

NXZ(H)M and NXZB Automatic Transfer Switch Controller

User Manual of the Communication Protocol

Product name: Automatic Transfer Switching Equipment

Model: NXZM、NXZHM、NXZB、NXZHB series

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ZHEJIANG CHINT ELECTRICS CO., LTD.

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Foreword

This user manual is established by Distributing Apparatus Manufacturing Division I of ZHEJIANG CHINT ELECTRICS CO., LTD.

This user manual only represents the information included in this version. No notice will be given for any update. Please pay attention to the latest version of our company. This is version V2.2 of the user manual.

Communication Protocol of NXZ(H)M and NXZB Automatic Transfer Switch Controller

User Manual

Modbus-RTU

1 Scope

This user manual specifies the basic terminology, protocol composition and communication datasheet of Modbus-RTU protocol. This user manual is applicable to NXZ(H) M and NXZB Automatic Transfer Switching Equipment.

2 Terms and definitions

The following terms are applicable to this user manual.

2.1 Open system interconnection (OSI) model

The standard formulated by ISO (International Organization for Standardization) in 1984, with an aim to provide a common basis and standard frame for the interconnection of the computers of different manufacturers .

2.2 Physical layer

The first layer of OSI model, which provides a physical link to realize transparent transmission in the communication.

2.3 Data-link layer

The second layer in OSI model, which provides transparent and reliable information transmission service between adjacent node.s

2.4 Application layer

The seventh layer of OSI model, which realizes the function of data manipulation and information exchange .

2.5 Frame

The special information structure composed of several bits or fields pre-established according to a certain standard in data and digital communication. Data are transferred in the network in frame which is a very small unit. Frame is composed of several parts. Different parts have different functions.

3 Introduction to Modbus Protocol

Modbus protocol is an industrial bus protocol designed based on ISO/OSI model (7 layers), but only 3 (physical layer, data-link layer and application layer) of the 7 layers are used, which simplifies the protocol model and reduces the difficulty in use.

Modbus protocol has two transmission modes, namely ASCII and RTU. The circuit breaker produced by our company adopts RTU transmission.

4 Protocol Overview

4.1 Physical layer

Physical layer parameter	Physical layer content	Remarks
Communication mode	RS485	Half duplex
Communication address	1~247 optional	Default: 3
Communication baud rate	9.6kbps\19.2kbps\38.4kbps optional	Default: 9.6kbps
Communication distance	≤ 1000 m	With a low baud rate
Communication media	Shielded Twisted Pair	Category A

4.2 Data-link layer

4.2.1 Transmission mode: master-slave half-duplex mode (the master inquires; the slave responds)

4.2.2 Protocol type: Modbus-RTU communication protocol

4.2.3 Serial transmission format: 1 start bit, 8 data bits, even parity check bit, 1 stop bit (1 frame data)

Start	Data								Check	Stop
Start	1	2	3	4	5	6	7	8	CRC	Stop

4.2.4 Packet (multi-frame) format: as shown in the table

Start	Address frame	Function frame	Data frame	Check frame	Termination
T3.5	8 bits	8 bits	n×8 bits	16 bits	T3.5

Note: In RTU model, beginning of information needs at least 3.5-character (or frame) resting time. The resting time can be easily figured out according to the baud rate used (such as T3.5 in the table above). This time delay needs to be considered by UART when it uses Single Chip Micropyco to make the communication protocol. It need not be considered if configuration software or DCS is used, because the bottom layer of the software has already been established.

4.3 Application layer

The application layer can make analysis of the packet (including the address code, function code, data field, check code etc.) for the purpose of data exchange.

When the packet sent by the master arrives at the slave, it can enter the addressable device through the communication port. The slave can remove the "envelop" (data head) of the packet and read the valid data. If the data are correct, it will execute the task requested by the data, and add the data it generates to the "envelop" it obtains to form a new packet and send it back to the master. The response data returned include the following: Slave address, executed function, request data generated in command execution, and a check code.

4.3.1 Address code

The address code is at the beginning of frame and is composed of 8 bits (take 1~247). These bits mark the address of the slave specified by the user. The slave will receive the data from the master which is connected with it. In the same network, the address of each slave shall be unique, and only the addressable slave will respond to the inquiry including the address. When the slave sends back a response, the address data of the slave that gives the response can tell the master that it's communicating with the master.

4.3.2 Function code

The function code can tell which function the addressable slave is executing. All function codes and their definition and behavior are shown in table 2.

