Modify	Serial No.
P10.00	Simple PLC	0: Stop after running once 1: Run at the final value after running once 2: Cycle running	0~2	0	○	354
P10.01	Simple PLC memory	0: Power loss without memory 1: Power loss memory	0~1	0	○	355

Note: P29 group is the factory parameter which can not be read or changed. Some parameters can not be changed when the inverter is in the running state and some parameters can not be changed in any state. The setting range, unit and relative instructions should be paid attention to when modifying the function code parameters.

Besides, EEPROM is stocked frequently, which may shorten the usage time of EEPROM. For users, some functions are not necessary to be stocked on the communication mode. The needs can be met on by changing the value in RAM. Changing the high bit of the function code form 0 to 1 can also realize the function. For example, the function code P00.07 is not stocked into EEPROM. Only by changing the value in RAM can set the address to 8007H. This address can only be used in writing RAM other than reading. If it is used to read, it is an invalid address.

7.4.2 The address instruction of other function in Modbus

The master can operate on the parameters of the inverter as well as control the inverter, such as running or stopping and monitoring the working state of the inverter.

Below is the parameter list of other functions

Function instruction	Address definition	Data meaning instruction	R/W characteristics
Communication control command	2000H	0001H:forward running	W
		0002H:reverse running	
		0003H:forward jogging	
		0004H:reverse jogging	
		0005H:stop	
		0006H:coast to stop (emergency stop)	
		0007H:fault reset	
		0008H:jogging stop	
The address of the communication n setting value	2001H	Communication setting frequency(0~Fmax(unit: 0.01Hz))	W
	2002H	PID reference, range(0~1000, 1000 corresponds to100.0%)	
	2003H	PID feedback, range(0~1000, 1000 corresponds to100.0%)	W
	2004H	Torque setting value (-3000~3000, 1000 corresponds to the 100.0% of the rated current of the motor)	W
	2005H	The upper limit frequency setting during forward rotation(0~Fmax(unit: 0.01Hz))	W
	2006H	The upper limit frequency setting during reverse rotation(0~Fmax(unit: 0.01Hz))	W
	2007H	The upper limit torque of electromotion torque (0~3000, 1000 corresponds to the 100.0% of the rated current of the motor)	W
	2008H	The upper limit torque of braking torque (0~3000, 1000 corresponds to the 100.0% of the rated current of the motor)	W
	2009H	Special control command word Bit0~1:=00:motor 1 =01:motor 2 =10:motor 3 =11:motor 4 Bit2:=1 torque control prohibit =0: torque control prohibit invalid Bit3: =1 power consumption clear =0: no power consumption clear Bit4: =1 pre-exciting =0: pre-exciting prohibition Bit5: =1 DC braking =0: DC braking prohibition	W
	200AH	Virtual input terminal command , range:	W

Function instruction	Address definition	Data meaning instruction	R/W characteristics
		0x000~0x1FF	
	200BH	Virtual input terminal command , range: 0x00~0x0F	W
	200CH	Voltage setting value(special for V/F separation) (0~1000, 1000 corresponds to the 100.0% of the rated voltage of the motor)	W
	200DH	AO output setting 1 (-1000~1000, 1000 corresponds to 100.0%)	W
	200EH	AO output setting 2 (-1000~1000, 1000 corresponds to 100.0%)	W
SW 1 of the inverter	2100H	0001H:forward running	R
		0002H:forward running	
		0003H:stop	
		0004H:fault	
		0005H: POFF state	
		0006H: pre-exciting state	
SW 1 of the inverter	2101H	Bit0: =0:bus voltage is not established =1:bus voltage is established Bi1~2:=00:motor 1 =01:motor 2 =10:motor 3 =11:motor 4 Bit3: =0:asynchronous motor =1:synchronous motor Bit4:=0:pre-alarm without overload =1:overload pre-alarm Bit5~ Bit6:=00: keypad control =01:terminal control =10:communication control	R
Fault code of the inverter	2102H	See the fault type instruction	R
Identifying code of the inverter	2103H	GD20-----0x0106	R
Operation frequency	3000H	Range: 0.00Hz~P00.03	R
Setting frequency	3001H	Range: 0.00Hz~P00.03	R
Bus voltage	3002H	Range: 0~2000V	R
Output voltage	3003H	Range: 0~1200V	R
Output current	3004H	Range: 0.0~3000.0A	R
Operation speed	3005H	Range: 0~65535RPM	R

