

# RM-01

## Modbus to wireless mesh network converter

Datasheet

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### Key features:

- Direct cable replacement for Modbus RTU installations
- DIN rail mountable
- 12-28 DC voltage power supply
- RS-485 interface with configurable baudrate
- Full functional isolation between all ports
- License free 868MHz radio interface
- Secure radio transmission
- Dual antenna with antenna diversity for improved reliability
- Seamless operation in a wireless mesh network with multiple hops
- Mini-USB configuration interface with a dedicated application
- Quick installation and setup

### Short description

The RM-01 is a Modbus to wireless mesh network converter that can easily replace the cabling in Modbus driven automation installations. The device can be mounted on a standard DIN rail and can be powered from a 12-28V DC source. It features a RS-485/Modbus RTU interface and can act both as a Modbus master or Modbus slave.

The RM-01 devices seamlessly form a wireless mesh network with up to 4 network hops. The network consists of a single RM-01 configured as Modbus master and multiple other RM-01 devices configured as Modbus slaves. The Modbus packet sent via RS-485 interface to the master is forwarded to all the slaves, and the answer from slaves is forwarded to the master, so that the network acts as a directed cable replacement.

The RM-01 devices feature a dual antenna SMA outputs for improved reliability. The integrated, advanced radio frequency front-end allows the devices to operate even in the presence of strong electromagnetic interference, typical for industrial environments.

## 1. How it works

### Overview

The RM-01 devices are designed to automatically form a wireless mesh network upon being powered on. In this radio network one RM-01 device that is connected to a Modbus master (typically SCADA or PLC) is configured to work in master mode, while the other devices, connected to Modbus slaves are configured in slave mode. The job of the RM-01 devices configured in slave mode is to detect (using the Modbus slave detection mechanism described below) the addresses of each and every Modbus device connected to a particular RM-01. This information is sent to the RM-01 master device. In such network, each time the Modbus master sends out a command, the RM-01 that is working in master mode forwards this message to the proper RM-01 working in slave mode, to which the recipient of the Modbus packet is connected. If a Modbus packet is produced in response, the RM-01 slave sends it back to the RM-01 master, which in turn forwards it to the Modbus master device.

### Mode of operation

The RM-01 can be configured to work in two modes:

- the **master** mode, in which it is connected to a single Modbus master device
- the **slave** mode, in which it is connected to one or more Modbus slave devices

In master mode, the RM-01 accepts Modbus requests from a Modbus master device (typically SCADA or PLC). Each time a valid Modbus packet is received, the RM-01 decodes the request and checks, if the recipient of the packet is known, meaning that the RM-01 master knows to which of the RM-01 slaves this Modbus packet should be forwarded. If the recipient is known, the packet is forwarded to this particular RM-01 slave. In cases when the recipient is not known, the RM-01 master broadcasts the request to all RM-01 slaves, expecting response from one of them. If the response is received, the RM-01 replies to the Modbus master device and saves the information about the origin of the response. This way, next time the request to this Modbus address is issued, the master RM-01 knows to which RM-01 slave it should be forwarded.

In slave mode, after being powered up the RM-01 first tries to detect the Modbus devices, connected to its RS-485 bus using Modbus slave detection algorithm (described below). Once it's done, the information about the Modbus devices is sent to the master RM-01. If a Modbus packet is sent to the RM-01 slave, it is being transmitted on the RS-485 bus. If a valid response is received it is being forwarded back to the RM-01 master.

### Modbus slave detection

When RM-01 is configured to operate in slave mode it automatically detects the Modbus devices connected to its RS-485 bus. It does that by issuing a READ COIL STATUS (FC=01) with coil (data) address = 0 and data count = 1 to each of the potential Modbus addresses. The scanned address range can be limited using the configuration software. The issued command is a valid Modbus command (with a valid CRC). If a Modbus device with a given address exists on the bus, it should respond with either the READ COIL STATUS RESPONSE or the INVALID REQUEST EXCEPTION. Either way, the RM-01 will then know that a Modbus device with particular address is present on its RS-485 bus. This information is stored in the slave RM-01 operating and also sent to the master RM-01.

The Modbus slave detection algorithm is triggered each time the slave RM-01 device is powered on. It is also triggered remotely by the master RM-01 in case, when the master RM-01 is restarted and it needs to update the information from the field. The scanning procedure has always the lowest priority on the RS-485 bus and does not interfere with the actual Modbus requests and responses.

