CHV Series Vector Control Inverter Options

Operating Instructions for Communication Card

(Attachment: Modbus Communication Protocol)

1. Model and Specifications

1.1 Model Description

The model of CHV inverter communication card is PN000TXWX, which provides serial ports for remote communications of CHV series inverters. The communication card provides two physical communication modes (RS232 and RS485) for users.

1.2 Schematic Diagram of Appearance

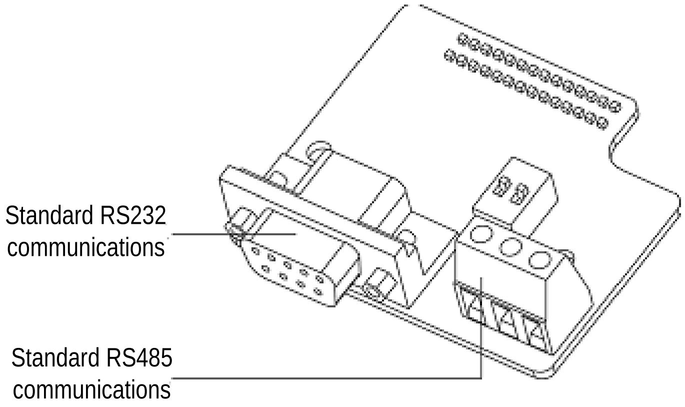


Figure 1.1 Diagram of Communication Card.

1.3 Schematic Diagram of Installation

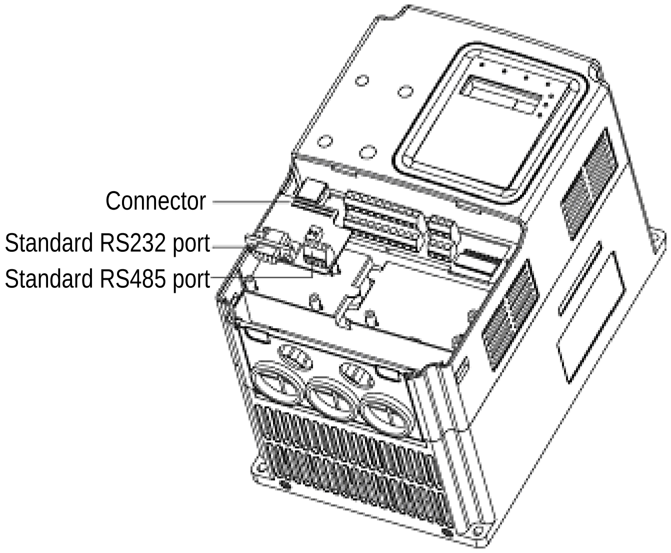


Figure 1.2 Installation of Communication Card.

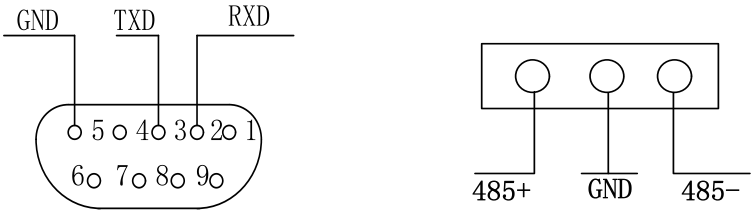
2. Operational Instructions

2.1 Functions

If need to use CHV inverters and upper computer (PLC, industrial PC), the user must choose this communication card. It provides two physical communication modes (RS232 and RS485). The electric parameters can meet the related international standards completely and can implement smooth communications between CHV inverter and upper computer system. Please choose the corresponding physical channel according to the actual applications.

2.2 Wiring Terminals

The communication card has two groups of wiring terminals, as shown in Figure 2.1.



D9: Bus-connector wiring terminal

RS485 wiring terminal

Figure 2.1 Wiring Terminals.

2.3. Precautions of Wiring

- Please install this card after the inverter is completely powered off.
- Please make perfect connection between the communication card and the extension slot of control card.
- Use screws to fix the communication card.
- To prevent communication signals from external disturbance, please choose twisted pairs as communication line, and try to avoid parallel wiring with the drive power.
- It is better to choose the shielded cable as RS232 communication line.

3. Modbus Communication Protocol of CHV Inverter

CHV series inverter provides RS232/RS485 communication ports, and adopts the standard ModBus communication protocol for master/slave communications. The user can use PC/PLC or upper control computer to implement centralized control (setting control command of inverter, operating frequency, modification of related functional code parameters, working status of inverter and fault message monitoring), to meet special application requirement.