Function instruction	Address definition	Data meaning instruction	R/W characteristics
Output power	3006H	Range: -300.0~300.0%	R
Output torque	3007H	Range: -250.0~250.0%	R
Close loop setting	3008H	Range: -100.0%~100.0%	R
Close loop feedback	3009H	Range: -100.0%~100.0%	R
PID setting	3008H	-100.0~100.0% (unit: 0.1%)	R
PID feedback	3009H	-100.0~100.0% (unit: 0.1%)	R
Input IO	300AH	000~1FF	
Input IO	300BH	000~1FF	
AI 1	300CH	Range: 0.00~10.00V	R
AI 2	300DH	Range: 0.00~10.00V	R
AI 3	300EH	Range: 0.00~10.00V	R
AI 4	300FH	Range: -10.00~10.00V	R
Read high speed pulse 1 input	3010H	Range: 0.00~50.00kHz	R
Read high speed pulse 2 input	3011H	Reserved	R
Read current step of the multi-step speed	3012H	Range: 0~15	R
External length	3013H	Range: 0~65535	R
External counting value	3014H	Range: 0~65535	R
Torque setting	3015H	-300.0~300.0%(Unit: 0.1%)	R
Inverter code	3016H		R
Fault code	5000H		R

R/W characteristics means the function is with read and write characteristics. For example, “communication control command” is writing chrematistics and control the inverter with writing command (06H). R characteristic can only read other than write and W characteristic can only write other than read.

Note: when operating on the inverter with the table above, it is necessary to enable some parameters. For example, the operation of running and stopping, it is necessary to set P00.01 to communication running command channel and set P00.02 to MODBUS communication channel. And when operate on “PID given”, it is necessary to set P09.00 to “MODBUS communication setting”.

The encoding rules for device codes (corresponds to identifying code 2103H of the inverter)

Code high 8bit	Meaning	Code low 8 position	Meaning
01	Goodrive	06	Goodrive20 Vector Inverter

Note: the code is consisted of 16 bit which is high 8 bits and low 8 bits. High 8 bits mean the motor type series and low 8 bits mean the derived motor types of the series. For example, 0110H means Goodrive20 vector inverters.

7.4.3 Fieldbus ratio values

The communication data is expressed by hex in actual application and there is no radix point in hex. For example, 50.12Hz can not be expressed by hex so 50.12 can be magnified by 100 times into 5012, so hex 1394H can be used to express 50.12.

A non-integer can be timed by a multiple to get an integer and the integer can be called fieldbus ratio values. The fieldbus ratio values are referred to the radix point of the setting range or default value in the function parameter list. If there are figures behind the radix point (n=1), then the fieldbus ratio value m is 10^n. Take the table as the example:

Function code	Name	Detailed instruction of parameters	Setting range	Default value	Modify	Serial No.
P01.20	Hibernation restore delay time	0.0~3600.0s (valid when P01.19=2)	0.0~3600.0	0.0s	○	39
P01.21	Restart after power off	0: Disable 1: Enable	0~1	0	○	40

If there is one figure behind the radix point in the setting range or the default value, then the fieldbus ratio value is 10. if the data received by the upper monitor is 50, then the “hibernation restore delay time” is 5.0 (5.0=50÷10).

If Modbus communication is used to control the hibernation restore delay time as 5.0s. Firstly, 5.0 can be magnified by 10 times to integer 50 (32H) and then this data can be sent.

01	06	01 14	00 32	49 E7
inverter address	read command	parameters address	data number	CRC check

After the inverter receives the command, it will change 50 into 5 according to the fieldbus ratio value and then set the hibernation restore delay time as 5s.

Another example, after the upper monitor sends the command of reading the parameter of hibernation restore delay time ,if the response message of the inverter is as following:

01	03	02	00 32	39 91
inverter address	read command	2 bytes data	parameter data	CRC check

Because the parameter data is 0032H (50) and 50 divided by 10 is 5, then the hibernation restore delay time is 5s.

7.4.4 Fault message response

There may be fault in the communication control. For example, some parameter can only be read. If a writing message is sent, the inverter will return a fault response message.

