网为电气®
Wangwei Electric

Communication Protocol of WQ7A ATS Controller

Beijing Wangwei Electric Limited Company

Foreword

Version updates

Date	Version	Contents
2019-3-1	1.0	Start
2019-12-16	1.1	Revision of individual elements

网为电气 Wangwei Electric

Beijing Wangwei Electric Limited Company

Address: 3rd Floor, No. 65, You'anmennei Street, Xuanwu District, Beijing
Tel: 010-58376706
Fax: 010-83531092
Postcode: 100053
Website: http://www.chinawangwei.com
E-mail: wv@ chinawangwei.com
National Technical Support Hotline: 4006-988-180

Attention

● This manual is for information purposes only. The information in this manual is subject to change without prior notice.

● The manufacturer or distributor is not responsible for errors or omissions in this manual, nor for any damage that may be caused by necessity in the execution or use of this manual.

● Without the permission of the company, this information is strictly prohibited to be reproduced or reproduced for other purposes.

Contents

1. Introductiono

This communication protocol describes in detail the formats of reading and writing commands of the serial port communication of the native machine and the definition of internal information data, so that the third party can develop and use it.

The MODBUS communication protocol allows this device to communicate effectively with information and data among programmable sequential devices (PLCs), RTU, SCADA systems, DCS, or third parties with MODBUS-compatible monitoring systems of Schneider, Siemens, Modicon, and other internationally renowned brands. As long as a set of PC-based (or Industrial-Personal-Computer-based) master control display software of central communication(such as: Kingview, Intouch, FIX, synall and so on) can be added, a monitoring system can be set up.

2. Basic Rules of ModBus:

- All RS485 communication circuits should follow the master-slave mode. In this way, data can be transferred between a master station (such as PC) and 32 substations.
- All information that transferred by the initialized master station on the RS485 communication circuit.
- No communication can start from a substation.
- All communications on the RS485 communication circuit is transmitted in the form of "information frame".
- If the master stations or substations receive an info frame with an unknown command, they will not respond.

3. Data Frame Format:

Communication transmission is asynchronous and takes byte (data frames) as its unit. Each data frame passed between the master station and the substation is through 11-bit serial data streams.

Data Frame Format:

Start Bit	1 bit
Data Bits	8 bits
Parity Check Bit	Null
Stop Bit	2 bits

4. Communication Protocol:

When a communication command is sent to an instrument, the device that matches the corresponding address receives the communication command, removes the address and reads the information. And if there is no error, it will execute the corresponding tasks and return the execution results to the sender. The returned information includes the address, the function code of executing the action, the data after the action is performed, and the error check code (CRC). If you make a mistake, no information will be sent.

4.1 Information Frame Format:

Initial Structure	Address	Function Code	DATA	Error Check	Ending Structure
Delay(an equivalent of the time of 4 bytes)	1 byte 8 bits	1 byte 8 bits	N bytes N*8 bits	2 bytes 16 bits	Delay(an equivalent of the time of 4 bytes)

4.1.1 ADDRESS：

The address is the first data frame (8 bits) in the information frame transmitted by each communication, from 0 to 255. The address range of a single device is from 1 to 247. This byte indicates that the slave computer with the address set by the user will receive the messages sent by the host computer, and each slave device has a unique address, and all responses sent back start from their own addresses. The address sent by the host computer indicates the address of the slave computers to be sent to, and the addresses sent by the slave computers indicate the addresses of the slave ones which send back responses.

4.1.2 FUNCTION CODE

The function code is the second data transmitted for each communication. The ModBus communication protocol defines the function code as 1-255 (01H-0FFH). This computer uses some of the function codes. Being sent as the requests of the host computer, the function code is tells its slave computer what actions to take. As a response of the slave computer, the function code sent by the slave one is the same as the function code sent by the host one and indicates that the slave computer has responded to the host computer and operated. If the highest bit of the function code sent by the slave computer is 1 (function code > 127), the slave computer does not respond or has an error.