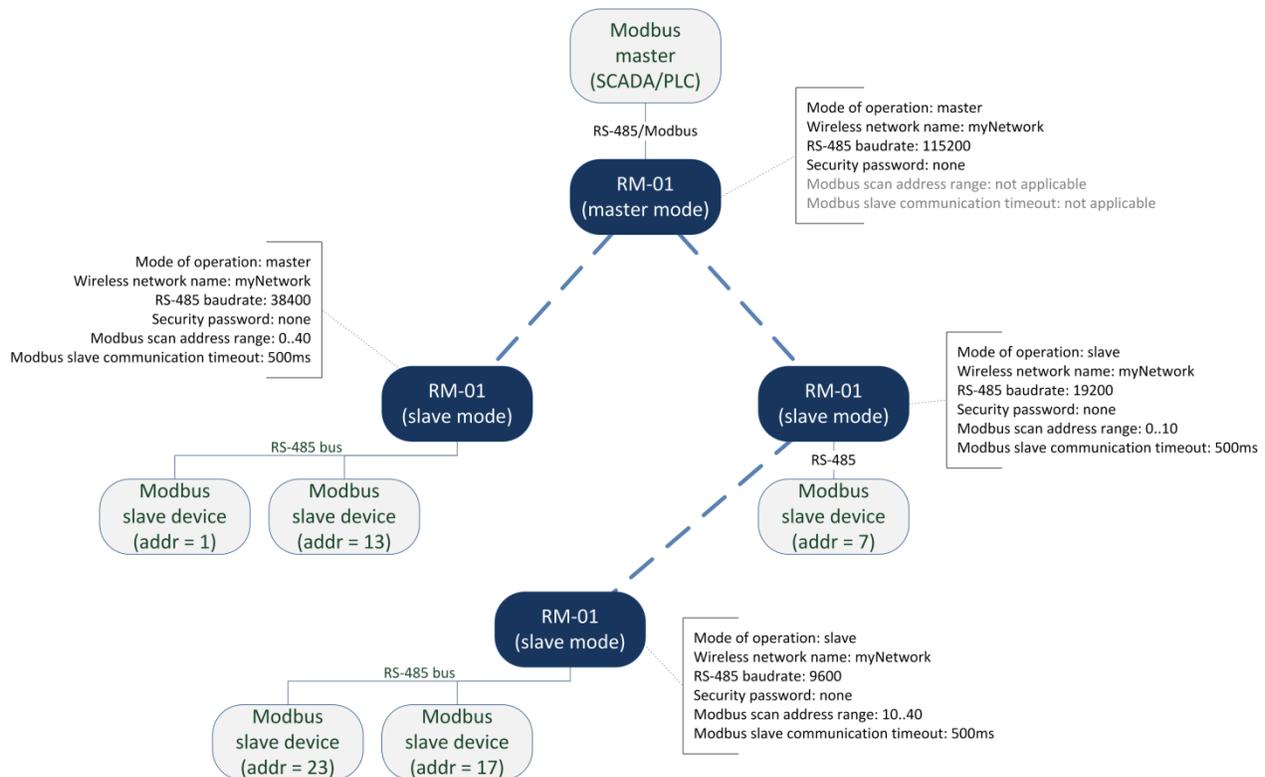
## 2. Configuration

The RM-01 is configured using a dedicated PC application. The connection is established by connecting the device to a PC using a mini-USB to USB-A standard cable. The configuration application allows to set the following parameters:

