

# 13 Modbus

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# 13.1 Introduction

Modbus is a communication protocol for use with its programmable logic controllers (PLCs). Modbus has become a de facto standard communication protocol and is now a commonly available means of connecting industrial electronic devices. It was developed for industrial applications, is relatively easy to deploy and maintain compared to other standards, and places few restrictions other than size on the format of the data to be transmitted.

Modbus enables communication among many devices connected to the same network, for example, a system that measures temperature and humidity and communicates the results to a computer. Modbus is often used to connect a supervisory computer with a remote terminal unit (RTU) in supervisory control and data acquisition (SCADA) systems. Many of the data types are named from industry usage of Ladder logic and its use in driving relays: a single-bit physical output is called a coil, and a single-bit physical input is called a discrete input or a contact.

WCC Lite supports both Modbus Master and Slave protocols. One can select between transmission over TCP/IP or serial connection (RS-485/RS232). Bytes to transmit can either be encoded according to both RTU and ASCII parts of standard.

# 13.2 Modbus Master

Modbus communication contains a single Master and may include more than 1, but not more than 247 devices. To gather data from peripheral devices, master device request a cluster of slave devices for data. If any device understand that this message is addressed for it – it replies with data. As no timestamp is sent along with data, having recent data requires frequent polling. WCC Lite can be configured to acquire data periodically in custom-defined intervals.

## Configuring datapoints

To use Modbus Master in WCC Lite, it has to be configured via an Excel configuration. This configuration contains two Excel sheets where parameters have to be filled in - Devices and Signals

### Modbus Master parameters for Devices tab

| Parameter    | Type    | Description   | Required |               | Default Value<br>(when not specified) | Range   |       |
|--------------|---------|---|----------|---------------|---------------------------------------|---|-------|
|              |         |   | TCP      | RTU/A<br>SCII |                                       | Min   | Max   |
| name         | string  | User-friendly name for a device   | Yes      | Yes           |                                       |   |       |
| description  | string  | Description of a device   | No       | No            |                                       |   |       |
| device_alias | string  | Alphanumeric string to identify a device  | Yes      | Yes           |                                       |   |       |
| enable       | boolean | Enabling/disabling of a device  | No       | No            | 1                                     | 0   | 1     |
| protocol     | string  | Protocol to be used   | Yes      | Yes           |                                       | Modbus RTU, Modbus TCP  |       |
| ip           | string  | IP address of TCP slave device  | Yes      | -             |                                       |   |       |
| port         | integer | TCP communication port  | Yes      | -             | 502                                   |   |       |
| bind_address | string  | IP address of network adapter used to connect to slave device (Default: "0.0.0.0")                                    | No       | No            | 0.0.0.0                               |   |       |
| id           | integer | Modbus Slave ID   | Yes      | Yes           |                                       |   |       |
| mode         | string  | Choosing between RTU ("rtu"), ASCII ("ascii") and TCP("tcp") modes. ASCII is the same as RTU, but with ASCII symbols. | No       | No            | TCP (for TCP)<br>RTU (for Serial)     | rtu, ascii, tcp   |       |
| timeout_ms   | integer | Response timeout in milliseconds  | Yes      | Yes           | 10000                                 |   |       |
| device       | string  | Communication port ("PORT1"/"PORT2")  | -        | Yes           |                                       | PORT1   | PORT2 |
| baudrate     | integer | Communication speed, baud/s   | -        | Yes           | 9600                                  | 300, 600, 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200 |       |

