DMM-OT

OpenTherm/+ interface convertor with MODBUS RTU protocol

Operation manual

Version 1.00

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Contents

History of revisions

Document name: dmm-ot_g_en_100.pdf

Revision	Date	Author of change	Changes
100	19. 05. 2016	Zbyněk Říha	New document

Related documentation

1. Help file for EsiDet part of DetStudio development environment
   file: Psedet_cs.chm
2. Application Note AP0008 – MODBUS Network Communication file:
   file: ap0008_en_xx.pdf
3. Application Note AP0016 – Principles of using RS485 interface
   file: ap0016_en_xx.pdf
4. http://www.opentherm.eu– OpenTherm protocol

1. Introduction

DMM-OT is an OpenTherm/+ (OT/+) interface convertor with MODBUS RTU protocol. Convertor (in combination with superior system) works as room on-wall controller with OT/+ interface and allows to control certain types of boilers.

Basic features

- Control of one boiler (with one or two independent circuits), including OT/+ interface
- OT/+ line with galvanic isolation
- RS485 line without galvanic isolation
- Power supply 24 V DC / AC

2. Technical parameters

OpenTherm

Overvoltage protection	Transil 600 W
Galvanic isolation	Yes
Isolation strength	300 V AC / 1 minute [1])
Maximum wire length	30 m / 1000 bps
Operation indication	LED on panel
Connection point	WAGO 734-202/037-000
Wire cross section	0.08 mm^2 to 1.5 mm^2

Note [1]) Isolation must not be used for dangerous voltage isolation.

RS485

Overvoltage protection	Transil 600 W
Galvanic isolation	No
Terminating resistor [1])	120 Ω on the unit
Idle state definition [1]) to +5 V DC to 0 V DC	 1 kΩ on the unit 1 kΩ on the unit
Maximum wire length	1200 m / 19200 bps
Max. number of stations on network	63
Max. number of stations on segment	32
Operation indication	LED on panel
Connection point	WAGO 231-303/102-000
Wire cross section	0.08 mm^2 to 2.5 mm^2

Note [1]) Terminating resistor and idle state definition are connected concurrently.

Power supply

Nominal power supply voltage	24 V DC / AC
Power supply voltage range	20 V DC to 28 V DC 18 V AC to 30 V AC
Overvoltage protection	Transil 600 W
Maximum power consumption	100 mA at 24 V DC
Power outage (type)	0.5 W
Connection point	WAGO 231-302/102-000
Wire cross section	0.08 mm^2 to 2.5 mm^2

Mechanics

Mechanical design	Plastic box
Mounting	DIN 35 mm rail mounting
Ingress protection rate	IP20
Weight – netto – brutto	0.08 kg ±5 % 0.12 kg ±5 %
Dimensions (w × h × d)	(36 × 99 × 75) mm [1])

Note [1]) Dimensions including connectors and DIN rail lock.

Temperatures

Operating temperature range	0 °C to 50 °C
Storage temperature range	0 °C to 50 °C

Others

Maximum ambient humidity	< 95 % non-condensing

2.1. Dimensions

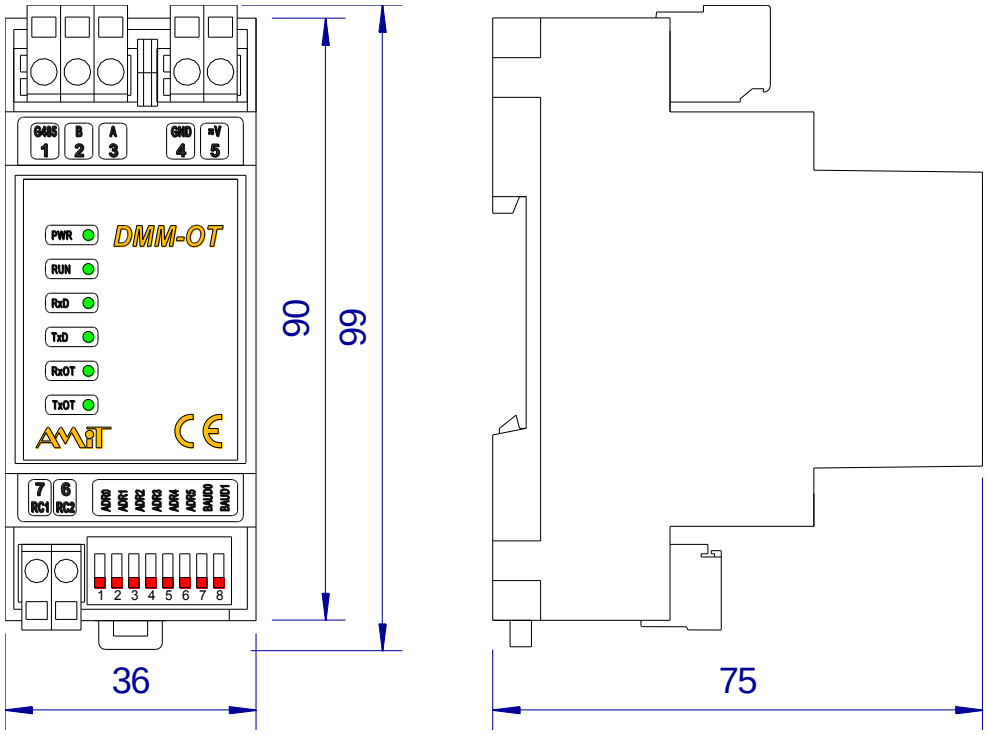

Fig. 1 - **DMM-OT** dimensions

2.2. Recommended drawing symbol

Following drawing symbol is recommended for **DMM-OT** converter. Only part of it will be visible in following examples.

