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HOME OF SENSOR TECHNOLOGY

Description of RS485 MODBUS interface

FT-RDF18+ (LCD) RS485 Modbus
RDF-IR+ (LCD) RS485 Modbus
LDF+ (LCD) RS485 Modbus
AGS55+ (LCD) RS485 Modbus
FTA54+ (LCD) RS485 Modbus
WSA (LCD) RS485 Modbus
LA+ (LCD) RS485 Modbus
Li65+ (LCD) RS485 Modbus
AKF10+ (LCD) RS485 Modbus
SKF02+ (FR) (LCD) RS485 Modbus
MWF+ (LCD) RS485 Modbus
FTK+ (LCD) RS485 Modbus
LK+ (LCD) RS485 Modbus
VFG54+ (LCD) RS485 Modbus
AF25+ (LCD) RS485 Modbus
TF25+ (LCD) RS485 Modbus
WK02+ (LCD) RS485 Modbus
DPA+ (Dual) (Flow) (2IN) (LCD) RS485 Modbus
LP+ (LCD) RS485 Modbus

Revision

Revision	Date	Description
A	24.03.2017	First issue
B	11.05.2017	New issue, different error corrections
C	20.07.2017	Different corrections
D	04.08.2017	Register 50…53 added (available since firmware V1.6)
E	31.082017	- Register data types added - Register 411 and 412 added (available since firmware 1.8)
F	30.08.2018	Registers for light sensor (LI65+ & LDF+), dual channel pressure- and flow sensor (DPA+ Dual), additional inputs and second temperature sensor (RDF+) added (firmware 2.0 and higher).
G	07.02.2019	Correction for the description of register 408, 410 and 616.
H	07.08.2020	Default values for BETA-Value NTC 1 and BETA-Value NTC 2 corrected to 3977.
I	18.08.2020	Description for registers 407, 408, 409, 410, 490 and 491 adapted to firmware v2.2.
J	22.02.2021	Description for registers 216…223 and 617…620 adapted to firmware v2.3.
K	19.08.2021	Description for registers 14, 15, 316 and 317 added (available since firmware v2.6).
L	10.09.2021	List of supported device updated. Description for register 501 modified (firmware 2.8).
M	18.11.2021	Parity DIP switch settings updated.

Table of Contents

1 General

This document describes the RS485 Modbus interface of the Thermokon USE devices:

Note:
Depending on the device type and configuration level not all measuring values and configuration parameters shown in this document are available. The corresponding values are defined in the data sheets of the product in question.

1.1 Hardware Installation

The device can be connected by means of a twisted-pair cable (line resistance 120 Ohm).
Detailed information on the installation and mounting can be found in the product data sheet of the corresponding device and the data sheet wiring_rs485_network.pdf.

1.2 RS485 Transceiver

The maximal number of bus participants without the use of a repeater is default by the RS485 transceiver.
The transceiver used in the device enables 32 devices per bus segment.

1.3 Protocol

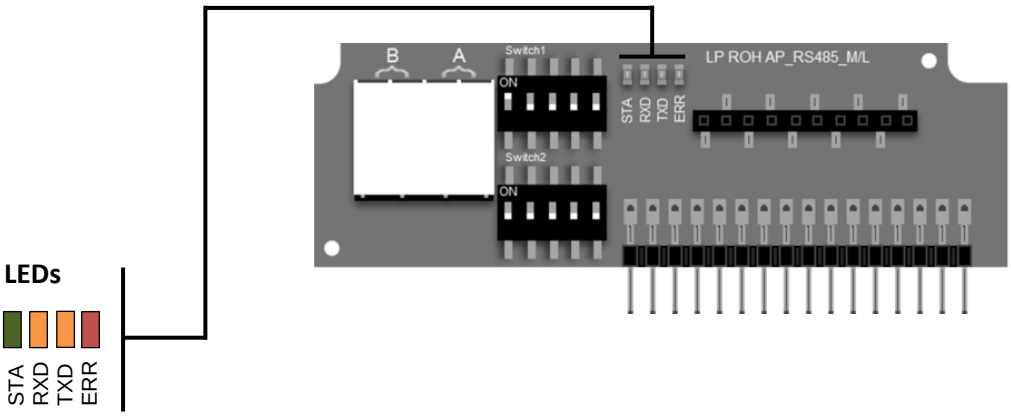
The device is a slave bus participant which is only allowed to send to the bus on request of a master. The protocol is in accordance with the defaults of:
- MODBUS Application Protocol Specification V1.1 (Link)
- MODBUS over Serial Line Specification & Implementation guide V1.0 (Link)

