Protocol Description
WRF06-RS485-Modbus

Index of Changes

Rvision	Date	Description
K	21.05.2014	Description for BELIMO 6-way valve added (from firmware 2.10 and configuration software 2.5 or higher)
L	30.03.2016	Description for device type AOKCO added (from firmware 2.12 and configuration software 2.7 or higher)
M	20.09.2016	Description for device type 6WV_INV added (from firmware 2.14 and configuration software 2.8 or higher)
N	09.02.2017	Description for device type SAUTER 6WV DN15 and DN20 added (from Firmware 2.15 and configuration software 2.9 or higher) Optional address extension

1 WRF06-RS485-Modbus

The present document describes the serial interface of the room operating panel WRF006-RS485-MODBUS. The MODBUS protocol developed by the company Modicon is an open protocol for the communication of various intelligent devices on Master-Slave base.

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

2 Device Description

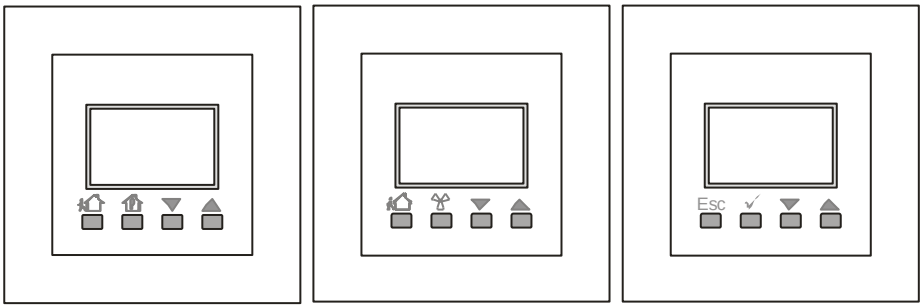
2.1 Device types

The WRF06-RS485-Modbus could be delivered in different types.

- Devices without temperature controller
  - Type 2V — Analogue output 1: temperature, Analogue output 2: set point
  - Type4DI — 4 digital input
  - Type2VPS — Analogue output 1: room occupancy, Analogue output 2: set point
  - TypeVSS — Analogue output 1: set point 2, Analogue output 2: set point 1
  - Type VNS — Analogue output 1: temperature, Analogue out 2: set point night temp
- Devices with temperature controller
  - Type AO2V — Analogue output 1: Heating, Analogue output 2: Cooling
  - Type DO2R — Digital output 1: Heating, Digital output 2: Cooling
  - Type DO2T — Digital output 1: Heating, Digital output 2: Cooling
  - Type OVR — Digital output 1: Heating, Analogue output 2: Cooling
  - Type OVT — Digital output 1: Heating, Analogue output 2: Cooling
  - Type AOV — Analogue output 2: Heating / cooling, Changeover-mode
  - Type AOFV — Analogue output 1: Fan speed,
Analogue output 2: Heating / cooling, Changeover-mode
  - Type AOK — Analogue output 1: Heating, Analogue output 2: Cooling
Kampmann 0-3V Off, 3-10 V On (0…100%)
  - Type AOK — Analogue output 2: Heating / Cooling, ChangeOver-mode,
Kampmann 0-3V Off, 3-10 V On (0…100%)
  - Type 6WV — Analogue output 1: Fan speed,
Analogue output 2: Cooling 2..4,7V / Heating 7,3..10V
BELIMO 6-Way Valve
  - Type 6WV_INV — Analogue output 1: Fan speed,
Analogue output 2: heating 2..4,7V / cooling 7,3..10V
BELIMO 6-Way Valve
  - Type Sauter 6WV DN15 — Analogue output 1: Fan speed,
Analogue output 2: heating/cooling
SAUTER 6-Way valve, nominal diameter DN15
  - Type Sauter 6WV DN20 — Analogue output 1: Fan speed,
Analogue output 2: heating/cooling
SAUTER 6-Way valve, nominal diameter DN20

2.2 Display-printing

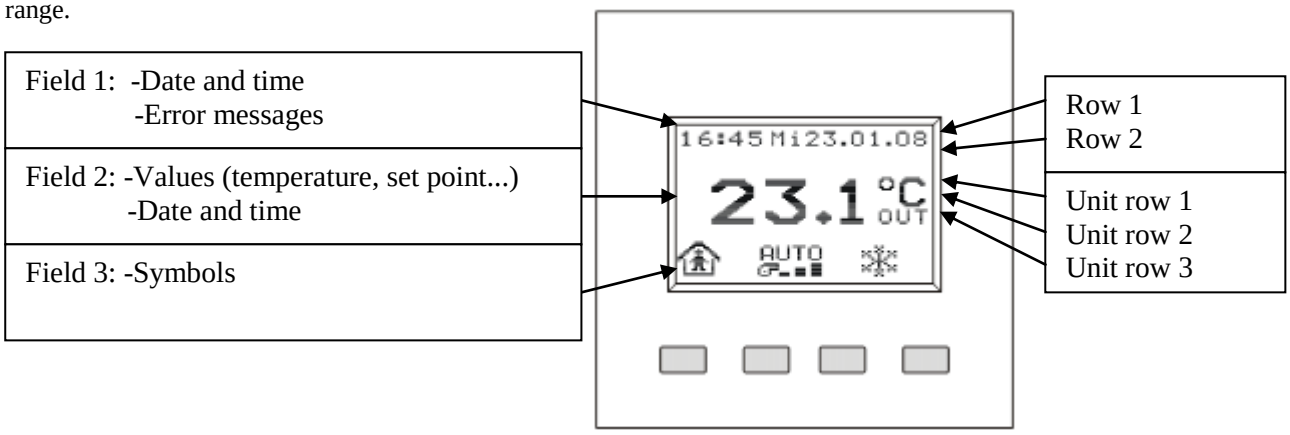
The display of WRF06-RS485-Modbus is in 3 types possible. Other printings are of request possible.



Typ 1 *Type 1* | Typ 2 *Type 2* | Typ 3 *Type 3*

2.3 LCD- Display

The display is divided into 3 display areas: field 1 in the upper range, field 2 in the middle and field 3 in the bottom range.



The symbols displayed and their functions are as follows:

- Set point adjustment
- Error
- Heating
- Cooling
- Window “open”
- De point detector “active”
- Occupied (comfort) / Unoccupied (stand-by)

Fan off
Fan stage 1
Fan stage 2
Fan stage 3

AUTO Fan off
AUTO Fan stage 1
AUTO Fan stage 2
AUTO Fan stage 3

By means of the LCD-display different values can be displayed. As a standard, only the temperature is indicated. The values to be shown in the display can be set via the configuration 0x0000 – 0x000A. The following values can be indicated in the display:

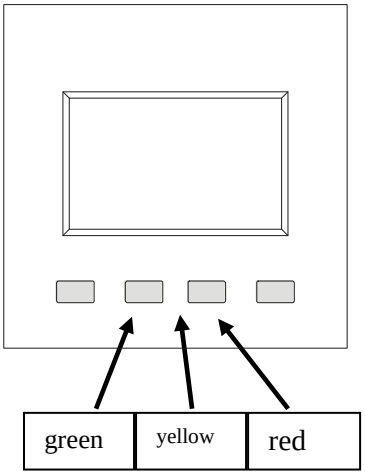
- Temperature
  - Room temperature
  - 2 field programmable text rows in field 11
- 2 Set Points
  - Unit and display are field definable
  - Set point effective and offset
  - Adjustment via operating buttons possible
  - Per value 2 field parameterize able text rows in field 1
- 4 External Measuring Values
  - Unit and display are field definable
  - e.g. for outdoor temperature, pressure, percent value etc.
  - Per value 2 field parameterize able text rows in field 1
- 4 Alarm Messages
  - 2 external values e.g. for time, pressure etc.
  - 2 set points effective and offset
  - Per message 2 field parameterize able text rows in field 1

2.4 Lower Part of Device (base plate): LED Display

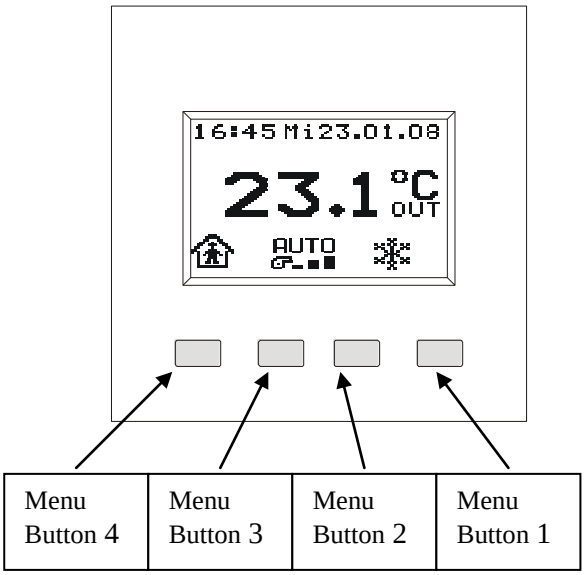
The room operating panel has 3 LEDs for the indication of different status for verifying device functions and bus communication.

