

MM-OT101

**Communication gateway with Modbus and
OpenTherm**

Technical documentation

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1 Introduction

This module MM-OT1010 servers as a gateway between systems with Modbus RTU RS485 (EIA-485) communication and boilers and thermostats with Opentherm/Plus (OT/+).

MM-OT1010 allows operation in two basic modes:

1. Monitor – module only listens to the communication between boiler and thermostat
2. Controller – module controls boiler by modification of Modbus registers

Description of all registers is documented in chapter 3.5.

2 Technical parameters

2.1 Power supply

| | |
|-----------------------------|-------------|
| Power supply | 5 – 24 V DC |
| Overvoltage protection | Yes |
| Reverse polarity protection | Yes |
| Power consumption | Max 750 mW |

2.2 RS485

| | |
|------------------------|---------------|
| Galvanic isolation | Yes |
| Overvoltage protection | 15kV ESD |
| Termination resistor | Optional 120R |

2.3 Opentherm

| | |
|------------------------|--------------|
| Galvanic isolation | No |
| Overvoltage protection | Transil 600W |
| Insulation strength | 60V DC |
| Polarity | Independent |

2.4 Operating and installation conditions

| | |
|-----------------------|---------------------------|
| Storage temperature | -25 ÷ +70 °C |
| Storage humidity | < 95 % non-condensing |
| Operating temperature | 0 ÷ + 55 °C |
| Operating humidity | < 95 % non-condensing |
| Construction | Plastic box |
| Installation | DIN rail (35mm) |
| Protection | IP10 |
| Connection | Separable screw clamps |
| Wire crosscut | Max 2,5 mm ² |
| Dimensions | 53 x 90 x 58 mm (w, h, d) |
| Weight | 85 g |

3 Configuration and communication

3.1 Function

The module supports two basic modes, by default the module is in monitor mode after startup. In case of using functions that read data directly from Opentherm, it is necessary to take into account this behaviour which can lead up to 800ms.

3.1.1 Monitor

MONITOR mode (mode 1) requires both boiler and thermostat to be connected. Module resends and monitor messages between boiler and thermostats and save their content to the appropriate internal memory (Modbus registers 0 - 127) considering the direction (read/write). Invalid data are not recorded. Messages/registers that newer passed through the gateway has 0 value.

3.1.2 Controller

When in CONTROLLER mode (mode 0) the module acts as a thermostat for the boiler. The connected control unit (PLC) must periodically send commands to the boiler. Commands are sent using Modbus protocol - functions `read_register(reg)` or `write_register(reg, value)` considering that it always has to be only one register.

Controller mode supports 2 sub-modes which are set in coil 1(Active scan) – see Coil table.

If coil 1 is set to 1 (True), the module periodically sends all messages from the internal register map to the Opentherm line according to the chapter 3.5.2.

If coil 1 is set to 0 (False), unlike the previous sub-mode, the module sends messages to the Opentherm line immediately while receiving a write to a register. Then the module waits for the response from the boiler and the response is sent back to Modbus. (Be aware of the timeout!)

3.2 Modbus

The communication line with the module is EIA-485 (RS-485) with Modbus protocol. The following parameters of the communication can be set by the onboard DIP switch inside:

- Address 1 - 7 (Address 0 is not allowed)
- Speed 9.6/19.2 kbps
- Parity E/N

Configuration of the parameters is described in the following table

| Switch | Description | ON State | OFF State |
|--------|----------------|------------|-----------|
| 1 | Baud rate | 19200 baud | 9600 baud |
| 2 | Parity | Even | No parity |
| 3 | Modbus address | weight 4 | - |
| 4 | Modbus address | weight 2 | - |
| 5 | Modbus address | weight 1 | - |

Configuration example:

Switches 1,2 and 3 - ON; 4 and 5 Off → Address = 4, even parity, 19200baud

By default, the module is configured as 19200baud with even parity and address 1.

Note: On some versions, the parity cannot be changed by the switch and is always set as even!

The terminal resistor (120R) of the RS485 line can be optionally connected using switch SW2, see chapter 4.

Available functions:

- `read_coil(c)` – returns the value of coil `c`
- `write_coil(c, value)` – writes the value to the coil `c`
- `read_holding_register(reg, 1)` – reads register directly from Opentherm
- `read_register(reg, count)` – reads a group of registers from the memory map
- `read_register(reg, 1)` – reads 1 register directly from the boiler, if the module is in CONTROLLER mode, otherwise from the internal map
- `write_register(reg, 1, value)` – writes the value to the register and directly to the boiler (in CONTROLLER mode)
- `write_registers(reg, count, values)` – writes values to registers starting from `reg`, only for registers ≥ 1000 (only to memory)

When attempting to write/read register or coil that is not mapped, the gateway will return value 0. See chapter 3.5 for a list of all registers/coils.

