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Protocol Description
WRF07 RS485 ModBus

Version 1.2, 25.04.2012

Index of Changes

Version	Date	Description
1.0	13.07.2010	First Release
1.1	28.03.2011	- Changes in manual output mode: valid since firmware version 1.01, configuration software since version 1.1 - Type DI4 added
1.2	25.04.2012	Corrections

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1 WRF07-RS485-Modbus

The present document describes the serial interface of the room operating panel WRF07-RS485-MODBUS. The MODBUS-Protocol developed by the company Modicon is a disclosed protocol for communication of several intelligent Master-Slave based devices.

For further information and definitions on the topic MODBUS, please see www.modbus.org.

1.1 Control.

1.1.1 Device Types

The control is integrated in the following devices: AO2V, OVR, OVT, DO2R, DO2T.

1.1.2 Function Mode of PI-Controller

The integrated PI-controller controls the temperature (register 0x0102) of set point 1 (Register 0x0104). The control variable resulting is directly output to the outputs. The PI-controller can be set by properties. The control variable of the controller is re-calculated approx. every 10 seconds. Thus, changes, such as e.g. adjustment of set point or triggering of window contact are only considered after expiration of the control time.

1.1.3 Change-Over Operation

The device can be used for a 2-pipe and a 4-pipe wire system. The corresponding selection is made via the configuration coil “Change-Over Operation“.
If the change-over operation is activated, the corresponding mode (heating or cooling of controller) must be defined (e.g. by digital input or register 0x203, Controller mode). The Change-Over Operation runs via output 1!

1.1.4 Energy Stop / Dew Point Detector

If a window contact or a dew point detector are connected to the digital inputs and the digital inputs are parameterized the same, both are directly affecting the control.

1.1.1 Override of Outputs

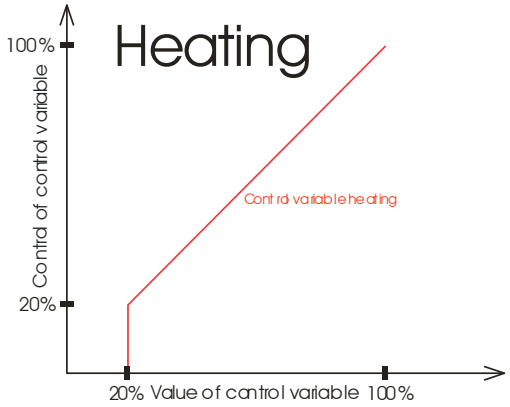
The outputs can be affected and overwritten directly by a master device. Therefore, it is necessary to set the outputs into manual operation (configuration bits 0x0004 and 0x0005). In the configuration registers 0x00021 and 0x0022 the requested start values for the outputs are parameterized. During operation an overriding of the outputs is possible via the input registers 0x0204 and 0x0205.

1.1.2 Minimal Control Variable

By means of the property “Use minimal control variable with control variable = 0“(Coil-Bit 8 = 0) the minimal control variable is only used, if the control variable is › 0. If Coil-Bit 8 is =1, the minimal control variable is also used if the control variable is = 0.

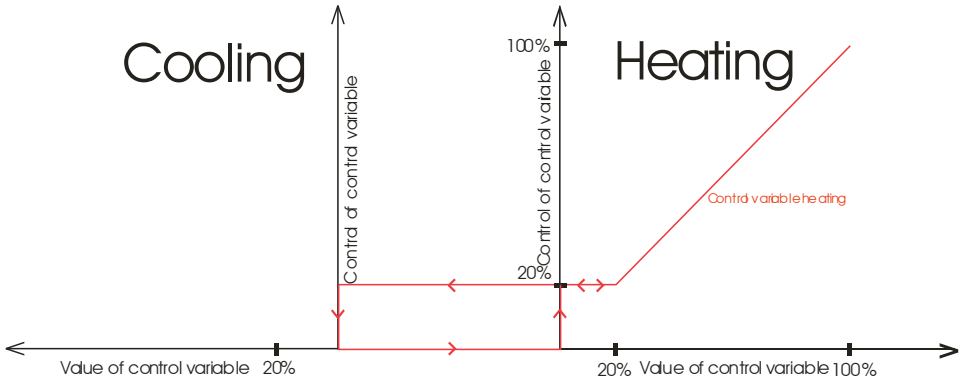
Mode Selection Control Variable (Coil Register 0x0000)

(1) Mode selection Control Variable = 1
Ymin = 20%



The control variable is only sent to the output if the calculated value of the control variable is bigger than the minimal control variable.