- Green LED: Operating voltage
- Yellow LED: Flashs upon receipt of a flawless telegram which was addressed to the device.
- Red LED: Flashs upon receipt of a telegram, which was addressed to another device.
- Yellow + Red LED: Flashs upon receipt of a flawless telegram.

If telegrams are sent from the Master and no LEDs are flashing at the operating unit, the communication properties must be verified.



2.5 Definition Button Numeration



The respective function of the button can be set via the register 0x0006 – 0x0009.
The following button functions are possible:

- Button pushed / not pushed e.g. for light, blinds
  - Output in output registers 257-258
  - Register 257 shows current status of buttons
  - Register 258 saves pushed buttons until readout of register
- Set Point Adjustment
  - Up to two set points can be adjusted
  - When pushing the button, the corresponding set point is indicated in the display
  - Set point 1 can only be used in the mode "room occupied"
- Adjustment of Fan Stages
  - The corresponding fan stage is automatically shown in the display
- Adjustment of Room Occupancy
  - The corresponding room occupancy is shown automatically in the display

2.6 Temperature Calibration Mode

Each temperature sensor is calibrated during production by the manufacturer. Due to the fact, that the temperature measuring with flush-mounting sensors is besides the voltage-dependent self-heating of the electronics also affected by the temperature dynamic of the wall, a recalibration might become necessary in some cases.

For the user the calibration mode offers the possibility to make a supplementary calibration via the operating buttons without needing a service engineer to make these adjustments via the RS485 bus. Also changeable is the basic set point, lower set point adjustment and upper set point, night-lowering and jump distance set point change.

Polling of calibration mode:	Parallel actuation of the buttons **T1 and T4** for a time exceeding 5s.
Chose parameter:	Button T3 or T4
Adjust Temperature:	Button T1 for **- 0,1** Button T2 for **+ 0,1**
Exit Calibration Mode:	No button actuation for a time exceeding 10s.

2.7 Control

2.7.1 Device Types

The control is integrated in the following devices: AO2V, OVR, OVT, DO2R, DO2T, AOV, AOFV, AOK, AOKCO2, 6WV (Belimo/Sauter).

2.7.2 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 adjusted 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.

2.7.3 Change-Over-mode AOV, AOFV, AOKCO

The device could work for 4-pipe-systems and also for 2-pipe-systems (Change-over mode). The device types AOV, AOFV and AOKCO work with change-over mode. By using change-over mode with Holding Register „Controller mode“ (Address 0x215) could the mode of the controller be selected. **Change-over mode work on output 2!**

2.7.4 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 as the same, both are directly affecting the control.

2.7.5 Override of Controller

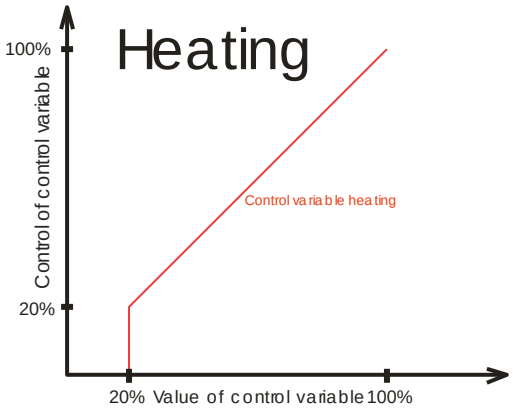
Register 534 can be used to override controller mode.

2.7.6 Minimal Control Variable

By means of the property “Use minimal control variable with control variable = 0“(Coil-Bit 28 = 0) the minimal control variable is only used, if the control variable is > 0. If Coil-Bit 28 is =1, the minimal control variable is also used if the control variable is = 0.

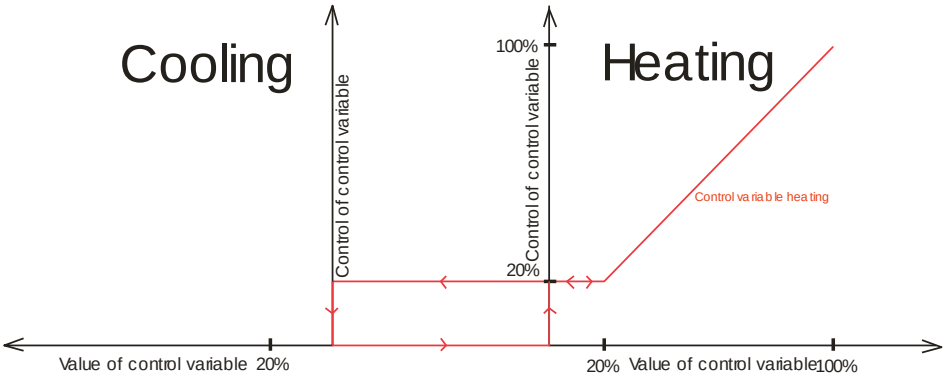
Chose mode control variable **(Register 0x001B)**

(1) Chose mode 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) Chose mode control variable = 0
Ymin = 20%



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

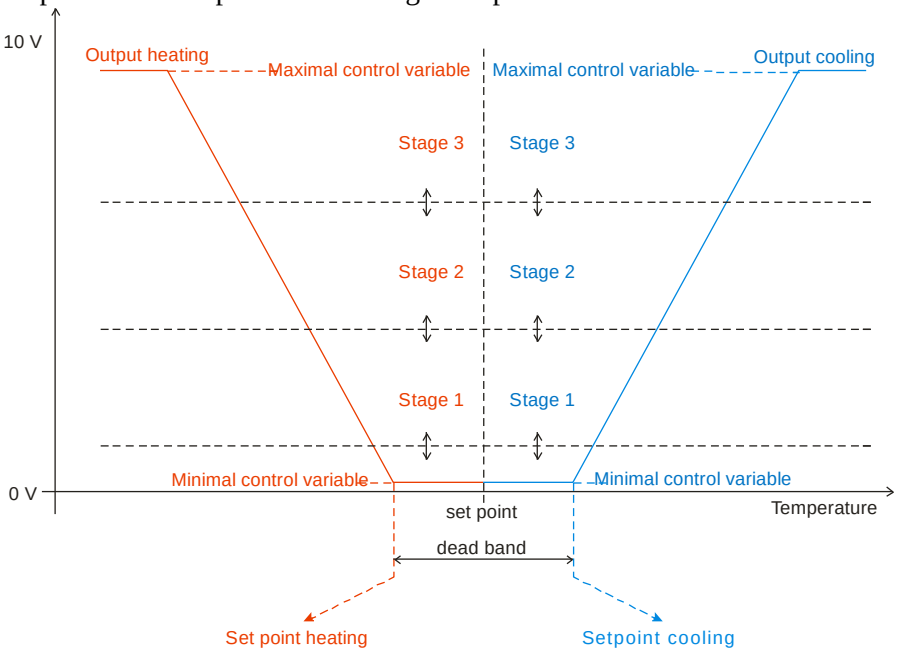
2.7.7 Display of set point

The controller uses set point 1 as control set point (Register 0x0104). After reset the controller uses the set point which was set in register 44. There are 2 possibilities for displaying the set point:

- Basic set point + adjustment
  - Heating mode: Set point = Basic set point + manual adjustment
  - Cooling mode: Set point = Basic set point + manual adjustment
- Real control variable – set point is shown which is used by the controller
  - Heating mode: Set point = Basic set point – dead band / 2 + manual adjustment
  - Cooling mode: Set point = Basic set point + dead band / 2 + manual adjustment

2.7.8 Fan speed AOFV, 6WV

The device type AOFV and 6WV can control a fan coil or a valve. The fan stages are parameterize able. The output of the fan speed is on analogue output AO1.