|                    |         |   |     |     |      |                 |   |
|--------------------|---------|---|-----|-----|------|-----------------|---|
| databits           | integer | Data bit count for communication  | -   | Yes | 8    | 6               | 9 |
| stopbits           | integer | Stop bit count for communication  | -   | Yes | 1    | 1               | 2 |
| parity             | string  | Communication parity option   | -   | Yes | none | none, even, odd |   |
| flowcontrol        | string  | Number of requests, before link is considered lost (device status signals are changed) and reconnect attempt will be issued   | -   | Yes | none | none            |   |
| scan_rate_ms       | integer | If provided and positive - all jobs will have similar scan rate - all reads and writes will be executed within this timeframe (parameter scan_rate_ms in Signals tab will be ignored) | Yes | Yes | 300  |                 |   |
| retry_count        | integer | Number of requests, before link is considered lost (device status signals are changed) and reconnect attempt will be issued   | No  | No  | 3    |                 |   |
| serial_delay       | integer | RS485 delay between read and write operations in milliseconds   | -   | Yes | 50   |                 |   |
| keep_alive_timeout | integer | Time interval for sending a keep alive packet (in milliseconds)   | No  | No  | 60   |                 |   |
| modbus_multi_write | boolean | Use 15/16 functions to write 1 register/coil (Default: 0)   | No  | No  | 0    | 0               | 1 |
| comm_restart_delay | integer | Time delay between disconnecting from slave device and restarting connection (in milliseconds) (Default: 500)   | No  | -   | 500  |                 |   |
| update             | boolean | Enable to keep updating the tags even if they have the same value.  | No  | No  | 0    | 0               | 1 |

### Modbus Master parameters for Signals tab

| Parameter    | Type   | Description   | Required |               | Default Value<br>(when not specified) | Range |     |
|--------------|--------|---|----------|---------------|---------------------------------------|-------|-----|
|              |        |   | TCP      | RTU/A<br>SCII |                                       | Min   | Max |
| signal_name  | string | User-friendly signal name                             | Yes      | Yes           |                                       |       |     |
| device_alias | string | Alphanumeric string to identify a device              | Yes      | Yes           |                                       |       |     |
| signal_alias | string | Unique alphanumeric name of the signal to be Yes used | Yes      | Yes           |                                       |       |     |

|                     |         |   |     |     |   |   |   |
|---------------------|---------|---|-----|-----|---|---|---|
| enable              | boolean | Enabling/disabling of an individual signal  | No  | No  | 1 | 0 | 1 |
| job_todo            | string  | Request to send according to Modbus specification without device address and checksum. This field can be identical on several tags to fetch them in single request              | Yes | Yes |   |   |   |
| tag_job_todo        | string  | Similar format to job_todo field. Address and length must be a subset of job field. Defines the individual tag's register(s) or coil(s). Can be described in HEX or DEC formats | Yes | Yes |   |   |   |
| number_type         | string  | Type of a number (FLOAT, DOUBLE, DIGITAL, etc.)   | Yes | Yes |   |   |   |
| log                 | integer | Size of this signal's log in Event log.   | No  | No  | 0 |   |   |
| pulse_short_time_ms | integer | Time interval for short output pulse to stay active   | No  | No  | 0 |   |   |
| pulse_long_time_ms  | integer | Time interval for long output pulse to stay active  | No  | No  | 0 |   |   |

## Device status signals

Modbus Master has an additional signal which can be configured to show communication status. It is used to indicate if the slave device has disconnected from master (WCC Lite). To configure such signal for Modbus protocol, `job_todo` and `tag_job_todo` fields with string values are required. For Modbus master required parameters for status signal will be: **signal\_name** **device\_alias**, **signal\_alias**, **number\_type**, **job\_todo** and **tag\_job\_todo**. `job_todo` value must be `device_status` and for `tag_job_todo` there are 4 variations: `communication_status`, `device_running`, `device_error`, `unknown_error`. Each signal has 4 possible values and are based on the same logic. If signal returns value of 0, it means unknown error has appeared, 1 – device or protocol connection is on and working properly, 2 – device is off or protocol is disconnected, 3 – error or service is down.

Different device vendors can have different implementations of a Modbus protocol stack. A register table can be a one of the primary differences. WCC Lite Modbus Master transmits the most significant word (byte) first, however, devices from some vendors might require transmitting the least significant word (byte) first. If that is the case, make sure to switch bytes as needed. To find out more about setting a correct number format, one should consult a section `number_type`.

