



HOME OF SENSOR TECHNOLOGY

**Description of the
RS485 MODBUS interface**

WRF06 Modbus
WRF06 (x) Modbus
WRF07 (x) Modbus

Revision

Revision	Date	Description	Author
A	18.01.2021	First Release	JR
B	04.02.2022	Layout changes	JD, JR
C	11.04.2022	LED control added	JR
D	23.05.2022	Firmware V1.3 LED and fan stage configuration added	JR
E	03.12.2024	WRF06, WRF06 (x) and WRF07 (x) merged	JD

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1 WRF06/07 RS485 Modbus

This document describes the RS485 Modbus interface of the WRF06 Modbus room sensor and the WRF06 (x) Modbus and WRF07 (x) Modbus room operating units, with CO₂ and optional additional sensor elements. The Modbus registers and functions depend on the device version used.

1.1 Hardware Installation

The device can be connected using a twisted pair cable (line resistance 120 Ohm). For detailed information on commissioning and installation, please refer to the relevant product data sheet.

1.2 RS485 Transceiver

The maximum number of bus devices without using a repeater is specified by the RS485 transceiver. The transceiver used here allows a maximum of 32 devices per bus segment.

1.3 Protokoll

The device is a slave bus participant that may only transmit to the bus when requested by the master. The protocol corresponds to the specifications from:

- MODBUS Application Protocol Specification V1.1 ([Link](#))
- MODBUS over Serial Line Specification & Implementation guide V1.0 ([Link](#))

1.4 Configuration options

The device can be adapted to the respective bus topology using dip switches.

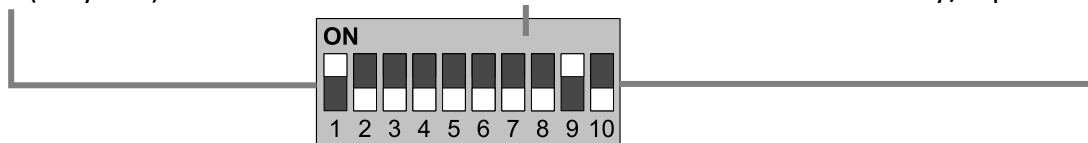
- Device bus address (1 – 63)
- Baud rate 9600, 19200, 38400 or 57600
- Parity even, odd or none
- The number of stop bits is determined automatically by the device depending on the parity
- 1 stop bit at parity „even“ or „odd“
- 1 or 2 stop bits at Parity „none“, configurable

1.5 Dip switches and LED

Modbus-address - DIP 1..6 (binary coded)

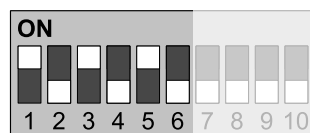
Baud rate - DIP 7 & 8

Parity / Stopbits - DIP 9 & 10



(picture shows factory default settings)

Modbus Adresse



(example.: 1 + 4 + 16 = address 21)

Dip switch	ON	ON	ON	ON	ON	ON
	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6
Value	on= 2 ⁰ (1)	on= 2 ¹ (2)	on= 2 ² (4)	on= 2 ³ (8)	on= 2 ⁴ (16)	on= 2 ⁵ (32)

Baud rate - DIP 7 & 8				Parity / Stopbits - DIP 9 & 10			
off off				off off			
9600				None 2 Stopbits			
on off				on off			
19200				Even 1 Stopbit			
off on				off on			
38400				Odd 1 Stopbit			
on on				on on			
57600				None 1 Stopbit			

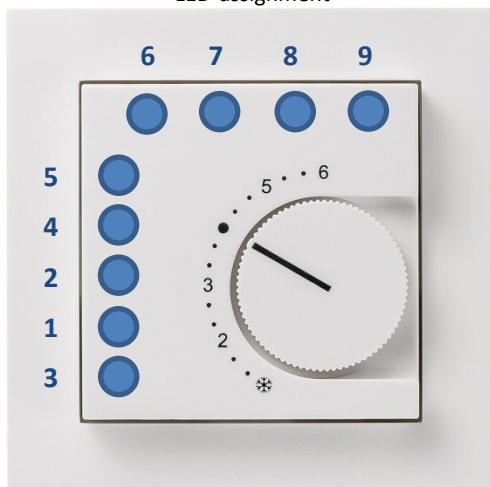
Operation state BUS communication

LED	Colour	Description
STA	green	Lights up permanently during normal operation
RXD	yellow	Blinks when RS485 Modbus telegrams are received
TXD	yellow	Blinks when RS485 Modbus telegrams are sent
ERR	red	Lights up in case of a corrupt bus configuration and internal errors