The fault message is from the inverter to the master, its code and meaning is as below:

Code	Name	Meaning
01H	Illegal command	The command from master can not be executed. The reason maybe: 1. This command is only for new version and this version can not realize. 2. Slave is in fault state and can not execute it.
02H	Illegal data address.	Some of the operation addresses are invalid or not allowed to access. Especially the combination of the register and the transmitting bytes are invalid.
03H	Illegal value	When there are invalid data in the message framed received by slave. **Note:** This error code does not indicate the data value to write exceed the range, but indicate the message frame is an illegal frame.
04H	Operation failed	The parameter setting in parameter writing is invalid. For example, the function input terminal can not be set repeatedly.
05H	Password error	The password written to the password check address is not same as the password set by P7.00.
06H	Data frame error	In the frame message sent by the upper monitor, the length of the digital frame is incorrect or the counting of CRC check bit in RTU is different from the lower monitor.
07H	Written not allowed.	It only happen in write command, the reason maybe: 1. The written data exceeds the parameter range. 2. The parameter should not be modified now. 3. The terminal has already been used.
08H	The parameter can not be modified during running	The modified parameter in the writing of the upper monitor can not be modified during running.
09H	Password protection	When the upper monitor is writing or reading and the user password is set without password unlocking, it will report that the system is locked.

The slave uses functional code fields and fault addresses to indicate it is a normal response or some error occurs (named as objection response). For normal responses, the slave shows corresponding function codes, digital address or sub-function codes as the response. For objection responses, the slave returns a code which equals the normal code, but the first byte is logic 1.

For example: when the master sends a message to the slave, requiring it to read a group of address data of the inverter function codes, there will be following function codes:

0 0 0 0 0 0 1 1 (Hex 03H)

For normal responses, the slave responds the same codes, while for objection responses, it will return:

1 0 0 0 0 0 1 1 (Hex 83H)

Besides the function codes modification for the objection fault, the slave will respond a byte of abnormal code which defines the error reason.

When the master receives the response for the objection, in a typical processing, it will send the message again or modify the corresponding order.

For example, set the “running command channel” of the inverter (P00.01, parameter address is 0001H) with the address of 01H to 03, the command is as following:

01	06	00 01	00 03	98 0B
inverter address	read command	parameter address	parameter data	CRC check

But the setting range of “running command channel” is 0~2, if it is set to 3, because the number is beyond the range, the inverter will return fault response message as below:

01	86	04	43 A3
inverter address	abnormal response code	fault code	CRC check

Abnormal response code 86H means the abnormal response to writing command 06H; the fault code is 04H. In the table above, its name is operation failed and its meaning is that the parameter setting in parameter writing is invalid. For example, the function input terminal can not be set repeatedly.

7.5 Example of writing and reading

Refer to section 7.3 for the command format.

7.5.1 Example of reading command 03H

Example 1: read the state word 1 of the inverter with the address of 01H (refer to table 1). From the table 1, the parameter address of the state word 1 of the inverter is 2100H.

RTU mode:

The command sent to the inverter:

01	03	21 00	00 01	8E 36
Inverter address	Read command	Parameters address	Data number	CRC check

If the response message is as below:

01	03	02	00 03	F8 45
Inverter address	Read command	Data address	Data content	CRC check

ASCII mode:

The command sent to the inverter:

:	01	03	21 00	00 01	DA	CR LF
START	Inverter address	Read command	Parameters address	Data number	LRC check	END

If the response message is as below:

:	01	03	02	00 03	F7	CR LF
START	Inverter address	Read command	Byte number	Data content	LRC check	END

The data content is 0003H. From the table 1, the inverter stops.

7.5.2 Example of writing command 06H

Example 1: make the inverter with the address of 03H to run forward. See table 1, the address of "communication control command" is 2000H and forward running is 0001. See the table below.

Function instruction	Address definition	Data meaning instruction	R/W characteristics
Communication control command	2000H	0001H:forward running	W/R
		0002H:reverse running	
		0003H:forward jogging	
		0004H:reverse jogging	
		0005H:stop	
		0006H:coast to stop (emergency stop)	
		0007H:fault reset	
		0008H:jogging stop	

RTU mode:

The command sent by the master:

03	06	20 00	00 01	42 28
Inverter address	Write command	Parameters address	Forward running	CRC check

If the operation is successful, the response may be as below (the same with the command sent by the master):

03	06	20 00	00 01	42 28
Inverter address	Write command	Parameters address	Forward running	CRC check

ASCII mode:

The command sent to the inverter:

:	01	06	20 00	00 01	D6	CR LF
START	Inverter address	Write command	Parameters address	Data number	LRC check	END

If the response message is as below:

:	01	06	20 00	00 01	D6	CR LF
START	Inverter address	Write command	Parameters address	Data number	LRC check	END

Example 2: set the Max. Output frequency of the inverter with the address of 03H as100Hz.