3.3 Opentherm

The Opentherm line allows communication with devices that support the Opentherm/Plus (OT/+) protocol. The module can be operated in two modes (see chapter 3.1) where the module can serve as master (controller mode) or both master and slave (monitor mode). Both Opentherm lines (to the boiler and the thermostat) are polarity independent.

3.4 Opentherm to Modbus mapping

Translation between Opentherm messages to Modbus register describes the following function:

$$y = x \text{ for } 0 \leq x < 128$$

where `x` is the ID of the Opentherm message (MsgID) and `y` is the Modbus register. The ID of the Opentherm messages is equal to the number of registers. Representation of the datatypes is preserved from the Opentherm protocol. A detailed description of the mapping can be seen in chapter 3.5.

3.5 Overview of available Modbus registers/coils

Besides of the registers reserved for the Opentherm, the module contains configuration registers and sets of statistical registers and coils. Their meaning is described below.

Overview of used parameters:

- R/W – determination of reading/write register
 - R – read-only register
 - W – write register
- DataType – datatype of the value of the register
 - HB – upper byte of 16bit register
 - LB – lower byte of 16bit register
 - S>M – information flow from slave to master
 - M>S – information flow from master to slave
 - flag8 – 8bit flag map
 - s8 – signed 8bit integer (-128 ... 127)

- s16 – signed 16bit integer (-32768 ... 32767)
- u8 – unsigned 8bit integer (0 ... 255)
- u16 – unsigned 16bit integer (0 ... 65535)
- u32 – unsigned 32bit integer (0 ... 4294967295)
- f8.8 – signed real number (recommended to read as s16 and divide by $256_{(dec)}$)

Example of representation of f8.8 datatype:

- Value 1,3 is saved as $333_{(dec)} \dots 1,3 * 256 = 333$
- Value -3,86 is saved as $-988_{(dec)} \dots -3,86 * 256 = -988$ (rounded)

Detailed description can be found in the Opentherm protocol specification.

3.5.1 Minimal configuration requirements for using CONTROLLER mode

To be able to run the gateway in CONTROLLER mode variables marked with * are necessary to set.

| Register | Name | DataType | Description |
|----------|-------------------|----------|--|
| 0 | HB: Master status | flag8 | bit: description [enable - 1, disable - 0] *0: CH enable *1: DHW enable 2: Cooling enable 3: OTC active 4: CH2 5-7: reserved |
| | LB: Slave status | flag8 | bit: description [active/on - 1, inactive/off - 0] 0: fault indication 1: CH mode 2: DHW mode 3: Flame status 4: Cooling mode status 5: CH2 mode 6: diagnostic indication 7: reserved |
| 1 | W | f8.8 | * Control setpoint (°C) |

3.5.2 Opentherm messages to Modbus register map

| Register | R/W | DataType | Description |
|----------|-----|---------------------|--|
| 0 | RW | LB(flag8)/HB(flag8) | Master and Slave Status flags |
| 1 | W | f8.8 | Control setpoint ie CH water temperature setpoint (°C) |
| 2 | W | flag8/u8 | Master Configuration Flags / Master MemberID Code |
| 3 | R | flag8/u8 | Slave Configuration Flags / Slave MemberID Code |
| 4 | W | u8/u8 | Remote Command |
| 5 | R | flag8 | Application-specific fault flags and OEM fault code |
| 6 | R | flag8 | Remote boiler parameter transfer-enable & read/write flags |
| 7 | W | f8.8 | A cooling control signal (%) |
| 8 | W | f8.8 | Control setpoint for 2e CH circuit (°C) |
| 9 | R | f8.8 | Remote override room setpoint |
| 10 | R | u8 | Number of Transparent-Slave-Parameters supported by slave |
| 11 | RW | u8 | Index number / Value of referred-to transparent slave parameter. |
| 12 | R | u8 | Size of Fault-History-Buffer supported by slave |
| 13 | R | u8 | Index number / Value of referred-to fault-history buffer entry. |
| 14 | W | f8.8 | Maximum relative modulation level setting (%) |
| 15 | R | u8 | Maximum boiler capacity (kW) / Minimum boiler modulation level (%) |
| 16 | W | f8.8 | Room Setpoint (°C) |