1.4 Configuration Options

The device can be adapted to the corresponding bus topology by means of a dip switch.

- Bus address of device (1…31)
  An address in the range 1 ... 247 can be selected via the Thermokon USE APP. To do this, set the address dip to 0 and select desired address via the USE APP.
- Baud rate 9600, 19200, 38400 or 57600
- Even parity (even), uneven (odd) or none (none)
  The number of stop bits is determined depending on the parity, possible configurations are:
  - Parity “even” and 1 stopbit
  - Parity “odd” and 1 stopbit
  - Parity “none” and 1 stopbit
  - Parity “none” and 2 stopbit

1.5 Dip switch and LED



Via the integrated LEDs the current operating status of the Modbus interface is indicated.

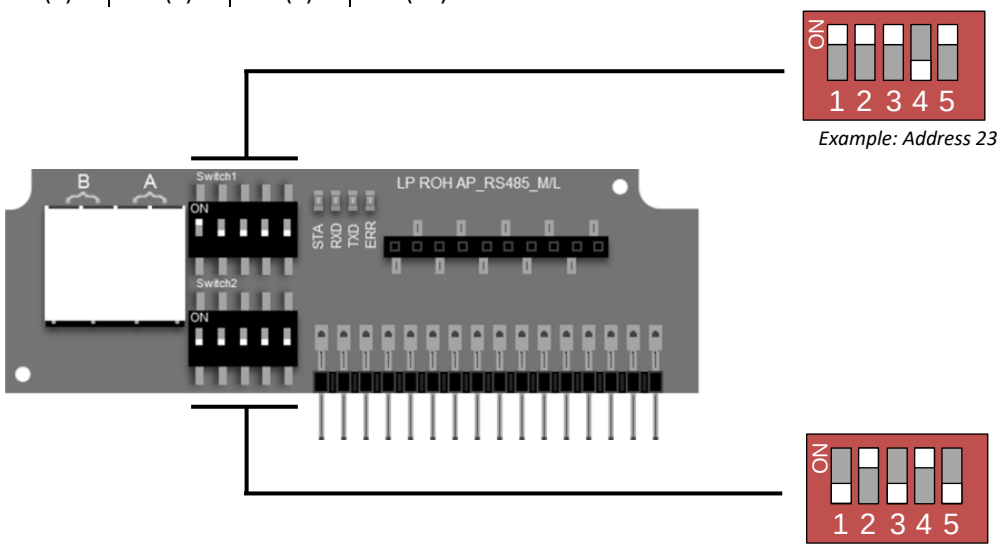
LED	Meaning
STA	Blinks during normal operation Lights up permanently during sensor initialization of device start
RXD	Blinks when RS485 Modbus telegrams are received
TXD	Blinks when RS485 Modbus telegrams are sent
ERR	Lights up in case of a corrupt bus configuration and internal errors

All settings are saved even after removal of the Modbus option conductor board.

Modbus Address (Switch 1)

The Modbus address of the device is set via a 5-gang dip switch, binary coded in the range of 1…31.
If the address is set to 0 it is possible to select an address from an extended address range (32..247) by means the USEapp.