2.7.9 Manual mode / automatic mode

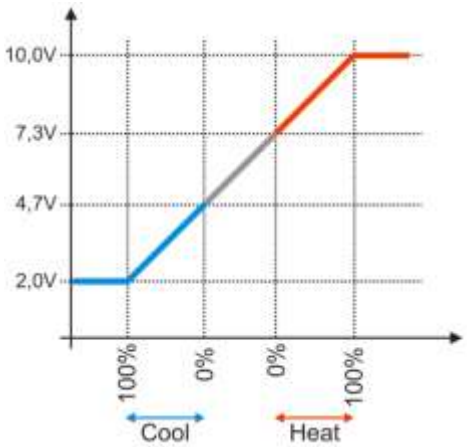
The analogue outputs could be set from a DDC via register 0x0216 and 0x0217. To remove the manual mode set register 0x0216 respectively 0x0217 to -1 / 0xFFFF.

2.7.10 Symbol fade-in/-out

Symbols Heating, Cooling and OFF can be faded-in and out. Internal controller has to be disabled. In combination with the manual mode the device can be used as a simple IO-device with.

2.7.11 Type 6WV for BELIMO 6-Way Valve

If device type BELIMO® 6-way valve is enabled, output AO2 is used as control variable output for 6-way valve. Control variable is calculated by integrated PI controller and the output voltage is adapted according to characteristic curve of used device type. Choosing type _INV inverts sequences for heating and cooling.



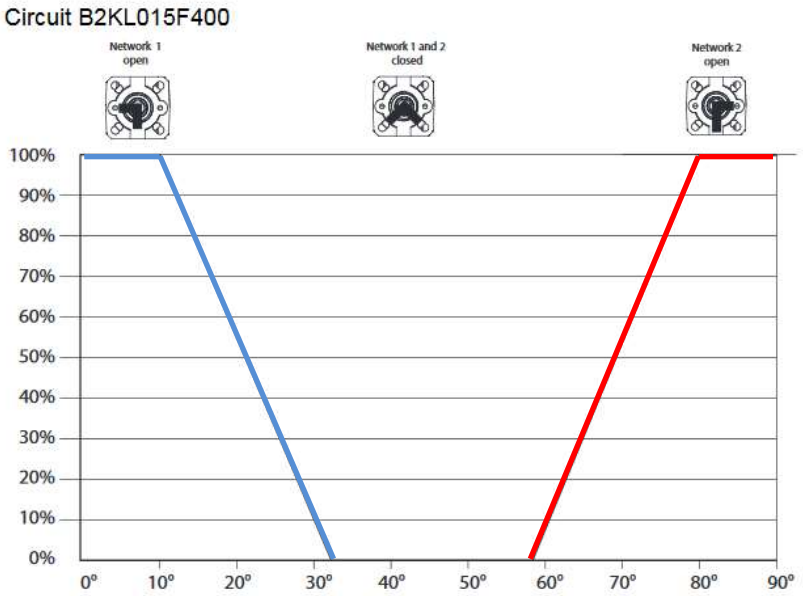
Type: 6WV
100…0% cooling ⇒ 2,0…4,7V
0…100% heating ⇒ 7,3…10,0V

Type: 6WV_INV
heating cooling sequences inverted

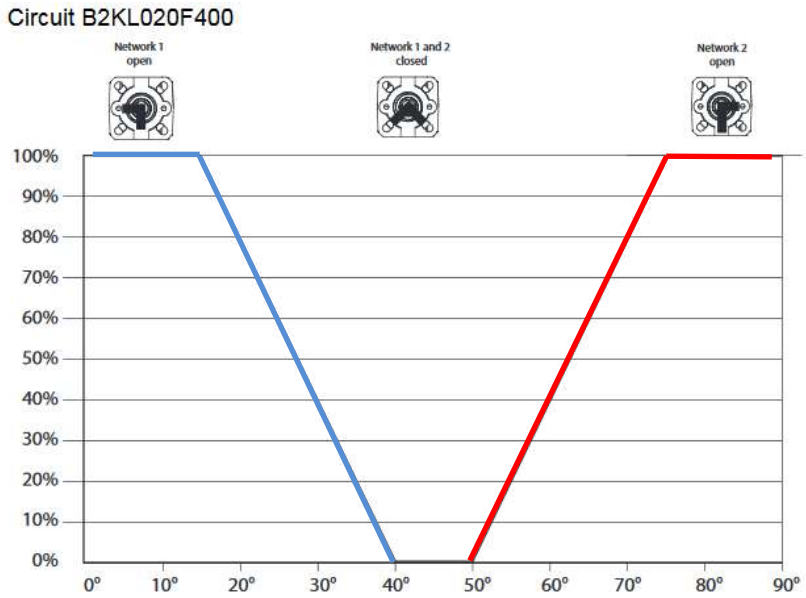
2.7.12 Function 6WV for SAUTER 6-way valves DN15 und DN20

If device type SAUTER 6-way valves is enabled, output AO2 is used as control variable output for 6-way valve. Control variable is calculated by integrated PI controller and the output voltage is adapted according to characteristic curve of used device type. Please see SAUTER datasheet 58.001, B2KL: 6-way-ball valve with male thread, PN16). Additionally the control variable is output on AO1 adapted to settings in registers 45-50 (see chapter 2.7.8).

Note: The 6WV-function is only available on device type AO2V.



Picture 1 Charactersitic curve of DN15 valve (extract from SAUTER datasheet 58.001e)



Picture 2 Charactersitic curve of DN20 valve (extract from SAUTER datasheet 58.001e)

2.8 Communication failure monitoring

The device monitors Modbus communication. In case of a 90s communication failure the outputs are set to default values, which can be configured in registers 45 and 46.
Setting -1 (=0xFFFF) as default value, the outputs keep their last values (manual mode) respectively the controller triggers them (automatic mode).

2.9 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 WRF06-RS485-Modbus and the data sheet wiring_rs485_network.pdf.

2.10 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.

2.11 Protocol

The room operating panel WRF06-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

2.12 Configuration Options

2.12.1 Device addressing

In addition to address setting via dip switch (1-32) an option for address extension (1-247) is implemented. To use extended addressing write a valid address (1-247) to register 16386 (data address 0x4001) and set dip switch to address 0! As long as an dip switch address > 0 is set, the device uses the dip switch address as network address.
To modify register 16386 (data address 0x40001) following sequence must be strictly adhered:
Set valid dip switch address (1-31). Use Modbus command ‘Write multiple registers’(FC16) and write value 0x4793 to register 16385 (data address 0x4000) and the selected address to register 16386 (data address 0x4001) in one sequence. Subsequently set dip switch address to 0. Device uses the exntended address setting as network address.
As long as the dip switch address is set to 0 it´s not possible to modify the extended address!!!
5pole DIP switch:

- Bus address of device (1 - 31) via5 pole DIP switch; DIP switch: 1-5 = 6pole DIP switch:

2.12.2 Interface parameters

6pole 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: 57600
- Parity
  - DIP 4 off + DIP 5 off: non
  - DIP 4 on + DIP 5 off: even
  - DIP 4 off + DIP 5 on: uneven
- Bus terminating resistor 120 Ohm
  - DIP 6 off
  - DIP 6 on

- 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_wrf06_rs485.pdf“.

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

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

3 WRF06-RS485-Modbus Protocol

3.1 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

3.2 Data Administration

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

3.3 EEprom – non volatile memory

Configuration parameters are not allowed to write permanently. Device has maximum write cycles of nonvolatile memory. (dimension: <10000).