Modbus job or tag (as a task to be completed) can be built in two different formats - user can select a more convenient way for him:

- hexadecimal format with every single byte separated by | symbol. Device address, bytes containing output information and CRC (LRC) bytes should be excluded from the message;
- decimal format containing function number, first address and address count, separated by ; symbol. All other information should be excluded from the message;

`job_todo` can group several `tag_job_todo`'s. That way one Modbus message can be used to extract several tags. Grouping is accomplished dynamically meaning that if several identical jobs are found, their tags are grouped automatically.

## Debugging a Modbus Master application

If configuration for Modbus Master is set up, handler for protocol will start automatically. If configuration is missing or contains errors, protocol will not start. It is done intentionally to decrease unnecessary memory usage.

Modbus Master command line debugging options

`modbus-master`

```
-h [ -help ] Display help information
-V [ -version ] Show version
-d<debug level> Set debugging level
-c [ -config ] Config path
-r [ -raw ] Show raw telegram data
-f [ -frame ] Show frame data
-s [ -serial ] Show serial port data
-tcp Show tcp packets
-ascii Show ASCII messages
```

```
-rtu Show RTU messages  
-e [ -redis ] Show redis debug information  
-R [ -readyfile ] Ready notification file
```


If Modbus Master does not work properly (e.g. no communication between devices, data is corrupted, etc.), a user can launch a debug session from command line interface and find out why link is not functioning properly. To launch a debugging session, a user should stop modbus-master process and run modbus-master command with respective flags as shown above.

# 13.3 Modbus Slave

WCC Lite can act as one (or several) of slave devices in a communication line. This can be used to transmit data to SCADA systems or other RTU devices. It can reply to a messages from Modbus Master with matching device and register addresses.

## Configuring datapoints

To use Modbus Slave in WCC Lite, it has to be configured via an Excel configuration. This configuration contains two Excel sheets where parameters have to be filled in - Devices and Signals

 If TCP/IP is used as a trasmission medium, only devices with IPs predefined in host column are allowed to connect. All other connections are rejected

### Modbus Slave parameters for Devices tab

| Parameter          | Type    | Description   | Required |               | Default Value<br>(when not specified) | Range   |       |
|--------------------|---------|---|----------|---------------|---------------------------------------|---|-------|
|                    |         |   | TCP      | RTU/A<br>SCII |                                       | Min   | Max   |
| name               | string  | User-friendly name for a device   | Yes      | Yes           |                                       |   |       |
| description        | string  | Description of a device   | No       | No            |                                       |   |       |
| device_alias       | string  | Alphanumeric string to identify a device  | Yes      | Yes           | unknown                               |   |       |
| enable             | boolean | Enabling/disabling of a device  | No       | No            | 1                                     | 0   | 1     |
| protocol           | string  | Protocol to be used   | Yes      | Yes           |                                       | Modbus serial Slave, Modbus TCP Slave                         |       |
| host               | string  | Space separated host IP addresses of master device  | Yes      | -             |                                       |   |       |
| port               | integer | TCP port to listen for incoming connections   | Yes      | -             |                                       |   |       |
| bind_address       | string  | IP address of network adapter used to connect to slave device (Default: "0.0.0.0")                                    | No       | No            | 0.0.0.0                               |   |       |
| keep_alive_timeout | integer | Minimum time a connection can be idle without being closed in milliseconds  | No       | No            | 60                                    |   |       |
| mode               | string  | Choosing between RTU ("rtu"), ASCII ("ascii") and TCP("tcp") modes. ASCII is the same as RTU, but with ASCII symbols. | No       | No            | TCP (for TCP)<br>RTU (for Serial)     | rtu, ascii, tcp   |       |
| device             | string  | Communication port ("PORT1"/"PORT2")  | -        | Yes           |                                       | PORT1   | PORT2 |
| baudrate           | integer | Communication speed, baud/s   | -        | Yes           | 9600                                  | 300, 600, 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200 |       |
| databits           | integer | Data bit count for communication  | -        | Yes           | 8                                     | 6   | 9     |
| stopbits           | integer | Stop bit count for communication  | -        | Yes           | 1                                     | 1   | 2     |
| parity             | string  | Communication parity option   | -        | Yes           | none                                  | none, even, odd   |       |

|             |        |   |   |    |      |      |
|-------------|--------|---|---|----|------|------|
| flowcontrol | string | Communication device's flow control option. | - | No | none | none |
|-------------|--------|---|---|----|------|------|