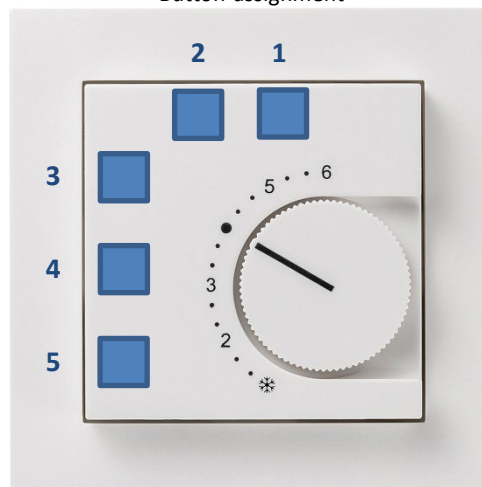
Note:
During startup, all 4 LEDs blink for a few seconds.

1.6 LED- and Button assignment*

LED-assignment



Button-assignment



*type depending

2 Modbus Register description

All the registers listed below are holding registers that can be addressed via Modbus function codes 3, 6 and 16 (0x03, 0x06 and 0x10).

The data address of the respective register is listed in the "Register Address" column. The "Access" column indicates whether the respective register can only be read (R - read only) or read and written (RW - read write). In addition, the data type of the respective register is also specified in the "Access" column (u16 - unsigned 16 bit, s16 - signed 16 bit).

2.1 Sensor values

The various measured values can be read out via registers 0...8. Register address 501 (sensor detection) can be used to determine which measured values are available for the respective device.

Register address	Access	Description	default	Comment
400	RW / s16	Selection of the unit system	1	1: SI 2: Imperial

Register address	Access	Description	resolution / unit	
1	R / s16	Relative humidity	0.1	%rF
5	R / s16	CO2	1.0	ppm
6	R / s16	VOC	0.1	%
7	R / s16	CO2 VOC mix	0.1	
8	R / s16	Setpoint potentiometer	1.0	-

Register address	Access	Description	resolution / unit (SI) register address 400 = 1		resolution / unit (Imp) register address 400 = 2	
0	R / s16	Temperature	0.1	°C	0.1	°F
2	R / s16	Absolute humidity	0.01	g/m³	0.01	gr/ft³
3	R / s16	Enthalpy	0.1	kJ/kg	0.1	BTU/lb
4	R / s16	Dewpoint	0.1	°C	0.1	°F

2.2 Offset-/ Adjustment values

Offset/correction values for the individual measured values can be specified via registers 100...104.

Example Offset temperature (register 100):

Offset +1 °C (+1 °F) = 1010 (0000'0000'0000'10102) = 00 0a16

Offset -1 °C (-1 °F) = -1010 (1111'1111'1111'01102) = ff f616

Register address	Access	Description	default	resolution / unit (Imp) register address 400 = 2	
101	RW / s16	Offset relative humidity	0	1.0	%rF
102	RW / s16	Offset CO2	0	1.0	ppm
103	RW / s16	Offset VOC	0	1.0	%
104	RW / s16	VOC Scale	100	1.0	ppb/%
105	RW / s16	Height	0	1.0	m

Register address	Access	Description	default	resolution / unit (SI) register 400 = 1		resolution / unit (Imp) register 400 = 2	
100	RW / S16	Offset temperature	0	0.1	°C	0.1	°F

2.3 Measuring value Upper/lower limits

The measured value upper/lower limits can be used to limit the values in a specific range. The scaling affects the values in registers 0..8.