(2) Mode selection Control Variable = 0
Ymin = 20%



The minimal control variable at the output remains unchanged until the controller changes the operating mode

1.1.3 Calculating Set Points:

(1) OCCUPIED

- *Heating set point* =basic set point + offset(Adr. 0x0200) + poti offset*
- *Cooling set point* = basic set point + dead zone (Adr.0x0014) + offset(Adr. 0x0200) + Poti-Offset*

(2) UNOCCUPIED

- *Heating set point* = basic set point + offset(Adr. 0x0200) + poti offset* -night lowering
- *Cooling set point* = basic set point + dead zone(Adr.0x0014) + offset(Adr. 0x0200) + poti offset* + night lowering (Adr.0x0013)

*if used

1.2 Hardware Installation

The room operating panel can be connected by means of a twisted-pair cable (line resistance 120 Ohm). For detailed information on installation and mounting, please see the product data sheet WRF07-RS485 and the data sheet wiring_rs485_network.pdf.

1.3 RS485 Transceiver

The maximum number of bus participants without use of a repeater is preset by the RS485-transceiver. The transceiver used enables 32 devices per bus segment at maximum.

1.4 Protocol

The room operating panel WRF04-RS485-Modbus is a slave-bus participant only allowed to send to the bus on demand of the master. The protocol corresponds to the defaults of:
- MODBUS Application Protocol Specification V1.1
- MODBUS via Serial Line Specification & Implementation guide V1.0

1.5 Configuration Options

By means of the DIP switch the device can be adapted to the corresponding bus topology.

5pole DIP switches:

- Bus address of device (1 - 31) via 5-pole DIP switch; DIP switch: 1-5 = 5pole DIP switch:
- Transmitting mode
  - DIP 1 off: RTU
  - DIP 1 on: ASCII
- Baud rate
  - DIP 2 off + DIP 3 off: 9600
  - DIP 2 on + DIP 3 off: 19200
  - DIP 2 off + DIP 3 on: 38400
  - DIP 2 on + DIP 3 on: 57600
- Parity
  - DIP 4 off + DIP 5 off: none
  - DIP 4 on + DIP 5 off: even
  - DIP 4 off + DIP 5 on: odd
- The number of data bits is fixed and preset to: RTU 8 data bits and ASCII 7 data bits

As the data sheet contains a detailed description of position and meaning of the jumpers, please refer to the file „Produktblatt_wrf07_rs485.pdf“.

Important notice for operation in the Master/Slave system:

!! The bus address must be adjusted differently for each device

!! Transmission mode, baud rate and parity must be identical

2 WRF07-RS485-Modbus Protocol

2.1 Control Commands Supported

The following MODBUS – control commands are supported:

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

Table 1

2.2 Data Administration

All data in a MODBUS-Slave are assigned to addresses. Data access (read or write) is made by the corresponding control command and the indication of the corresponding data address.

Due to limited memory resources, the maximum number of readable and writable registers and coils in a telegram is limited in dependence on the
transmitting mode.

Procedure	RTU	ASCII
Read register	20	10
Write register	20	10
Read coils	16	8
Write Coils	8	8

2.3 Register Definition

2.3.1 Configuration Register (Holding Register R/W)

Register	Data Address	Value Range	Description		Default values
1 R	0x0000	0x0003	Device coding, not changeable		
2 R	0x0001	0x0012	Firmware version, not changeable		
2 – 60	0x0002 – 0x0025	Configuration of the operating panel, EEPROM- data			
3 R/W	0x0002	0x0000-0x0004	Device Type	0x0000, Type AO2V (AO1: Heating, AO2: Cooling)	0x0000, AO2V
				0x0001, Type DO2R (DO1: Heating, DO2: Cooling)	
				0x0002, Type DO2T (DO1: Heating, DO2: Cooling)	
				0x0003, Type OVR (DO1: Heating, AO2: Cooling)	
				0x0004, Type OVT (DO1: Heating, AO2: Cooling)	
				0x0005, Type 4DI (4 digital inputs)	
4 R/W	0x0003	0x0000-0xFFFF	Device location		0
5 R/W	0x0004	0x0000-0x0C80	Min-Response-Delay-Time	signed int, (max 3100 ms) e.g 0x0A = 10ms	10ms
6 R/W	0x0005	0x0000-0x00FF	Function button 1	0x00,without special function 0x20, Room unoccupied 0x21, Room occupied 0x22, Room occupancy toggle 0x23, Maker Room occupancy 0x23, Bypass mode	0x00, without special function
7 R/W	0x0006	0x0000-0x00FF	Function button 2		
8 R/W	0x0007	0x0000-0x00FF	Function button 3		
9 R/W	0x0008	0x0000-0x00FF	Function button 4		
10 R/W	0x0009	0x0000-0x00FF	Function button 5		
11 R/W	0x000A	0x0000-0x0004	Trigger LED 1	0x00, external trigger 0x01, room occupied (ON) /unoccupied(OFF) 0x02, controller active(ON)/ inactive(OFF) 0x03, controller cooling active(ON)/inactive(OFF) 0x04, controller heating active(ON)/inactive(OFF)	0x01, room occupied (ON) / unoccupied (OFF)
12 R/W	0x000B	0x0000-0x0004	Trigger LED 2		
13 R/W	0x000C	0x0000-0x0004	Trigger LED 3		
14 R/W	0x000D	0x0000-0x0004	Trigger LED 4		
15 R/W	0x000E	0x0000-0x0004	Trigger LED 5		