Function code	Definition	Functional behavior
03H	Read the data register	Read the data value of one or more registers
06H	Write one register	Write data in one register

4.3.3 Data field

Data field includes the data required by the slave for executing the specific function or the data acquired by the slave when it responds to an inquiry. These data may include values, reference addresses or limiting values. Details can be found in the table of communication address register.

For example: The functional domain tells the slave to read a register. The data field needs to specify the beginning register and read several data. For different types and different capabilities of slaves, embedded addresses and data are also different.

4.3.4 Check code

This field allows the master and slave to check the errors during transmission. Sometimes, owing to the electrical noise and other interference, when a set of data are transmitted from one device to the other, they may have some changes. Error check can ensure that the master or slave won't respond to the data that are changed during transmission, which can improve the system safety and efficiency. Error check adopts the 16-bit cyclic redundancy check method.

Cyclic redundancy check (CRC) field occupies two bytes and contains a 16-bit binary value. CRC value is calculated by the transfer equipment and then affixed to the data frame. The receiving equipment calculates CRC value again when the data are received, and then compares it with the value received in CRC field. If the two values are different, it shows there are errors.

Generation method of CRC16 is provided in appendix A CRC-16 generation principle.

4.3.5 Explanation of the functions of the application layer

4.3.5.1 Read data register (03H)

03H function code allows the user to acquire the data collected and recorded by the intelligent controller and the system parameters.

For example: for NXZ(H) M series, it can read phases A, B and C voltage value of the normal supply, and according to the data returned, the result is Uan = 0001, Ubn = 0002, Ucn = 0003.

Inquiry by the master			Response by the slave			
Frame field	Content	Description	Frame field	Content	Description	
Address code	03	slave address	Address code	03	slave address	
Function code	03	Function code	Function code	03	Function code	
Data field	00	Read the high byte of register address	Data field	06	Total number of data returned	
	06	Read the low byte of register address		00	High byte of data 1	
	00	Read the high byte of data number		01	Low byte of data 1	
	03	Read the low byte of data number		00	High byte of data 2	
Check code	E4	Low byte of CRC check		02	Low byte of data 2	
	28	High byte of CRC check		00	High byte of data 3	
				Check code	03	Low byte of data 3
					E4	Low byte of CRC check
			14		High byte of CRC check	

The master sends [03 03 00 06 00 03 E4 28]

The slave responds to [03 03 06 00 01 00 02 00 03 E4 14]

4.3.5.2 Write data register (06H)

Function code 06H allows the user to modify the content of a single register. Any writable register in an intelligent controller can use this function code to change its value.

For example: For NXZ(H) M series, it can revise the undervoltage setting value of the normal supply (register address: 0x2065) to 160V (hexadecimal number 0x00A0).

Inquiry by the master			Response by the slave		
Frame field	Content	Description	Frame field	Content	Description
Address code	03	Slave address	Address code	03	Slave address
Function code	06	Function code	Function code	06	Function code
Data field	20	High byte of the address to be written in	Data field	20	High byte of the address written in
	65	Low byte of the address to be written in		65	Low byte of the address written in
	00	High byte of read-in data		00	High byte of read-in data
	A0	Low byte of read-in data		A0	Low byte of read-in data
Check code	93	Low byte of CRC check	Check code	93	Low byte of CRC check
	8F	High byte of CRC check		8F	High byte of CRC check

The master sends [03 06 20 65 00 A0 93 8F].

The slave responds to [03 06 20 65 00 A0 93 8F].

