Monigear Device - Modbus TCP Communication Protocol

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1. Protocol Introduction

Modbus TCP uses Ethernet TCP/IP to transmit Modbus messages between sites. TCP/IP network provides data segmentation, confirmation, retransmission, addressing, routing, and other functions, ensuring that Modbus messages are correctly routed, reliably, and orderly transmitted between Ethernet devices, achieving efficient and reliable data exchange.

2. Client-Server Communication

Modbus TCP adopts a master-slave response method. The upper computer acts as the client (master) to send requests over the network, and the server (slave) processes the requests and sends back responses. The device acts as the server, actively listening to TCP port 502, waiting for client connection requests. After the connection is successfully established, it responds to data communication requests that comply with the Modbus TCP protocol.

3. Protocol Format

Modbus TCP data frame consists of the message header MBAP and the frame structure PDU. The MBAP header is 7 bytes long, composed as follows:

Transaction Identifier	Protocol Identifier	Length	Unit Identifier
2 bytes	2 bytes	2 bytes	1 byte

3.1 Description of each part of the MBAP:

Content	Description
Transaction ID	Sequence number of the message, generally incremented by 1 for each communication, used to distinguish different packet.
Protocol ID	00 00 indicates Modbus TCP
Length	the length of the following data, in bytes
Unit ID	Identifies the target device or unit within the Modbus network, can be understood as the device address

The PDU frame structure consists of a function code and a data field. The function code is 1 byte long, and the length and content of the data field depend on the specific function. The function codes supported by the device are as follows:

Function Code	**Function**	**Description**
0x01	Read Coils	Read one or more digital input/output (DIO) data
0x03	Read Holding Registers	Read one or more analog input/output (AIO) data
0x05	Write Single Coil	Write/control a single digital output (DIO)
0x06	Write Single Holding Register	Write/control a single analog output (AIO)

3.2 Example: Reading Digital input

Request frame information: Read device address 1, coil starting address 0000, and read 8 coils.

Transaction Identifier		Protocol Identifier		Length		Unit ID	Functio n Code	Coil Starting Address		Number of Coils	
0x00	0x01	0x00	0x00	0x00	0x06	0x00	0x01	0x00	0x00	0x00	0x08

Response frame information:

Transaction Identifier		Protocol Identifier		Length		Unit ID	Function Code	Number of Data Bytes	Data Content
0x00	0x01	0x00	0x00	0x00	0x06	0x00	0x01	0x01	0xFF

3.3 Example: Reading Analog Inputs

Request frame information: Read device address 0, register starting address 0002, and read 2 registers.

Transaction Identifier	Protocol Identifier	Length	Unit ID	Function Code	Register Starting Address	Number of Registers

0x00	0x02	0x00	0x00	0x00	0x06	0x00	0x03	0x00	0x02	0x00	0x02

Response frame information:

Transaction Identifier		Protocol Identifier		Length		Unit ID	Function Code	Number of Data Bytes	Data Content (HEX)			
0x00	0x02	0x00	0x00	0x00	0x07	0x00	0x03	0x04	59	17	42	43

3.4 Communication Errors

Typically, the master (computer) sends request data to the slave (device), and the slave responds and processes the request. However, communication errors may occur in the following situations:

- TCP/IP network anomalies, detected by the master program as query timeout or network interruption.
- The slave receives the request data without communication errors but cannot process it (e.g., reading a nonexistent register address) and reports the error to the master.

When the slave reports an error, the function code and data field differ from a normal response.

Function Code:

- For normal responses, the slave's response function code is the same as the master's request function code. All function codes have an MSB of 0 (value less than 80H).
- For abnormal responses, the slave sets the MSB of the function code to 1, making the value greater than 80H, higher than normal response values. The master application identifies abnormal response events by recognizing these values and checks the error code further.

Data Field:

- For normal responses, the data field contains the data or statistics requested.
- For abnormal responses, the data field contains an exception code explaining the condition and reason for the abnormal response.

Error Codes and Meanings

Code	Name	Meaning
0x01	Illegal Function	The received function code does not exist in the slave's program.
0x02	Illegal Data Address	The requested data address is not allowed by the slave; e.g., incorrect starting address for coils or registers, query count exceeds valid range.

Example: Abnormal Response

Request frame information: Read device address 0, register starting address 0123, and read 2 registers.