3.4 Register Definition

3.4.1 Configuration Register

Register	Data Address	Value Range	Description	
1 R	**0x0000**	**0x0200**	**Device coding, not changeable**	
2 R	**0x0001**	**0x0012**	**Firmware version, not changeable**	
2 – 52	**0x0002 – 0x0033**	**Configuration of the operating panel, EEPROM- data – !! Don't update permanently EEprom !!**		
3 R/W	0x0002	0x0000	Type 2V (AO1: Temperature, AO2: set point)	
		0x0001	Type 4DI (4 digital Inputs)	
		0x0002	Type AO2V (AO1: Heating, AO2: cooling)	
		0x0003	Type DO2R (DO1: Heating, AO2: cooling)	
		0x0004	Type DO2T (DO1: Heating, AO2: cooling)	
		0x0005	Type OVR (DO1: Heating, AO2: cooling)	
		0x0006	Type OVT (DO1: Heating, AO2: cooling)	
		0x0007	Type 2VPS (AO1: occupancy, AO2: set point)	
		0x0008	Type AOV (AO2: Heating / cooling)	
		0x0009	Type AOFV (AO1: Fan speed, AO2: heating / cooling)	
		0x000A	TypeVSS (AO1: set point 2, AO2: set point 1)	
		0x000B	TypeVNS (AO1: temperature, AO 2: set point night temp)	
		0x000C	Type AOK (AO1:heating, AO2: cooling)	
		0x000D	Type Belimo® 6WV (AO1: Fan speed, AO2: heating / cooling)	
		0x000E	Type AOVCO2 (AO2: heating / cooling)	
		0x000F	Type Belimo® 6WV (AO1: Fan speed, AO2: cooling / heating) Same as 6WV, but with swapped assignment of heating/cooling.	
		0x0010	Type Sauter 6WV DN15 (AO1: Fan speed, AO2: heating / cooling)	
		0x0011	Type Sauter 6WV DN20 (AO1: Fan speed, AO2: heating / cooling)	
4 R/W	0x0003	0x0000-0xFFFF	Device location identification (default = 0x0000)	
5 R/W	0x0004	0x0000-0x00FF	Intensity background illumination LCD, after 15s without button actuation (rest) (default = 0x000A)	
6 R/W	0x0005	0x0000-0x00FF	Intensity background illumination LCD with button actuation (active) (default = 0x00D0)	
7 R/W	0x0006	0x0000-0x00FF	Function button -T1	0x00, without special function(default) 0x01, Set point 1 + 0x02, Set point 1 – 0x03, Set point 2 + 0x04, Set point 2 – 0x05, Accept set point 1 0x06, Cancel set point 1 0x10, Fan stage Plus with "AUTO" 0x11, Fan Stage Minus with "AUTO" 0x12, Fan stage Plus without "AUTO"
8 R/W	0x0007	0x0000-0x00FF	Function button -T2	

Register	Data Address	Value Range	Description	
9 R/W	0x0008	0x0000-0x0013	Function button -T3	0x13, Fan stage Minus without "AUTO" 0x14, Fan stage only "AUTO" 0x20, Room unoccupied 0x21, Room occupied 0x22, Room occupied / unoccupied – toggle 0x30, Control Auto / Off – toggle 0x31, Control Heating 0x32, Control Cooling 0x33, Control Automatic 0x34, Control Off 0x35, Control Heat / Cool – toggle
10 R/W	0x0009	0x0000-0x0013	Function button -T4	
11 R/W	0x000A	0x00	Fade out display weekday	
		0x01	Display weekday in English	
		0x02	Display weekday in German (default)	
12 R/W	0x000B	0x00	Fade out display date	
		0x01	Display date in English (JJ.MM.TT)	
		0x02	Display date in German (TT.MM.JJ) (default)	
13 R/W	0x000C	0x00	Fade out display time	
		0x01	Display time (default)	
14 R/W	0x000D	0x00	Display time 24-hours-mode (default)	
		0x01	Display time 12-hours-mode	
15 R/W	0x000E	0x0000-0xFFFF	Updating interval of display in seconds (default = 0x0A)	
16 R/W	0x000F	0x0000-0x0C80	Min-Response-Time	signed int, (max 3100 ms) (default = 0x0A = 10 ms)
17 R/W	0x0010	0x0000-0x00FF	Temperature-Offset for calibration of temperature sensor signed char, e.g. 10_{dez} = +1.0 K, -5_{dez} = -0.5 K (default = 0x00)	
18 R/W	0x0011	0x0000-0xFFFF	Upper adjustable range set temperature 1 (default = 0x001E) signed char, e.g. 30_{dez} = + 3.0 K	
19 R/W	0x0012	0x0000-0xFFFF	Lower adjustable range set temperature 1 (default = 0xFFE2) signed char, e.g. 30_{dez} = - 3.0 K	
20 R/W	0x0013	0x0000-0x00FF	Jumping distance with set temperature 1 (default = 0x05) signed char, e.g. 5_{dez} = +/- 0.5 K per button actuation	
21 R/W	0x0014	0x0000-0xFFFF	Set temperature 1 – Basic set point after reset	Set temperature 1 – Basic set point after reset
22 R/W	0x0015	0x0000-0xFFFF	Upper adjustable range set temperature 2 (default = 0x001E) signed char, e.g. 30_{dez} = + 3.0 K	
23 R/W	0x0016	0x0000-0xFFFF	Lower adjustable range set temperature 2 (default = 0xFFE2) signed char, e.g. 30_{dez} = - 3.0 K	
24 R/W	0x0017	0x0000-0xFFFF	Jumping distance with set temperature 2 (default = 0x05) signed char, e.g. 5_{dez} = +/- 0.5 K per button actuation	
25 R/W	0x0018	0x0000-0xFFFF	Set temperature 2 – Basic set point after reset	Set temperature 2 – Basic set point after reset
26 R/W	0x0019	0x0000-0x0003	Number of fan stages (default = 0x03)	

Register	Data Address	Value Range	Description	
27 R/W	0x001A	0x0000-0x0003	Selection digital input 1	0x00, none function 0x01, Open contact 0x02, Open dew point 0x03, Open energy hold off 0x04, Open alarm message 0x05, Open room occupancy 0x06, Open message 0x07, Open controller auto / Off 0x08, Open ctrl Heating / Cooling 0x09, Open counter rising edge 0x0A, Open count rising/falling edge 0x0B, Open impulse time 0x0C, Open Reset set temperature 1 0x10, Close contact 0x11, Close dew point 0x12, Close energy hold off 0x13, Close message 0x14, Close room occupancy 0x15, Close message 0x16, Close Controller auto / Off 0x17, Close Ctrl Heating / Cooling 0x18, Close counter rising edge 0x19, Close count rising/falling edge 0x1A, Close impulse time 0x1B, Close Reset set temperature 1
28 R/W	0x001B	0x0000-0x0003	Selection digital input 2	
29 R/W	0x001C	0x0000-0x0003	Selection digital input 3 Only device DI4	
30 R/W	0x001D	0x0000-0x0003	Selection digital input 4 Only device DI4	
31 R/W	0x001E	0x0000-0x0064	Proportional range Xp (K) Heating Xp = 0 deactivates controller	(default = 0x28) e.g. 40_{dez} = 4.0 K
32 R/W	0x001F	0x0000-0x00FF	Reset time Tn (min) Heating	(default = 0x64) e.g. 100_{dez} = 100 min
33 R/W	0x0020	0x0000-0x0064	Proportional range Xp (K) Cooling Xp = 0 deactivates controller	(default = 0x28) e.g. 40_{dez} = 4.0 K
34 R/W	0x0021	0x0000-0x00FF	Reset time Tn (min) Cooling	(default = 0x64) e.g. 100_{dez} = 100 min
35 R/W	0x0022	0x0000-0x0064	Night-lowering (unoccupied) Heating = Set point 1 – night lowering Cooling = Sollwert1 + night lowering	(default = 0x28) e.g. 40_{dez} = 4.0 K
36 R/W		0x0000-0x0064	Dead zone between heating and cooling	(default = 0x28) e.g. 40_{dez} = 4.0 K
37 R/W	0x0024	0x0000-0x0064	Antifreeze 0x00 deactivates antifreeze	(default = 0x3C) e.g. 60_{dez} = 6.0 K
38 R/W	0x0025	0x0000-0x0064	Maximal control variable limit Heating	(default = 0x64) e.g. 100_{dez} = 100 %
39 R/W	0x0026	0x0000-0x0064	Minimal control variable limit Heating	(default = 0x00) e.g. 100_{dez} = 0 %
40 R/W	0x0027	0x0000-0x0064	Maximal control variable limit Cooling	(default = 0x64) e.g. 100_{dez} = 100 %
41 R/W	0x0028	0x0000-0x0064	Minimal control variable limit Cooling	(default = 0x00) e.g. 100_{dez} = 0 %
42 R/W	0x0029	0x0000-0x00FF	PWM-Cycle time	(default = 0x0F) e.g. 15_{dez} = 15 min