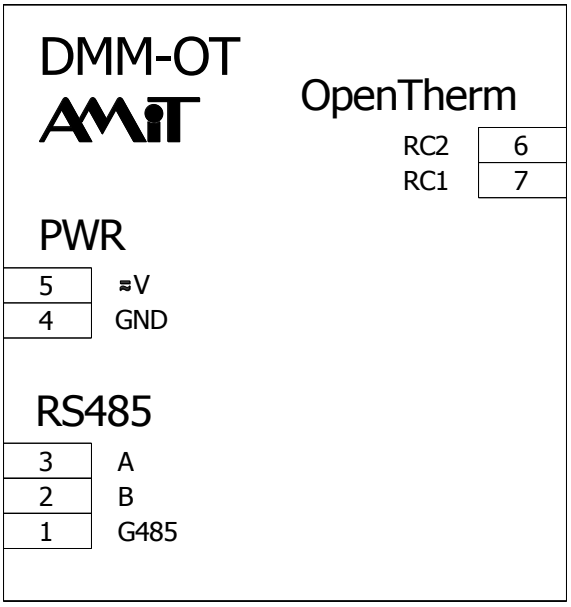

Fig. 2 - Recommended drawing symbol for **DMM-OT**

3. Conformity assessment

The equipment meets the requirements of NV616/2006 Czech governmental decree. The compliance assessment with NV616/2006 has been performed in accordance with harmonized standard EN 61326-1.

Tested in accordance with standard	Type of test	Classification
EN 55011:2009	Industrial, scientific and medical equipment – Radio-frequency disturbance characteristics – Limits and methods of measurement	Complies [1])
EN 61000-4-2:2009	Electromagnetic compatibility (EMC) – Part 4-2: EMC – Testing and measurement techniques – Electrostatic discharge immunity test, aerial discharge	Complies (±8 kV)
EN 61000-4-3:2006	Electromagnetic compatibility (EMC) – Part 4-3: Testing and measurement techniques – Radiated, radio-frequency, electromagnetic field immunity test, 800 MHz to 1000 MHz	Complies (10 V/m)
EN 61000-4-3:2006	Electromagnetic compatibility (EMC) – Part 4-3: Testing and measurement techniques – Radiated, radio-frequency, electromagnetic field immunity test, 1000 MHz to 2100 MHz	Complies (3 V/m)
EN 61000-4-3:2006	Electromagnetic compatibility (EMC) – Part 4-3: Testing and measurement techniques – Radiated, radio-frequency, electromagnetic field immunity test, 2100 MHz to 2500 MHz	Complies (1 V/m)
EN 61000-4-4:2012	Electromagnetic compatibility (EMC) – Part 4-4: Testing and measurement techniques – Electrical fast transient/burst immunity test, power supply	Complies (±2 kV)
EN 61000-4-4:2012	Electromagnetic compatibility (EMC) – Part 4-4: Testing and measurement techniques – Electrical fast transient/burst immunity test, RS485	Complies (±2 kV)
EN 61000-4-5:2006	Electromagnetic compatibility (EMC) – Part 4-5: Testing and measurement techniques – Surge immunity test, power supply	Complies (±2 kV)
EN 61000-4-5:2006	Electromagnetic compatibility (EMC) – Part 4-5: Testing and measurement techniques – Surge immunity test, RS485	Complies (±1 kV)
EN 61000-4-6:2009	Electromagnetic compatibility (EMC) – Part 4-6: Testing and measurement techniques – Immunity to conducted disturbances, induced by radio-frequency fields	Complies (3 V)

1) This is a Class A device. In the internal environment this product can cause some radio disturbances. In such case the user can be requested to take the appropriate measures.

3.1. Other tests

Device was tested according to:

Tested in accordance with standard	Type of test	Result
EN 60068-2-1:2007	Environmental testing – Part 2-1: Tests – Test A: Cold	Complies
EN 60068-2-2:2007	Environmental testing – Part 2-2: Tests – Test B: Dry heat	Complies
EN 61000-4-29:2000	Electromagnetic compatibility (EMC) – Part 4-29: Testing and measurement techniques – Voltage dips, short interruptions and voltage variations on DC input power port – Immunity test	Complies

4. Power supply

DMM-OT converter can be powered by either DC or AC power supply. Power source must meet requirements listed in chapter 2. Technical parameters.