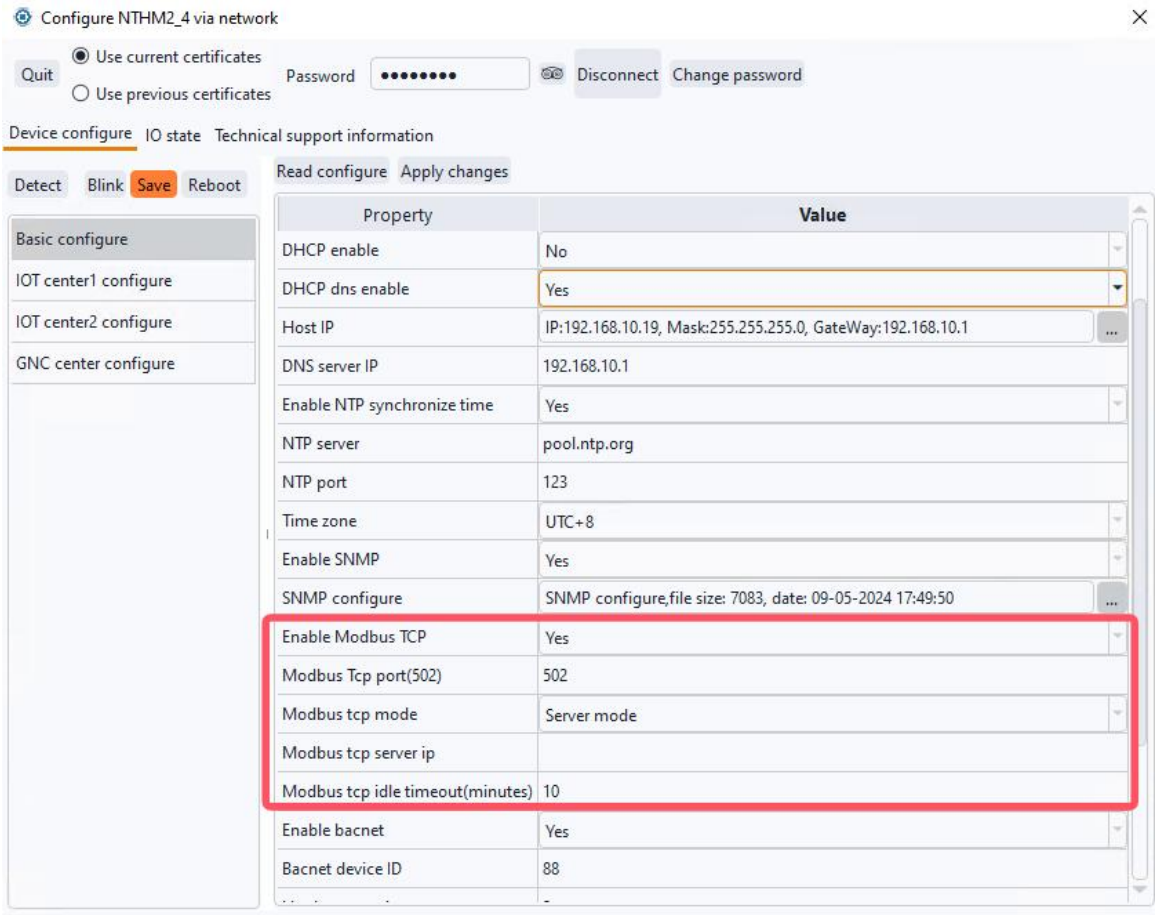
Transaction Identifier		Protocol Identifier		Length		Unit Id	Function Code	Register Starting Address		Number of Registers	
0x00	0x03	0x00	0x00	0	0x06	0x00	0x03	0x01	0x23	0x00	0x02

Response frame information: Due to incorrect register starting address, the response indicates an illegal data address.

Transaction Identifier		Protocol Identifier		Length		Unit Id	Function Code	Data Content
0x00	0x03	0x00	0x00	0x00	0x07	0x00	0x83	0x02

4. Enabling Modbus TCP Function on the Device

Use the network device configuration tool to connect to the device, then enable the Modbus TCP function in the basic settings.