Register	Data Address	Value Range	Description	
43 R/W	0x002A	0x0000-0x00FF	Set back room occupancy to night	(default = 0x00) e.g. 120_{dez} = 120 min
44 R/W	0x002B	0x0000-0x0003	Controller mode	(default = 0x03) 0 – Controller off 1 – Controller heating 2 – Controller cooling 3 – Controller automatic
45 R/W	0x002C	0x0000-0x0064	Fan speed 1 heating	(default = 0x0A) e.g. 10_{dez} = 1 V
46 R/W	0x002D	0x0000-0x0064	Fan speed 2 heating	(default = 0x1E) e.g. 30_{dez} = 3 V
47 R/W	0x002E	0x0000-0x0064	Fan speed 3 heating	(default = 0x46) e.g. 70_{dez} = 7 V
48 R/W	0x002F	0x0000-0x0064	Fan speed 1 cooling	(default = 0x0A) e.g. 10_{dez} = 1 V
49 R/W	0x0030	0x0000-0x0064	Fan speed 2 cooling	(default = 0x1E) e.g. 30_{dez} = 3 V
50 R/W	0x0031	0x0000-0x0064	Fan speed 3 cooling	(default = 0x46) e.g. 70_{dez} = 7 V
51 R/W	0x0032	0x0000-0x0003	Minimal fan speed heating	(default = 0x00) e.g. 1_{dez} = Fan speed 1
52 R/W	0x0033	0x0000-0x0003	Minimal fan speed cooling	(default = 0x00) e.g. 1_{dez} = Fan speed 1
53 R/W	0x0034	0xFFFF 0x0000-0x0064	Type: AO2V, OVR, OVT, 6WV Analogue value 0-10V after communi-cation failure **Output1 Heating**	Signed int, e.g. 1000_{dec} = 100% 0xFFFF = -1 = keep last value
			Type: DO2R, DO2T Digital value after communication failure **Output1 Heating***	0 - Open >=1 - Closed 0xFFFF = -1 = keep last value
54 R/W	0x0035	0xFFFF 0x0000-0x0064	Type: AO2V, OVR, OVT, 6WV Analogue value 0-10V after communi-cation failure **Output2 Cooling**	Signed int, e.g. 1000_{dec} = 100% 0xFFFF = -1 = keep last value
			Type: DO2R, DO2T Digital value after communication failure **Output2 Cooling***	0 - Open >=1 - Closed 0xFFFF = -1 = keep last value

3.4.2 Output Register

Register	Data Address	Value Range	Description	
257 – 269 R	**0x0100 – 0x010C**	**Measuring value (data output)**		
257 R	0x0100	0x0000-0x000F	bit0 button 1 1=pressed, 0=not pressed bit1 button 2 1=pressed, 0=not pressed bit2 button 3 1=pressed, 0=not pressed bit3 button 4 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 1=pressed, 0=not pressed bit1 button 2 1=pressed, 0=not pressed bit2 button 3 1=pressed, 0=not pressed bit3 button 4 1=pressed, 0=not pressed	
259 R	0x0102	0x0000-0xFFFF	Temperature	signed int, e.g. 184_{dez} = 18.4 °C
260 R	0x0103	0x0000-0xFFFF	Set temperature 1 offset	signed char, e.g. -25_{dez} = -2.5K
261 R	0x0104	0x0000-0xFFFF	Set temperature 1 effective	signed int, e.g. 220_{dez} = 22.0 °C Sum 0x26/0x27 + 0x104
262 R	0x0105	0x0000-0xFFFF	Set temperature 2 offset	signed char, e.g. -25_{dez} = -2.5K
263 R	0x0106	0x0000-0xFFFF	Set temperature 2 effective	signed int, e.g. 220_{dez} = 22.0 °C Sum 0x26/0x27 + 0x104
264 R	0x0107	0x0000-0x0003 0xFF00-0xFF03	Fan stage	0 – Off 1 – Stage 1 2 – Stage 2 3 – Stage 3 0xFF00 – Auto Off 0xFF01 – Auto Stage 1 0xFF02 – Auto Stage 2 0xFF03 – Auto Stage 3
265 R	0x0108	0x0000-0x0001	Room occupancy	0 – Room unoccupied 1 – Room occupied
266 R	0x0109	0x0000-0x0001	Digital input 1	0 – opened 1 – closed
267 R	0x010A	0x0000-0x0001	Digital input 2	0 – opened 1 – closed

Register	Data Address	Value Range	Description	
257 – 270 R	**0x0100 – 0x010D**	**Measuring value (data output)**		
268 R	0x010B	0x0000-0x03FF	2V: Temperature	unsigned int e.g. 409 = 20.0°C = 4V
		0x0000-0x0001	DI4: Digital input 3	0 – opened 1 – closed
		0x0000-0x03FF	AO2V, DO2R,DO2T, OVR, OVT: Control variables	unsigned int e.g. 511 = 50%
		0x0000-0x03FF	AOV, AOFV: Control variable Heating / Cooling	unsigned int e.g. 511 = 50%
		0x0000-0x03FF	6WV: Control voltage for 6-way valve	0…1023dec = 0…10V
269 R	0x010C	0x0000-0x03FF	2V: Set point	unsigned int e.g. 450 = 22.0°C = 4.4V
		0x0000-0x0001	DI4: Digital input 4	0 – opened 1 – closed
		0x0000-0x03FF	AO2V, DO2R,DO2T, OVR, OVT: Control variable cooling	unsigned int e.g. 614 = 60%
		0x0000-0x03FF	AOFV, 6WV: Fan speed	0…1023dec = 0…10V
270 R	0x010D	0x0000-0x0004	Controller mode	0 – Controller off 1 – Controller heating 2 – Controller cooling 3 – Controller automatic heating 4 – Controller automatic cooling

3.4.3 Input register

Register	Data Address	Value Range	Description							
513 - 536	**0x0200 – 0x0217**	**Control (ext. data default)**								
Register 0x0200 – 0x0205: Updating of time If the registers are written, weekday, date and time are indicated in the display. The display format is defined by the configuration registers 0x001D – 0x0020.										
513 R/W	0x0200	0x0000-0x003B	Seconds 0 – 59	B7	B6	B5	B4	B3	B2	B1	B0
				seconds							
514 R/W	0x0201	0x0000-0x003B	Minutes 0-60	B7	B6	B5	B4	B3	B2	B1	B0
				minutes							
515 R/W	0x0202	0x0000-0x0017	Hours 0 - 23h	B7	B6	B5	B4	B3	B2	B1	B0
				hours							
516 R/W	0x0203	0x0000-0x001F	Day 1-31	B7	B6	B5	B4	B3	B2	B1	B0
				day							
517 R/W	0x0204	0x0000-0x000C	Month 1-12	B7	B6	B5	B4	B3	B2	B1	B0
				month							
518 R/W	0x0205	0x0000-0x0833	Year 2000-2099	B7	B6	B5	B4	B3	B2	B1	B0
				year							
519 R/W	0x0206	reserve								
520 R/W	0x0207	0x0000-0xFFFF	External value 1	signed int, e.g. 234_{dez} = 23.4°C fade in with Coil 0x0001							
521 R/W	0x0208	0x0000-0xFFFF	External value 2	signed int, e.g. 234_{dez} = 23.4°C fade in with Coil 0x0002							
522 R/W	0x0209	0x0000-0xFFFF	External value 3	signed int, e.g. 234_{dez} = 23.4°C fade in with Coil 0x0003							
523 R/W	0x020A	0x0000-0xFFFF	External value 4	signed int, e.g. 234_{dez} = 23.4°C fade in with Coil 0x0004							
524 R/W	0x020B	0x0000-0xFFFF	Set point 1 offset	signed char, e.g. -25_{dez} = -2.5K fade in with Coil 0x0005							
525 R/W	0x020C	0x0000-0xFFFF	Set point 2 offset	signed char, e.g. -25_{dez} = -2.5K fade in with Coil 0x0007							
526 R/W	0x020D	0x0000-0xFFFF	Basic set point 1	signed char, e.g. 220_{dez} = 22 °C							
527 R/W	0x020E	0x0000-0xFFFF	Basic set point 2	signed char, e.g. 220_{dez} = 22 °C							