5 Communication Datasheet

No.	Parameter	Data type	Unit	Access rule	Address	Parameter specification	Remarks
1	NL1 phase voltage	UINT	0.1V	R	0x0006	Normal supply NA	NXZ(H)M
2	NL2 phase voltage	UINT	0.1V	R	0x0007	Normal supply NB	NXZ(H)M
3	NL3 phase voltage	UINT	0.1V	R	0x0008	Normal supply NC	NXZ(H)M
4	RL1 phase voltage	UINT	0.1V	R	0x0009	Alternative supply RA	NXZ(H)M
5	RL2 phase voltage	UINT	0.1V	R	0x000A	Alternative supply RB	NXZ(H)M
6	RL3 phase voltage	UINT	0.1V	R	0x000B	Alternative supply RC	NXZ(H)M
7	Reserved item	UINT	\	R	0x000C	Return to 0	NXZ(H)M
8	Frequency	UINT	Hz	R	0x000D	Power frequency	NXZ(H)M
9	Reserved item	UINT	\	R	0x000E	Return to 0	NXZ(H)M
10	MAX-N-A phase voltage	UINT	1V	R	0x000F	Common A peak voltage	NXZ(H)M reserved
11	MAX-N-B phase voltage	UINT	1V	R	0x0010	Common B peak voltage	NXZ(H)M reserved
12	MAX-N-C phase voltage	UINT	1V	R	0x0011	Common C peak voltage	NXZ(H)M reserved
13	MAX-R-A phase voltage	UINT	1V	R	0x0012	Standby A peak voltage	NXZ(H)M reserved
14	MAX-R-B phase voltage	UINT	1V	R	0x0013	Standby B peak voltage	NXZ(H)M reserved
15	MAX-R-C phase voltage	UINT	1V	R	0x0014	Standby C peak voltage	NXZ(H)M reserved
16	Switching times on the common side	UINT	\	R	0x0015	Switching times of the common switch	Reserved
17	Switching times on the standby side	UINT	\	R	0x0016	Switching times of the standby switch	Reserved
18	Total operation time	UINT	h	R	0x0017	Operation time	Reserved
19	ModBus address	UINT	NA	R/W	0x0100	Address range: 1~247	NXZ(H)M,NXZB
20	ModBus baud rate	UINT	bps	R/W	0x0101	Baud rate: 0:9.6k; 1:19.2k; 2: 38.4k	NXZ(H)M, NXZB
21	Normal/alternative supply state	UINT	NA	R	0x004F	Power supply state ¹	NXZ(H)M,NXZB
22	Switching state	UINT	NA	R	0x0050	Switching state ²	NXZ(H)M,NXZB
23	Setting value of common under-voltage threshold U1	UINT	0.1V	R/W	0x2065	Setting range: 160~200	NXZ(H)M
24	Setting value of standby undervoltage threshold U2	UINT	0.1V	R/W	0x2066	Setting range: 160~200	NXZ(H)M

25	Setting value of common overvoltage threshold U3	UINT	0.1V	R/W	0x2067	Setting range: 240~290	NXZ(H)M
26	Setting value of standby overvoltage threshold U4	UINT	0.1V	R/W	0x2068	Setting range: 240~290	NXZ(H)M
27	Transfer delay time setting T1	UINT	1s	R/W	0x2069	NXZ(H)M: 0~180, NXZB: (0~30s) Read Only	NXZ(H)M,NXZB
28	Return delay time setting T2	UINT	1s	R/W	0x206A	NXZ(H)M: 0~180, NXZB: (0~30s)Read Only	NXZ(H)M,NXZB
29	Generator startup delay T3	UINT	1s	R/W	0x206B	Setting range: 0~180	NXZ(H)M
30	Generator shutdown delay T4	UINT	1s	R/W	0x206C	Setting range: 0~180	NXZ(H)M
31	Mode selection	UINT	NA	R/W	0x206D	0: Power grid-power grid automatic switching automatic recovery 1: Power grid-power grid automatic switching nonautomatic recovery 2: Power grid-generator automatic switching automatic recovery	NXZ(H)M
32	Compulsory switch command	UINT	NA	W	0x2700	Compulsory switch function ⁴	NXZ(H)M,NXZB
33	Control command	UINT	NA	W	0x2800	Control function ³	NXZ(H)M,NXZB

Table A.1 NXZ(H) M Power Supply State							
Bit15	Bit14	Bit13	Bit12	Bit11	Bit10	Bit9	Bit8
Reserved	Reserved	Normal supply C phase 00: normal, 01: undervoltage, 10: overvoltage		Normal supply B phase 00: normal, 01: undervoltage, 10: overvoltage		Normal supply A phase 00: normal, 01: undervoltage, 10: overvoltage	
Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
Reserved	Reserved	Alternative supply C phase 00: normal, 01: undervoltage, 10: overvoltage		Alternative supply B phase 00: normal, 01: undervoltage, 10: overvoltage		Alternative supply A phase 00: normal, 01: undervoltage, 10: overvoltage	

		overvoltage			overvoltage		
Continued Table A.1 NXZB Power Supply State							
Bit15	Bit14	Bit13	Bit12	Bit11	Bit10	Bit9	Bit8
Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Normal supply 00: normal, 10: abnormal	
Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Alternative supply 00: normal, 10: abnormal	
Table A.2 Switching State							
Bit15	Bit14	Bit13	Bit12	Bit11	Bit10	Bit9	Bit8
Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Remote control or not 0: no 1: yes
Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
Fault type 000: NA 001: Fire control linkage 010: Motor timeout 011: Common trip 100: Standby trip			Switch position on the common side 0: open 1: closed	Switch position on the standby side 0: open 1: closed	Middle position (double tripping position) 0: no 1: yes	Generator state 0: genset shut down 1: genset started	Reserved
Table A.3 Control Command							
Bit15	Bit14	Bit13	Bit12	Bit11	Bit10	Bit9	Bit8
Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved
Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
Reserved	Reserved	Clearance of motor timeout fault 0: no 1: yes	Clearance of fire control fault 0: no 1: yes	Reserved	Remote control 0: NA 1: remote control	Parameter setting 0: NA 1: restored to default parameter	Historic record setting 0: NA 1: clearance of historic records
Table A.4 Compulsory Switch Command							
0x0000	Compulsory switch to common position		Valid under the "remote control state"		Note: During compulsory switch of NXZ(H) M, NXZB, namely, when switching to the switching-on position, the voltage of the power supply shall be in a normal condition; in this way, the product can execute relevant action.		
0x00aa	Compulsory switch to standby position						
0x00ff	Compulsory switch to double tripping position						

