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Protocol Name	EMW75HDNC1A Modbus Protocol		

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Revision Record

Date	Revision Version	Software Version	Change Description	Author
2020-10-9	A/0		Initial version	Guan Jianhe
2020-10-30	A/1		Update setting for pump and compressor	Guan Jianhe
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2021-2-26	A/6		Add heating info	Guan Jianhe
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Contents

Air conditioner and Host Computer Modbus Protocol

1 Description

This protocol describes the protocol for command control and data exchange between the air conditioner and its dedicated upper computer monitoring module.

The functions stipulated in the protocol mainly include:

1) The host computer obtains the relevant information of the air conditioner by sending read commands.
2) The host computer sets relevant parameters and action control by sending write commands.

During the communication process, the host computer is the master node and exchanges information through a question and answer method, various information and parameters in the slave nodes use the target register as the storage address, and the master node completes the read and write commands by accessing the registers. This protocol supports the networking of one master node and multiple slave nodes. The slave nodes are distinguished by addresses. The address setting range is 1-127. Different slave nodes correspond to different addresses. Slave nodes with the same address cannot hang on the same communication.

2 Terminology

Master node: background monitoring system.

Slave node: air conditioner controller.

RS485: A serial communication standard that supports half-duplex serial short-range communication.

Read command: sent from the master node to the slave node, so that the slave node returns the content of the corresponding register.

Write command: The master node packages related parameters and sends them to the slave node to complete the corresponding parameter settings.

Register address: Each signal and parameter of the slave node corresponds to a 2-byte address. The master node obtains related information or sets related parameters by accessing these registers. This address is called a register.

3 Physical interface

3.1 Serial communication interface electrical standard

The slave node communicates with the master node through the serial port in RS485 mode.

3.2 Information transmission method

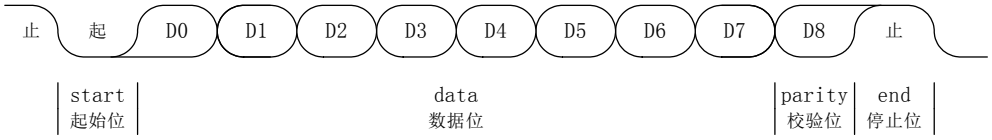
Communication transmission adopts asynchronous mode, and the unit is byte frame (data frame). Each data frame passed between the master node and the slave node is an 11-bit serial data stream.

Data frame format:

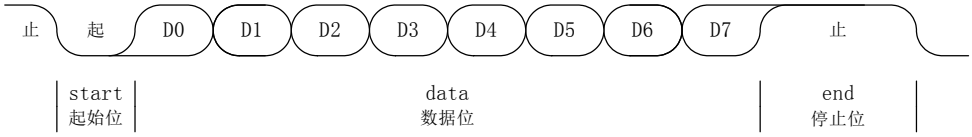
Start bit	1 bit
Data bit	8 bits (Low position first, high position back)
Parity bit	None: This protocol does not use parity bits
Stop bit	1 bit (I.e., the actual parity bits forced high)

Reference

Timing diagram with parity bit:



Timing diagram without parity bit:



3.3 Data transfer rate

The default baud rate uses 19200bps

4 Physical layer communication

4.1 Basic process

After the slave node is powered on or reset, it can respond to the read and write commands of the master node after stable operation. After receiving the relevant command from the contact, the information required by the master node is returned under normal conditions, and the error code corresponding to the specific error type is returned under abnormal conditions.

5 Application layer command types and formats

When the communication command is sent to the instrument, the device that meets the corresponding address code receives the communication command, reads the information, and if there is no error, executes the corresponding task, and then returns the execution result to the sender. The returned information includes the address code, the function code to perform the action, the data after the action is performed, and the error check code (CRC). If an error occurs, no message is sent.