The following chart demonstrates the detailed definitions and operations of function codes

Some of Function Codes of ModBus

Function Code	Definition	Operation
01H	Read switching value	Read single or multiple switching values
03H	Read register	Read data of single or multiple registers
05H	Store data of single switching value	Store data of single switching value

● 01H Read Switching Value

The host computer can use the communication command with function code of 01 to read various switching values within the device (such as switch closing, switch

opening, switch faults, automatic or manual status and so on). The maximum number of switches that can be read at one time is 64.

● 03H Read Register

The host computer uses the communication command with function code of 03H to read the numerical register in the device. The numerical register holds the various analog quantities and set values of parameters collected). The input value of the register of the DATA mapped by function code of 03H is 16 bits (2 bytes). In this way, the register value read from the device is 2 bytes. The maximum number of registers that can be read at one time is 32.

The command format of the responses of slave computer is its address, function code, DATA, and CRC code. The data in the DATA is a set of double bytes made of two bytes where the high byte is in the front.

● 05H Store Data of Single Switching Value

The host computer uses this command to store the data of single switching value to the bit memory in the device (such as the switching value controlling the ATS conversion). The slave computer also uses this function code to return information to the host computer.

4.1.3 DATA：

DATAs changes with function codes.

4.1.4 CRC：

The host or slave computer can use the check code to judge whether the received information is wrong. Sometimes, due to electronic noise or some other interference, the information will change slightly during the transmission. The error check code ensures that the host or the slave computer does not influence on the information that is in error during the transmission. This increases the security and efficiency of the system. The error check code uses the CRC-16 check method.

In two-byte error check code, low byte is in the front and high byte is in the back.

Notes:

All information frames have the same format: address, function code, DATA and error check code.

The Cycling Redundancy Check (CRC) contains 2 bytes, i.e. the 16-bit binary system. The CRC code is calculated by the sending end and placed at the end of the transmitted message. The receiving device then recalculates whether the CRC code of the received message is the same as the received one. If they are different, then there will be an error.

The computing method of CRC code is to preset all 16-bit registers to 1s firstly and then gradually process every 8-bit data information. Only 8-bit data bits are used when calculating the CRC code. The start bit and stop bit are not involved in CRC calculation.

When calculating the CRC code, the result obtained through XORing the 8-bit data and the register data is shifted one bit to the lower bit, and the highest bit is filled with 0. Then recheck the lowest bit. If the lowest bit is 1, the content of the register and the the

preset number need to be XORed . If the lowest bit is 0, the XOR calculation is needless.

This process needs to be repeated for many times. After the 8th shift, the contents of the next 8 bits are XORed with current contents of the register. This process needs to be repeated for 8 times as before. After all data information is processed, the contents of the last register are the values of CRC.

Calculation Steps of CRC-16 Code:

1、Set the 16-bit CRC register to hexadecimal FFFF;
2、XOR one 8-bit data with the lower 8-bit data of the CRC register and place the result in the CRC register;
3、Shift the contents of the CRC register to the right one bit, fill in the highest bit with 0, and check for the shift-out bit.
4、If the lowest bit is 0: repeat step 3 (shift again).
If the lowest bit is 1: the CRC register is XORed with the hexadecimal number A001.
5、Repeat steps 3 and 4 until you have shifted right for 8 times, so that the entire 8-bit data is processed.
6、Repeat steps 2-5 for the next data processing.
7、The final CRC register value is the CRC code. When transmitted, the lower 8 bits are transmitted firstly, and the higher 8 bits are transmitted later.

Notes:

The calculation of the CRC code starts from <address of slave computer>, except for all bytes of <CRC code>.

4.2 Examples of Information Frame Format

◎ Function Code 01H

The address of slave computer is 00. Read 20H(decimal 32) switching values whose start address is 0000H.

Sent by Host Computer	Number of Bytes	Examples(hexadecimal)	
Address of Slave Computer	1	01	Send to Slave Computer 01
Function Code	1	01	Read Switching Values
Start Address	2	00 00	Start Address is 0000
Number of Switching Values to Be Read	2	00 1C	Read 28 Switching values
CRC Code	2	3D C3	CRC Code Calculated by Host Computer

The value of the switch value 07–00 is expressed as 30H in the hexadecimal system and 00110000 in the binary system. Switch value of 07 is the higher bit and 00 is the lower one. The state of the switch value 07-00 is: OFF-OFF-ON-

ON-OFF-OFF-OFF-OFF.