Register address	Access	Description	Default	Resolution / unit	
202	RW / s16	Lower limit relative humidity	0	1.0	%rF
203	RW / s16	Upper limit relative humidity	100	1.0	
210	RW / s16	Lower limit CO2	0	1.0	ppm
211	RW / s16	Upper limit CO2	5000	1.0	
212	RW / s16	Lower limit VOC	0	1.0	%
213	RW / s16	Upper limit VOC	100	1.0	
214	RW / s16	Lower limit CO2 VOC mix	0	1.0	%
215	RW / s16	Upper limit CO2 VOC mix	100	1.0	
216	RW / s16	CO2 VOC mix share (CO2 share)	50	1.0	%
217	RW / s16	Lower limit potentiometer setpoint	-30	1.0	-
218	RW / s16	Upper limit potentiometer setpoint	30	1.0	-

Register address 400 = 1 (SI)

Register address	Access	Description	Default	Resolution / unit	
200	RW / s16	Lower limit temperature	0	1.0	°C
201	RW / s16	Upper limit temperature	50	1.0	
204	RW / s16	Lower limit absolute humidity	0	1.0	g/m³
205	RW / s16	Upper limit absolute Humidity	83	1.0	
206	RW / s16	Lower limit enthalpy	0	1.0	kJ/kg
207	RW / s16	Upper limit enthalpy	274	1.0	
208	RW / s16	Lower limit dewpoint	-110	1.0	°C
209	RW / s16	Upper limit dewpoint	50	1.0	

Register address 400 = 2 (Imperial)

Register address	Access	Description	Default	Resolution / unit	
200	RW / s16	Lower limit temperature	32	1.0	°F
201	RW / s16	Upper limit temperature	122	1.0	
204	RW / s16	Lower limit absolute humidity	0	1.0	gr/ft³
205	RW / s16	Upper limit absolute humidity	36	1.0	
206	RW / s16	Lower limit enthalpy	0	1.0	BTU/lb
207	RW / s16	Upper limit enthalpy	118	1.0	
208	RW / s16	Lower limit dewpoint	-166	1.0	°F
209	RW / s16	Upper limit dewpoint	122	1.0	

2.4 Device configuration

The required unit system can be selected via register address 400.

Register address	Access	Description	Default	Comment
400	RW / s16	Selection of the unit system	1	1: SI 2: Imperial

Register address	Access	Description	Default	Comment
401	RW / s16	Modbus Slave ID	1	1 ... 147 = Modbus ID at dip switch address 0
402	RW / s16	Preset fan stage	0	0 = Fan stage „0“ 1 = Fan stage „1“ 2 = Fan stage „2“ 3 = Fan stage „3“ 4 = Fan stage „Auto“
403	RW / s16	AUTO fans stage available	1	0 = not available 1 = available
404	RW / s16	Fan stage after reset	0	-1 = previous fan stage 0 = Fan stage „0“ 1 = Fan stage „1“ 2 = Fan stage „2“ 3 = Fan stage „3“ 4 = Fan stage „Auto“
405	RW / s16	Room occupancy after reset	0	-1 = previous room occupancy 0 = room not occupied 1 = room occupied
406	RW / s16	Room occupancy zeit	0	0 = deactivated 1...1440 = „active“time [Min]

Depending on the device type, buttons or digital inputs can be configured.

Register address	Access	Description	Default	Comment
410	RW / s16	Button function 1	0x00	0x00 = w/o special function
411	RW / s16	Button function 2	0x00	0x22 = toggle room occup.
412	RW / s16	Button function 3	0x00	0x25 = Fan stage „up“
413	RW / s16	Button function 4	0x00	0x26 = Fan stage „down“
414	RW / s16	Button function 5	0x00	0x27 = Fan stage „loop“ 0x28 = Fan stage „up/down“

Register address	Access	Description	Default	Comment
420	RW / s16	Digital input 1 function	0x00	0x00 = w/o special function 0x01 = n.c. Dew point monitor 0x02 = n.c. window contact 0x03 = n.c. room occupancy 0x11 = n.o. dew point monitor 0x12 = n.o. window contact
421	RW / s16	Digital input 2 function	0x00	0x13 = n.o. room occupancy 0x22 = toggle room occupancy 0x25 = Fan stage „up“ 0x26 = Fan stage „down“ 0x27 = Fan stage „loop“ 0x28 = Fan stage „up/down“

n.c.= normally closed | n.o. = normally open

2.5 General register

General device information can be read out via registers address 500...505.