Setting	Description
<b>Mode of operation</b>	This setting controls the mode of operation (see also description above). Set the device to “MODBUS master” if the RM-01 is connected to a Modbus master device, typically a PLC or SCADA. Set the device to “MODBUS slave” if the RM-01 is connected to a bus of slaves. Default setting is: MODBUS slave
<b>RS-485/Modbus baudrate</b>	Configures the baudrate of the RS-485 serial interface. This value can be set differently in every RM-01 device, as it only controls the communication over the wired serial connection (and not over the radio). Default setting is: 115200 bps
<b>Wireless network name</b>	Name of the wireless network. Allows to form logically separated networks. Only devices with the same network name are able to communicate with each other.
<b>Security password</b>	An optional data encryption password. If this field is provided, the RM-01 will encrypt all the application data sent through the wireless interface using AES-128 ciphering algorithm. In such case, only devices with the same security password are able to communicate with each other. It is highly advised to use a strong security password. Default setting is: blank (no encryption)
<b>Modbus scan address range</b>	This setting allows to limit the Modbus address range that is being scanned during the Modbus slave detection procedure. This limitation can effectively make the scanning process quicker. This setting is only valid for slave mode of operation. It is ignored in master mode. Default setting is: 0 to 255
<b>Modbus slave communication timeout</b>	This setting controls how long the RM-01 operating in slave mode will wait for the answer from a Modbus device. This timeout is used particularly during the Modbus slave detection procedure. This setting is only valid for slave mode of operation. It is ignored in master mode. Default setting is: 500ms

### 3. Exemplary setup

Picture below presents a simple exemplary network consisting of a single Modbus master with an accompanying RM-01 media converter (operating in master mode) and five Modbus slave devices connected through three RM-01 media converters.



The picture also presents an exemplary configuration for each of the RM-01 devices. In order to communicate, each RM-01 must have the same wireless network name (and security password, if set). The RS-485 baud rates can be specified separately for each RM-01 operating in slave mode. Each RM-01 can also scan different range of Modbus addresses with various timeout settings.

### 4. Modbus timeouts

Each RM-01 operating in slave has a configurable slave communication timeout. It is the maximum allowed time between sending a Modbus request and receiving an answer for any of the connected Modbus slave devices. However in the application design, it is important to know the timeout value at the master – that is the maximum time between sending a request from master Modbus device to the RM-01 (operating in master mode) and receiving an answer. We recommend setting this time approx. 2 seconds larger, than the greatest slave communication timeout value set in any of the slave RM-01 devices, operating in the same network.

In the example above, we recommend at least 2.5 second timeout at the Modbus master device.

## 5. Specifications

### Serial interface

**Protocol:** Modbus RTU Master/Slave

**Number of ports:** 1

**Serial standard:** RS-485 (2wire: Data+, Data-, GND)

**Isolation:** functional built-in isolation between RS-485 port and DC power supply antennas  
functional built-in isolation between RS-485 port and the antennas

### Serial Communication Parameters

**Data bits:** 8

**Stop bits:** 1

**Parity:** none

**Flow control:** automatic

**Baudrate:** 9 600 bps – 115 200 bps (user selectable)

### Modbus

**Max. no. of devices in the whole network:** 255

**Max. no. of devices connected to a single device:** 16

### Radio interface

**Operating frequency:** 868.0 – 868.6MHz

**Output power:** up to +14dBm (25mW)

**Over the air baudrate:** 20kbps

**Modulation:** DSSS-BPSK

**Sensitivity:** -110dBm

### Antennas

**No. of antenna connectors:** 2

**Antenna connector:** SMA (female)

**Antenna impedance:** 50Ohm

**Isolation:** functional built-in isolation between antennas and RS-485 port  
functional built-in isolation between antennas and DC power supply

### Configuration interface

**Configuration connector:** mini-USB

### Configuration Software

**Supported platforms:** Windows 7,8,10, Linux

### Power supply

**Input voltage:** 12 to 28 VDC ( $\pm 15\%$ )

**Input current:** 300 mA max.

**Power connector:** Terminal block

### Environmental Limits

**Operating temperature:** -25 to 65°C (-13 to 149°F)

**Storage temperature:** -40 to 85°C (-40 to 185°F)

**Ambient relative humidity:** 5 to 95% (non-condensing)

### Certification

**EMC:** Device conforms to 2014/30/UE directive

**EMI:** CISPR 22

**EMS:** IEC 61000-4-2 ESD: Contact: 8 kV; Air: 15 kV  
 IEC 61000-4-3 RS: 80 MHz to 1 GHz: 10 V/m  
 IEC 61000-4-4 EFT: Power: 4 kV; Signal: 2 kV  
 IEC 61000-4-5 Surge: Power: 2 kV; Signal: 2 kV