5.1 Information frame format

START	ADDR	CMD	DATA	CRC	END
Delay (>=3.5 character time)	1 byte 8 bit	1 byte 8 bit	N byte N×8 bit	2 byte 16 bit	Delay(>=3.5 character time)

Note 1: The maximum frame length is not greater than 255 bytes

Note2: CRC check code low byte first, high byte last

5.2 CMD

The function code (CMD) is the second data frame in the information frame transmitted with each communication. The communication ModBus protocol defines the function code as1～127(01H～7FH). This protocol uses some of these function codes. It is sent as a master node request, and the slave node is informed by a function code what action to perform. As a slave node response, the function code sent by the slave node is the same as the function code sent by the master node, and indicates that the slave node has responded to the master node to perform the operation. If the most significant bit of the function code sent from the node is 1(CMD＞127), It means that the slave is not responding or has an error.

Command encoding	Meaning	Mark
0x03	Read command	Supports single/multiple register continuous reads
0x10	Write multiple register commands	Support multiple registers to write continuously
0x06	Write single register command	Support single registers to write continuously

5.3 Read command format

Note 3: MSB means high byte, LSB means low byte

Note 4: Each register stores two bytes. for register data of one byte, it is required to be stored in the low byte (LSB).

Master node sends frame format:

No.	0	1	2	3	4	5	6	7
Definition	ADDR	CMD	MSB	LSB	MSB	LSB	LSB	MSB
Explanation	Controller address	Command type	Register start address		Number of registers n		CRC verify	

Normal response frame format from the slave node:

No.	0	1	2	3	4	5	6	…	L+1	L+2	L+3	L+4
Definition	ADDR	CMD	Length	MSB	LSB	MSB	LSB	…	MSB	LSB	LSB	MSB
Explanation	Controller address	Command type	Number of sent bytes L = n * 2	First register		Second register		…	The value of the last register		CRC verify	

Slave node abnormal response format:

No.	0	1	2	3	4
Definition	ADDR	CMD + 128	ErrCode	LSB	MSB
Explanation	Controller address	Command type +128	Error Code	CRC verify	

5.4 Write single register command format

Master node sends frame format:

No.	0	1	2	3	4	5	6	7
Definition	ADDR	CMD	MSB	LSB	MSB	LSB	LSB	MSB
Explanation	Controller address	Command type	Register address		DATA		CRC verify	

Normal response frame format from the slave node:

No.	1	2	3	4	5	6	7
Definition	CMD	MSB	LSB	MSB	LSB	LSB	MSB
Explanation	Controller address	Command type		Register address		CRC verify	

Slave node abnormal response format:

No.	0	1	2	3	4
Definition	ADDR	CMD +128	ErrCode	LSB	MSB
Explanation	Controller address	Command type +128	Error Code	CRC verify	

5.5 Write multiple register command format

Master node sends frame format:

No.	0	1	2	3	4	5	6	7	8	9	10	...	L+5	L+6	L+7	L+8
Definition	ADDR	CMD	MSB	LSB	MSB	LSB	Length	MSB	LSB	MSB	LSB	...	MSB	LSB	LSB	MSB
Explanation	Controller address	Command type	Start register address		Number of registers n		Number of sent bytes L = n * 2	First register		Second register		...	The value of the last register		CRC verify	

Normal response frame format from the slave node:

No.	0	1	2	3	4	5	6	7
Definition	ADDR	CMD	MSB	LSB	MSB	LSB	LSB	MSB
Explanation	Controller address	Command type	Start register address		Number of registers		CRC verify	

Slave node abnormal response format:

No.	0	1	2	3	4
Definition	ADDR	CMD +128	ErrCode	LSB	MSB
Explanation	Controller address	Command type +128	Error Code	CRC verify	

Note: The CRC check range is the check of all bytes before the CRC field.

5.6 Error code definition

When the slave device sends a request to the master node device, the slave node expects a normal response. One of the following four possible events occurs in the query from the master node:

1) If the slave device receives a request without communication errors and can process the query normally, the slave device will return a normal response.