Register	Data Address	Value Range	Description		Default values
16 R/W	0x000F	0x0000-0x00FF	Temperature-Offset for calibration of temperature sensor signed int, e.g. 10_{dec} = +1.0 K, -5_{dez} = -0.5 K		0 K
17 R/W	0x0010	0x0000-0xFFFF	Adjustable range set point +-3K signed int, e.g. 30_{dec} = + 3.0 K		+/-3K
18 R/W	0x0011	0x0000-0xFFFF	Set temperature – Basic set point after reset signed int, e.g. 220_{dez} = 22.0 °C		22 °C
19R/W	0x0012	0x0000-0x0001	Set temperature display	0x00 – Basic set point 0x01 – Change over display of heating/cooling set point depending on activated operating	0x00 Basic set point
20R/W	0x0013	0x0000-0xFFFF	Night setback (unoccupied) Heating = set point – night lowering Cooling = set point + night lowering signed int, e.g. 40_{dec} = 4.0 K		5K
21R/W	0x0014	0x0000-0x0064	Dead band between heating and cooling Signed int, e.g. 20_{dec} = 2.0K		2K
22 R/W	0x0015	0x0000-0x0064	Proportional range Xp (K) Heating signed int, e.g. 40_{dec} = 4.0 K Xp = 0 deactivates controller		2K
23 R/W	0x0016	0x0000-0x00FF	Reset time Tn (min) Heating signed int, e.g. 100_{dec} = 100 min		100min
24 R/W	0x0017	0x0000-0x0064	Maximal control variable limit Heating signed int, e.g. 100_{dec} = 100 %		100%
25 R/W	0x0018	0x0000-0x0064	Minimal control variable limit Heating signed int, e.g. 10_{dec} = 10 %		0%
26 R/W	0x0019	0x0000-0x00FF	PWM-Cycle time Heating signed int, e.g. 15_{dec} = 15 min		15min
27 R/W	0x001A	0x0000-0x0064	Proportional range Xp (K) Cooling signed int, e.g. 40_{dec} = 4.0 K Xp = 0 deactivates controller		2K
28 R/W	0x001B	0x0000-0x00FF	Reset Time Tn (min) Cooling signed int, e.g. 100_{dec} = 100 min		100min
29 R/W	0x001C	0x0000-0x0064	Maximal control variable limit Cooling signed int, e.g. 100_{dec} = 100 %		100%
30 R/W	0x001D	0x0000-0x0064	Minimal control variable limit Cooling signed int, e.g. 10_{dec} = 10%		0%
31 R/W	0x001E	0x0000-0x00FF	PWM-Cycle time Cooling signed int, e.g.15_{dec} = 15 min		15min
32 R/W	0x001F	0x0000-0x0064	Frost protection 0x00 deactivates antifreeze signed int, e.g. 50_{dez} = 5.0 K		5K
33 R/W	0x0020	0x0000-0x0003	Controller mode after reset and Off	0 – Controller off 1 – Controller heating 2 – Controller cooling 3 – Controller automatic	3 automatic

Register	Data Address	Value Range	Description		Default values
34 R/W	0x0021	0x0000-0x03E8	Type: AO2V Analogue value 0-10V after reset Output1 Heating*	signed int, e.g. 1000_{dec} = 100%	0
			Type: DO2R, DO2T, OVR, OVT Digital value after reset Output1 Heating*	0 - Open >=1 - Closed	0
35 R/W	0x0022	0x0000-0x03E8	Type: AO2V, OVR, OVT Analogue value 0-10V after reset Output2 Cooling	Signed int, e.g. 1000_{dec} = 100%	0
			Type: DO2R, DO2T Digital value after reset Output2 Cooling*	0 - Open >=1 - Closed	0
36 R/W	0x0023	0x0000-0x0003 0x0010-0x0013	Selection digital input 1	0x00, Break contact 0x01, Breaker dew point 0x02, Breaker energy hold off 0x03, Breaker occupied 0x04, Breaker controller 0 – auto/ 1 - off 0x05, Breaker controller 0 - heating/ 1 - cooling 0x10, Make contact 0x11, Maker dew point 0x12, Maker energy hold off 0x13, Maker occupied 0x14, Maker controller 0 - auto/ 1- off 0x15, Maker controller 0 - heating/ 1 - cooling	0x10, Maker contact
37 R/W	0x0024	0x0000-0x0003 0x0010-0x0013	Selection digital input 2		
38 R/W	0x0025	0x0000-0x0002	Counter mode digit.input1	0x00, edge 0x01, pulse 0x02, duration	0x00, edge
39 R/W	0x0026	0x0000-0x0002	Counter mode digit.input 2		
40R/W	0x0027	0x0000-0x0078	Bypass time occupancy (min) signed int, e.g. 0x0078 = 120_{dec} = 120 min		120min
41 R/W *	0x0028	0x0000-0x0003 0x0010-0x0013	Selection digital input 3	0x00, Break contact 0x01, Breaker dew point 0x02, Breaker energy hold off 0x03, Breaker occupied 0x04, Breaker controller 0 – auto/ 1 - off 0x05, Breaker controller 0 - heating/ 1 - cooling 0x10, Make contact 0x11, Maker dew point 0x12, Maker energy hold off 0x13, Maker occupied 0x14, Maker controller 0 - auto/ 1- off 0x15, Maker controller 0 - heating/ 1 - cooling	0x10, Maker contact
42 R/W *	0x0029	0x0000-0x0003 0x0010-0x0013	Selection digital input 4		