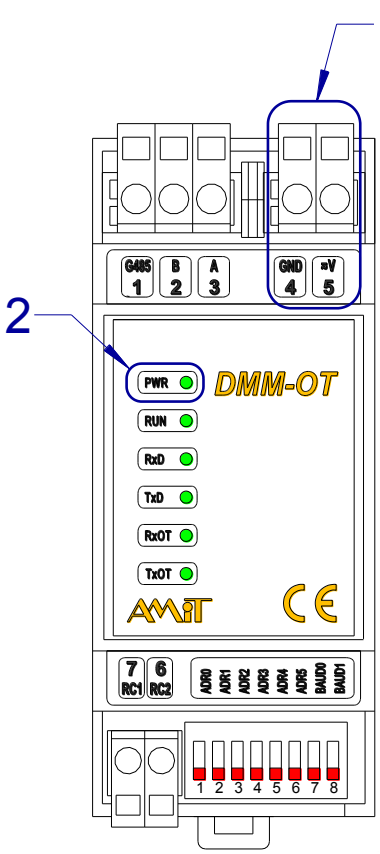

Fig. 3 - Power supply connector and LED indicator location

Legend

Number	Description
1	Power supply connector
2	Indication LED PWR

Connector labelling

PIN	Signal	Description
4	GND	Power supply, ground
5	≂V	Power supply 24 V DC / AC

Presence of supply voltage on the connector is indicated by the PWR LED indicator.

Description of PWR LED

Status	Description
ON	Power supply is attached.
OFF	Power supply is not attached.

Note It is recommended to connect the GND terminals with switchboard PE terminal during installation.

DC power supply

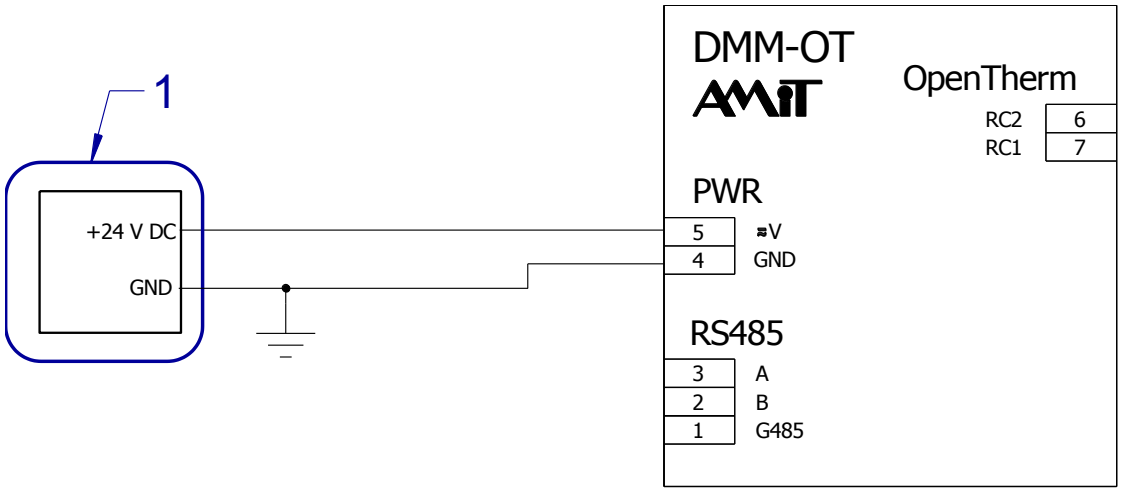

Fig. 4 - Example of DC power supply connection

Legend

Number	Description
1	External power supply 24 V DC

AC power supply

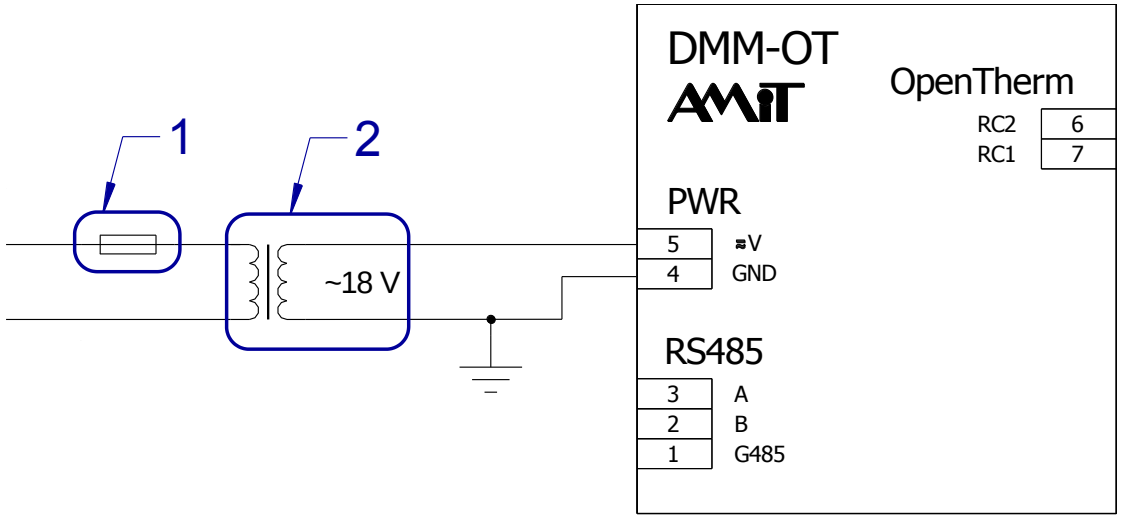

Fig. 5 - Example of AC power supply connection

Legend

Number	Description
1	T 50 mA fuse
2	External power supply 18 V DC

5. Communication lines

DMM-OT is fitted with RS485 and OT/+ communication lines.