Register	Data Address	Value Range	Description	
528 R/W	0x020F	0x0000-0xFFFF	Fan stage	signed int, 0_{dez} = Off 1_{dez} = Stage 1 2_{dez} = Stage 2 3_{dez} = Stage 3 signed int, 0xFF00 = Auto Off 0xFF01 = Auto Stage 1 0xFF02 = Auto Stage 2 0xFF03 = Auto Stage 3
529 R/W	0x0210	0x0000-0x0001	Room occupancy	0 – Room unoccupied 1 – Room occupied
530 R/W	0x0211	0x0000-0x0001	Alarm message 1	0 – fade out 1 – fade in
531 R/W	0x0212	0x0000-0x0001	Alarm message 2	0 – fade out 1 – fade in
532 R/W	0x0213	0x0000-0x0001	Alarm message 3	0 – fade out 1 – fade in
533 R/W	0x0214	0x0000-0x0001	Alarm message 4	0 – fade out 1 – fade in
534 R/W	0x0215	0x0000-0x0003	Controller mode	0 – Controller off 1 – Controller heating 2 – Controller cooling 3 – Controller automatic heating
535 R/W	0x0216	0xFFFF -0x03FF	Manual set analogue output 2	signed int, e.g. 512_{dez} = 50 % = 5 V automatic= 0xFFFF / -1
536 R/W	0x0217	0xFFFF -0x03FF	Manual set analogue output 1	signed int, e.g. 512_{dez} = 50 % = 5 V automatic= 0xFFFF / -1
537 R/W	0x0218	0x0000-0xFFFF	Temperature (external)	signed char, e.g. 220_{dez} = 22 °C internal Temp.: 0x7FFF/32767

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

3.4.4 Text Row Line 1 and Line 2

Register	Data Address	Value Range	Description
769 – 988 R/W	**0x0300 – 0x03DD**	**Configuration Property – !! Don't update permanently EEprom !!**	

BS 1-14 = ASCII letter
Example for row 1: Set point 1

R 769		R 770		R 771		R 772		R 773		R 774		R 775	
Hi	Lo	Hi	Lo	Hi	Lo	Hi	Lo	Hi	Lo	Hi	Lo	Hi	Lo
S	o	L	l	w	e	r	t		1				
0x53	0x6F	0x6C	0x6C	0x77	0x65	0x72	0x74	0x20	0x31	0x20	0x20	0x20	0x20

Example for row 2: Room 1

R 779		R 780		R 781		R 782		R 783		R 784		R 785	
Hi	Lo	Hi	Lo	Hi	Lo	Hi	Lo	Hi	Lo	Hi	Lo	Hi	Lo
R	a	u	m		1								
0x52	0x61	0x75	0x6D	0x20	0x31	0x20	0x20	0x20	0x20	0x20	0x20	0x20	0x20

- Input of letters and numbers in ASCII format
- If no input is made, row 1 and row 2 are not changed in the display
- If there is no sign in row 2 (0x00), row 1 is displayed in type size 2 (7 signs)
- If row 1 and row 2 are written, up to 14 signs can be displayed in type size 1.

769 R/W -778	0x0300	0x0000-0xFFFF	Set Point 1 Row 1	Register 769 (High BS 1, Low BS 2) … Register 775 (High BS 13, Low BS 14)
779 R/W -788	0x030A	0x0000-0xFFFF	Set Point 1 Row 2	Register 779 (High BS 1, Low BS 2) … Register 785 (High BS 13, Low BS 14)
789 R/W -798	0x0314	0x0000-0xFFFF	Set Point 2 Row 1	Register 789 (High BS 1, Low BS 2) … Register 795 (High BS 13, Low BS 14)
799 R/W -808	0x031E	0x0000-0xFFFF	Set Point 2 Row 2	Register 799 (High BS 1, Low BS 2) … Register 805 (High BS 13, Low BS 14)
809 R/W -818	0x0328	0x0000-0xFFFF	External Measuring Value 1 Row 1	Register 809 (High BS 1, Low BS 2) … Register 805 (High BS 13, Low BS 14)
819 R/W -828	0x0332	0x0000-0xFFFF	External Measuring value 1 Row 2	Register 819 (High BS 1, Low BS 2) … Register 825 (High BS 13, Low BS 14)

829 R/W -838	0x033C	0x0000-0xFFFF	External Measuring value 2 Row 1	Register 829		Register 830		…		Register 835	
				High	Low	High	Low			High	Low
				BS 1	BS 2	BS 3	BS 4			BS 13	BS 14
839 R/W -848	0x0346	0x0000-0xFFFF	External Measuring Value 2 Row 2	Register 839		Register 840		…		Register 845	
				High	Low	High	Low			High	Low
				BS 1	BS 2	BS 3	BS 4			BS 13	BS 14
849 R/W -858	0x0350	0x0000-0xFFFF	External Measuring Value 3 Row 1	Register 849		Register 850		…		Register 855	
				High	Low	High	Low			High	Low
				BS 1	BS 2	BS 3	BS 4			BS 13	BS 14
859 R/W -868	0x035A	0x0000-0xFFFF	External Measuring Value 3 Row 2	Register 859		Register 860		…		Register 865	
				High	Low	High	Low			High	Low
				BS 1	BS 2	BS 3	BS 4			BS 13	BS 14
869 R/W -878	0x0364	0x0000-0xFFFF	External Measuring Value 4 Row 1	Register 869		Register 870		…		Register 875	
				High	Low	High	Low			High	Low
				BS 1	BS 2	BS 3	BS 4			BS 13	BS 14
879 R/W -888	0x036E	0x0000-0xFFFF	External Measuring Value 4 Row 2	Register 879		Register 880		…		Register 885	
				High	Low	High	Low			High	Low
				BS 1	BS 2	BS 3	BS 4			BS 13	BS 14
889 R/W -898	0x0378	0x0000-0xFFFF	Alarm Message 1 Row 1	Register 889		Register 890		…		Register 895	
				High	Low	High	Low			High	Low
				BS 1	BS 2	BS 3	BS 4			BS 13	BS 14
899 R/W -908	0x0382	0x0000-0xFFFF	Alarm Message 1 Row 2	Register899		Register 900		…		Register 905	
				High	Low	High	Low			High	Low
				BS 1	BS 2	BS 3	BS 4			BS 13	BS 14
909 R/W -918	0x038C	0x0000-0xFFFF	Alarm Message 2 Row 1	Register 909		Register 910		…		Register 915	
				High	Low	High	Low			High	Low
				BS 1	BS 2	BS 3	BS 4			BS 13	BS 14
919 R/W -928	0x0396	0x0000-0xFFFF	Alarm Message 2 Row 2	Register 919		Register 920		…		Register 925	
				High	Low	High	Low			High	Low
				BS 1	BS 2	BS 3	BS 4			BS 13	BS 14
929 R/W -938	0x03A0	0x0000-0xFFFF	Alarm Message 3 Row 1	Register 929		Register 930		…		Register 935	
				High	Low	High	Low			High	Low
				BS 1	BS 2	BS 3	BS 4			BS 13	BS 14

939 R/W -948	0x03AA	0x0000-0xFFFF	Alarm Message 3 Row 2	Register939		Register 940		…		Register 945	
				High	Low	High	Low			High	Low
				BS 1	BS 2	BS 3	BS 4			BS 13	BS 14
949 R/W -958	0x03B4	0x0000-0xFFFF	Alarm Message 4 Row 1	Register 949		Register 950		…		Register 955	
				High	Low	High	Low			High	Low
				BS 1	BS 2	BS 3	BS 4			BS 13	BS 14
959 R/W -968	0x03BE	0x0000-0xFFFF	Alarm Message 4 Row 2	Register 959		Register 960		…		Register 965	
				High	Low	High	Low			High	Low
				BS 1	BS 2	BS 3	BS 4			BS 13	BS 14
969 R/W -978	0x03C8	0x0000-0xFFFF	Room temperature Row 1	Register 969		Register 970		…		Register 975	
				High	Low	High	Low			High	Low
				BS 1	BS 2	BS 3	BS 4			BS 13	BS 14
979 R/W -988	0x03D2	0x0000-0xFFFF	Room temperature Row 2	Register979		Register 980		…		Register 985	
				High	Low	High	Low			High	Low
				BS 1	BS 2	BS 3	BS 4			BS 13	BS 14

3.4.5 Unit Row 1, Row 2 and Row 3

Register	Data Address	Value Range	Description
1024–1083 R/W	**0x0400 – 0x043B**	**Configuration Properties – !! Don't update permanently EEprom !!**	

BS 1-3 = ASCII letter
Example for row 1, row 2: °C and row 3: out

R 1044		R 1045		R 1046		1047		R 1048		R 1049		R 1050	
Hi	Lo	Hi	Lo	Hi	Lo	Hi	Lo	Hi	Lo	Hi	Lo	Hi	Lo
°	C							O	u	t			
0xB0	0x43	0x00	0x00	0x00	0x00	0x00	0x00	0x4F	0x75	0x74	0x00	0x00	0x00