Register	Data Address	Value Range	Description		Default values
43 R/W *	0x002A	0x0000-0x0002	Counter mode digit.input3	0x00, edge 0x01, pulse 0x02, duration	0x00, edge
44 R/W *	0x002B	0x0000-0x0002	Counter mode digit.input 4		

Important notice

Configuration registers are saved in the EEPROM, i.e. these are no volatile data. The registers may only be written during installation for parametrization
of the device because a too frequent writing of the EEPROM results in a damage of the same.

* Registers 41-44 are only available with device type 4DI
  Registers 34-35 are irrelevant

2.3.2 Output Register (Modbus Input Registers R)

Register	Data Address	Value Range	Description	
257 – 271 R	0x0100 – 0x0111	Measuring value (data output)		
257 R	0x0100	0x0000-0x000F	bit0 button 1=pressed, 0=not pressed bit0 button 1=pressed, 0=not pressed bit0 button 1=pressed, 0=not pressed bit0 button 1=pressed, 0=not pressed bit0 button 1=pressed, 0=not pressed	
258 R	0x0101	0x0000-0x000F	It is buffered if a button was actuated since the last read out of the register. After the read out, all bits are reset to the actual value. bit0 button 1= pressed 0=not pressed bit0 button 1= pressed 0=not pressed bit0 button 1= pressed 0=not pressed bit0 button 1= pressed 0=not pressed bit0 button 1= pressed 0=not pressed	
259 R	0x0102	0x0000-0x01F4	Temperature	signed int, e.g. 184_{dec} = 18.4 °C
260 R	0x0103	0x0000-0xFFFF	Set temperature offset*	signed int, Temperature: e.g. -25_{dez} = -2.5K
261 R	0x0104	0x0000-0xFFFF	Set temperature effective	signed int, e.g. 220_{dec} = 22.0 °C
262 R	0x0105	0x0000-0x0001	Occupancy mode	0 – unoccupied 1 – occupied
263 R	0x0106	0x0000-0x03FF	Regulating variable heating	signed int, e.g. 1023_{dec}=100.0% range 0-1023 corresponds to. 0-100%
264 R	0x0107	0x0000-0x03FF	Regulating variable cooling	signed int, e.g. 1023_{dec}=100.0% range 0-1023 corresponds to 0-100%
265R/W	0x0108	0x0000-0x0003	Controller mode	0 = stop of controller 1 = heating 2 = cooling 3 – automatic heating control 4 – automatic cooling control
266 R	0x0109	0x0000-0x03E8	Type: AO2V Analogue output value 0-10V Output1 Heating*	Unsigned int, e.g. 500_{dec} = 5V
			Type: DO2R, DO2T, OVR, OVT Digital output state Output1 Heating*	0 – open 1 - closed
267 R	0x010A	0x0000-0x03E8	Type:AO2V, OVR, OVT Analogue output value 0-10V Output2 cooling	signed int, e.g. 500_{dez} = 5V
			Type: DO2R, DO2T Digital output state Output2 cooling	0 – open 1 - closed

268 R	0x010B	0x0000-0x0001	Digital input1	0 - open 1 - closed
269 R	0x010C	0x0000-0x0001	Digital input2	0 - open 1 - closed
270 R	0x010D	0x0000-0xFFFF	Counter value digit. Input1**	0-65535
271 R	0x010E	0x0000-0xFFFF	Counter value digit. Input2**	0-65535
272 R	0x010F	0x0000-0x0001	Digital input3	0 - open 1 - closed
273R	0x0110	0x0000-0x0001	Digital input4	0 - open 1 - closed
274 R	0x0111	0x0000-0xFFFF	Counter value digit. Input3**	0-65535
275 R	0x0112	0x0000-0xFFFF	Counter value digit. Input4**	0-65535

* Value output of local set point adjuster (poti).
** With any reading out of the counter the value is zeroed! The counter mode is depending on the adjustment of the corresponding configuration property. Counter base is 100ms!

Note:
In version 4DI registers 266 and 267 are irrelevant!!