| | | | |
|-----|----|-------|--|
| 17 | R | f8.8 | Relative Modulation Level (%) |
| 18 | R | f8.8 | Water pressure in the CH circuit (bar) |
| 19 | R | f8.8 | The water flow rate in the DHW circuit. (litres/minute) |
| 20 | RW | u8 | Day of Week and Time of Day |
| 21 | RW | u8 | Calendar date |
| 22 | RW | u16 | Calendar year |
| 23 | W | f8.8 | Room Setpoint for 2nd CH circuit (°C) |
| 24 | W | f8.8 | Room temperature (°C) |
| 25 | R | f8.8 | Boiler flow water temperature (°C) |
| 26 | R | f8.8 | DHW temperature (°C) |
| 27 | R | f8.8 | Outside temperature (°C) |
| 28 | R | f8.8 | Return water temperature (°C) |
| 29 | R | f8.8 | Solar storage temperature (°C) |
| 30 | R | f8.8 | Solar collector temperature (°C) |
| 31 | R | f8.8 | Flow water temperature CH2 circuit (°C) |
| 32 | R | f8.8 | Domestic hot water temperature 2 (°C) |
| 33 | R | s16 | Boiler exhaust temperature (°C) |
| 48 | R | s8 | DHW setpoint upper & lower bounds for an adjustment (°C) |
| 49 | R | s8 | Max CH water setpoint upper & lower bounds for an adjustment (°C) |
| 50 | R | s8 | OTC heat curve ratio upper & lower bounds for adjustment |
| 56 | RW | f8.8 | DHW setpoint (°C) (Remote parameter 1) |
| 57 | RW | f8.8 | Max CH water setpoint (°C) (Remote parameters 2) |
| 58 | RW | f8.8 | OTC heat curve ratio (°C) (Remote parameter 3) |
| 100 | R | flag8 | The function of manual and program changes in master and remote room |
| 115 | R | u16 | OEM-specific diagnostic/service code |
| 116 | RW | u16 | Number of starts burner |
| 117 | RW | u16 | Number of starts CH pump |
| 118 | RW | u16 | Number of starts DHW pump/valve |
| 119 | RW | u16 | Number of starts burner during DHW mode |
| 120 | RW | u16 | Number of hours that burner is in operation (i.e. flame on) |
| 121 | RW | u16 | Number of hours that CH pump has been running |
| 122 | RW | u16 | Number of hours that DHW pump has been running or DHW valve has been |
| 123 | RW | u16 | Number of hours that burner is in operation during DHW mode |
| 124 | W | f8.8 | The implemented version of the OpenTherm Protocol Specification in the |
| 125 | R | f8.8 | The implemented version of the OpenTherm Protocol Specification in the |
| 126 | W | u8 | Master product version number and type |
| 127 | R | u8 | Slave product version number and type |

3.5.3 Registers 1000 – 1999

| Registr | R/W | DataType | Description |
|---------|-----|----------|---|
| 1000 | RW | u16 | Value of logical 0 on OT line(mA) |
| 1001 | RW | u16 | Value of logical 1 on the OT line(mA) |
| 1002 | RW | u16 | The gap before reply to the thermostat (us) |
| 1003 | RW | u16 | Boiler transaction time (ms) |
| 1004 | RW | u16 | Sanity gap before reply (ms) |

3.5.4 Statistical registers 2000 – 2099

Registers 2000 – 2099 contains statistical information of the Opentherm line to the connected boiler.

| Registr | R/W | DataType | Description |
|---------|-----|----------|-------------------------------|
| 2000 | R | u16 | Max time of 1 bit |
| 2001 | R | u16 | Min time of 1 bit |
| 2002 | R | u16 | Pulse time min |
| 2003 | R | u16 | Pulse time threshold |
| 2004 | R | u32 | Received messages counter |
| 2006 | R | u32 | Sent messages counter |
| 2008 | R | u32 | Noreply messages counter |
| 2010 | R | u32 | Frame errors counter |
| 2012 | R | u32 | Parity errors counter |
| 2014 | R | u32 | Bit too short counter |
| 2016 | R | u32 | Two short bits errors counter |
| 2018 | R | u32 | Bit too long counter |
| 2020 | R | u16 | Average long bit time |
| 2021 | R | u16 | Min long bit time |
| 2022 | R | u16 | Max long bit time |
| 2023 | R | u16 | An average short bit time |
| 2024 | R | u16 | Min short bit time |
| 2025 | R | u16 | Max short bit of time |
| 2026 | R | u16 | Start bit min time |
| 2027 | R | u16 | Start bit max time |