5.1. RS485

RS485 line circuits are not galvanically isolated. RS485 line is used to connect to the superior system and uses MODBUS RTU communication protocol. For proper operation of RS485 it is necessary to abide the rules presented in Application Note *AP0016 – Principles of using RS485 interface*.

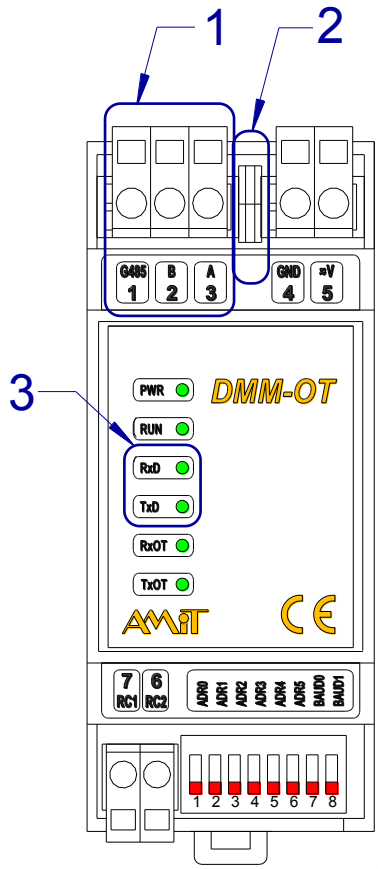

Fig. 6 - Location of connector, configuration jumpers and indication LEDs

Legend

Number	Description
1	RS485 line connector
2	RS485 configuration jumpers
3	RS485 indication LEDs

Connector labelling

PIN	Signal	Description
1	G485	RS485 line, ground (shielding)
2	B	RS485 line, signal B
3	A	RS485 line, signal A

Caution G485 terminal (1) is internally connected with GND terminal (4).

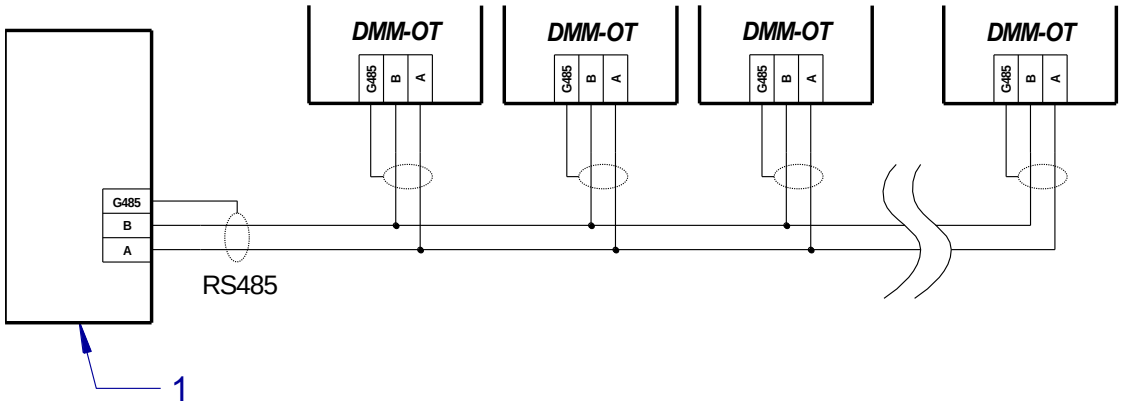

Fig. 7 - RS485 wiring example

Legend

Number	Description
1	Superior control system

Configuration jumpers

Each station on RS485 communication line must have line termination resistors properly set. Configuration jumpers located between RS485 connector and power supply connector allow setting the termination.

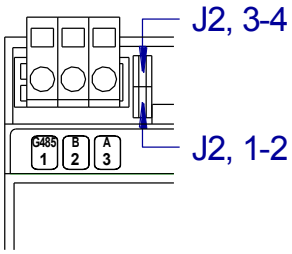

Fig. 8 - Configuration jumpers detail

Description of jumpers

Jumper	Description
J2, 1–2	Signal A idle state + termination
J2, 3–4	Signal B idle state + termination

Jumpers	Description
Fitted	End-station – Idle state and line termination is active
Not fitted	Intermediate station - Idle state and line termination is inactive

Status indication

Line status is indicated by system LEDs located on the front panel.

Description of LED indicators

LED	Description
RxD	Is ON when receiving data from RS485
TxD	Is ON when sending data to RS485

5.2. OpenTherm/+ (OT/+)

OT/+ line is intended for communication with boiler electronics via OT/+ protocol. Converter is always master. More information about communication via OT/+ protocol can be found on website of OpenTherm communication protocol developer (www.opentherm.eu).

