Where to send a Modbus TCP command?

In an Ethernet network, the device address is its IP address. Typically, devices are on the same subnet, where IP addresses differ by the last two digit 192.168.1.**20** when using the most common subnet mask 255.255.255.0.

The interface is an **Ethernet** network, the data transfer protocol is **TCP / IP**.

The TCP port used is: **502**.

Back to contents

Description of the Modbus TCP protocol

The Modbus TCP command consists of a portion of the Modbus RTU message and a special header.

From the Modbus RTU message, the SlaveID address at the beginning and the CRC checksum at the end are removed, which forms the PDU, the Protocol Data Unit.

The following is an example of a Modbus RTU request for obtaining the AI value of the holding registers from registers # 40108 to 40110 with the address of the device 17.

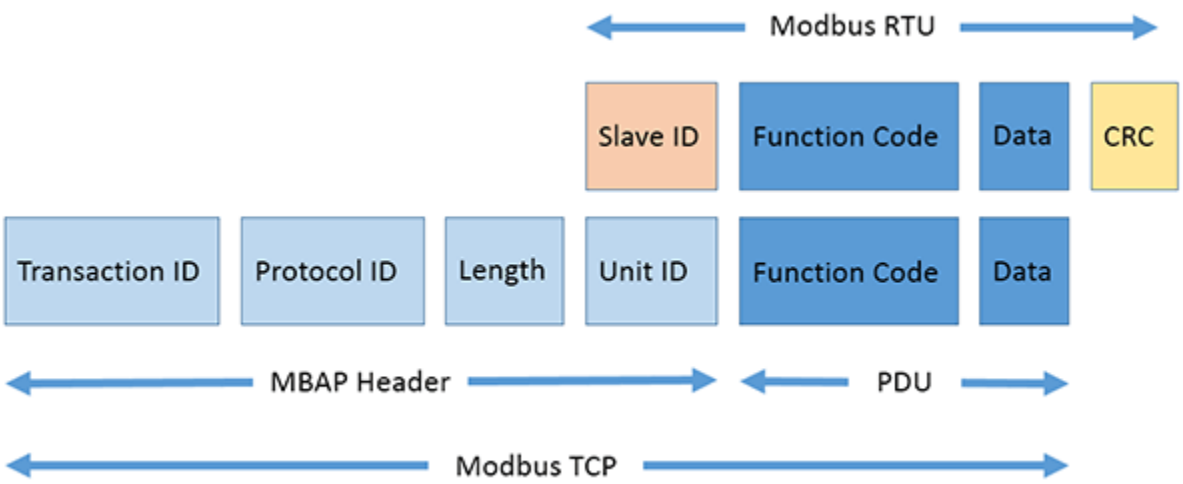
11 03 006B 0003 7687

11	Device address SlaveID (17 = **11** hex)
03	Function Code (read Analog Output Holding Registers)
006B	Address of the first register (40108-40001 = 107 = **6B** hex)
0003	The number of required registers (reading 3 registers from 40108 to 40110)
7687	Checksum CRC

We drop the address of the SlaveID device and the CRC checksum and get the PDU: 03 006B 0003

03 006B 0003

At the beginning of the received PDU message, a new 7-byte header is added, which is called MBAP Header (Modbus Application Header). This header has the following data:



Transaction Identifier: 2 bytes are set by the Master to uniquely identify each request. Can be any. These bytes are repeated by the Slave device in the response, since the responses of the Slave device may not always be received in the same order as the requests.

Protocol Identifier: 2 bytes are set by the Master, will always be 00 00, which corresponds to the Modbus protocol.

Length: 2 bytes are set by the Master, identifying the number of bytes in the message that follow. It is counted from Unit Identifier to the end of the message.

Unit Identifier: 1 byte is set to Master. It is repeated by the Slave device to uniquely identify the Slave device.

Total we get:

Modbus RTU	Slave ID	Inquiry	CRC
Modbus RTU	11	**03 006B 0003**	7687
Modbus TCP	0001 0000 0006 11	**03 006B 0003**	
Modbus TCP	MBAP Header	PDU	

Modbus TCP	ADU, Application Data Unit	

Where:

0001	**Transaction identifier**	Transaction Identifier
0000	**Protocol identifier La**	Protocol Identifier
0006	**Length** (6 bytes are followed)	Message Length
11	**The device address** (17 = 11 hex)	Unit Identifier
03	**Function code** (read Analog Output Holding Registers)	Function Code
006B	**First address register** (107 = 40108-40001 = 6B hex)	Data Address of the first register
0003	**The number of required registers** (read 3 registers 40108 by 40110)	The total number of registers