- Input of letters and numbers in ASCII format
- If no input is made, row 1, row 2 and row 3 are not changed in the display
- If there is no sign in row 2 (0x00), row 1 is displayed in type size 2 (1 sign)
- If row 1 and row 2 are written, up to 3 signs per line can be displayed in type size 1
- Row 3 is displayed in type size 1 (3 signs)

1024 R/W -1033	0x0400	0x0000-0xFFFF	Unit Set Point 1	Reg 1024		Reg 1025		…		Reg 1029	
				High	Low	High	Low			High	Low
				BS 1	BS 2	BS 3	0x00			BS3	0x00
1034 R/W -1043	0x040A	0x0000-0xFFFF	Unit Set Point 2	Reg 1034		Reg 1035		…		Reg 1039	
				High	Low	High	Low			High	Low
				BS 1	BS 2	BS 3	0x00			BS3	0x00
1044 R/W -1053	0x0400	0x0000-0xFFFF	Unit External Measuring Value 1	Reg 1044		Reg 1045		…		Reg 1049	
				High	Low	High	Low			High	Low
				BS 1	BS 2	BS 3	0x00			BS3	0x00
1054 R/W -1053	0x0400	0x0000-0xFFFF	Unit External Measuring Value 2	Reg 1054		Reg 1055		…		Reg 1059	
				High	Low	High	Low			High	Low
				BS 1	BS 2	BS 3	0x00			BS3	0x00
1064 R/W -1063	0x0400	0x0000-0xFFFF	Unit External Measuring Value 3	Reg 1064		Reg 1065		…		Reg 1069	
				High	Low	High	Low			High	Low
				BS 1	BS 2	BS 3	0x00			BS3	0x00
1074 R/W -1083	0x0400	0x0000-0xFFFF	Unit External Measuring Value 4	Reg 1074		Reg 1075		…		Reg 1079	
				High	Low	High	Low			High	Low
				BS 1	BS 2	BS 3	0x00			BS3	0x00

3.5 Bit Allocation / Coil Definition

3.5.1 Configuration Bits

Bit	Data Address	Description	
0x0000 – 0x0020	**Configuration of Operating Panel Bit-Register, EEPROM- Data Configuration of Display Field 2 – !! Don't update permanently EEprom !!**		
1 R/W	0x0000	Room temperature	1 = display 0 = do not display
2 R/W	0x0001	External value default 1 Value of 0x0207	1 = display 0 = do not display
3 R/W	0x0002	External value default 2 Value of 0x0208	1 = display 0 = do not display
4 R/W	0x0003	External value default 3 Value of 0x0209	1 = display 0 = do not display
5 R/W	0x0004	External value default 4 Value of 0x020A	1 = display 0 = do not display
6 R/W	0x0005	Set Point 1 offset Value of 0x0103	1 = display 0 = do not display
7 R/W	0x0006	Set Point 1 effective Value of 0x0104	1 = display 0 = do not display
8 R/W	0x0007	Set Point 2 offset Value of 0x0105	1 = display 0 = do not display
9 R/W	0x0008	Set Point 2 effective Value of 0x0106	1 = display 0 = do not display
10 R/W	0x0009	Time	1 = display 0 = do not display
11 R/W	0x000A	Date 1 = display	0 = do not display
12 R/W	0x000B	Room Occupancy	1 = display 0 = do not display
13 R/W	0x000C	Fan Stage	1 = display 0 = do not display
14 R/W	0x000D	Reserved	
15 R/W	0x000E	Reserved	
16 R/W	0x000F	Reserved	
17 R/W	0x0010	Display Temperature	1 = with tenth digit 0 = without tenth digit
18 R/W	0x0011	Display External Value 1	1 = with tenth digit 0 = without tenth digit
19 R/W	0x0012	Display External Value 2	1 = with tenth digit 0 = without tenth digit
20 R/W	0x0013	Display External Value 3	1 = with tenth digit 0 = without tenth digit

Bit	Data Address	Description
0x0000 – 0x0020	**Configuration of Operating Panel Bit-Register, EEPROM- Data – !! Don't update permanently EEprom !!**	
21 R/W	0x0014	Display External Value 4 — 1 = with tenth digit 0 = without tenth digit
22 R/W	0x0015	Display Set Point 1 — 1 = with tenth digit 0 = without tenth digit
23 R/W	0x0016	Display Set Point 2 — 1 = with tenth digit 0 = without tenth digit
24 R/W	0x0017	Display Set Point 1 — 1 = Basic set point + Offset 0 = Controls et point
25 R/W	0x0018	°C/°F — 1 = °C 0 = °F
26 R/W	0x0019	Display Adjustment Set Point 1 — 1 = Set point effective 0 = Set point offset
27 R/W	0x001A	Display Adjustment Set Point 2 — 1 = Set point effective 0 = Set point offset
28 R/W	0x001B	Use Minimal Control Variable with control variable > 0: = 1 Use Minimal Control Variable with control variable = 0: = 0
29 R/W	0x001C	Room occupancy after voltage reset — 1 = Room occupied 0 = Room unoccupied
30 R/W	0x001D	Activate device by 1. Button press — 1 = activ 0 = not activ
31 R/W	0x001E	Save actual room occupancy — 1 = Save 0 = Don't save
32 R/W	0x001F	Reserved

3.5.2 Input Bits

Bit	Data Address	Description
0x0100 – 0x010F	**Input Value of Operating Panel Bit-Register Override of Controller**	
257 R/W	0x0100	Symbol Failure 1 = ON, 0 = OFF
258 R/W	0x 0101	Symbol Heating - Controller Heating Mode 1 = ON, 0 = OFF
259 R/W	0x0 102	Symbol Cooling - Controller Cooling Mode 1 = ON, 0 = OFF
260 R/W	0x0 103	Symbol Window - Energy Stop 1 = ON, 0 = OFF
261 R/W	0x0 104	Symbol Dew Point - Dew Point Alarm 1 = ON, 0 = OFF
262 R/W	0x 0105	Symbol Off - Controller off 1 = ON, 0 = OFF
263 R/W	0x 0106	Without Function
264 R/W	0x 0107	Without Function
265 R/W	0x 0108	Without Function
266 R/W	0x 0109	Without Function
267 R/W	0x0 10A	Without Function
268 R/W	0x0 10B	Without Function
269 R/W	0x0 10C	Without Function
270R/W	0x 010D	Without Function
271 R/W	0x 010E	Without Function
272 R/W	0x 010F	Without Function

3.5.3 Extended address range

Register	Data Address	Value Range	Description
16385 – 16386 R/W	**0x4000 – 0x4001**		
16385 R/W	0x4000	0x4793	Access protection
16386 R/W	0x4001	$1\text{-}247_{dez}$	Extended address

To modify extended address strictly adhere to sequence as described in chapter 2.12.1!

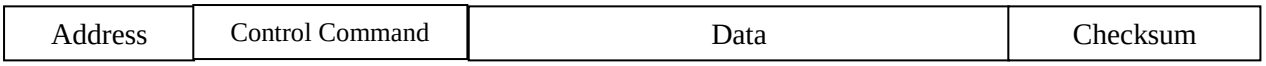
4 Data Transmission

4.1 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.

4.2 Data Frame

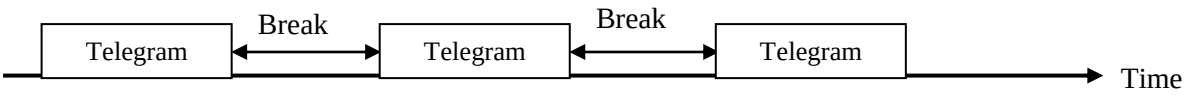
The data are sent to the bus in accordance to severely defined defaults:



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.

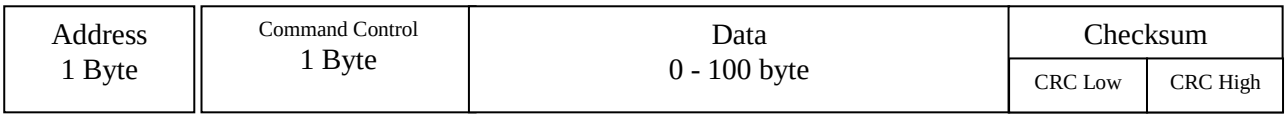
4.3 Transmission Mode RTU

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.

4.3.1 Telegram Layout



4.3.2 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);
}
```

4.4 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.

4.4.1 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**

4.4.2 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;
```

5 Examples: Telegrams

5.1 Register

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

5.1.1 Parameterization of Operating Unit

The operating unit can be parameterized by the configuration registers 3-42 and the control commands „Write Register“(10hex or 06hex).