2.3.3 Input register (Modbus Holding Registers R/W)

Register	Data Address	Value Range	Description		Default values
513 - 516	0x0200 – 0x0203	Control (ext. data default)			
513 R/W	0x0200	0x0000-0xFFFF	Set point offset	signed int, e.g. -25_{dez} = -2.5K einblenden mit Coilregister 0x0005	0k
514 R/W	0x0201	0x0000-0xFFFF	Base set point	signed int, e.g. 220_{dez} = 22 °C	0°C
515 R/W	0x0202	0x0000-0x0001	Occupancy mode	0 – unoccupied 1 – occupied 2 – bypass mode	0x00, unoccu-pied
516 R/W	0x0203	0x0000-0x0003	Controller mode*	0 = controller off 1 = heating (cooling deactivated) 2 = cooling (heating deactivated) 3 = automatic	0x03, Auto-matic
517 R/W	0x0204	0x0000-0x03E8	Type: AO2V Analogue output value 0-10V Output1 Heating*	Unsigned int, e.g. 500_{dec} = 5V	**
			Type: DO2R, DO2T, OVR, OVT Digital output state Output1 Heating*	0 – open 1 - closed	
518 R/W	0x0205	0x0000-0x03E8	Type:AO2V, OVR, OVT Analogue output value 0-10V Output2 cooling	signed int, e.g. 500_{dez} = 5V	**
			Type: DO2R, DO2T Digital output state Output2 cooling	0 – open 1 - closed	

*Mode change-over upon use of a 2-wire pipe system, i.e. warm and cold water are sharing the inflow and waste pipe (Change-Over operation, please also see configuration bit Change-Over-operation with data address 0x0001). Active frost protection automatically activates the heating controller.

** Depends on configuration of registers 34 and 35, manual values after reset

Note:
In version 4DI registers 517 and 518 are irrelevant!!

Data- Address	Description
0xFF00 – 0xFFFF	Range defined by the manufacturer, not allowed to be changed!

Data- Address	Description

2.4 Bit Allocation / Coil Definition

2.4.1 Configuration bits (Coils R/W)

Bit	Data Address	Description		Default values
0x0000 – 0x0005	Configuration of Operating Panel Bit-Register, EEPROM- Data			
1 R/W	0x0000	Use Minimal Control Variable with control variable > 0: = 1 Use Minimal Control Variable with control variable = 0: = 0 (default)		0
2 R/W	0x0001	Change over mode	0 – 4-wire-system 1 – 2-wire-system*	0x00 4-wire system
3 R/W	0x0002	°C/°F	1 = °C 0 = °F	°C
4 R/W	0x0003	Room occupancy after reset	1 = occupied 0 = unoccupied	0x01, occupied
5 R/W	0x0004	Manual/Automatic operation of Output 1	0 – Auto 1- Manual	0x00, Auto
6 R/W	0x0005	Manual/Automatic operation of Output 2	0 – Auto 1 - Manual	

* If the Change-Over operation is activated, the corresponding mode of the controller (heating,cooling) must be defined via the Holding Register „Control mode“ with the data address 0x203 or by one of the digital inputs.
The Change-Over operation runs via output1.

Important notice

Configuration registers are saved in the EEPROM, i.e. these are no volatile data. The registers may only be written during installation for parametrization
of the device because a too frequent writing of the EEPROM results in a damage of the same.

2.4.2 Input bits (Coils R/W)

Bit	Data Address	Description		Default values
0x0100 – 0x0108	Input Value of Operating Panel Bit-Register Override of Controller			
257 R/W	0x0100	Status signal dew point	0 – Dew point inactive 1 – Dew point active	0, Dewpoint inactive
258 R/W	0x0101	Status signal energy hold off	0 – Energy hold off inactive 1 – Energy hold off active	0, Energy hold off inactive
259 R/W	0x0102	Release of local presence button[1]	0 – Locked 1 – Released	1, Released
260 R/W	0x0103	Release of controller[2]	0 – Locked 1 – Released	1, Released
261 R/W	0x0104	Trigger LED1 [3]	0 – OFF 1 – ON	0, OFF
262 R/W	0x0105	Trigger LED2 [3]	0 – OFF 1 – ON	0, OFF
263 R/W	0x0106	Trigger LED3 [3]	0 – OFF 1 – ON	0, OFF
264 R/W	0x0107	Trigger LED4 [3]	0 – OFF 1 – ON	0, OFF
265 R/W	0x0108	Trigger LED5 [3]	0 – OFF) 1 – ON	0, OFF

[1] *Release* – Change of presence model vial local presence button possible
Locked– Local presence buttons are locked

[2] *Controller locked*– Both controllers are inactive, active antifreeze automatically activates the heating controller
Release Controller – Both controllers are released, the controllers are working in the controller mode, which is set in the corresponding configuration property „Controller Mode“.

[3] The *LED* can only be controlled, if the configuration register for the LED control is parameterized, accordingly!

3 Data Transmission

3.1 Master/Slave Protocol

One master and one or more slaves are connected to the serial bus. The communication between master and slave is exclusively controlled by the master. The slaves are only allowed to send if they have been addressed by the master before. Slaves are only sending back to the master, never to another slave.