In the response from the Modbus TCP Slave device we get:

0001 0000 0009 11 **03 06 022B 0064 007F**

Where:

0001	**Transaction identifier**	Transaction Identifier
0000	**Protocol identifier**	Protocol Identifier
0009	**The length** (9 bytes are followed)	Message Length
11	**The device address** (17 = 11 hex)	Unit Identifier

03	**Function code** (read Analog Output Holding Registers)	Function Code
06	**The number of bytes later** (6 bytes are followed)	Byte Count
02	**Value of the high register bit** (02 hex)	Register value Hi (AO0)
2B	**Early discharge value register** (2B hex)	Register value Lo (AO0)
00	**Value of the high register bit** (00 hex)	Register value Hi (AO1)
64	**Value of the low register bit** (64 hex)	Register value Lo (AO1)
00	**Value of the high register bit** (00 hex)	Register value Hi (AO2)
7F	**Early discharge value register** (7F hex)	Register value Lo (AO2)

The analog output register AO0 has the value 02 2B HEX or 555 in the decimal system.

The analog output register AO1 has the value 00 64 HEX or 100 in the decimal system.

The analog output register AO2 has the value 00 7F HEX or 127 in the decimal system.

Back to contents

Modbus TCP command types

Here is a table with the codes for reading and writing the Modbus TCP registers.

Function Code	What the function does		Value type	Access type
01 (0x01)	Reading DO	Read Coil Status	Discrete	Reading

02 (0x02)	Reading DI	Read Input Status	Discrete	Reading
03 (0x03)	Reading AO	Read Holding Registers	16 bit	Reading
04 (0x04)	Reading AI	Read Input Registers	16 bit	Reading
05 (0x05)	One DO recording	Force Single Coil	Discrete	Recording
06 (0x06)	Recording one AO	Preset Single Register	16 bit	Recording
15 (0x0F)	Multiple DO recording	Force Multiple Coils	Discrete	Recording
16 (0x10)	Recording multiple AOs	Preset Multiple Registers	16 bit	Recording

Back to contents

How do I send a Modbus TCP command to read discrete output? Command 0x01

This command is used to read the values of the DO digital outputs.

The PDU request specifies the start address of the first DO register and the subsequent number of required DO values. In the PDU, the DO values are addressed starting from zero.

The DO values in the response are in one byte and correspond to the value of the bits.

The bit values are defined as 1 = ON and 0 = OFF.

The low bit of the first data byte contains the DO value whose address was specified in the request. The remaining values of DO follow the increasing value to the highest value of the byte. Those. from right to left.

If less than eight DO values were requested, the remaining bits in the response will be filled with zeros (in the direction from the low to high byte). Field Byte Count **Number byte further** indicates the number of full data bytes in response.

Byte	Request	Byte	Answer
(Hex)	Field name	(Hex)	Field name
01	**Transaction identifier**	01	**Transaction identifier**
02		02	
00	**Protocol identifier**	00	**Protocol identifier**
00		00	
00	**Message length**	00	**Message length**
06		04	
01	Device address	01	Device address
01	Functional code	01	Functional code
00	Address of the first byte of register Hi	01	Number of bytes more
00	Address of the first byte of register Lo	02	The value of register DO 0-1
00	Number of registers Hi Byte		
02	Number of registers Lo Byte		

The output states DO0-1 are shown as 02 hex values, or in the binary system 0000 0010.

The DO1 value will be the second to the right, and DO0 will be the first on the right (low-order bit).

The other six bits are filled with zeros to the full byte, because They were not requested.

Channels	-	-	-	-	-	-	DO 1	DO 0
Bits	0	0	0	0	0	0	1	0
Hex	02							

Back to contents

How to send a Modbus TCP command to read a digital input? Command 0x02

This command is used to read the values of digital inputs DI.

The query and response for DI is similar to the query for DO.

Byte	Request	Byte	Answer
(Hex)	Field name	(Hex)	Field name
01	**Transaction identifier**	01	**Transaction identifier**
02		02	
00	**Protocol identifier**	00	**Protocol identifier**
00		00	
00	**Message length**	00	**Message length**

06		04	
01	Device address	01	Device address
02	Functional code	02	Functional code
00	Address of the first byte of register Hi	01	Number of bytes more
00	Address of the first byte of register Lo	03	The value of register DI 0-1
00	Number of registers Hi Byte		
02	Number of registers Lo Byte		

The output states of DI 0-1 are shown as 03 hex values, or in the binary system 0000 0011.

The DI1 value will be the second to the right, and the value of DI0 will be the first right (low-order bit).

The other six bits are filled with zeros.