Dip switch	1	2	3	4	5
Priority	2^0 (1)	2^1 (2)	2^2 (4)	2^3 (8)	2^4 (16)



Example: Address 23

Example.:
Termination resistor: deactivated
Baud rate 19200
Parity: EVEN

Modbus Options (Switch 2)

1	Load resistor
off	disabled
on	enabled

2	3	Baud rate
off	off	9600
on	off	19200
off	on	38400
on	on	57600

4	5	Parity
off	off	None – 2 Stopbits
on	off	Even
off	on	Odd
on	on	None – 1 Stopbit

2 Modbus Register Description

All following registers listed are holding registers which are addressable via the Modbus function codes 3, 6 and 16 (0x03, 0x06 und 0x10). For further information please see chapter 3.

2.1 Sensor Value

Via the registers 0…99 different measuring values can be read out. Which measuring values are available in the respective devices can be inquired via the register 501 (sensor identification).

Address	Access	Description	Remarks
400	RW / u16	**Selection of unit systems**	1: SI 2: Imperial On devices with differential pressure / volume flow / light and on RDF-IR+ this value is only readable and is adjusted via the dip switches

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	
14	R / s16	**Condensate (raw value 0…495)**	1	raw
15	R / s16	**Condensate (relay state)**	0/1	off/on

If Register 400 = 1, then Unit System = SI …

Address	Access	Description	Resolution / Unit		
0	R / s16	**Temperature 1**	SI	0.1	°C
2	R / s16	**Absolute humidity**	SI	0.01	g/m³
3	R / s16	**Enthalpy**	SI	0.1	kJ/kg
4	R / s16	**Dew Point**	SI	0.1	°C
8	R / s16	**Differential pressure 1**	SI	1.0	Pa
9	R / u16	**Volume flow 1 (16 Bit)** (if register address 404 is set to the value 2, the value scales the unit m³/s)	SI	100.0	m³/h
				0.01	m³/s
10	R / s16	**Differential pressure 2**	SI	1.0	Pa
11	R / u16	**Volume flow 2 (16 Bit)** (if register address 406 is set to the value 2, the value scales the unit m³/s)	SI	100.0	m³/h
				0.01	m³/s
12	R / u16	**Atmospheric Pressure**	SI	1.0	hPa
13	R / s16	**Temperature 2**	SI	0.1	°C
50 Low 51 High	R / u32	**Volume flow 1 (32 Bit)** (if register address 404 is set to the value 2, the value scales the unit m³/s) *This register is available since firmware V1.6 (see register 505)*	SI	1.0	m³/h m³/s
52 Low 53 High	R / u32	**Volume flow 2 (32 Bit)** (if register address 406 is set to the value 2, the value scales the unit m³/s) *This register is available since firmware V1.6 (see register 505)*	SI	1.0	m³/h m³/s

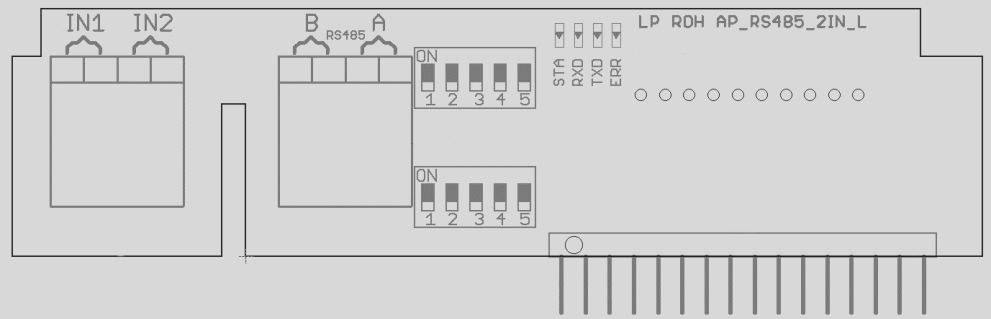
60 Low 61 High	R / u32	**Illumination 1 (32 Bit)**	SI	1.0	Lux
62 Low 63 High	R / u32	**Illumination 2 (32 Bit)**	SI	1.0	Lux