2) If the slave node does not receive the request due to a communication error, the response cannot be returned. The master node program will eventually process the timeout status of the request.

3) If the slave receives the request, but detects a communication error (parity, LRC, CRC, ...), then the response cannot be returned. The master node program will eventually process the timeout status of the request.

4) If the slave receives a request without communication errors, but cannot process the request (for example, if the request reads a non-existent output or register), the slave will return an exception response to notify the user of the nature of the error.

The abnormal response message has two fields that are different from the normal response:

Function code field: In normal response, the slave node uses the response function code field to respond to the originally requested function code. The most significant bit (MSB) of all function codes is 0 (their values are all lower than 128). In the abnormal response in the slave node, the MSB of the function code is set to 1. This makes the function code value in the abnormal response higher than the function code value in the normal response by 128.

By setting the MSB of the function code, the application of the master node can identify the abnormal response and can detect the data field of the abnormal code.

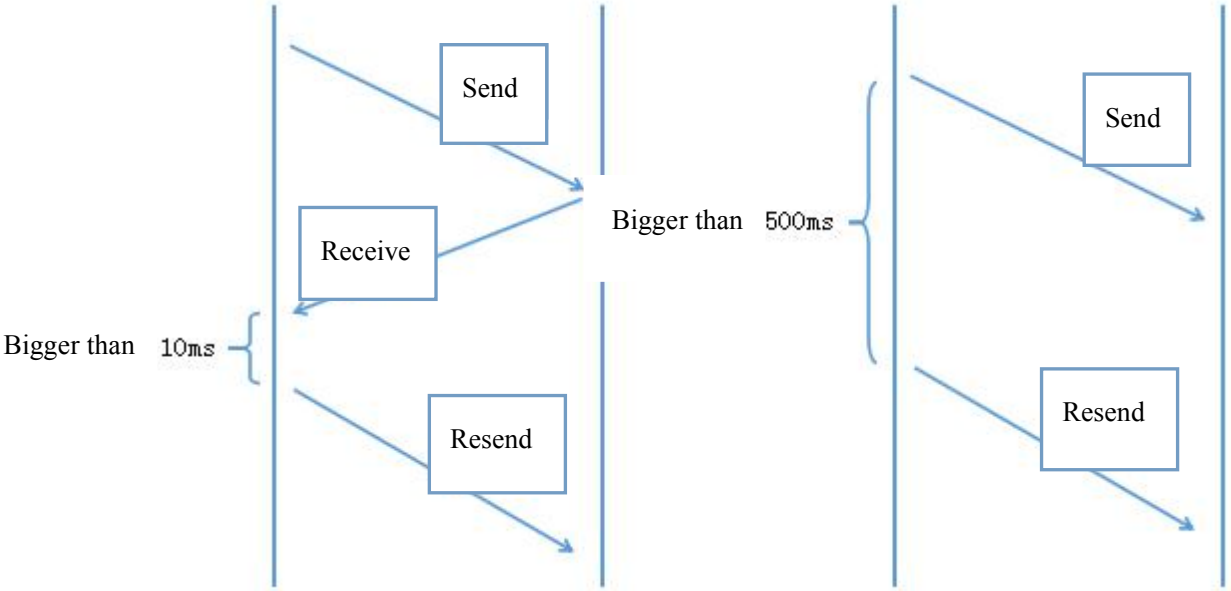
Data domain: In the normal response, the slave node can return data or statistics table (any message required in the request) in the data domain. In the exception response, the slave node returns the exception code in the data domain. This defines the occurrence of an exception Status of the slave node.