Function code	Name	Detailed instruction of parameters	Setting range	Default value	Modify	Serial No.
P00.03	Max. output frequency	P00.04~600.00Hz (400.00Hz)	10.00~600.00	50.00Hz	◎	3.

See the figures behind the radix point, the fieldbus ratio value of the Max. output frequency (P00.03) is 100. 100Hz timed by 100 is 10000 and the corresponding hex is 2710H.

RTU mode:

The command sent by the master:

03	06	00 03	27 10	62 14
Inverter address	Write command	Parameters address	Forward running	CRC check

If the operation is successful, the response may be as below (the same with the command sent by the master):

03	06	00 03	27 10	62 14
Inverter address	Write command	Parameters address	Forward running	CRC check

ASCII mode:

The command sent to the inverter:

:	03	06	00 03	27 10	BD	CR LF
START	Inverter address	Write command	Parameters address	Data number	LRC check	END

If the response message is as below:

:	03	06	00 03	27 10	BD	CR LF
START	Inverter address	Write command	Parameters address	Data number	LRC check	END

7.5.3 Example of continous writing command10H

Example 1: make the inverter whose address is 01H run forward at 10Hz. Refer to the instruction of 2000H and 0001. Set the address of “communication setting frequency” is 2001H and 10Hz corresponds to 03E8H. See the table below.

Function instruction	Address definition	Data meaning instruction	R/W characteristics
Communication control command	2000H	0001H:forward running	W/R
		0002H:reverse running	
		0003H:forward jogging	
		0004H:reverse jogging	
		0005H:stop	
		0006H:coast to stop (emergency stop)	
		0007H:fault reset	
		0008H:jogging stop	
The address of communication setting	2001H	Communication setting frequency(0~Fmax(unit: 0.01Hz))	W/R
	2002H	PID given, range(0~1000, 1000 corresponds to100.0%)	

RTU mode:

The command sent to the inverter:

01	10	20 00	00 02	04	00 01	03 E8	3B 10
Inverter address	Continuous writing command	Parameters address	Data number	Byte number	Forward running	10Hz	CRC check

If the response message is as below:

01	10	20 00	00 02	4A 08
Inverter address	Continuous writing command	Parameters address	Data number	CRC check

ASCII mode:

The command sent to the inverter:

:	01	10	20 00	00 02	04	00 01	03 E8	BD	CR LF
START	Inverter address	Continuous writing command	Parameters address	Data number	Byte number	Forward running	10Hz	LRC check	END

If the response message is as below:

:	01	10	20 00	00 02	CD	CR LF
START	Inverter address	Continuous writing command	Parameters address	Data number	LRC check	END

Example 2: set the ACC time of 01H inverter as 10s and the DEC time as 20s

P00.11	ACC time 1	Setting range of P00.11 and P00.12:	Depend on model	○
P00.12	DEC time 1	0.0~3600.0s	Depend on model	○

The corresponding address of P00.11 is 000B, the ACC time of 10s corresponds to 0064H, and the DEC time of 20s corresponds to 00C8H.

RTU mode:

The command sent to the inverter:

01	10	00 0B	00 02	04	00 64	00 C8	F2 55
Inverter address	Continuous writing command	Parameters address	Data number	Byte number	10s	20s	CRC check

If the response message is as below:

01	10	00 0B	00 02	30 0A
Inverter address	Continuous writing command	Parameters address	Data number	CRC check

ASCII mode:

The command sent to the inverter:

:	01	10	00 0B	00 02	04	00 64	00 C8	B2	CR LF
START	Inverter address	Continuous writing command	Parameters address	Data number	10s	20s		LRC check	END

If the response message is as below:

:	01	10	00 0B	00 02	E2	CR LF
START	Inverter address	Continuous writing command	Parameters address	Data number	LRC check	END

Note: the blank in the above command is for illustration. The blank can not be added in the actual application

unless the upper monitor can remove the blank by themselves.

7.6 Common communication fault

Common communication faults: no response to the communication or the inverter returns abnormal fault.

The possible reason for no response to the communication:

Selecting wrong serial interface, for example, if the converter is COM1, selecting COM2 during the communication

The baud rate, digital bit, end bit and check bit are not the same with the inverter + and - of RS485 are connected in reverse.

The 485 wire cap on the terminal board of the inverter is not plug in. the wire cap in behind the terminal arrangement.