3.1 Protocol Content

The Modbus serial communication protocol defines frame content and using format of asynchronous transmission in serial communications, including: polling and broadcast frame of the master, and reply frame format of the slave. The frame content of the master includes: address (broadcast address) of the slave, execution command, data, error check, and so on. The response of the slave also adopts the same structure, including: action confirmation, data return, error check, and so on. If an error occurs when the slave is receiving a frame or cannot complete the action required by the master, the slave will organize a fault frame and send it to the master as a response message.

3.2 Application Mode

CHV series inverters can be connected with the “single-master multi-slave” control network with RS232/RS485 bus.

3.3 Bus Structure

1)Interface mode

RS232/RS485 hardware interface

2)Transmission mode

Asynchronous serial and half-duplex transmission mode. At the same time, only one of the master and slave sends data, while the other receives data. Data is sent frame by frame in form of packets during asynchronous serial communications.

3)Topology

“Single master multi-slave” system. The setting range of slaves address is 1~247, where “0” is the broadcast communication address. In network, the unique character of each slave address is the basis to ensure ModBus serial communications.

3.4 Protocol Description

The communication protocol of CHV inverters is asynchronous serial master/slave ModBus communication protocol. Only one device (the master) can establish protocol (called “query/command”) over the entire network. Other devices (the slave) can only provide data to make response to the “query/command” of the master or take the corresponding actions according to the “query/command” of the master. Here the master refers to PC, industrial control device or programmable logic controller (PLC), and the slave refers to CHV inverters or other control devices with the same communication protocol. The master can conduct independent communications with slave and can send broadcast messages to all slaves. For the “query/command” of the master who makes independent access, the slave should return a message (called response); for the broadcast messages sent by the master, the slave does not need to make a response to the master.

3.5 Communication Frame Structure

The communication data format of the ModBus protocol of CHV inverter is RTU (Remote Terminal Unit) mode. In the RTU mode, the format of each byte is as follows:

Coding system: Eight-bit binary notation, hexadecimal 0-9, A~F, and each 8-bit frame field includes two hexadecimal characters.

Byte bit: includes start bits, eight data bits, parity check bits and stop bits.

The description of the byte bits is as follows:

Start bit	Bit 1	Bit 2	Bit 3	Bit 4	Bit 5	Bit 6	Bit 7	Bit 8	1. Odd parity check bit 2. Even parity check bit 3. No parity check bit	Stop bit

In RTU mode, new frames always have the transmission hold time of at least 3.5 bytes, as the start. Over a network using baud rate to calculate the transmission rate, the transmission time of 3.5 bytes can be controlled easily. The subsequently transmitted data fields are in turn: slave address, operation command code, data and CRC check word. The transmission bytes of each field are 0…9, A…F in hexadecimal notation. The network device monitors the activities of the communication bus all the time, even during the silent delay interval. When receiving the first field (address message), each network device will confirm the byte. After the completion of the transmission of the last byte, another transmission time interval similar to that of 3.5 bytes is used to indicate the end of the frame. After that, the transmission f a new frame starts.

The information of a frame should be transmitted in consecutive data streams. If there is an interval over 1.5 bytes before completion of the entire frame transmission, the receiving device will clear the incomplete information, and mistake the last byte to be the address field part of new frame. Likewise, if the interval between the start of a new frame and the previous frame is less than 3.5 bytes, the receiving device will regard it as the subsequent part of the previous frame. Due to frame disorder, the final CRC value is incorrect, which will lead to communication failure.

Standard Structure of RTU Frame:

Frame header (START)	T1-T2-T3-T4 (transmission time of 3.5 bytes)
Slave address field (ADDR)	Communication address: 0~247 (decimal) ("0" stands for the broadcast address)

Function field (CMD)	03H: Read slave parameters;
	06H: Write slave parameters;

Data field DATA (N-1) DATA (0)	Data of 2*N bytes: this part is the main content of communications, and is also the data exchange core in communications.
CRC CHK lower bit	Detection value: CRC value (16BIT).
CRC CHK higher bit	
Frame tail (END)	T1-T2-T3-T4 (transmission time of 3.5 bytes)

3.6 Command Codes and Communication Data

1. Command Code: 03H (0000 0011), read N words (can ready a maximum of consecutive five words)

For example: for an inverter with the slave address of 01H, the start address of memory is 0004, read two words consecutively, the structure of the frame is as follows:

Command Message of the Master

START	T1-T2-T3-T4 (transmission time of 3.5 bytes)
ADDR	01H
CMD	03H
Higher bits of start address	00H
Lower bits of start address	04H
Higher bits of data number	00H
Lower bits of data number	02H
CRC CHK lower bit	85H
CRC CHK higher bit	CAH
END	T1-T2-T3-T4 (transmission time of 3.5 bytes)