MODBUS Error code:

Error code name	Description
01 Illegal Function Code	For the slave node, the function code received in the query is an inadmissible operation. This may be because the function code is only applicable to new equipment and is not achievable in the selected unit. It also indicates that the slave node is in an error state. This kind of request is handled in, for example, because it is unconfigured and requires the return of register values.
02 Illegal data address	For slave nodes, the data address received in the query is an unallowable address. In particular, the combination of the reference number and the transmission length is invalid. For a controller with 100 registers, it has an offset Requests with 96 and length 4 will succeed, and requests with offset 96 and length 5 will generate exception code 02.
03 Illegal data value	For slave nodes, the value included in the query is an unallowable value. This value indicates a fault in the remaining structure of the combined request, for example: the implicit length is incorrect. It does not mean that because the MODBUS protocol does not know anything The significance of any special value of a special register.The data item in the register that is submitted for storage has a value that is not expected by the application.

5.7 Interval time

After sending data and receiving data, the pins may not switch when sending the next frame, so the unified sending and receiving interval is greater than 10ms and the timeout is greater than 500ms.



6 CRC verify algorithm

6.1 CRC algorithm

```
unsigned short count_CRC (unsigned char *addr, int num)
{
    unsigned short CRC = 0xFFFF.
    int i.
    while (num--)
    {
        CRC ^= *addr++.
        for (i = 0. i < 8. i++)
        {
            CRC = (CRC & 0x0001) ? ((CRC >> 1)^0xa001) : (CRC >> 1).
        }
    }
    return CRC.
}
```

7 Register list

Convention:

1. Each register holds two bytes.
2. Data transmission mode: high byte first, low byte last.
3. If the register content is about temperature, the relationship between the register value and the actual temperature is 10 times. For example, if the register value is 200, the actual temperature is 20.0℃. If the register value is 236, the actual temperature is 23.6℃.
4. If the register content is pressure, the relationship between the register value and the actual pressure is 100 times. For example, if the register value is 200, the actual pressure is 2Bar. If the register value is 236, the actual pressure is 2.36Bar.
5. Before setting the modified parameters, you must enter the password (1) to modify the setting successfully, the password address is 0x8100, the register type (function code 0x06)

NO.	Item	unit	Register Address	Attribute	Ratio	Remark	Alarm action
On/off status							
1	System ON/OFF		0x0400	Read/Write	x1	0 OFF 1 ON	
Setting status							
1	Mode selection		0x0401	Read/Write	x1	0 OFF, 1 Inner loop, 2 cooling, 3 heating, 4 automatic 5 water supply	
2	Cooling Set Point (T1, See section 8 Appendix)	℃	0x8B0C	Read/Write	x 10	Keep one decimal place, if you want to	

						set 23.5℃, write 235 in this register	
3	Heating Set Point	℃	0x8B0D	Read/Write	x 10	Keep one decimal place, if you want to set 23.5℃, write 235 in this register	
4	Cooling Hysteresis setting	℃	0x8B0E	Read/Write	x 10	Retain a decimal, if you want to set 1.5 ℃, write 15 in this register	
5	Heating Hysteresis setting	℃	0x8B0F	Read/Write	x 10	Retain a decimal, if you want to set 1.5 ℃, write 15 in this register	
Temperature Sensor Status							
1	Supply water temperature	℃	0xA000	Read Only	x 10	If the value read is 235, it means 23.5℃, keep one decimal place	
2	Return water temperature	℃	0xA002	Read Only	x 10	If the value read is 235, it means 23.5℃,	

						keep one decimal place	
3	Environment temperature	℃	0xA00D	Read Only	x 10	Optional temperature and humidity sensor	
4	Inlet water pressure	Bar	0xA00E	Read Only	x 100	If the value read is 235, it represents 2.35 Bar, with two decimal places	
5	Outlet water pressure	Bar	0xA00F	Read Only	x 100	If the value read is 235, it represents 2.35 Bar, with two decimal places	
Alarm status							
1	Outlet high water temperature		0xB100	Read Only		0 normal, 1 alarm If outlet water temp. ＞30℃, alarm will be generated; if ＜ 28℃, the alarm will be released	Electric heater will stop
2	Outlet low water temperature		0xB101	Read Only		0 normal, 1 alarm When outlet water temp ＜ - 5 ℃ , alarm will be generated, when it is ＞0℃, alarm will be released	Compressor will stop
3	Outlet water temperature sensor failure		0xB102	Read Only		0 normal, 1 fault This alarm is generated when the outlet water temp.	Only alarm, does not act. If the water inlet temperature sensor also fails, chiller will