Convertor communicates in OT/+ network constantly, regardless on MODBUS RTU communication (RS485 line).

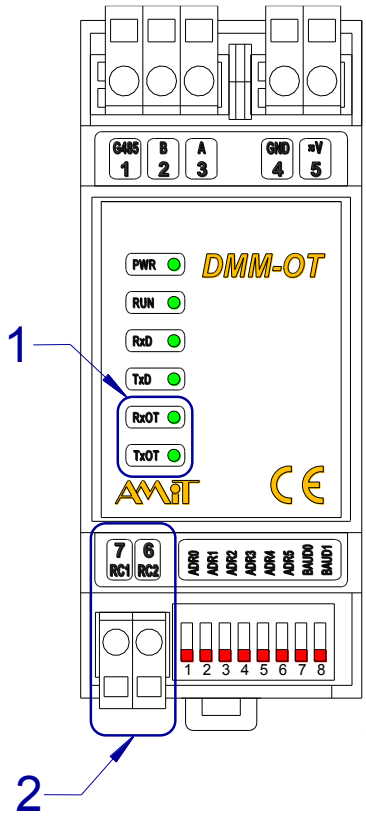

Fig. 9 - Location of connectors and indication LEDs

Legend

Number	Description
1	Indication LED OT/+
2	OT/+ line connector

Connector labelling

PIN	Signal	Description
6	RC2	OT/+ line
7	RC1	OT/+ line

Status indication

Line status is indicated by system LEDs located on the front panel.

Description of LED indicators

LED	Description
RxOT	Is ON when receiving data from OT/+
TxOT	Is ON when sending data to OT/+

6. RUN indication LED

LED with RUN designation on front panel indicates the status of the convertor by flashing.

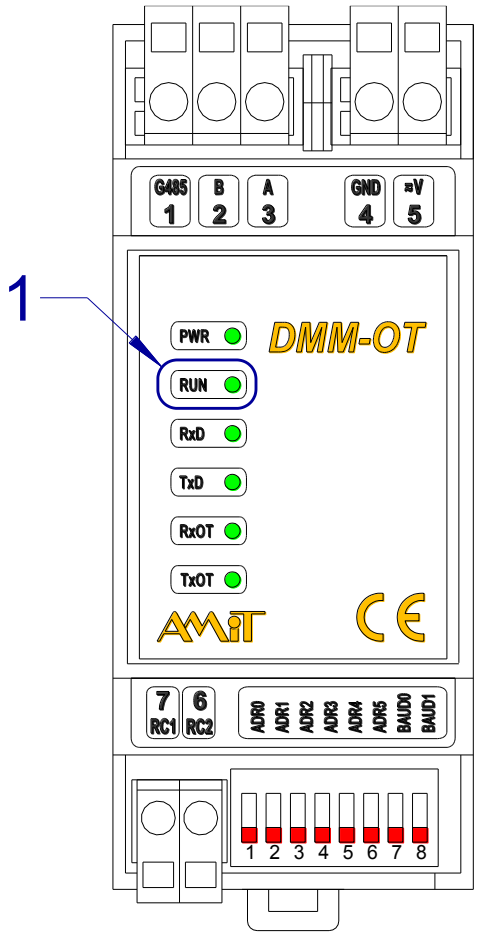

Fig. 10 - RUN indication LED location

Legend

Number	Description
1	RUN indication LED

Following table describes individual states of LED RUN:

Light	Description
Flashing in 1 s period	Convertor communicates in MODBUS RTU network.
Flashing in 0.25 s period	Communication interruption in MODBUS RTU network.
Irregular flashing	Irregular flashing means that 5 quick flashes are followed by a pause. This state signalizes mode for convertor parity settings.

7. Setting of communication parameters

Every device in MODBUS RTU network must have the following set:
- All peripherals in the network must have **identical** parity set.
- Address (each peripheral in the network must have a **unique one**).
- All peripherals must have **identical** communication rate set.

Communication parameters can be set by the DIP switch.

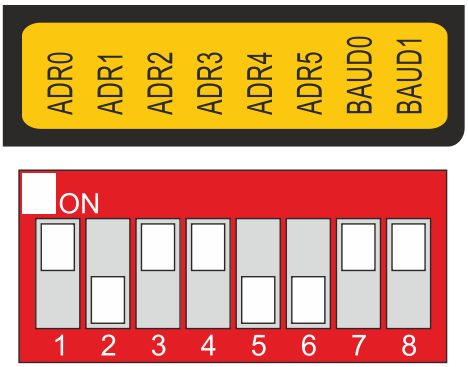

Fig. 11 - DIP switch for setting the communication parameters

Superior system must have wait time set for ca. 150 characters (which in case of communication rate of 9600 bps corresponds to approx. 150 ms).