**Vibration:** IEC 60068-2-6, IEC 60068-2-64

**Shock:** IEC 60068-2-27

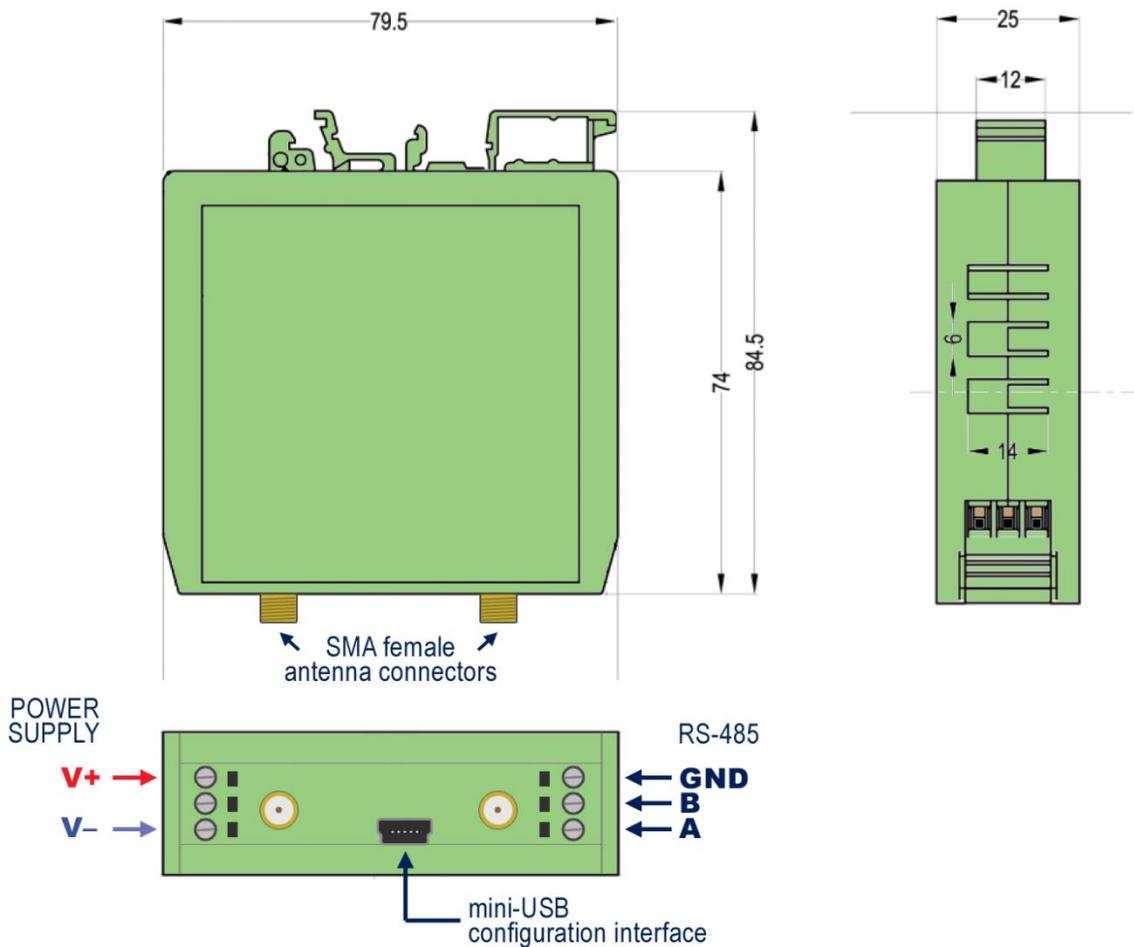
**Drop:** IEC 60068-2-32

### Warranty

**Warranty period:** 2 years

**Details:** see [www.embe.tech/warranty](http://www.embe.tech/warranty)

## 6. Dimensions and connections



## 7. Ordering information

The following device versions are available:

Ordering code	Description
<b>RM-01</b>	Basic device version. No antennas.

The following accessories are available:

Ordering code	Description
<b>ANT-RM-01-868-PANEL-2</b>	A set of two antennas, matched for RM-01, mounted directly on the SMA connectors on the RM-01 panel. Suitable for installation in non-conductive housings.
<b>ANT-RM-01-868-MAGNET-2</b>	A set of two antennas, matched for RM-01, connected by shielded wire to the RM-01 SMA connectors. These antennas are magnetically mounted to a metallic surface. Suitable for installation outside of conductive housings.