## Modbus Slave parameters for Signals tab

| Parameter          | Type    | Description   | Required |               | Default Value<br>(when not specified) | Range |     |
|--------------------|---------|---|----------|---------------|---------------------------------------|-------|-----|
|                    |         |   | TCP      | RTU/A<br>SCII |                                       | Min   | Max |
| signal_name        | string  | User-friendly signal name   | Yes      | Yes           |                                       |       |     |
| device_alias       | string  | Alphanumeric string to identify a device  | Yes      | Yes           |                                       |       |     |
| signal_alias       | string  | Unique alphanumeric name of the signal to be Yes used                                     | Yes      | Yes           |                                       |       |     |
| enable             | boolean | Enabling/disabling an individual signal   | No       | No            | 1                                     | 0     | 1   |
| number_type        | string  | Type of a number (FLOAT, DOUBLE, DIGITAL, etc.). This defines the size that will be read. | Yes      | Yes           |                                       |       |     |
| log                | integer | Size of this signal's log in the Event log.   | No       | No            | 0                                     |       |     |
| slave_id           | integer | Address of a slave device   | Yes      | Yes           |                                       |       |     |
| function           | integer | Function number   | Yes      | Yes           |                                       |       |     |
| register_addresses | integer | Register address  | Yes      | Yes           |                                       |       |     |


## Device status signals

Modbus slave has an additional signal which can be configured to show communication status. It is used to indicate if the master device has disconnected from slave (WCC Lite). To configure such signal for Modbus protocol, `job_todo` and `tag_job_todo` fields with string values are required. For Modbus slave required parameters for status signal will be: **signal\_name**, **device\_alias**, **signal\_alias**, **number\_type**, **slave\_id**, **function**, **register\_address**, **job\_todo** and **tag\_job\_todo**. `job_todo` value must be `device_status` and for `tag_job_todo` there are 4 variations: `communication_status`, `device_running`, `device_error`, `unknown_error`. Each signal has 4 possible values and are based on the same logic. If signal returns value of 0, it means unknown error has appeared, 1 - device or protocol connection is on and working properly, 2 - device is off or protocol is disconnected, 3 - error or service is down.

## Mapping values to registers

Internally stored values aren't organised in a register-like order, therefore mapping should be done by the user. This mapping includes setting an address of the device WCC Lite is simulating as well as function number, register number and how much 16-bit registers are used to store a value. These values should be set in `common_address`, `function`, `info_address` and `size` columns respectively in the Excel configuration.

To find out how many register should be used for storing a values, how values can have their values swapped, a user should consult a section `number_type`.

 If a Modbus master device requests a data from a register that is mapped but doesn't yet have initial value, **ILLEGAL DATA ADDRESS** error code will be returned. The same error code is returned if a requested size of value is bigger that defined or if register is not configured at all.

## Debugging a Modbus Slave application

If configuration for Modbus Slave is set up, handler for protocol will start automatically. If configuration is missing or contains errors, protocol will not start. It is done intentionally to decrease unnecessary memory usage.

Modbus Slave command line debugging options

```
modbus-slave
```

```
-h [ -help ] Display help information
-V [ -version ] Show version
-d<debug level> Set debugging level
-c [ -config ] Config path
-r [ -raw ] Show raw telegram data
-f [ -frame ] Show frame data
-s [ -serial ] Show serial port data
-tcp Show tcp packets
-ascii Show ASCII messages
-rtu Show RTU messages
-e [ -redis ] Show redis debug information
-R [ -readyfile ] Ready notification file
```



If Modbus Slave does not work properly (e.g. no communication between devices, data is corrupted, etc.), a user can launch a debug session from command line interface and find out why link is not functioning properly.



To launch a debugging session, a user should stop `modbus-slave` process and run `modbus-slave` command with respective flags as shown above.