7.1. Parity setting

Parity can be set by following steps:
- Switch the convertor's power supply off.
- Switch all switches to OFF state.
- Switch the power supply on.
- Parity can be set by ADR0 (DIP 1) and ADR1 (DIP 2) switches according to the following table:

ADR0 (DIP1)	ADR1 (DIP2)	Parity
OFF	OFF	None
ON	OFF	Even
OFF	ON	Odd

- Confirm the settings by switching the BAUD1 (DIP 8) switch to ON state (LEDs on converter will flash sequentially).

Parity setting will display on LED RxD and TxD according to table:

RxD	TxD	Parity
OFF	OFF	None
ON	OFF	Even
OFF	ON	Odd

Parity change will be active after turning the convertor off and on again.

Note **Communication with one stop bit takes place** if there is **an odd or even parity** set. **Communication with two stop bits takes place**, when **no parity** is set.

7.2. Setting of address and data transmission rate

Address setting can be done by ADR0 (DIP 1) to ADR5 (DIP 6) switches. Available address values are 1 to 63. **Address value 0 is not allowed!**

Communication rate settings can be done by BAUD0 (DIP 7) and BAUD1 (DIP 8) switches.

Values of single switches for setting the address and communication rate are described below.

Switches bit values

ADR0	Value of 1
ADR1	Value of 2
ADR2	Value of 4
ADR3	Value of 8
ADR4	Value of 16
ADR5	Value of 32

BAUD0	**BAUD1**	**Communication rate**
OFF	OFF	9600 bps
ON	OFF	19200 bps
OFF	ON	38400 bps
ON	ON	57600 bps

Converter Address setting

		ADR5	OFF	OFF	OFF	OFF	ON	ON	ON	ON
		ADR4	OFF	OFF	ON	ON	OFF	OFF	ON	ON
		ADR3	OFF	ON	OFF	ON	OFF	ON	OFF	ON
ADR0	**ADR1**	**ADR2**	**Address of converter in MODBUS RTU network.**							
OFF	OFF	OFF	X	8	16	24	32	40	48	56
ON	OFF	OFF	1	9	17	25	33	41	49	57
OFF	ON	OFF	2	10	18	26	34	42	50	58
ON	ON	OFF	3	11	19	27	35	43	51	59
OFF	OFF	ON	4	12	20	28	36	44	52	60
ON	OFF	ON	5	13	21	29	37	45	53	61
OFF	ON	ON	6	14	22	30	38	46	54	62
ON	ON	ON	7	15	23	31	39	47	55	63

On Fig. 11 is the converter address set to 13 and communication rate is 57600 bps.

Note All changes made in switches settings takes effect only after the converter restart (i.e. disconnecting and connecting of power supply).

8. Mounting

DMM-OT convertor is mounted on DIN 35 mm rail – takes up 2 module slots. Mechanical position on DIN rail is fixed by locking latch, located on the convertor bottom part.

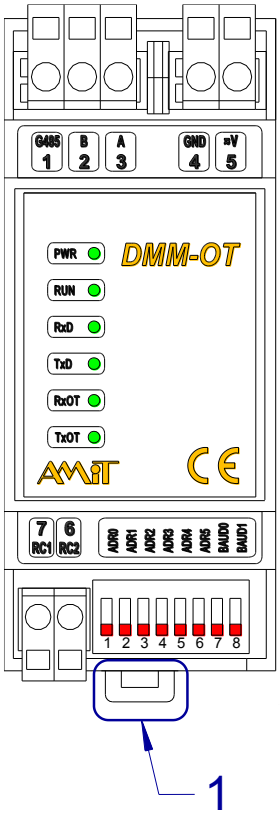

Fig. 12 - Position of locking latch for DIN rail

Legend

Number	Description
1	DIN 35 mm rail lock

8.1. Installation rules

EMC filter EMC filter is used on power supply input. This requirement can be revised based on environment nature, power source properties and wiring layout.

Connecting to PE Connect negative power supplying terminal of the convertor (GND) to the switchboard's PE terminal (at the power source).

If the wires are led outside the building, the appropriate inputs and outputs needs to be overvoltage protected.

RS485 line It is necessary to perform connecting of RS485 line according to recommendations presented in Application Note AP0016 – Principles of using RS485 interface.

OT/+ line It is necessary to perform connecting of OpenTherm line according to recommendations from developer of OpenTherm (www.opentherm.eu). Cable length is limited to 30 m.

Note All connections to PE terminal must be realized with impedance as low as possible. Technical parameters of the converter are guaranteed only when these wiring principles are applied.

9. Factory settings

RS485 configuration The RS485 line is fitted by jumpers, which activates the line termination and idle state definition.

10. Software operation

Convertor provides data to MODBUS RTU, which are read from OT/+ network via input and holding registers. Writing of requested values can be done by holding registers.

All values are saved in BigEndian format. **In the case the values are represented by Float type, it is necessary to always communicate as a pair of register at one time. Otherwise, the converter will report an error illegal data address** (MODBUS error num. 2)! For holding registers, it is a necessity to use Modbus function 16.