Appendix A

CRC-16 Generation Principle

During CRC calculation, firstly, it pre-sets a 16-bit register to 1 totally, and then it continuously calculates the 8-bit byte in the data frame and the current value in the register. Only 8 data bits of each byte are involved to generate CRC. The start bit, stop bit, and the parity bit possibly used will not affect CRC.

During generation of CRC, each 8-bit byte executes XOR with the content in the register and then shifts the result to a lower bit. The high bit is supplemented with "0". The least significant bit (LSB) is shifted out and checked. If the LSB is 1, the register will have an XOR operation with a preset fixed value. If LSB is 0, no actions will be taken.

The above procedures will be repeated, till 8 shift operations are finished. When the last bit (the 8th bit) is shifted, the next 8-bit byte will have an XOR operation with the current value of the register. Another 8 shift XOR operations will be repeated. When all bytes in the data frame are handled, the end value generated is CRC value.

The process of generation of a CRC value is:

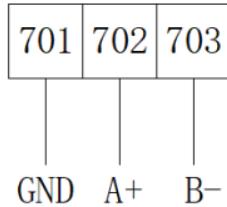
- a) Pre-set a 16-bit register as 0FFFFH (total 1), which is called CRC register;
- b) Execute XOR operation between the first 8-bit byte in the data frame with the low byte in the CRC register, and store the result in CRC register;
- c) Shift CRC register rightward for one bit, fill 0 to the most significant bit, and shift the least significant bit out and check it;
- d) If the least significant bit is 0, repeat step 3 (make a shift next time);
- e) If the least significant bit is 1, execute XOR operation between CRC register and a preset fixed value (0A001H);
- f) Repeat step 3 and step 4, till the 8th shift. In this way, operation of a complete 8 bits will be finished;
- g) Repeat steps 2~5 to deal with the next 8-bit byte, till all bytes are processed;
- h) The final CRC register value is then the CRC value.

Appendix B

Example of Application of NXZ(H) M Communication---Switch of Remote Control to Double Tripping Position

B.1 Correct Installation and Debugging Procedure

(1) Wiring between the power supply and communication: First of all, power on the controller normally to ensure the common and standby voltages are normal. Then reliably connect wires A, B and GND in RS485 bus with 702 (A+), 703 (B-) and 701 (G) terminal of NXZ(H) M automatic transfer switch controller.



(2) Adjust the communication address parameter in the intelligent controller to 3 and adjust the baud rate to 9.6kbps (the default communication address parameter is 3 and baud rate is 9600) according to the user manual.

(3) Connect RS485 bus converter to the debugging computer.

(4) Start the serial port debugging tool, and set the serial port No. and baud rate according to actual conditions. Configure the serial port parameter as: 1 start bit, 8 data bits, even parity check and 1 stop bit.

(5) Send the testing frame (03 06 28 00 00 04 80 4B). If the controller returns (03 06 28 00 00 04 80 4B) data, and the "manual" and "automatic" buttons on the controller screen blink at the same time, it means the communication is normal, and it enters the "remote control state".

(6) Send the testing frame (03 06 27 00 00 FF C2 DC). The controller will return (03 06 27 00 00 FF C2 DC), and at the same time, the product will be compulsorily switched to the double tripping position (middle position).

B.2 Inspection of Communication Anomaly

(1) Check if the connection between RS485 communication buses A and B and the terminal 702 (A+), 703 (B-) of the dual power switch intelligent controller is loose or reverse.

(2) Check if the communication parameters of the dual power switch intelligent controller are correctly set (they shall be consistent with those of the upper computer).

(3) Check if the serial port parameters of the master (debugger) are correctly set (they shall be consistent with the parameters of the controller).

(4) Check if the communication adapter (RS485 convertor) is damaged (change for a new one to be tested).

(5) If the above problems do not exist, please contact with us for a further analysis.