3.2 Data Frame

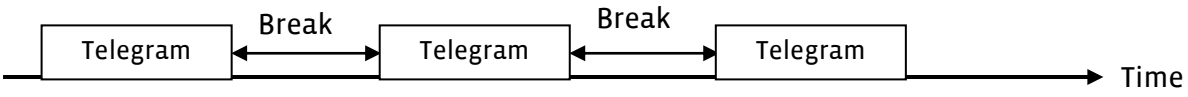
The data are sent to the bus in accordance to severely defined defaults:

Address	Control command	Data	Checksum

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

3.3 Transmission Mode RTU

In the transmission mode RTU telegrams are separated by means of transmission breaks:



The period of the transmission breaks for separating telegrams is depending on the adjusted baud rate and amounts to 3,5 * word transmission time (11 bit). With 9600 baud at least 4 ms must pass by and with 57600 at least 1 ms must pass by between two telegrams.

3.3.1 Telegram Layout

Address 1 Byte	Control command 1 Byte	Data 0 - 100 byte	Checksum	
			CRC Low	CRC High

3.3.2 Calculation of CRC-Checksum

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

The receiver re-calculates the CRC checksum and compares it with the checksum received. If the values do not correspond, a transmission error is assumed and the data received are rejected.

The least significant byte of the 16 bit checksum is set to the penultimate location and the most significant byte is set at last location.

Calculation of checksum (Programming example in C):

```
crc = 0xFFFF;                                   // CRC-Check, Initialisation
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

// Function definition CRC calculation
unsigned int    crc_calc(unsigned int   crc_temp, unsigned int data)
{
        unsigned int    Index_CC=0;             // Loop counter
        unsigned int    LSB=0;                  // Help variable

        // Exclusive-Oder des 8Bit-Char with the lower 8Bit of CRC
        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 polynominal für CRC16
        }

        return(crc_temp);
}
```

3.4 Transmission Mode ASCII

The ASCII transmission mode does not make that high demands on the computer speed of the bus participants. The telegrams are not separated by break times, but by ASCII control characters.

3.4.1 Telegram Layout

The ASCII control character „: “always identifies the beginning of a telegram. The ASCII control characters „CR“and „LF“identify the end of a telegram. The telegram data are output hexa-decimal in the ASCII format:

e.g.: 197dez (1Byte) = C5hex (1 Byte) = C (1 Byte) 5 (1 Byte) ASCII

As one data byte is displayed by 2 ASCII characters, the number of data bytes to be transmitted is doubled compared with the RTU mode.

Start 1 char	Address 2 char	Control command 2 char	Data 0 - 2 x 100 char	Checksum LRC 2 char	End 2 char
:					CR LF

3.4.2 Calculation of LRC-Checksum

The LRC checksum (Longitudinal Redundancy Check) is calculated by the sender out of all bytes transmitted (without „:“, „CR“, „LF“) and pasted in the message of „CR„ and „LF“. The receiver re-calculates the LRC checksum and compares it with the checksum received. If the values do not correspond, a transmission error is assumed and the data received are rejected.

The most significant ASCII character of the 8 bit checksum is sent in the telegram before the least significant ASCII character.

Calculation of checksum (programming example in C):

```
lrc = 0;
for(i = 1; i < Telegram length -4; i++)
        lrc = lrc + Telegram data [i];

lrc = 0xFF - lrc;
lrc = lrc + 1;
```

4 Examples: Telegrams

4.1 Register

The operating unit has different registers for the configuration, for the display of values and for the input values.

4.1.1 Configuration of parameter

The operating unit can be parameterized by the configuration registers and the control commands „Write Register“(10hex or 06hex).

Example: Digital input 1 as breaker dew point and digital input 2 as maker energy hold off.

Master - Telegram in Transmission Mode RTU:

Device	command	Start address		Number of registers		Number of Bytes	Data Register 1F		Data Register 20		Check Sum	
		H Byte	L Byte	H Byte	L Byte		H Byte	L Byte	H Byte	L Byte	L CRC	H CRC
02h	10h	00h	23h	00h	02h	04h	00h	01h	00h	12h	CRC	

Slave – Response Telegram in Transmission Mode RTU:

Device	command	Start Address		Number of Register		Check Sum	
		H Byte	L Byte	H Byte	L Byte	L CRC	H CRC
02h	10h	00h	23h	00h	02h	CRC	

4.1.2 Read-Out of Output Register

Button and digital input status and values are stored in the output registers. After a reset the basic set points are taken over from the configuration registers for the corresponding set points.