10.1. Input registers layout

Supported functions:

- 04 Read Input Registers – register reading

<table>
<tr><th>Address</th><th>Modicon address</th><th>Description</th><th>Signal</th></tr>
<tr><td>100</td><td>30101</td><td>R (Int)</td><td>Status register. Individual bits have the following signification:
<table>
<tr><th>Bit</th><th>Servo address</th></tr>
<tr><td>0</td><td>Communication with device on OT/+ line is OK.</td></tr>
<tr><td>1</td><td>Device on OT/+ line is in failure.</td></tr>
<tr><td>2</td><td>CH1 heating active.</td></tr>
<tr><td>3</td><td>DHW heating active.</td></tr>
<tr><td>4</td><td>Burner starts.</td></tr>
<tr><td>5</td><td>DHW heating present.</td></tr>
<tr><td>6</td><td>CH2 heating active.</td></tr>
<tr><td>7</td><td>CH2 present.</td></tr>
<tr><td>8</td><td>CH1 heating allowed.</td></tr>
<tr><td>9</td><td>DHW allowed.</td></tr>
<tr><td>10</td><td>Maximum relative boiler modulation level setting allowed.</td></tr>
<tr><td>11</td><td>CH2 heating allowed.</td></tr>
<tr><td>12</td><td>Summer boiler mode.</td></tr>
</table></td></tr>
<tr><td>101</td><td>30102</td><td>R (Int)</td><td>Last error code.</td></tr>
<tr><td>102
103</td><td>30103
30104</td><td>R (Float)</td><td>Flow temperature CH1 [°C].</td></tr>
<tr><td>104
105</td><td>30105
30106</td><td>R (Float)</td><td>Flow temperature CH2 [°C].</td></tr>
<tr><td>106
107</td><td>30107
30108</td><td>R (Float)</td><td>DHW temperature [°C].</td></tr>
<tr><td>108
109</td><td>30109
30110</td><td>R (Float)</td><td>Return water temperature[°C].</td></tr>
<tr><td>110
111</td><td>30111
30112</td><td>R (Float)</td><td>Outside temperature [°C].</td></tr>
<tr><td>112
113</td><td>30113
30114</td><td>R (Float)</td><td>Heating source performance [%].</td></tr>
<tr><td>114</td><td>30115</td><td>R (Float)</td><td>CH Water pressure [bar].</td></tr>
</table>

Address	Modicon address	Description	Signal
115	30116		
116 117	30117 30118	R (Float)	DHW flow rate [l/s].
118 119	30119 30120	R (Float)	Exhaust temperature [°C].
120	30121	R (Int)	Value read from OT/+ register, ID is entered via MODBUS holding register 216 [1]).
121	30122	R (Int)	Status of register 120 reading [2]).
122	30123	R (Int)	Writing status to OT/+ register, entered via MODBUS holding register 213 [2]).

[1]) In case ID register in OT/+ is f88 type, reading value from OT/+ is multiplied by 10 and saved to MODBUS register 120. To obtain a correct value it is necessary to divide MODBUS register value by 10. If there is value such as "231" in MODBUS register, transferring value from OT/+ is "23.1".

[2]) It can take values from following table:

Value	Description
0	Not processed
1	Value read
2	Value written
3	OT/+ communication error

10.2. Holding register layout

Holding registers are distributed into two groups:
- System registers,
- Application registers.

Supported functions:
- 03 Read Holding Registers – reading
- 06 Write Single Register
- 16 Write Multiple Registers

System registers

Address	Modicon address	Description	Signal
0	40001	R (Int)	Hardware identification. Unit type is given by number. 118 = **DMM-OT**.
1	40002	R (Int)	Firmware version.
2 3	40003 40004	R (Long)	Not used.
4	40005	R/W (Int)	Number of [s] used for communication interruption evaluation in MODBUS RTU network.
5	40006	R (Int)	Data communication rate settings on DIP.
6	40007	R (Int)	Parity.
7	40008	R (Int)	Address, settings on DIP.
8	40009	R (Int)	Not used.
9	40010	R/W (Int)	Number of messages received from MODBUS RTU.