◎ Function Code 03H

The address of slave computer is 01. Three points whose start address is 0026 H.

Addresses of point data in this example:

Address	Data(hexadecimal)
0026	0014
0028	0014
002A	0005

Responses of Slave Computer	Number of Bytes	Examples(hexadecimal)	
Address of Slave Computer	1	01	Sending to Slave Computer 01
Function Code	1	01	Read Points
Number of Switching Values to Be Read	1	04	28 Switching Values(a Total of 4 Bytes)
Data1	1	30	Contents with the Address of 07－00
Data1	1	00	Contents with the Address of 0F－08
Data1	1	93	Contents with the Address of 17－10
Data1	1	0A	Contents with the Address of 1C－18
CRC Code	2	18 26	CRC Code Calculated by Slave Computer

Sent by Host Computer	Number of Bytes	Examples(hexadecimal)	
Address of Slave Computer	1	01	Send to Slave Computer 01
Function Code	1	03	Read Points
Start Address	2	00 26	Start Address is 0032
Number of Switching Values to Be Read	2	00 03	Read 3 Points(A Total of 6 Bytes)
CRC Code	2	E4 00	CRC Code Calculated by Host Computer

Responses of Slave Computer	Number of Bytes	Examples(hexadecimal)	
Address of Slave Computer	1	01	Send to Slave Computer 01
Function Code	1	03	Read Points
Number of Bytes to Be Read	1	06	3 Points(A Total of 6 Bytes)
Data of Point 1	2	00 14	Contents with Address of 0026
Data of Point 2	2	00 14	Contents with Address of 0028
Data of Point 3	2	00 05	Contents with Address of 002A
CRC Code	2	91 71	CRC Code Calculated by Slave Computer

◎Function Code 05H

The address of slave computer is 01. A switching value with the start address of 0002H. Set the unit of 0002 to 1.

Data addresses of switching values in this example:

Address	Data(hexadecimal)
0000	0
0001	1
0002	0

Explanation: the switching values of hexadecimal values of FF00 and 0000H are forced to 1 and 0 separately. Other values are illegal and do not affect the state of the switching values.

Sent by Host Computer	Number of Bytes	Example(hexadecimal)	
Address of Slave Computer	1	01	Send to Slave Computer 01
Function Code	1	05	Force Switching Values
Start Address	2	00 04	Start Address is 0002
Data	2	FF 00	Set Switching Value to 1
CRC Code	2	CD FB	CRC Code Calculated by Host Computer

Responses of Slave Computer	Number of Bytes	Example(hexadecimal)

Address of Slave Computer	1	01	Send to Slave Computer 01
Function Code	1	05	Force Switching Values
Start Address	2	00 04	Start Address is 0002
Data	2	FF 00	Set Switching Value to 1
CRC Code	2	CD FB	CRC Code Calculated by Host Computer

4.3 Error Handling

When the device detects an error other than the error of CRC code, it must send a feedback message to the host device. Set the highest bit of the function code to 1, which means the function code resent by the slave computer is adding 128 to the basis of the function code sent by the host computer. The following codes show that there is an unexpected error.

If the information received from the host computer has a CRC error, it will be ignored by the device.

The formats of error codes resent by the slave computer are as follows (except CRC):

Address	1 Byte
Function Code	1 Byte(the highest bit is 1)
Error Code	1 Byte
CRC Code	2 Bytes

Error Function Code:

01 Illegal function code
Unsupported received function code

02 Illegal data address
Appointed address which exceeds the range of the slave computer

03 Illegal data value
Data value received by host computer exceeds the data range of the corresponding address.

5. Appendix: address and data

Chart 1: Function code 01H maps to the switch volume area, that is, the read-only switch volume area (0000H~003FH).