Register address	Access	Description	Comment
500	R / s16	Device identifier, cannot be changed	0x0230
501		Sensor identifier	1 = Sensor value available 0 = Sensor value not available Bit 0: Temperature Bit 1: Relative Humidity Bit 2: Absolute Humidity Bit 3: Enthalpy Bit 4: Dewpoint Bit 5: CO2 Bit 6: VOC Bit 7: CO2 VOC mix
502		MC PCB hardware version	Ex.: V 1.1 = 0x0101 Readability in hexadecimal
503		Firmware version	
504		KL PCB Hardware version	
505		Factory settings	
506		Sensor failure	1 = Sensor failure 0 = Sensor OK Bit 0: Temperature Bit 1: Relative Humidity Bit 2: Absolute Humidity Bit 3: Enthalpy Bit 4: Dew point Bit 5: CO2 Bit 6: VOC Bit 7: CO2 VOC mix
507		Firmware compilation date DDMMYY	Bit 0 – Bit 4: day Bit 5 – Bit 8: month Bit 9 – Bit 15: year

2.6 Display configuration

The TLF parameters can be adjusted via registers address 614...616.

Register address	Access	Description	Default	Comment
614	RW / s16	TLF channel selection	0	0 = w/o function 1 = temperature 2 = relative humidity 3 = CO2 4 = VOC 5 = Potentiometer

** type depending*

Register address	Access	Description	Default	Resolution / unit	
615	RW / s16	Traffic light function Threshold value Range 1→2 (relative humidity)	33	1.0	%rF
		Range 1→2 (CO2)	750	1.0	ppm
		Range 1→2 (VOC)	33	1.0	%
		Range 1→2 (Potentiometer)	-15	1.0	-
616	RW / s16	Traffic light function Threshold value Range 2→3 (relative humidity)	66	1.0	%rF
		Range 2→3 (CO2)	1250	1.0	ppm
		Range 2→3 (VOC)	66	1.0	%
		Range 2→3 (Potentiometer)	15	1.0	-

Register address 400 = 1 (SI)

Register address	Access	Description	Default	Resolution / unit	
615	RW / s16	Traffic light function Threshold value Range 1→2 (temperature)	180	0.1	°C
616	RW / s16	Traffic light function Threshold value Range 2→3 (temperature)	240	0.1	°C

Register address 400 = 2 (Imperial)

Register address	Access	Description	Default	Resolution / unit	
615	RW / s16	Traffic light function Threshold value Range 1→2 (temperature)	640	0.1	°F
616	RW / s16	Traffic light function Threshold value Range 2→3 (temperature)	750	0.1	°F

Register address	Access	Description	Comment
617	R / s16	Current TLF zone	0 = off 1 = Zone 1 2 = Zone 2 3 = Zone 3
618	R / s16	Current fan stage	0 = Fan stage „0“ 1 = Fan stage „1“ 2 = Fan stage „2“ 3 = Fan stage „3“ 4 = Fan stage „Auto“
619	RW / s16	Fan stage LED overrun time	0 = always on 1...60 = „on“ time [s]

Register address	Access	Description	Default	Comment
803	RW / s16	Function LED 1	0	-1 = non
804	RW / s16	Function LED 2	0	0 = external control
805	RW / s16	Function LED 3	0	1 = occupancy
806	RW / s16	Function LED 4	0	2 = TLF zone 1
807	RW / s16	Function LED 5	0	3 = TLF zone 2
808	RW / s16	Function LED 6	0	4 = TLF zone 3
809	RW / s16	Function LED 7	0	5 = Fan stage 0
810	RW / s16	Function LED 8	0	6 = Fan stage 1
811	RW / s16	Function LED 9	0	7 = Fan stage 2 8 = Fan stage 3 9 = Fan stage Auto 10 = dew point monitor 11 = window contact
814	RW / s16	Lowest fan stage	0	0 ... 3
815	RW / s16	Highest fan stage	-1	-1 = non 0 ... 3

2.7 Reset settings

Register address	Access	Description	Comment
1000	RW / s16	Reset device	1 = factory reset 2 = restart only

2.8 Discrete Inputs

Register address	Access	Description	Comment
0	R	Room occupancy	0 = Room not occupied 1 = room occupied
1	R	Button 1	0 = not pressed 1 = pressed
2	R	Button 2	
3	R	Button 3	
4	R	Button 4	
5	R	Button 5	
6	R	Button 1 (saved)	0 = not pressed 1 = pressed <i>The button status remains stored until the register is read out</i>
7	R	Button 2 (saved)	
8	R	Button 3 (saved)	
9	R	Button 4 (saved)	
10	R	Button 5 (saved)	