Master - Telegram in Mode RTU		Slave – Response Telegram in Mode RTU		
Description	Value (Hex)	Description		Value (Hex)
Slave Address	02	Slave Adresse		02
Command	03	Command		03
Start address High	01	Number of Bytes		14
Start address Low	00	Register value High (0100)		00
Number of Registers High	00	Register value Low (0100)	Button state	01
Number of Registers Low	04	Register value High (0101)		00
Checksum Low	CRC	Register value Low (0101)	Button memory	01
Checksum High		Register value High (0102)	Temperature	00
		Register value Low (0102)	Temperature	DC
		Register valueHigh (0103)	Set point offset	FF
		Register Wert Low (0103)	Set point offset	E7
		Checksum Low		CRC
		Checksum High		

4.1.3 Setting of Input Registers

By means of the input registers different values can be overwritten in the operating unit.

Example: Activate occupancy bypass mode

Master - Telegram in Transmission mode RTU:

Device	Command	Start address		Data Register 513		Checksum	
		H Byte	L Byte	H Byte	L Byte	L CRC	H CRC
02h	06h	02h	02h	00h	02h	CRC	

Slave – Response telegram in Transmission mode RTU:

Device	Command	Start address		Number of Registers		Checksum	
		H Byte	L Byte	H Byte	L Byte	L CRC	H CRC
02h	06h	02h	02h	00h	02h	CRC	

4.2 Coil / Bit Allocation

The operating unit has different configuration bits. By means of the input bits different LEDs, controller etc. can be controlled.

4.2.1 Writing Configuration Bits

By means of the control command „Write Bit(s)“ (0Fhex or 05hex) a configuration bit (or more) can be written with the value „1“ or „0“.

Example: Set temperature unit to °F

Master - telegram in Transmission mode RTU:

Slave Address	commandl	Start address		Number of bits		Number of bytes	Data	Checksum	
		H Byte	L Byte	H Byte	L Byte		H Byte	L CRC	H CRC
02h	0Fh	00h	02h	00h	01h	01h	00	CRC	

Slave – response telegram Transmission mode RTU:

Slave Address	command	Start address		Number of bits		Checksum	
		H Byte	L Byte	H Byte	L Byte	L CRC	H CRC
02h	0Fh	00h	02h	00h	01h	CRC	

4.2.2 Read Bits

By means of the control command „Read bits“(01hex or 02hex) one or more bits can be read out.

Example: Inquiry of operating mode of outputs (Data Address = 0x0004hex 0x0005hex) -> Here: Both outputs are in manual operation

Master - Telegram in Mode RTU		Slave – Response Telegram in Mode RTU	
Description	Value (Hex)	Description	Value (Hex)
Device	02	Device	02
Command	01	Command	01
Start address High	00	Number of bytes	01
Start address Low	04	Bit value 0,0,0,0,0,0,bit1,bit0	02
Number of bits High	00	Checksum Low	CRC
Number of bits Low	02	Checksum High	
Checksum Low	CRC		
Checksum High			

5 Configuration Software

By means of a RS485-interface (e.g. RS232-RS485-level converter e.g. ADAM-4520) it is possible to access to the Modbus by the configuration software. The configuration software is not obligatory necessary for the installation of the WRF07-RS485 Modbus. It is possible to use any programme producing Modbus telegrams which is suitable to set registers.

6 Software Installation

For the installation of the configuration software, the setup files „WRF07_RS485_Modbus_ Config_Setup.exe “must be started. Please note that you must have administrator rights for the installation. During the installation, please follow the screen instructions.