(The maximum number of switches that can be read at one time is 64)

Switching Values		
Address	Item	Explanation
0000H	1# Breaker Closing/Opening	1: Close 0: Open
0001H	2# Breaker Closing/Opening	1: Close 0: Open
0002H	Retain	Undefined
0003H	Start Signal for Gnerator	1: start 0: stop
0004H	Load unloading signal	1: unload 0: load
0005H	Auto/Manual	1: auto 0: manual
0006H	Controller lock	1: alarming 0:None
0007H	Retain	Undefined
0008H	1# Voltage is normal	1: normal 0: abnormal
0009H	1# Voltage is too high	1: too high 0: normal
000AH	1# Voltage is too low	1: too low 0: normal
000BH	1# Total voltage loss of power supply	1: loss of voltage, 0: normal
000CH	1# Loss of Phase Lines	1: phase missing, 0: normal
000DH	1# Power frequency is too high	1: too high, 0: normal
000EH	1# Power frequency is too low	1: too low, 0: normal
000FH	Retain	Undefined
0010H	Retain	Undefined
0011H	2# Voltage is normal	1: normal 0: abnormal
0012H	2# Voltage is too high	1: too high 0: normal
0013H	2# Voltage is too low	1: too low 0: normal
0014H	2# Total voltage loss of power supply	1: loss of voltage, 0: normal
0015H	2# Loss of Phase Lines	1: phase missing, 0: normal
0016H	2# Power frequency is too high	1: too high, 0: normal
0017H	2# Power frequency is too low	1: too low, 0: normal
0018H	Retain	Undefined
0019H	Retain	Undefined
001AH	Comprehensive alarming	1: alarming 0: None
001BH	1# Breaker Close failure	1: alarming 0: None
001CH	2# Breaker Close failure	1: alarming 0: None
001DH	Retain	Undefined

001EH	1# Breaker Opening failure	1: alarming 0: None
001FH	2# Breaker Opening failure	1: alarming 0: None
0020H	Retain	Undefined
0021H	1# Breaker trip	1: alarming 0: None
0022H	2# Breaker trip	1: alarming 0: None
0023H	Retain	Undefined
0024H	1# Phase sequence Wrong	1: alarming 0: None
0025H	2# Phase sequence Wrong	1: alarming 0: None
0026H	Forced Open	1: alarming 0: None
0027H	Retain	Undefined
0028H	Two sources of power are in parallel	1: alarming 0: None
0029H～003FH	Retain	Undefined

Chart 2: Switch area mapped by function code 05H -- that is, write only coil area (0040H~004FH)

Switching Values		
Address	Item	Explanation
0040H	Remote Control 1# Breaker close	1(FF00H): close 0(0000H): null
0041H	Remote Control 1# Breaker Open	1(FF00H): open 0(0000H): null
0042H	Remote Control 2# Breaker close	1(FF00H): close 0(0000H): null
0043H	Remote Control 2# Breaker Open	1(FF00H): open 0(0000H): null
0044H	Retain	Undefined
0045H	Retain	Undefined
0046H	Auto/Manual Setting	1(FF00H): auto 0(0000H): manual
0047H	Release Alarm	1(FF00H): Release 0(0000H): null
0048H～004FH	Retain	Undefined

Chart 3: The data area mapped by function code 03H, that is, the read-only register area (0080H~009FH).

(The maximum number of registers that can be read at one time is 32).

DATA		
Address	Item	Explanation
0080H	1# Ua	1# A Phase Voltage
0081H	1# Ub	1# B Phase Voltage
0082H	1# Uc	1# C Phase Voltage
0083H	1# Uab	1# AB Line Voltage

0084H	1# Ubc	1# BC Line Voltage
0085H	1# Uca	1# CA Line Voltage
0086H	1# Fr	1# Power Frequency （Unit：0.1Hz）
0087H	2# Ua	2# A Phase Voltage
0088H	2# Ub	2# B Phase Voltage
0089H	2# Uc	2# C Phase Voltage
008AH	2# Uab	1# AB Line Voltage
008BH	2# Ubc	2# BC Line Voltage
008CH	2# Uca	2# CA Line Voltage
008DH	2# Fr	2# Power Frequency （Unit：0.1Hz）
008EH	Ia	Load A phase current
008FH	Ib	Load B phase current
0090H	Ic	Load C phase current
0091H	P	The active power of the load conjunction
0092H	Q	The reactive power of the load conjunction
0093H	PF	Power factor of load conjunction (100 times the value, i.e. 100 means 1.00)
0094H～009FH	Retain	Undefined