Back to contents

How to send a Modbus TCP command to read the analog output? Command 0x03

This command is used to read the values of the analog outputs AO.

Byte	Request	Byte	Answer
(Hex)	**Field name**	(Hex)	**Field name**

01	**Transaction identifier**	01	**Transaction identifier**
02		02	
00	**Protocol identifier**	00	**Protocol identifier**
00		00	
00	**Message length**	00	**Message length**
06		07	
01	Device address	01	Device address
03	Functional code	03	Functional code
00	Address of the first byte of register Hi	04	Number of bytes more
00	Address of the first byte of register Lo	02	Register value Hi (AO0)
00	Number of registers Hi Byte	2B	Register value Lo (AO0)
02	Number of registers Lo Byte	00	Register value Hi (AO1)
		64	Register value Lo (AO1)

The output states AO0 are shown as 02 byte 2B hex, or in the decimal system 555.

The output states AO1 are shown as the byte values 00 64 hex, or in the decimal system 100.

Back to contents

How to send a Modbus TCP command to read an analog input? Command 0x04

This command is used to read the values of analog inputs AI.

Byte	Request	Byte	Answer
(Hex)	**Field name**	(Hex)	**Field name**
01	**Transaction identifier**	01	**Transaction identifier**
02		02	
00	**Protocol identifier**	00	**Protocol identifier**
00		00	
00	**Message length**	00	**Message length**
06		07	
01	Device address	01	Device address
04	Functional code	04	Functional code
00	Address of the first byte of register Hi	04	Number of bytes more
00	Address of the first byte of register Lo	00	Register value Hi (AI0)
00	Number of registers Hi Byte	0A	Register value Lo (AI0)
02	Number of registers Lo Byte	00	Register value Hi (AI1)

	64	Register value Lo (AI1)

The output states AI0 are shown as 00 0A hex values, or in the decimal system 10.

The output states AI1 are shown as the byte values 00 64 hex, or in the decimal system 100.

Back to contents

How do I send a Modbus TCP command to write discrete output? Command 0x05

This command is used to record one value of the DO digital output.

The value of FF 00 hex sets the output to ON.

The value 00 00 hex sets the output to OFF.

All other values are invalid and will not affect the output state.

The normal response to such a request is an echo (a repeat request in the response), is returned after the DO state has been changed.

Byte	Request	Byte	Answer
(Hex)	**Field name**	(Hex)	**Field name**
01	**Transaction identifier**	01	**Transaction identifier**
02		02	
00	**Protocol identifier**	00	**Protocol identifier**
00		00	
00	**Message length**	00	**Message length**

06		06	
01	Device address	01	Device address
05	Functional code	05	Functional code
00	Hi Register Address byte	00	Hi Register Address byte
01	Lo Register Address byte	01	Lo Register Address byte
FF	Hi Byte Meaning	FF	Hi Byte Meaning
00	Lo Byte Meaning	00	Lo Byte Meaning

The output status of DO1 has changed from OFF to ON.

Back to contents

How do I send a Modbus TCP command to record analog output? Command 0x06

This command is used to record one value of the analog output AO.

Byte	Request	Byte	Answer
(Hex)	**Field name**	(Hex)	**Field name**
01	**Transaction identifier**	01	**Transaction identifier**
02		02	
00	**Protocol identifier**	00	**Protocol identifier**

00		00	
00	**Message length**	00	**Message length**
06		06	
01	Device address	01	Device address
06	Functional code	06	Functional code
00	Hi Register Address byte	00	Hi Register Address byte
01	Lo Register Address byte	01	Lo Register Address byte
55	Hi Byte Meaning	55	Hi Byte Meaning
FF	Lo Byte Meaning	FF	Lo Byte Meaning

The output status of AO0 has changed to 55 FF hex, or in the decimal system 22015.

Back to contents

How do I send a Modbus TCP command to write multiple discrete pins? Command 0x0F

This command is used to record multiple values of DO's digital output.

Byte	Request	Byte	Answer
(Hex)	**Field name**	(Hex)	**Field name**
01	**Transaction identifier**	01	**Transaction identifier**

02		02	
00	**Protocol identifier**	00	**Protocol identifier**
00		00	
00	**Message length**	00	**Message length**
08		06	
01	Device address	01	Device address
0F	Functional code	0F	Functional code
00	Address of the first byte of register Hi	00	Address of the first byte of register Hi
00	Address of the first byte of register Lo	00	Address of the first byte of register Lo
00	Number of registers Hi Byte	00	Number of recorded reg. Hi byte
02	Number of registers Lo Byte	02	Number of recorded reg. Lo bytes
01	Number of bytes more		
02	Byte Value		

The output status of DO1 has changed from OFF to ON.

