MM-OT101

Communication gateway with Modbus and Opentherm

Technical documentation

unipi technology

Content

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:

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

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$_{(dec)}$ ... 1,3 * 256 = 333
- ○ Value -3,86 is saved as -988$_{(dec)}$ ... -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.
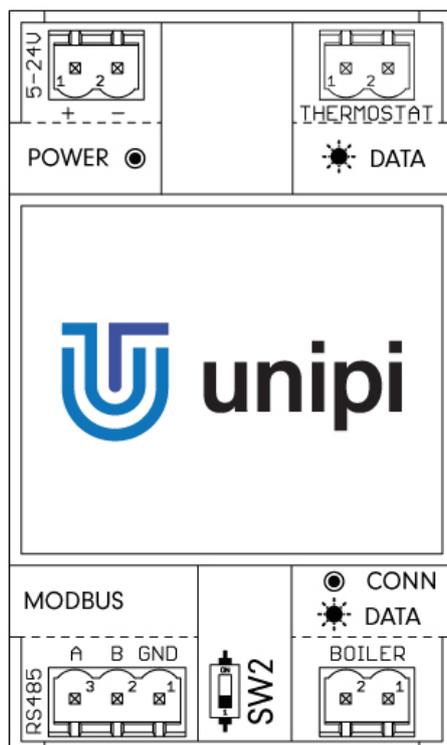
5   Connection

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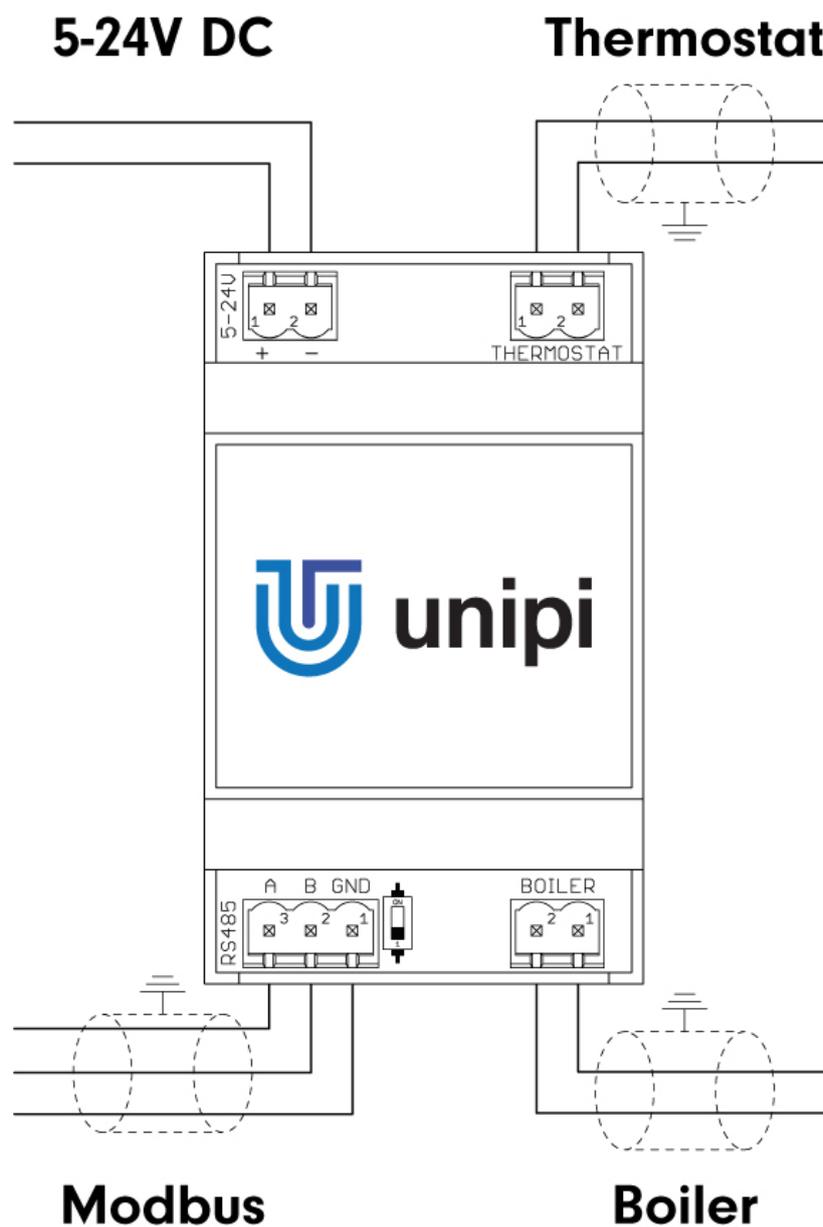
6   Usage example

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 (DHW)
- 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 $11520_{(dec)}$ – 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

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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