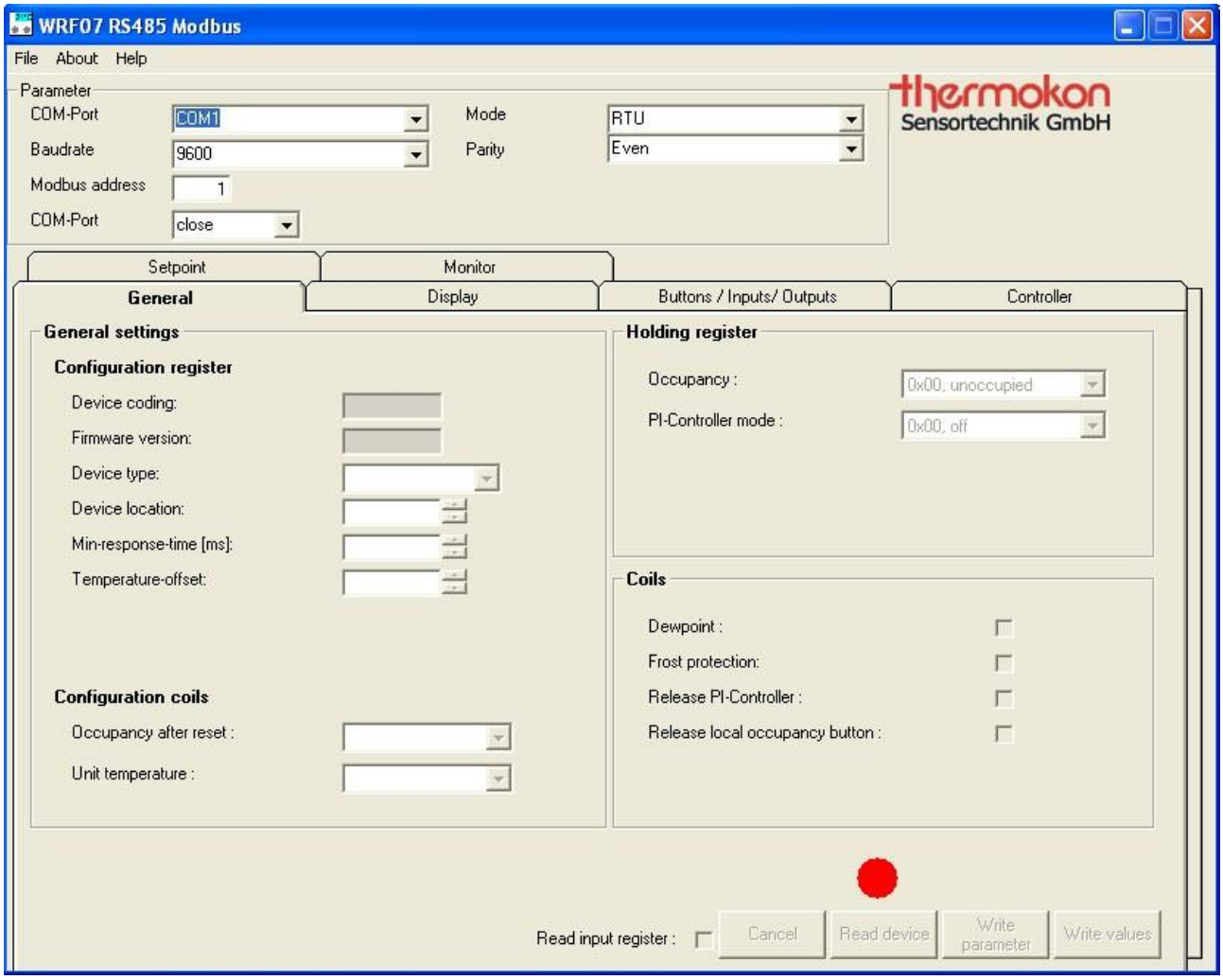
After a successful operation, the configuration software can be started via the “Starting Menu/Programs/Thermokon“

Operating systems supported: Windows9x; WindowsNT; WindowsMe; Windows2000; WindowsXP; WindowsServer, Windows 7

7 Configuration of WRF07-RS485-Modbus

7.1 Software Configuration

By means of the configuration software the configuration registers can be clearly adjusted. Output registers of the WRF07 can be read out and input registers can be set. The load of the individual registers is described in chapter 2.3



Picture 7-1: Configuration software

7.2 Parameter-Frame

The Modbus can be accessed via the configuration software by means of a COM-Port. In the "Parameter"-Frame hardware settings can be made. They must be in conformity with the Modbus receiver, in order to produce a connection.

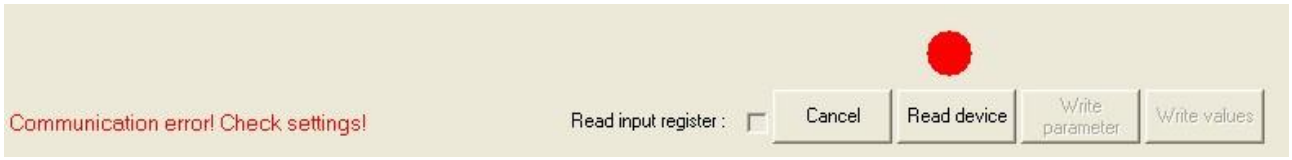
The following options can be selected:

- COM-Port
- Baud rate 9600 , 19200, 57600
- Parity none, even, odd
- Modus for setting of transmission ASCII or RTU
- Modbus address (1-31)

In the field "Modbus address" the address of the WRF06-RS485 Modbus that shall be configured is entered (value between 1 and 31).

Via the selection menu behind "COM-Port" the port can be opened "open" and closed "close".
If the COM-Port is used already, an error message is shown.

After having opened the COM-Port, the current register values of the device can be read out via the button “read out device“. If no connection to the device can be made, the same is shown by an error message.



Picture 7-2: Communication Problems

7.3 Register

The configuration register/coils as well as the input register/coils can be modified in the different riders.
Upon change of these values, the pushbutton "write parameter" is activated. Upon change of an input register/coil, the pushbutton "write values" is activated.
Changes are transmitted to the WRF07-RS485 operating unit after pressing the pushbutton "write parameters" / "take over values".
By pressing the pushbutton "abort", changes which are not yet transmitted (to be recognized by the red colour) are reset to the current device status by reading out the device.

By activating the hook "read output register" all output registers are read out cyclically.

Picture 7-3: Data

7.4 Save/Load parameter

Via the menu points "File" and "Save Parameter" respectively "Load Parameter", the configuration registers can be stored in a text file and can be reloaded into the WRF07-RS485-Modbus.