3.5.5 Statistical registers 2100 – 2199

Registers 2100 – 2199 contains statistical information of the Opentherm line to the connected boiler.

| Registr | R/W | DataType | Description |
|---------|-----|----------|-------------------------------|
| 2100 | R | u16 | Max time of 1 bit |
| 2101 | R | u16 | Min time of 1 bit |
| 2102 | R | u16 | Pulse time min |
| 2103 | R | u16 | Pulse time threshold |
| 2104 | R | u32 | Received messages counter |
| 2106 | R | u32 | Sent messages counter |
| 2108 | R | u32 | Noreply messages counter |
| 2110 | R | u32 | Frame errors counter |
| 2112 | R | u32 | Parity errors counter |
| 2114 | R | u32 | Bit too short counter |
| 2116 | R | u32 | Two short bits errors counter |
| 2118 | R | u32 | Bit too long counter |
| 2120 | R | u16 | Average long bit time |
| 2121 | R | u16 | Min long bit time |
| 2122 | R | u16 | Max long bit time |
| 2123 | R | u16 | Average short bit time |
| 2124 | R | u16 | Min short bit time |
| 2125 | R | u16 | Max short bit time |
| 2126 | R | u16 | Start bit min time |
| 2127 | R | u16 | Start bit max time |

3.5.6 Coil table

| Coil | Values | Description |
|------|--------|---------------------|
| 0 | 0/1 | MONITOR mode active |
| 1 | 0/1 | Active scan |

4 Description of connectors and LEDs

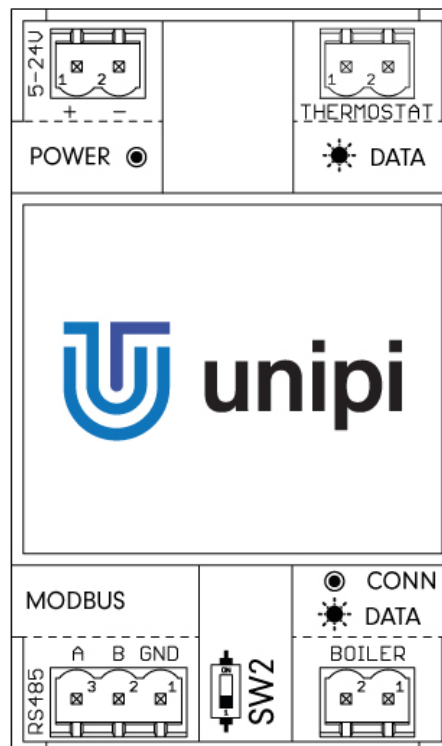
4.1 Description of LEDs

| Name | Function | Description | Colour |
|-----------------|----------|--------------------------------|--------|
| POWER | On | Indication of supply voltage | Green |
| Boiler CONN | On | Indication of connected boiler | Red |
| Boiler DATA | Blinking | Communication with boiler | Yellow |
| Thermostat DATA | Blinking | Communication with thermostat | Yellow |