If Register 400 = 2, then Unit System = Imperial …

Address	Access	Description	Resolution/Unit		
0	R / s16	**Temperature**	Imperial	0.1	°F
2	R / s16	**Absolute humidity**	Imperial	0.01	gr/ft³
3	R / s16	**Enthalpy**	Imperial	0.1	BTU/lb
4	R / s16	**Dew point**	Imperial	0.1	°F
8	R / s16	**Differential pressure 1**	Imperial	0.001	inWC
9	R / u16	**Volume flow 1**	Imperial	10.0	cfm
10	R / s16	**Differential pressure 2**	Imperial	0.001	inWC
11	R / u16	**Volume flow 2**	Imperial	10.0	cfm
12	R / u16	**Atmospheric Pressure**	Imperial	1.0	inWC
13	R / s16	**Temperature 2**	Imperial	0.1	°F
50 Low 51 High	R / u32	**Volume flow 1 (32 Bit)** (if register address 404 is set to the value 2, the value scales the unit m³/s) *This register is available since firmware V1.6 (see register 505)*	Imperial	1.0	cfm
52 Low 53 High	R / u32	**Volume flow 2 (32 Bit)** ((if register address 406 is set to the value 2, the value scales the unit m³/s) *This register is available since firmware V1.6 (see register 505)*	Imperial	1.0	cfm
60 Low 61 High	R / u32	**Illumination 1 (32 Bit)**	Imperial	1.0	fc
62 Low 63 High	R / u32	**Illumination 2 (32 Bit)**	Imperial	1.0	fc

2.2 Measurement Values of additional Inputs

Some device types include an option board with two additional inputs (IN1 & IN2). NTC10k temperature sensors or potential-free switching contacts can be connected to these inputs. The measured values are provided via the Modbus registers 90…93.
The BETA values of the connected NTC10k sensors can be configured via the Modbus registers 490 & 491.



For details how to connect the external sensors and contacts, please refer to the product data sheet of the respective device.

If Register 400 = 1, then Unit System = SI …

Address	Access	Description	Resolution/Unit		
90	R / s16	Input 1 - Temperature NTC10k	SI	0.1	°C
91	R / s16	Input 2 - Temperature NTC10k	SI	0.1	°C

If Register 400 = 2, then Unit System = Imperial …

Address	Access	Description	Resolution/Unit		
90	R / s16	Input 1 - Temperature NTC10k	SI	0.1	°F
91	R / s16	Input 2 - Temperature NTC10k	SI	0.1	°F

Address	Access	Description	Values	
92	R / s16	Input 1 – Switch contact	0	Contact open
93	R / s16	Input 2 – Switch contact	1	Contact closed

2.3 Offset-/Correction Values

Via the registers 100…199 the offset/correction values for the single measuring values can be default.

Example: Offset Temperature (Register 100):
Offset +1 °C (+1 °F) = 10_{10} (0000‘0000‘0000‘1010_2) = 00 $0a_{16}$
Offset -1 °C (-1 °F) = -10_{10} (1111‘1111‘1111‘0110_2) = ff $f6_{16}$

Address	Access	Description	Resolution/Unit	
101	RW / s16	**Offset relative humidity**	1.0	%rF
102	RW / s16	**Offset CO2**	1.0	ppm
103	RW / s16	**Offset VOC**	1.0	%
150	RW / u16	**Correction factor illumination 1**	0.001	-
151	RW / u16	**Correction factor illumination 2**		

If Register 400 = 1, then Unit System = SI …

Address	Access	Description	Resolution/Unit		
100	RW / s16	**Offset Temperature 1**	SI	0.1	°C
104	RW / s16	**Offset differential pressure 1**	SI	1.0	Pa
105	RW / s16	**Offset differential pressure 2**	SI	1.0	Pa
106	RW / s16	**Offset Illumination 1**	SI	1.0	Lux
107	RW / s16	**Offset Illumination 2**	SI	1.0	Lux
108	RW / s16	**Offset Atmospheric Pressure**	SI	1.0	hPa
109	RW / s16	**Offset Temperature 2**	SI	0.1	°C