						sensor is faulty	shut down
4	Return water temperature sensor failure		0xB104	Read Only		0 normal, 1 fault The alarm is generated when the return water temp. sensor is faulty	Only alarm does not act. If the outlet water temperature sensor also fails, chiller will shut down
5	Pump failure		0xB111	Read Only		0 normal, 1 fault This alarm is generated when the water pump is faulty	No this warning
6	Inverter communication failure		0xB115	Read Only		0 normal, 1 fault This alarm is generated when the communication board and the control board are faulty	Stop the compressor
7	System high pressure lock		0xB137	Read Only		0 normal, 1 locked If the high pressure is too high for several consecutive times in a certain period time, the lock alarm is triggered	Stop the compressor
8	System low pressure lock		0xB138	Read Only		0 normal, 1 locked If the low pressure is too low for several consecutive times within a certain period time, the locking alarm is	Stop the compressor

						triggered	
9	Exhaust gas high temperature lock		0xB139	Read Only		0 normal, 1 locked If the exhaust temperature is too high for several consecutive times within a certain period time, the lock alarm is triggered	Stop the compressor
10	Inverter overcurrent lock		0xB13A	Read Only		0 normal, 1 locked The lock alarm is triggered when the frequency converter current is too high for several consecutive times within a certain period time	Stop the compressor
11	Inverter over temperature lock		0xB13B	Read Only		0 normal, 1 locked The locking alarm is triggered when the temp. of the converter is too high for several consecutive times within a certain period time	Stop the compressor
12	Inverter overvoltage lock		0xB13C	Read Only		0 normal, 1 locked The lock alarm is triggered when the inverter voltage is	Stop the compressor

						too high for several consecutive times within a certain period time	
13	Inverter undervoltage lock		0xB13D	Read Only		0 normal, 1 locked If the voltage of the converter is too low for several consecutive times within a certain period time, the lock alarm is triggered	Stop the compressor
14	Inverter phase loss lock		0xB13E	Read Only		0 normal, 1 locked The locking alarm will be triggered if the frequency converter is out of phase for many times in a certain time	Stop the compressor
15	Other inverter fault lock		0xB13F	Read Only		0 normal, 1 locked The locking alarm will be triggered by other faults of the frequency converter for many times in a certain time	Stop the compressor
16	Heating failure		0xB10B	Read Only		0 normal, 1 fault Heating fault alarm	No this warning
17	Heating fault lock		0xB142	Read Only		0 normal, 1 locked The locking alarm will be triggered if	No this warning

						the electric heating fails for many times in a certain period of time	
18	Coolant replenishment alarm		0xB132	Read Only		0 normal, 1 lack of coolant System coolant shortage alarm	Chiller Shut down
19	System high pressure alarm		0xB11C	Read Only		0 normal, 1 fault High system pressure alarm	Stop the compressor
20	High outlet pressure alarm		0xB130	Read Only		0 normal, 1 fault When the outlet pressure is＞2.2 bar, alarm will be generated, and when it is ＜ 1.9 bar, the alarm will be released	Only alarm, does not act.
Pump information							
1	Pump command speed	%	0xA201	Read Only	x 10	If the value read is 300, it means that the pump is commanded to work at 30% speed, range [0,1000]	
2	Flow rate selection		0x9809	Read/Write		Range [0,3] 0:60L/min@100Kpa 1:80L/min@60Kpa 2:50L/min@75Kpa 3:50L/min@30Kpa	