The DO0 output state remains OFF.

Back to contents

How do I send a Modbus TCP command to write multiple analog outputs? Command 0x10

This command is used to record multiple values of the analog output AO.

Byte	Request	Byte	Answer
(Hex)	**Field name**	(Hex)	**Field name**
01	**Transaction identifier**	01	**Transaction identifier**
02		02	
00	**Protocol identifier**	00	**Protocol identifier**
00		00	
00	**Message length**	00	**Message length**
0B		06	
01	Device address	01	Device address
10	Functional code	10	Functional code
00	Address of the first byte of register Hi	00	Address of the first byte of register Hi
00	Address of the first byte of register Lo	00	Address of the first byte of register Lo
00	Number of registers Hi Byte	00	Number of recorded reg. Hi byte

02	Number of registers Lo Byte	02	Number of recorded reg. Lo bytes
04	Number of bytes more		
00	Byte value Hi AO0		
0A	Byte value Lo AO0		
01	Byte value Hi AO1		
02	Byte value Lo AO1		

The output state of AO0 has changed to 00 0A hex, or in decimal system 10.

The output status of AO1 has changed to 01 02 hex, or in the decimal system 258.

Back to contents

Modbus TCP request errors

If the device can not process it after receiving the request, the response will be sent with an error code.

The response will contain the modified Function code, its high-order bit will be 1.

Example:

It was	Became
Functional code in the query	**Functional error code in response**
01 (01 hex) 0000 0001	129 (81 hex) 1000 0001
02 (02 hex) 0000 0010	130 (82 hex) 1000 0010

03 (03 hex) 0000 0011	131 (83 hex) 1000 0011
04 (04 hex) 0000 0100	132 (84 hex) 1000 0100
05 (05 hex) 0000 0101	133 (85 hex) 1000 0101
06 (06 hex) 0000 0110	134 (86 hex) 1000 0110
15 (0F hex) 0000 1111	143 (8F hex) 1000 1111
16 (10 hex) 0001 0000	144 (90 hex) 1001 0000

Sample request and response with error:

Byte	Request	Byte	Answer
(Hex)	**Field name**	(Hex)	**Field name**
01	**Transaction identifier**	01	**Transaction identifier**
02		02	
00	**Protocol identifier**	00	**Protocol identifier**
00		00	
00	**Message length**	00	**Message length**
06		03	
0A	Device address	0A	Device address

01	Functional code	81	Functional code with changed bit
04	Address of the first byte of register Hi	02	Error code
A1	Address of the first byte of register Lo		
00	Number of registers Hi Byte		
01	Number of registers Lo Byte		

Explanation of error codes

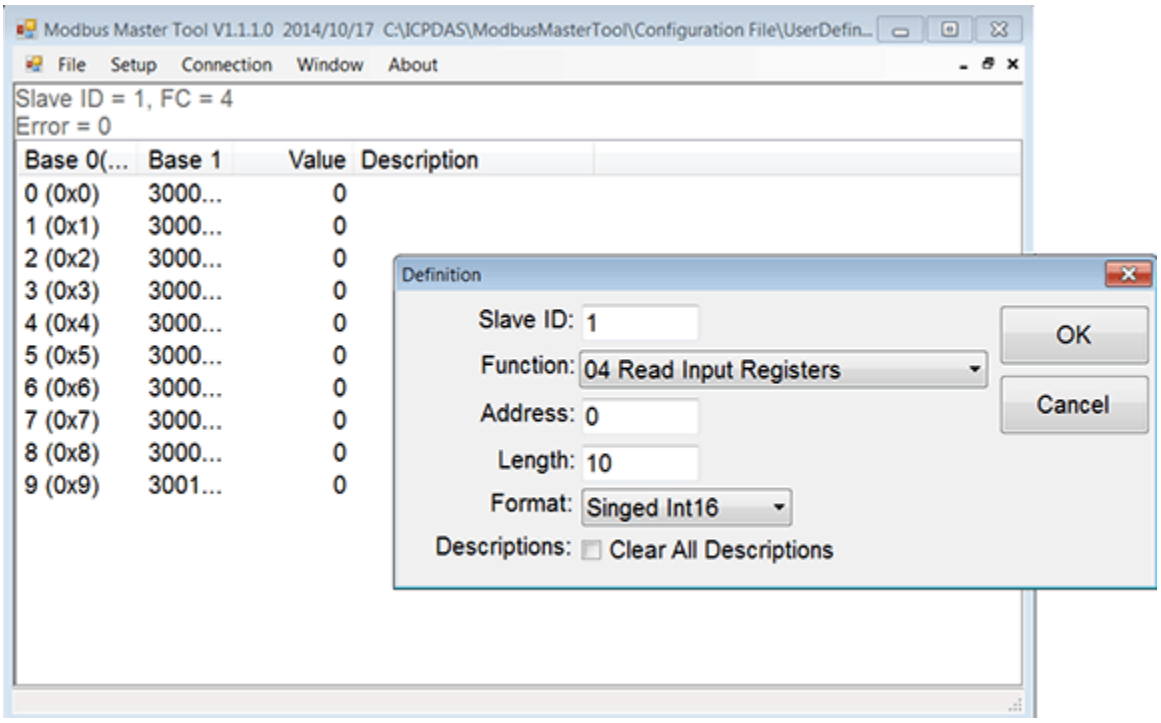
01	The received function code can not be processed.
02	The data address specified in the request is not available.
03	The value contained in the query data field is an invalid value.
04	An unrecoverable error occurred while the slave attempted to perform the requested action.
05	The slave has accepted the request and processes it, but it takes a long time. This response prevents the host from generating a timeout error.
06	The slave is busy processing the command. The master must repeat the message later when the slave is freed.
07	The slave can not execute the program function specified in the request. This code is returned for an unsuccessful program request using functions with numbers 13 or 14. The master must request diagnostic information or error information from the slave.
08	The slave detected a parity error when reading the extended memory. The master can repeat the request, but usually in such cases, repairs are required.