If Register 400 = 2, then Unit System = Imperial …

Address	Access	Description	Resolution/Unit		
100	RW / s16	**Offset Temperature**	Imperial	0.1	°F
104	RW / s16	**Offset differential pressure 1**	Imperial	0.001	inWC
105	RW / s16	**Offset differential 2**	Imperial	0.001	inWC
106	RW / s16	**Offset Illumination 1**	Imperial	1.0	fc
107	RW / s16	**Offset Illumination 2**	Imperial	1.0	fc
108	RW / s16	**Offset Atmospheric Pressure**	Imperial	1.0	inWC
109	RW / s16	**Offset Temperature 2**	Imperial	0.1	°F

2.4 Measuring Values Upper-/Lower Limits

Via the measuring values upper-/lower limits values in a special range can be localized. The scale concerns the values in the registers 0..99 and of both analogue outputs.

Address	Accesss	Description	Resolution/Unit	
202	RW / s16	**Relative humidity lower limit**	1.0	%rF
203	RW / s16	**Relative humidity upper limit**	1.0	%rF
210	RW / s16	**CO2 lower limit**	1.0	ppm
211	RW / s16	**CO2 upper limit**	1.0	
212	RW / s16	**VOC lower limit**	1.0	%
213	RW / s16	**VOC upper limit**	1.0	
214	RW / s16	**CO2 VOC Mix lower limit**	1.0	%
215	RW / s16	**CO2 VOC Mix upper limit**	1.0	

If Register 400 = 1, then Unit System = SI …

Address	Access	Description	Resolution/Unit		
200	RW / s16	**Temperature 1 lower limit**	SI	1.0	°C
201	RW / s16	**Temperature 1 upper limit**	SI	1.0	°C
204	RW / s16	**Absolute humidity lower limit**	SI	1.0	g/m³
205	RW / s16	**Absolute humidity upper limit**	SI	1.0	g/m³
206	RW / s16	**Enthalpy lower limit**	SI	1.0	kJ/kg
207	RW / s16	**Enthalpy upper limit**	SI	1.0	kJ/kg
208	RW / s16	**Dew point lower limit**	SI	1.0	°C
209	RW / s16	**Dew point upper limit**	SI	1.0	°C
218	RW / u16	**Volume flow 1 lower limit** (if the register address 404 is set to the value 2, the value scales the unit m³/s)	SI	100.0	m³/h
				0.01	m³/s
219	RW / u16	**Volume flow 1 upper limit** (if the register address 404 is set to the value 2, the value scales the unit m³/s)	SI	100.0	m³/h
				0.01	m³/s
222	RW / u16	**Volume flow 2 lower limit** (if the register address 404 is set to the value 2, the value scales the unit m³/s)	SI	100.0	m³/h
				0.01	m³/s
223	RW / u16	**Volume flow 2 upper limit** (if the register address 404 is set to the value 2, the value scales the unit m³/s))	SI	100.0	m³/h
				0.01	m³/s
224 Low 225 High	RW / float32bit	**Illumination 1 (32 Bit) lower limit**	SI	1.0	Lux
226 Low 227 High	RW / float32bit	**Illumination 1 (32 Bit) upper limit**	SI	1.0	Lux
228 Low 229 High	RW / float32bit	**Illumination 2 (32 Bit) lower limit**	SI	1.0	Lux
230 Low 231 High	RW / float32bit	**Illumination 2 (32 Bit) upper limit**	SI	1.0	Lux
232	RW / u16	**Atmospheric Pressure lower limit**	SI	1.0	hPa
233	RW / u16	**Atmospheric Pressure upper limit**	SI	1.0	hPa
234	RW / s16	**Temperature 2 lower limit**	SI	1.0	°C
235	RW / s16	**Temperature 2 upper limit**	SI	1.0	°C