Response Message of the Slave

START	T1-T2-T3-T4 (transmission time of 3.5 bytes)
ADDR	01H
CMD	03H
Higher bits of byte number	00H
Lower bits of byte number	04H
Higher bits of data address 0004H	00H
Lower bits of data address 0004H	00H
Higher bits of data address 0005H	00H
Lower bits of data address 0005H	00H
CRC CHK lower bit	43H

CRC CHK higher bit	07H
END	T1-T2-T3-T4 (transmission time of 3.5 bytes)

2. Command code: 06H (0000 0110), read one word

For example, read 5000 (1388H) into the address 0008H of the inverter with the slave address of 02H, the structure of the frame is as follows:

Command Message of the Master

START	T1-T2-T3-T4 (transmission time of 3.5 bytes)
ADDR	02H
CMD	06H
Write higher bits of the data address	00H
Write lower bits of the data address	08H
Higher bits of data content	13H
Lower bits of data content	88H
CRC CHK lower bit	05H
CRC CHK higher bit	6DH
END	T1-T2-T3-T4 (transmission time of 3.5 bytes)

Response Message of the Slave

START	T1-T2-T3-T4 (transmission time of 3.5 bytes)
ADDR	02H
CMD	06H
Write higher bits of the data address	00H
Write lower bits of the data address	08H
Higher bits of data content	13H
Lower bits of data content	88H
CRC CHK lower bit	05H
CRC CHK higher bit	6DH
END	T1-T2-T3-T4 (transmission time of 3.5 bytes)

3. Communication frame error check

Frame error check includes two parts: byte bit check (odd/even parity check) and entire frame data check (CRC check).

Byte bit check:

The user can select different bit check modes according to the actual needs. The user can also select “no parity”. This will affect the check bit setting of each byte. For details, refer to the relative serial communication description.

Cyclical Redundancy Check (CRC):

Using RTU frame format. The frame includes frame error detection field calculated on the basis of CRC. The CRC field detects the entire content of frame. The CRC field has two bytes, including 16 bits of binary values. It is added to the frame after calculation of the transmission device. The receiving device recalculates the CRC of frame, and compares it with the value in the received CRC field. If the two CRC values are not equal, it indicates a transmission error.

CRC is first stored in 0xFFFF, and then a process is called to process over six consecutive bytes in the frame and the value in the current register. Only the 8-bit data in each character is valid for CRC. The start bit, stop bit and parity check bit are invalid.

During CRC generation, each 8-bit character independently conducts “XOR” with the content of register. The result moves to the least significant bit (LSB) direction, and the most valid bit (MSB) is filled in with 0. LSB is extracted for detection. If LSB is 1, the register independently conducts “XOR” with the preset value; if LSB is 0, the operation will not be conducted. The entire process will be repeated for eight times. After the completion of the last bit (the eight bit), the next 8-bit byte will independently conduct “XOR” with the current value of register. The final value of register is the CRC value after the execution of all bytes in the frame.

The calculation method of CRC adopts the CRC principle with international standard. When editing CRC algorithm, the user can refer to the CRC algorithm in related standard to write a CRC calculation program that really meets requirement.

A simple function for CRC calculation is provided for reference (programmed in 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 calculates the CRC value according to the frame content in tale loop-up method. This method has several features: simple program, fast operation speed, but wider ROM space of program. Please use this method prudently in occasions with certain program space requirement.

4. Definition of Communication Data Address

This part is the definition of communication data address, can be used to control inverter operation, and obtain status information and settings of related functional parameters of the inverter.

1) Functional code parameter expression rule

To use a functional code serial number as a parameter to correspond to the register address, but needs to conversion in hexadecimal notation. For example, the serial number of P5.05 is 82, the address of the functional address in hexadecimal notation is 0052H.

Ranges of higher/lower bytes are respectively: higher-bit bytes: 00~11; lower-bit bytes: 00~FF.

Notice:

PE group: factory setting, do not read or change the parameters in the group. Some parameters should not be changed during operation of the inverter. Some parameters should not be changed no matter in which state the inverter is. To change functional code parameters, pay attention to the setting range, unit and related description of parameters.

In addition, frequency storage of EEPROM may reduce the service life of the EEPROM. For users, some functional codes do not need storage in communication mode, only need to change the value in RAM to meet the user requirement. Changing the highest bit of the corresponding functional code address from 0 to 1 can implement this function. For example, functional code P0.12 is not stored in EEPROM. Modify the value in RAM only can set the address to 800CH. This address can only be used in writing RAM, cannot be used for reading. It will be an invalid address if it is used for reading.