Back to contents

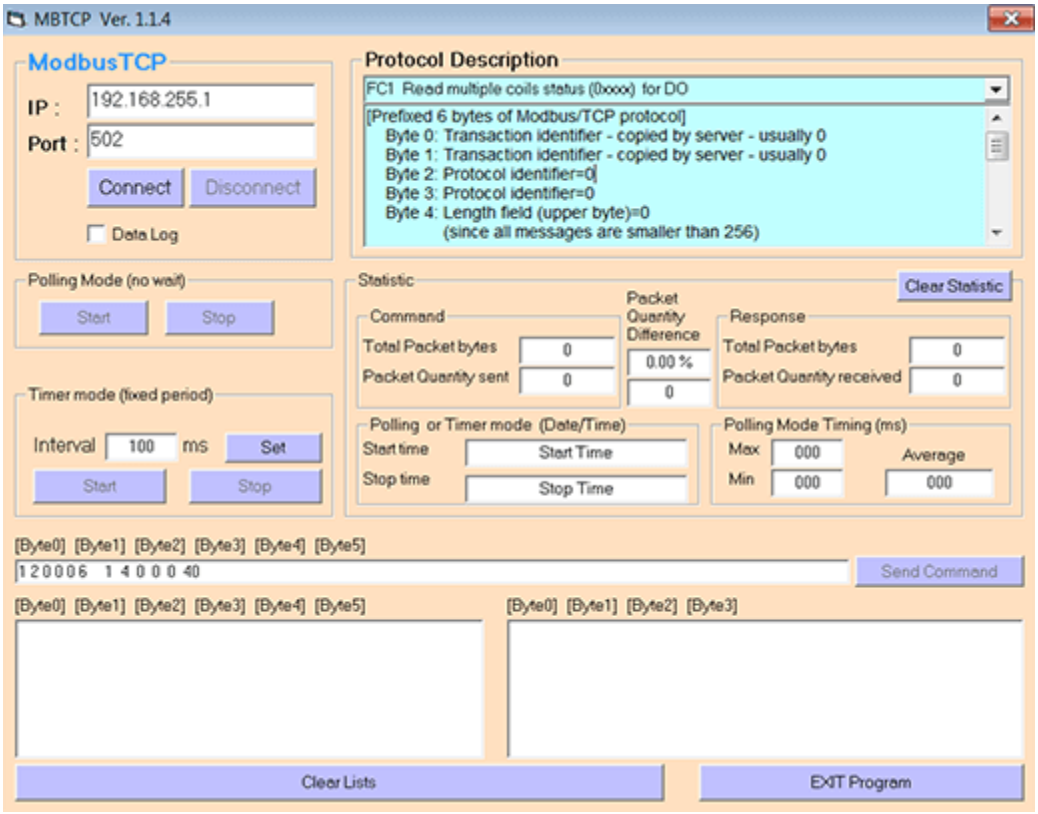
Programs for working with the Modbus TCP protocol

Below are the programs that will help you easily interact with Modbus TCP devices.

Modbus Master Tool with support for Modbus RTU, ASCII, TCP. Download



Modbus TCP client with support for Modbus TCP. Download



Back to contents