Register 400 = 2 (Imperial)

Address	Access	Description		Resolution/Unit	
200	RW / s16	**Temperature 1 lower limit**	Imperial	1.0	°F
201	RW / s16	**Temperature 1 upper limit**	Imperial	1.0	°F
204	RW / s16	**Absolute humidity lower limit**	Imperial	1.0	gr/ft³
205	RW / s16	**Absolute humidity upper limit**	Imperial	1.0	gr/ft³
206	RW / s16	**Enthalpy lower limit**	Imperial	1.0	BTU/lb
207	RW / s16	**Enthalpy upper limit**	Imperial	1.0	BTU/lb
208	RW / s16	**Dew point lower limit**	Imperial	1.0	°F
209	RW / s16	**Dew point upper limit**	Imperial	1.0	°F
218	RW / u16	**Volume flow 1 lower limit**	Imperial	10.0	cfm
219	RW / u16	**Volume flow 1 upper limit**	Imperial	10.0	cfm
222	RW / u16	**Volume flow 2 lower limit**	Imperial	10.0	cfm
223	RW / u16	**Volume flow 2 upper limit**	Imperial	10.0	cfm
224 Low 225 High	RW / float32bit	**Illumination 1 (32 Bit) lower limit**	Imperial	1.0	fc
226 Low 227 High	RW / float32bit	**Illumination 1 (32 Bit) upper limit**	Imperial	1.0	fc
228 Low 229 High	RW / float32bit	**Illumination 2 (32 Bit) lower limit**	Imperial	1.0	fc
230 Low 231 High	RW / float32bit	**Illumination 2 (32 Bit) upper limit**	Imperial	1.0	fc
232	RW / u16	**Atmospheric Pressure lower limit**	Imperial	1.0	inWC
233	RW / u16	**Atmospheric Pressure upper limit**	Imperial	1.0	inWC
234	RW / s16	**Temperature 2 lower limit**	Imperial	1.0	°F
235	RW / s16	**Temperature 2 upper limit**	Imperial	1.0	°F

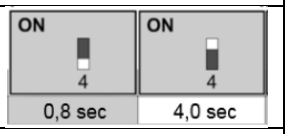
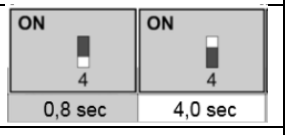
2.5 Selection of Sensor Channels

Via the registers 300…399 the channel numbers of the single measuring values can be adapted afterwards, e.g to change the assignment of the analogue outputs and the indication in the display (optionally).

Address	Access	Description	Note
300	RW / u16	**Channel number** Temperature 1	Selection of channel number. The channels with number 1 &2 are output via Modbus as well as via the analogue outputs AO1 & AO2. Moreover, the channel numbering 3 and 4 for displaying the measuring values in the LCE has to be considered. Valid values: 1…4* Every channel number must only be assigned on time! Unused channels are set to 0.
301	RW / u16	**Channel number** Relative humidity	
302	RW / u16	**Channel number** Absolute humidity	
303	RW / u16	**Channel number** Enthalpy	
304	RW / u16	**Channel number** Dew point	
305	RW / u16	**Channel number** CO2	
306	RW / u16	**Channel number** VOC	
307	RW / u16	**Channel number** CO2 VOC Mix	
308	RW / u16	**Channel number** Differential pressure 1	
309	RW / u16	**Channel number** Volume flow 1	
310	RW / u16	**Channel number** Differential pressure 2 (only devices with 2 pressure sensors)	
311	RW / u16	**Channel number** Volume flow 2 (only devices with 2 pressure sensors)	
312	RW / u16	**Channel number** Illumination 1	
313	RW / u16	**Channel number** Illumination 2	
314	RW / u16	**Channel number** Atmospheric Pressure	
315	RW / u16	**Channel number** Temperature 2	
316	RW / u16	**Channel number** Condensate RAW value	
317	RW / u16	**Channel number** Condensate relay	

2.6 Sensor Configuration

Via the register 400...499 the requested unit system can be selected and further sensor parameters can be default.