Heartbeat information							
1	Heartbeat		0x8004	Read Only		Range [0,65535], when it reaches 65535, it starts from 0 and increases by 1 every second	
Communicate Information							
1	ID		0x9000	Read/Write		[1,247]	
2	Baudrate		0x8A09	Read/Write		[4800,57600]	
Password information							
1	Password		0x8100	Read/Write		Password is 1, valid time is 180s	
Compressor							
1	Compressor gear selection	%	0x8928	Read/Write		[0,3] 0: 100% 1: 75% 2: 60% 3: 50%	
2	Compressor speed setting	Hz	0x890A	Read/Write		{249,189,150,126} 249:100% 189:75% 150:60% 126:50%	
Software Information							
1	Software part number		0xFE51	Read/Write		It can be written, but DO NEVER USE THIS. Frozen the “write” function on host computer	
2	Software version number		0xFE52	Read/Write		It can be written, but DO NEVER USE THIS. Frozen the “write”	

						function on host computer	

For example:

① Read the value of a single register - data:

Send command:01 03 00 01 00 01 D5 CA
Return instruction:01 03 02 40 11 49 88
Parsing instructions:

01 ADDR
03 CMD
02 Length
40 11 Data
49 88 CRC

② Read the value of multiple registers-1#-2#-3# return air temperature:

Send command:01 03 01 00 00 03 04 37
Return instruction:01 03 06 01 08 01 20 00 FE 40 D3
Parsing instructions:

01 ADDR
03 CMD
06 Length

01 08 Data:1# return air temperature, Decimal 264→26.4℃

01 20 Data:2# return air temperature, Decimal 288→28.8℃

00 FE Data:3# return air temperature, Decimal 254→25.4℃

40 D3 CRC

③ Write Single Register-Temp set point 30℃:

Send command:01 06 03 00 01 2C 89 C3
Return instruction:01 06 03 00 01 2C 89 C3
Parsing instructions:

01 ADDR

06 CMD
03 00 Register address

01 2C Data: Decimal 300→30℃

89 C3 CRC

④ Write the value of multiple registers-High Temp set point40℃-Low Temp set point1℃

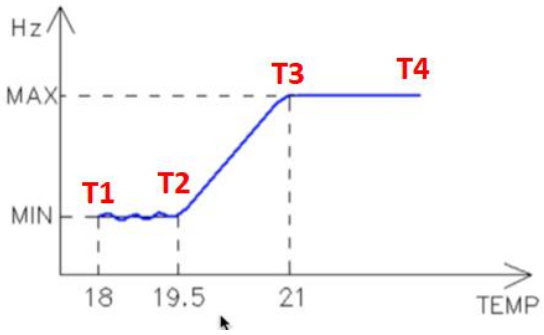
Send command:01 10 03 04 00 02 04 01 90 00 96 67 13
Return instruction:01 10 03 04 00 02 00 4D
Parsing instructions:

01 ADDR
10 CMD
03 04 Start register address
00 02 Register number
00 4D CRC

Note: Although the 0x10 Write multiple registers, the instruction can be sent and return success, but only to modify the address of the first register, other modifications unsuccessful, does not return an exception.

8. Appendix

Cooling set point explanation:



- T1 is the set point that can be set and read at the Modbus register 0x8B0C, and corresponds to the fluid temperature below which the chiller controller will turn the compressor OFF
- T2 is 1.5° C (if hysteresis set at 3° C) above T1 and corresponds to the cooling fluid temperature above which the chiller controller will turn the compressor ON
- Between T1 and T2 the compressor operating load is 21%
- T3 is 3° C (if hysteresis set at 3° C) above T1 and corresponds to the fluid temperature where the compressor reaches 100% of its capacity
- T4 is any other temperature of the cooling fluid above T3, and helps to indicate that the compressor will not continue to increase its capacity beyond T3