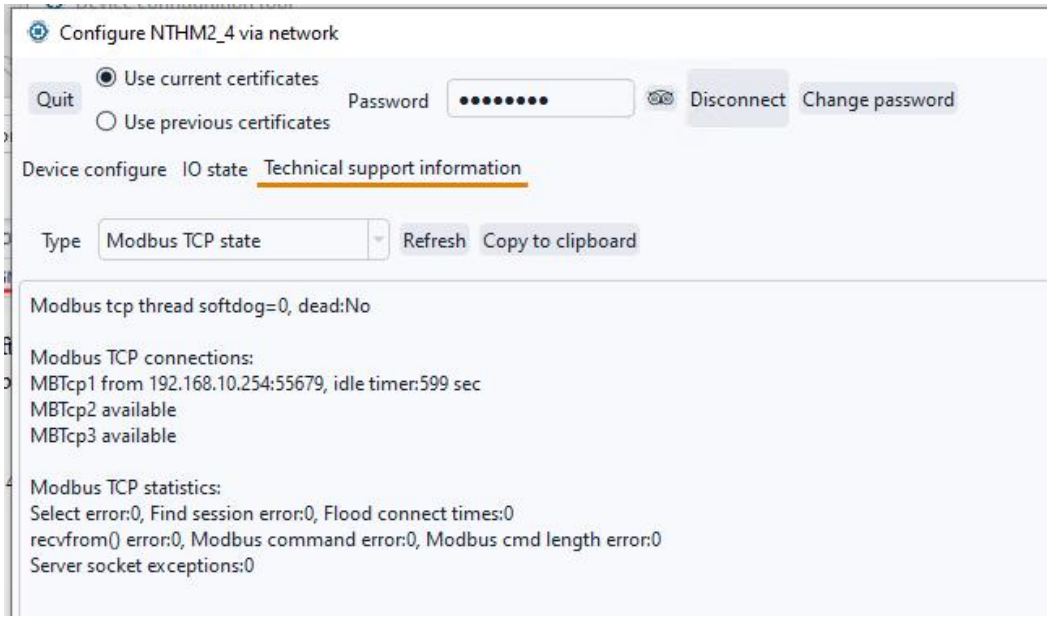


Modbus TCP Function Configuration Items

Configuration Item	Description
Enable Modbus TCP	Enable this function, because the modbus tcp function is not a safe way for communication in the internet, so it was disabled by default.
Modbus tcp port	Default 502
Modbus tcp mode	Server mode/Client mode Server mode is default. Some software developers want the device to actively connect to a certain port of the server, and only after the connection is connected will the software side initiate the query command of the modbus protocol, so the corresponding client mode has been developed.

Modbus tcp server ip	Center IP to connect to in client mode
Modbus tcp idle timeout	Disconnect and reconnect if idle for a long time (unit is minutes)

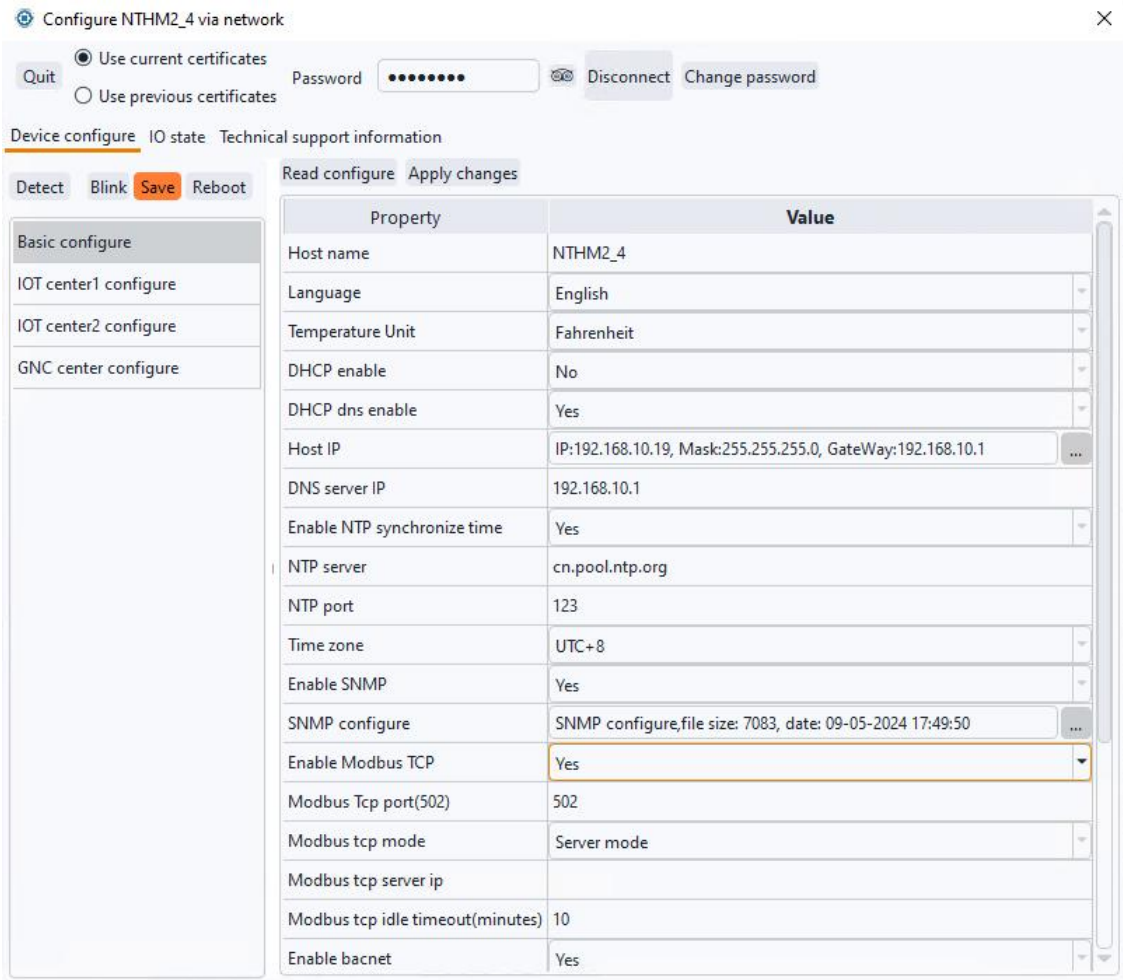
The device's Modbus TCP function supports up to 3 clients connected to the device's TCP 502 port in server mode. Check the status statistics of this function in the technical support information.