Example: button 1 and button 2 for set point adjustment of temperature 1.

Master - Telegram in Transmission Mode RTU:

Device	command	Start address		Number of Register		Number of Bytes	Data Register 08		Data Register 09		Check Sum	
		H Byte	L Byte	H Byte	L Byte		H Byte	L Byte	H Byte	L Byte	L CRC	H CRC
02	10	00	06	00	02	04	00	01	00	02	CRC	

Slave – Response Telegram in Transmisson Mode RTU:

Device	command	Start address		Number of Register		Check Sum	
		H Byte	L Byte	H Byte	L Byte	L CRC	H CRC
02	10	00	06	00	02	CRC	

If button 1 or 2 is pushed, the set point for temperature is changed.

5.12 Read-Out of Output Register

Button 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 Modus RTU		**Slave – Response Telegram in Modus RTU**	
Description	Value (Hex)	Description	Value (Hex)
Slave address	02	Slave Address	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 1-4	08
Number of Registers Low	04	Register value High (0101)	01
Check sum Low	CRC	Register value Low (0101) Button 1-4	23
Check sum High		Register value High (0102) Temperature	00
		Register value Low (0102) Temperature	DC
		Register value High (0103) Set point offset	FF
		Register value Low (0103) Temperature 1	E7

		Check sum Low	CRC
		Check sum High	

5.1.2 Setting of Input Registers

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

Example: Setting of time: 14:23:47

Master - Telegram in the transmission mode TU:

Device	Command	Start address		Number of l Register		Number ofl Bytes	Data Register 513		Data Register 514		Data Register 515		Check Sum	
		H Byte	L Byte	H Byte	L Byte		H Byte	L Byte	H Byte	H Byte	L Byte	L Byte	L CRC	H CRC
02	10	02	00	00	03	06	00	47	00	23	00	14	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
02	10	02	00	00	03	CRC	

Example: Setting of date: 23.01.2008

Master - Telegram in transmission mode RTU:

Device	Command	Start address		Number of Register		Number of Bytes	Data Register 516		Data Register 517		Datea Register 518		Check Sum	
		H Byte	L Byte	H Byte	L Byte		H Byte	L Byte	H Byte	H Byte	L Byte	L Byte	L CRC	H CRC
02	10	02	03	00	03	06	00	23	00	01	00	08	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
02	10	02	03	00	03	CRC	

5.2 Coil / Bit Allocation

The operating unit has different configuration bits for the setting of the display value in the display. By means of the input bits different symbols and LEDs of the operating unit can be controlled.

5.2.1 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: Display outdoor temperature

Master - Telegram in transmission mode RTU:

Slave Address	Command	Start address		Number of Bits		Number of Bytes	Data	Check Sum	
		H Byte	L Byte	H Byte	L Byte		H Byte	L CRC	H CRC
02	0F	00	01	00	01	01	01	CRC	

Slave – Response Telegram in transmission mode RTU:

Slave Address	Command	Start address		Number of Bits		Check Sum	
		H Byte	L Byte	H Byte	L Byte	L CRC	H CRC
02	0F	00	01	00	01	CRC	

5.2.2 Read Out of Bits

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

Example: Read out indicated symbols (Data address = 00000hex 00001hex)

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	00	Bit value 0,0,0,0,0,0,Bit1,Bit0	03
Number of Bits High	00	Check Sum Low	CRC
Number of Bits Low	02	Check Sum High	
Check Sum Low	CRC		
Check Sum High			

6 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 WRF06-RS485 Modbus. It is possible to use any programme producing Modbus telegrams which is suitable to set registers.

7 Software Installation

For the installation of the configuration software, the setup files „WRF06_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“

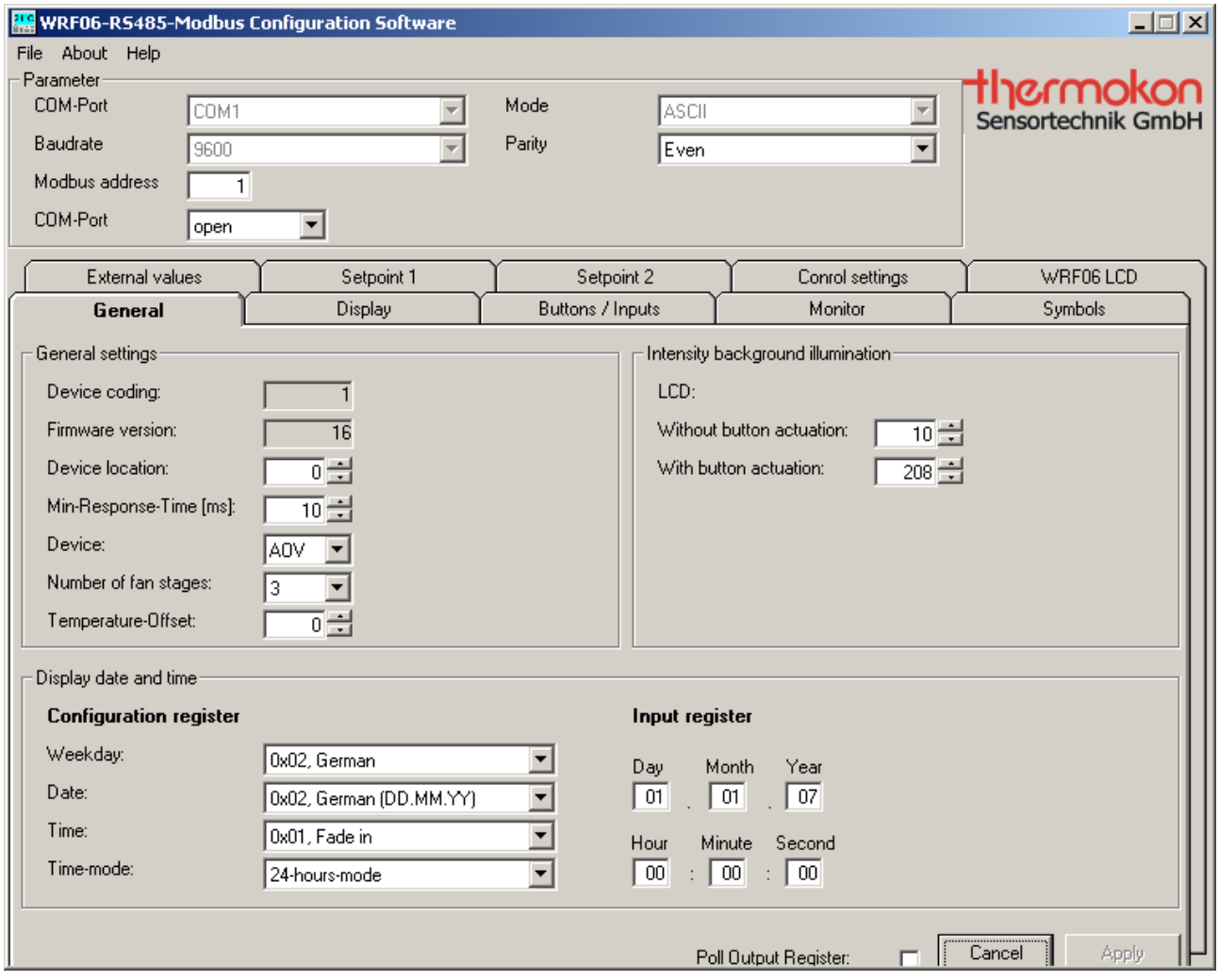
Operating systems supported: Windows9x; WindowsNT; WindowsMe; Windows2000; WindowsXP; WindowsServer

8 Configuration of WRF06-RS485-Modbus

8.1 Software Configuration

By means of the configuration software the configuration registers can be clearly adjusted. Output registers of the WRF06 can be read out and input registers can be set. The load of the individual registers is described in chapter 3.4.

Via the menu points "File" and "Saving of Parameter" respectively "Loading of Parameter", the configuration registers can be stored in a text file and can be reloaded into the WRF06-RS485-Modbus.



Picture 8-1: Configuration Software

8.2 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 connection failed, the same is shown by an error message.

Picture 8-2: Communication Problems

8.3 Register

The configuration registers can be set in the different riders. Furthermore, the output registers can be read and the input registers can be set.

Changes are sent to the WRF06-RS485 Modbus after having pressed the button "take over". By actuating the button "Cancel" the registers of the WRF06-RS485-Modbus are read out again.

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

Picture 8-3: Data