2) Address of other functions:

Function Description	Address Definition	Data Meaning	R/W Feature
Communication control command	1000H	0001H: Forward running	W
		0002H: Reverse running	
		0003H: Forward jogging	
		0004H: Forward jogging	
		0005H: Stop	
		0006H: Free stop (emergency stop)	
		0007H: Fault reset	
Inverter state	1001H	0001H: Forward running	R
		0002H: Reverse running	
		0003H: Inverter standby	
		0004H: Fault	
Communication setting address	2000H	Communication setting range (-10000~10000) Note: the communication setting is the percentage of the relative value (-100.00%~100.00%), which can conduct communication wiring operation. If it is set as frequency source, it corresponds to the percentage of the maximum frequency (P0.07); when it is set as torque, it corresponds to the percentage of the upper torque limit (P3.14). If it is set or fed back as PID, it corresponds to the percentage of PID. Where, PID setting value and PID feedback value go through PID calculation in form of percentage.	W
Virtual terminal input function setting	2001H	Setting range: 000H~03FFH. Each bit corresponds to S1~S5, HDI1, HDI2 and S6~S8 respectively. Note: the functional code P5.01 should be set to the communication virtual terminal input function, and should also be unrelated to HDI1 and HDI2 input types.	W
Run/stop parameter address	3000H	Operating frequency	R
	3001H	Set frequency	R
	3002H	Bus voltage	R
	3003H	Output voltage	R
	3004H	Output current	R
	3005H	Rotation speed upon running	R
	3006H	Output power	R
	3007H	Output torque	R
	3008H	PID setting value	R

	3009H	PID feedback value	R
	300AH	Terminal input sign input	R
	300BH	Terminal output sign input	R
	300CH	Analog input AI1	R
	300DH	Analog input AI2	R
	300EH	Analog input AI3	R
	300FH	Analog input AI4	R
	3010H	High-speed pulse frequency (HDI1)	R
	3011H	High-speed pulse frequency (HDI2)	R
	3012H	Multi-step and current steps of PLC	R
	3013H	Length	R
	3014H	External counter input	R
Parameter lock password check address	4000H	****	W
Parameter lock password command address	4001H	55AAH	W
Inverter fault address	5000H	Fault message codes should be consistent with fault types in the functional code menu. The difference is that here hexadecimal data is returned to the upper computer, instead of fault characters.	R
ModBus communication fault address	5001H	0000H: Not fault 0001H: Password error 0002H: Command code error 0003H: CRC error 0004H: Illegal address 0005H: Illegal data 0006H: Parameter change invalid 0007H: System locked 0008H: Inverter busy (EEPROM is storing)	R

3.7 Communication Parameters of PC Group

This part details the PC group (communication parameter group) in the functional design of CHV100 series inverters.

PC-00	Local communication address	Default Setting	1
	Setting range	1~247, 0 stands for the broadcast address	

When the master is writing the frame, if the communication address of the slave is set to be 0 (that is the broadcast communication address), all slaves on the MODBUS bus will receive the frame, but the slaves will not make any response. Note that the slave address should not be set to be 0.

The local communication address is a unique address over the communication network. This is the basis for point-to-point communications between the upper computer and the inverter.

PC-01	Communication baud rate selection		Default Setting	3
	Setting range	0	1200BPS	
		1	2400BPS	
		2	4800BPS	
		3	9600BPS	
		4	19200BPS	
		5	38400BPS	

This parameter is used to set the data transmission rate between the upper computer and the inverter. Note the baud rate setting of the upper computer should be the same as that of the inverter. Otherwise, communications cannot be implemented. The higher the baud rate, the faster the communication speed is.

PC-02	Data format		Default Setting	0
	Setting range	0	No parity: data format <8,N,2>	
		1	Even parity: data format <8,E,1>	
		2	Odd parity: data format <8,O,1>	

The data format setting of the upper computer should be the same as that of the inverter. Otherwise, communications cannot be implemented.

PC-03	Communication reply delay	Default Setting	2ms
	Setting range	0~20ms	

Reply delay: refers to the interval time between the end of data receiving of the inverter and the reply data sending of the upper computer. If the reply delay time is less than the system processing time, take the system processing time as reply delay reference. If the reply delay is longer than the system processing time, after data processing, the system has to wait until the reply delay time is reached before sending data to the upper computer.

PC-04	Communication timeout fault time	Default Setting	0.0 s
	Setting range	0.0s (invalid), 0.1~100.0s	

If the functional code is set to 0.0s, the communication delay time parameter is disabled.

When the functional code is set to be a valid value, if the interval between the current communication and the next communication exceeds the communication delay time, the system will send a communication fault error (Err18).

Normally, it is set to be “disabled”. If this parameter is set in a consecutive communication system, communication status can be monitored.

PC-05	Local master/slave selection (Reserved function)	Default Setting	0
PC-09	Setting range	Reserved function	