5. Test Example

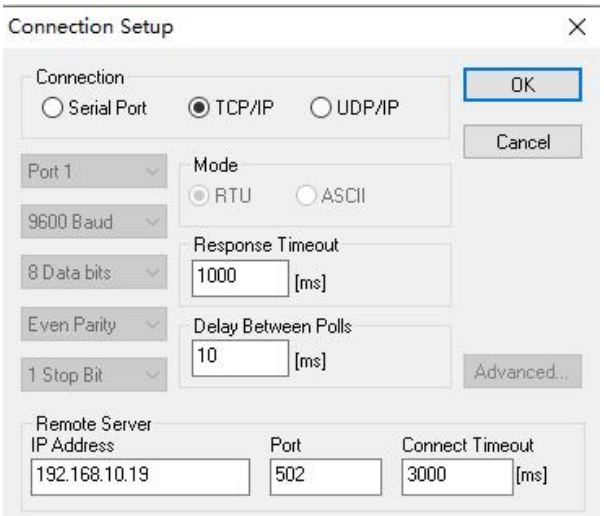
Using the network temperature and humidity transmitter MN-NHTM as an example, enable the Modbus TCP function and use the testing tool mbpoll to read real-time temperature and humidity data.

Refer to the following diagram for device IP and function settings, for example:

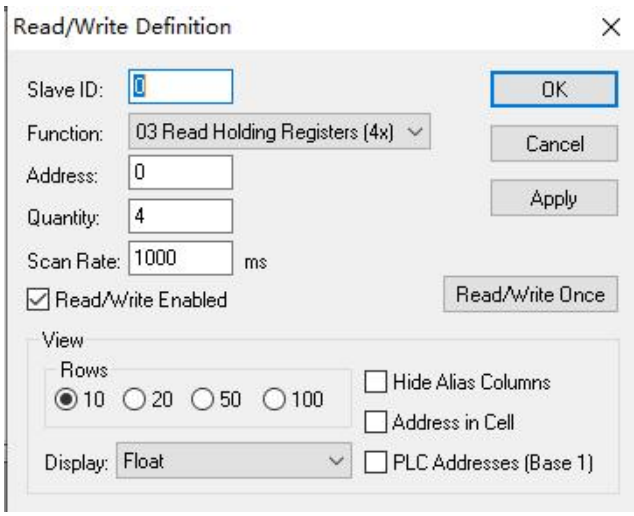


Viewing Current Temperature and Humidity

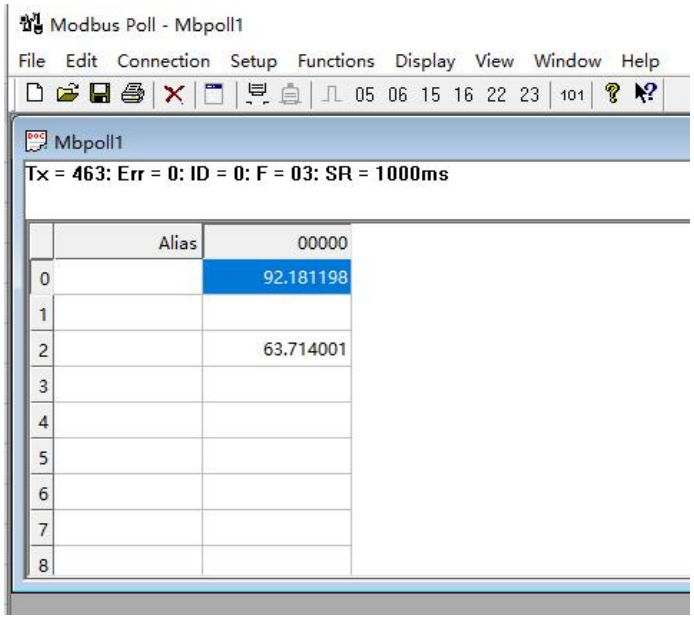
Open the mbpoll testing tool, select Connection -> Connect (shortcut key F3) from the menu bar, choose TCP/IP in the connection settings page, and enter the device's IP address and default port number 502.



After successfully connecting to the device using mbpoll, select Setup -> Read/Write Definition (shortcut key F8) from the menu bar. Set the Modbus TCP command's device address/SlaveID, function code, data address, quantity to read, and display method.



Viewing Real-Time Temperature and Humidity Values



6. Modbus Address Table

Common Modbus address table for devices.

6.1 Network Temperature and Humidity Transmitter MN-NHTM

Analog values (device address 0, function code 0x03)

Address	Name	R/W	Data type	Unit	Remark
0	Temperature	R	Float	℃/F	-30-85 ℃
2	Hmidity	R	Float	% RH	0-100 %RH

6.2 Network series Gas transmitter

e.g., MN-NCO2 for monit CO2 concentration

Analog values (device address 0, function code 0x03)

Address	Name	R/W	Data type	Unit	Remark
0	Gas Indicator (CO2 Concentration)	R	Float	ppm	0-2000ppm

6.3 Multifunction Input/Output Module MN-NIO

Digital values (device address 0, function codes 0x01/0x05)

Address	Name	R/W	Data type	Description	备注
0	DI1	R	bit	0: closed,1:open	Digital input1
1	DI2	R	bit	0: closed,1:open	Digital input2
2	DI3	R	bit	0: closed,1:open	Digital input3
3	DI4	R	bit	0: closed,1:open	Digital input4
4	DI5	R	bit	0: closed,1:open	Digital input5
5	DI6	R	bit	0: closed,1:open	Digital input6
6	DI7	R	bit	0: closed,1:open	Digital input7
7	DI8	R	bit	0: closed,1:open	Digital input8
8	DO9	RW	bit	0: open,1:closed	Relay1
9	DO10	RW	bit	0: open,1:closed	Relay2
10	DO11	RW	bit	0: open,1:closed	Relay3
11	DO12	RW	bit	0: open,1:closed	Relay4

Note: The general used digital input interface corresponds to the dry contact sensor, and the actual name and 0/1 value description of each channel are defined depending on the sensor type. For example, the smoke alarm connected to DI1 is actually called smoke detector status, 0: normal 1: alarm.

Analog values (device address 0, function code 0x03)

Address	Name	R/W	Data type	Unit	Remark
0	AI1	R	Float	\	Analog input1
2	AI2	R	Float	\	Analog input2
4	AI3	R	Float	\	Analog input3
6	AI4	R	Float	\	Analog input4
8	AI5	R	Float	\	Analog input5
10	AI6	R	Float	\	Analog input6

12	AI7	R	Float	\	Analog input7
14	AI8	R	Float	\	Analog input8

Note: The general used analogue input interface corresponds to industrial standard 4-20mA sensors, and the actual name and unit of each channel depends on the sensor type. For example, AI1 is connected to a 4-20mA water level transmitter, which is actually called water level. In addition, the upper and lower limits of analog quantities are further set according to the range of the sensor.