Application registers

<table>
<tr><th>Address</th><th>Modicon address</th><th>Description</th><th>Signal</th></tr>
<tr><td>100</td><td>40101</td><td>R (Int)</td><td>Status register. Individual bits have the following signification:
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<tr><td>0</td><td>Communication with device on OT/+ line is OK</td></tr>
<tr><td>1</td><td>Device on OT/+ line is in failure</td></tr>
<tr><td>2</td><td>CH1 heating active</td></tr>
<tr><td>3</td><td>DHW heating active</td></tr>
<tr><td>4</td><td>Flame on</td></tr>
<tr><td>5</td><td>DHW heating present</td></tr>
<tr><td>6</td><td>CH2 heating active</td></tr>
<tr><td>7</td><td>CH2 present</td></tr>
<tr><td>8</td><td>CH1 heating allowed</td></tr>
<tr><td>9</td><td>DHW allowed</td></tr>
<tr><td>10</td><td>Maximum relative boiler modulation level setting allowed</td></tr>
<tr><td>11</td><td>CH2 heating allowed</td></tr>
<tr><td>12</td><td>Summer boiler mode</td></tr>
</table></td></tr>
<tr><td>101</td><td>40102</td><td>R (Int)</td><td>Last error code.</td></tr>
<tr><td>102
103</td><td>40103
40104</td><td>R (Float)</td><td>Flow temperature CH1 [°C].</td></tr>
<tr><td>104
105</td><td>40105
40106</td><td>R (Float)</td><td>Flow temperature CH2 [°C].</td></tr>
<tr><td>106
107</td><td>40107
40108</td><td>R (Float)</td><td>DHW temperature [°C]:</td></tr>
<tr><td>108
109</td><td>40109
40110</td><td>R (Float)</td><td>Return water temperature [°C].</td></tr>
<tr><td>110
111</td><td>40111
40112</td><td>R (Float)</td><td>Outside temperature [°C].</td></tr>
<tr><td>112
113</td><td>40113
40114</td><td>R (Float)</td><td>Heating source performance [%].</td></tr>
<tr><td>114
115</td><td>40115
40116</td><td>R (Float)</td><td>CH Water pressure [bar].</td></tr>
<tr><td>116
117</td><td>40117
40118</td><td>R (Float)</td><td>DHW flow rate [l/min].</td></tr>
<tr><td>118
119</td><td>40119
40120</td><td>R (Float)</td><td>Exhaust temperature [°C].</td></tr>
<tr><td>120</td><td>40121</td><td>R (Int)</td><td>Value read from OT/+ register, ID is entered via MODBUS holding register 216 [1]).</td></tr>
<tr><td>121</td><td>40122</td><td>R (Int)</td><td>Status of register 120 reading [2]).</td></tr>
<tr><td>122</td><td>40123</td><td>R (Int)</td><td>Entry status to OT/+ register, entered via MODBUS holding register 213 [2]).</td></tr>
</table>

[1]) In case ID register in OT/+ is f88 type, reading value from OT/+ is multiplied by 10 and saved to MODBUS register 120. To obtain a correct value it is necessary to divide MODBUS register value by 10. If there is value such as "231" in MODBUS register, transferring value from OT/+ is "23.1".

[2]) It can take values from following table:

Value	Description
0	Not processed
1	Value read
2	Value written
3	OT/+ communication error

Following can be written into holding registers:

Address	Modicon address	Description	Signal
200	40201	R/W (Int)	Status register. Individual bits have the following signification: **Bit** / **Servo address** 0 – CH1 control setpoint write blocking. 1 – CH2 control setpoint write blocking. 2 – DHW control setpoint write blocking. 3 – CH1 room setpoint write blocking. 4 – CH2 room setpoint write blocking. 5 – CH1 allowing. 6 – DHW allowing. 7 – Enabling of maximum relative boiler modulation level setting. 8 – CH2 allowing. 9 – Summer boiler mode setting. 10 – Enabling to read from OT/+ register, entered via MODBUS holding register 216. 11 – Enabling to write from OT/+ register, entered via MODBUS holding register 213.
201 202	40202 40203	R/W (Float)	TV1 control setpoint [°C].
203 204	40204 40205	R/W (Float)	TV2 control setpoint [°C].
205 206	40206 40207	R/W (Float)	DHW control setpoint [°C].
207 208	40208 40209	R/W (Float)	CH1 room setpoint [°C].
209 210	40210 40211	R/W (Float)	CH2 room setpoint [°C].
211 212	40212 40213	R/W (Float)	Maximum relative boiler modulation level [%].
213	40214	R/W (Int)	ID of OT/+ register, value in holding register 215 is written to this ID.
214	40215	R/W (Int)	Data type of OT/+ register, value in holding register 215 is written to this ID [1]).
215	40216	R/W (Int)	Value is written to OT/+ register, ID is entered in holding register 213 [2]).

Address	Modicon address	Description	Signal
216	40217	R/W (Int)	ID of OT/+ register, value is read to input/holding register 120.
217	40218	R/W (Int)	Data type of OT/+ register, value is read to input/holding register 120 [1]).

[1]) It can take values from following table:

Value	Data type in OT/+ line
0	u8, flag8
1	s8
2	f88
3	u16
4	s16

[2]) In case ID register in OT/+ is f88 type, it is necessary to write integer value in format: "written value × 10". If we want to write, e.g. value "23.1", into peripheral, it is necessary to write value "231".

11. Ordering information and completion

Converter	**DMM-OT**	Unit complete, see chapter 11.1.Completion.

11.1. Completion

DMM-OT

Part	Quantity
OpenTherm/+ interface convertor with MODBUS RTU interface	1
WAGO 734-202/037-000	1
WAGO 231-303/102-000	1
WAGO 231-302/102-000	1

12. Maintenance

Device requires no periodic control, nor maintenance.

Cleaning Time after time with regard to way of device usage, it is necessary to remove dust from inner electronics. The equipment can be cleaned by dry soft brush or vacuum cleaner, only when turned-off and disassembled.

Note **The maintenance mentioned above can be performed by manufacturer or authorized service only!**

13. Waste disposal

Electronics disposal The disposal of electronic equipment is subject to the regulations on handling electrical waste. The equipment must not be disposed of in common public waste. It must be delivered to places specified for that purpose and recycled.