Register address	Access	Description	Comment
11	R	Digital input 1	0 = open 1 = closed
12	R	Digital input 2	
13	R	Digital input 1 (saved)	0 = open 1 = closed <i>The input status remains stored until the register is read out</i>
14	R	Digital input 2 (saved)	
15	R	Dew point message	0 = dew point not active 1 = dew point active
16	R	Window message	0 = closed 1 = open

2.9 Outputs (Coils)

Depending on the device type, states can be overwritten if necessary

Register adress	Access	Description	Comment
0	RW	Overwrite room occupancy	0 = Room not occupied 1 = Room occupied
1	RW	Overwrite status LED 1	0 = LED off 1 = LED on
2	RW	Overwrite status LED 2	
3	RW	Overwrite status LED 3	
4	RW	Overwrite status LED 4	
5	RW	Overwrite status LED 5	
6	RW	Overwrite status LED 6	
7	RW	Overwrite status LED 7	
8	RW	Overwrite status LED 8	
9	RW	Overwrite status LED 9	
10	RW	Deactivate status LEDs (STA, RXD, TXD, ERR)	0 = not deactivated 1 = deactivated

Note: Coils 0 to 10 retain their value even after a restart.

3 Modbus Protokoll (<http://www.modbus.org/>)

3.1 Supported control commands

The following MODBUS control commands are supported by the device:

Description	Function code	
Read bit position(s)	01 (hex)	1 (dez)
	02 (hex)	2 (dez)
Read register	03 (hex)	3 (dez)
	04 (hex)	4 (dez)
Write single bit	05 (hex)	5 (dez)
Write single register	06 (hex)	6 (dez)
Write several bits	0F (hex)	15 (dez)
Write several registers	10 (hex)	16 (dez)

3.2 Data transmission

3.2.1 Master/Slave Protocol

A master and one or more slaves are connected to the serial bus. Communication between master and slave is controlled exclusively by the master. The slaves may only transmit if they have previously been addressed by the master. Slaves only send back to the master, never to another slave.

3.2.2 Data framework

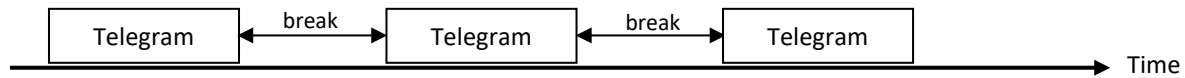
The data is sent to the bus according to strictly defined specifications:

Adress	Control command	Data	Check sum
--------	-----------------	------	-----------

In general, a MODBUS telegram starts with the address of the slave, followed by a control command (e.g. read register) and the data. With the help of the checksum at the end of the telegram, the bus participants can detect transmission errors.

3.2.3 Transmission mode RTU

In RTU transmission mode, telegrams are separated from each other by transmission pauses.



The duration of the transmission pauses for separating telegrams depends on the set baud rate and is $3.5 \times \text{word transmission time (11 bits)}$. At 9600 baud, this means that at least 4 ms and at least 2 ms between two telegrams at 19200.

3.2.3.1 Telegram structure

Adress 1 Byte	Control command 1 Byte	Data 0 - 100 Byte	Checksum	
			Low	High

3.2.3.2 Calculation of the CRC checksum

The CRC checksum (Cyclical Redundancy Check) is calculated by the sender from all transmitted bytes and appended to the message.

The receiver then calculates the CRC checksum again and compares it with the checksum received. If the values do not match, a transmission error is assumed and the received data is discarded.

received data is discarded. The least significant byte of the 16-bit checksum is sent at the penultimate position in the telegram and the most significant byte at the last position.

Calculating the checksum (program example in C):

```

crc = 0xFFFF; // CRC-Check, Init
for(i = 0; i < telegram_length-2; i++)
    crc = crc_calc(crc, telegram_data[i]);

crc_low = crc & 0x00FF; // Low-Byte
crc_high = (crc & 0xFF00) >> 8; // High-Byte

// Calculate CRC
unsigned int crc_calc(unsigned int crc_temp, unsigned int data)
{
    unsigned int Index_CC=0;
    unsigned int LSB=0;
    crc_temp = ( ( crc_temp ^ data ) | 0xFF00 ) & ( crc_temp | 0x00FF );
    for(Index_CC = 0; Index_CC<8; Index_CC++)
    {
        LSB = (crc_temp & 0x0001);
        crc_temp >>= 1;
        if(LSB)
            crc_temp = crc_temp ^ 0xA001; // calculation polynomial for CRC16
    }
    return(crc_temp);
}
  
```