4.2 Description of connectors

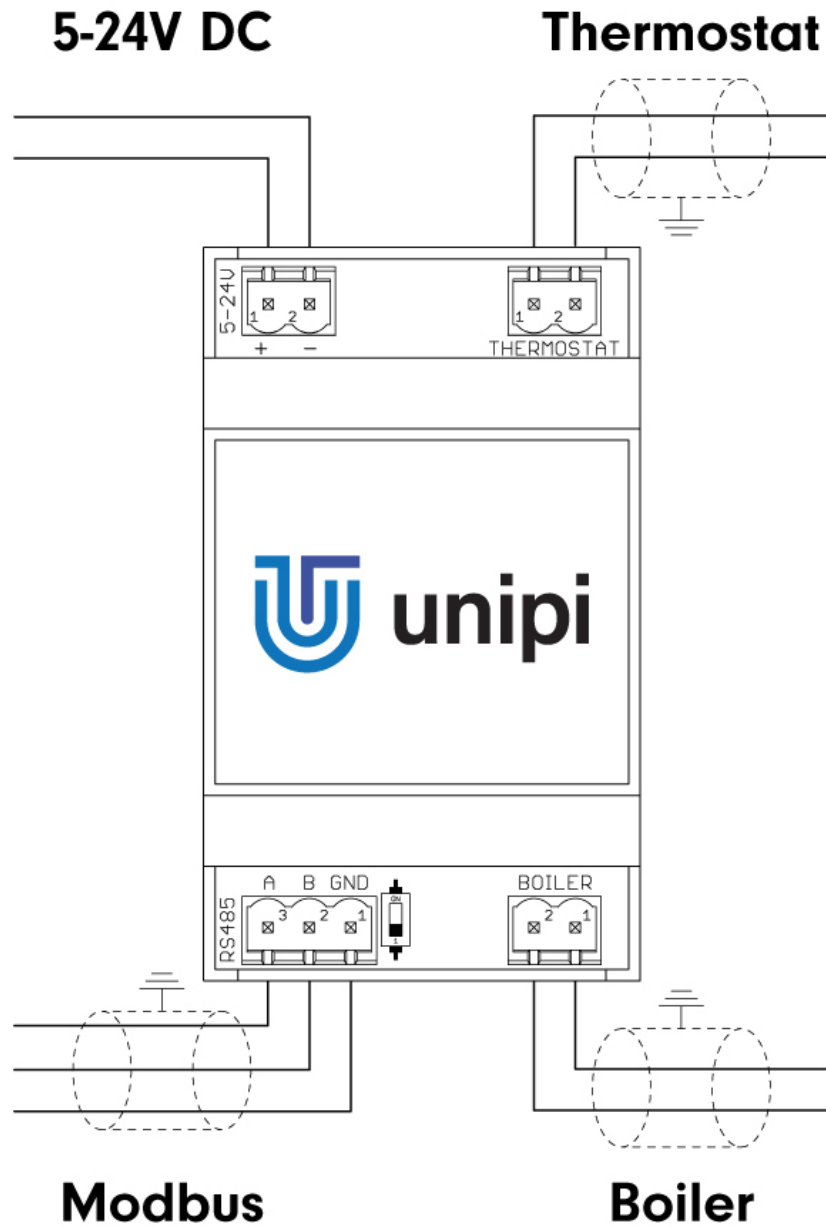
| Name | Description |
|--------------|-----------------------------------|
| POWER + | Power supply: 5-24V DC |
| POWER - | Power supply: ground |
| RS485 A | RS485: line A |
| RS485 B | RS485: line B |
| RS485 GND | RS485: ground |
| SW2 | RS485: terminal resistor (On/Off) |
| THERMOSTAT 1 | Opentherm: thermostat |
| THERMOSTAT 2 | Opentherm: thermostat |
| BOILER 1 | Opentherm: boiler |
| BOILER 2 | Opentherm: boiler |

Both Opentherm lines (boiler and thermostat) are polarity independent.



5 Connection

The module should be installed in an upright position to a standard DIN rail. Connection of wires can be seen in the following picture.



6 Usage example

This chapter demonstrates the minimum setup requirements using Modbus requests of both Monitor and Controller modes. It expects the Modbus address to be the same as the factory default (chapter 3.2).

6.1 Monitor Mode

This scenario expects the MM-OT101 to be placed on the Opentherm line between the Boiler and the Thermostat.

1.1. Enable Monitor Mode

Set coil 0 with value 1

Modbus Request: 01 05 00 00 FF 00 8C 3A

Note: Send periodically in case of a device reboot

1.2. Check monitored values

Read register 116 – Number of starts burner

Modbus Request: 01 03 0074 0001 C410

Note: Typically, a value greater than 0 should be seen. See other registers for more information.

6.2 Controller mode

In this scenario, the module can run independently on the Thermostat. However, it is highly recommended to test communication and proper value parsing using the Monitor Mode (described above).

1.1. Enable Controller Mode

- Set coil 0 with value 0
- Modbus Request: 01 05 00 00 00 00 CD CA
- Note: Send periodically in case of a device reboot

1.2. Enable Active Scan

- Set coil 1 with value 1
- Modbus Request: 01 05 00 01 FF 00 DD FA
- Note: Send periodically in case of a device reboot

1.3. Enable Central Heating (CH) and Domestic Hot Water (DWH)

- Set register 0 with value 384_(dec)
- Modbus Request: 01 06 00 00 01 80 89 FA
- Note: Send periodically in case of a device reboot

1.4. Configure Control Setpoint

- Set register 1 with value 115200_(dec) – this will set Control Setpoint to 45°C (see chapter 3.5 for encoding details)
- Modbus Request: 01 06 00 01 2D 00 C5 5A
- Note: Send periodically in case of a device reboot

7 Documentation Revisions

The table below contains a list of changes in this documentation and/or other firmware related updates.

| Revision Number | Revision Date | Description |
|-----------------|---------------|---|
| 2 | 07/07/2020 | Added Chapter - Usage example Redesigned |
| 1 | 27/03/2017 | Initial release |