Address	Access	Description	Note
400	RW / u16	Selection of unit system	1: SI 2: Imperial On devices with differential pressure / volume flow / light and on RDF-IR+ this value is only readable and is adjusted via the dip switches
401	*Reserved*		
402	RW / u16	Height (above sea level)	Unit: m
403	RW / u16	k-value volume flow 1 Conversion factor according to the fan manufacturer's specifications, applies to the calculation of the volumetric flow in the unit m³ / h respectively m³ / s (Fläkt Woods).	Scaling factor: 0.1 Example: k-value 1500 = 15000_{10}
404	RW / u16	Selection of calculation formula (depending on fan manufacturer) volume flow 1	0: Rosenberg, Comefri, Gebhardt, Nicotra $q = k * \sqrt{2 * \frac{\Delta p}{\rho}}$ 1: Ziehl-Abegg, EBM-Papst $q = k * \sqrt{\Delta p}$ 2: Fläkt Woods $q = \frac{1}{k} * \sqrt{\Delta p}$
405	RW / u16	k-value volume flow 2 Conversion factor according to the fan manufacturer's specifications, applies to the calculation of the volumetric flow in the unit m³ / h respectively m³ / s (Fläkt Woods).	Scaling factor: 0.1 Example: k-Wert 1500 = 15000_{10}
406	RW / u16	Selection of calculation formula (depending on fan manufacturer) volume flow 2	0: Rosenberg, Comefri, Gebhardt, Nicotra $q = k * \sqrt{2 * \frac{\Delta p}{\rho}}$ 1: Ziehl-Abegg, EBM-Papst $q = k * \sqrt{\Delta p}$ 2: Fläkt Woods $q = \frac{1}{k} * \sqrt{\Delta p}$
407	R / u16	State Dip Switch (on motherboard) Response Time Pressure 1	1: DIP off → 0,8 s 2: DIP on → 4,0 s 
408	RW / u16	Response Time Flow 1	1…30 s
409	R / u16	State Dip Switch (on motherboard) Response Time Pressure 2	1: DIP off → 0,8 s 2: DIP on → 4,0 s 
410	RW / u16	Response Time Flow 2	1…30 s
411	RW / u16	Zeroing differential pressure 1	0: no zeroing 1: start zeroing
412	RW / u16	Zeroing differential pressure 2	0: no zeroing 1: start zeroing
413	RW / u16	Percentage value of the CO2 value in the CO2 VOC Mix Signal	0…100%

			Example.: 25% means: CO2 VOC Mix = 25% CO2 and 75% VOC

490	RW / u16	BETA-Value NTC 1	Default: 3970
491	RW / u16	BETA-Value NTC 2	Default: 3970

2.7 General Registers

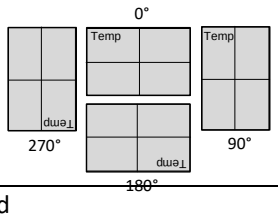
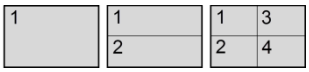
Via the registers 500…599 general device information can be read out and written.

<table>
<tr><th>Address</th><th>Access</th><th>Description</th><th>Note</th></tr>
<tr><td>500</td><td>R / u16</td><td>Device identification</td><td>0x700</td></tr>
<tr><td rowspan="2">501</td><td rowspan="2">R / u16</td><td rowspan="2">Sensor identification</td><td>1=sensor value available
0= sensor value not available</td></tr>
<tr><td>Bit 0: Temperature 1
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
Bit 8: Differential pressure 1
<table>
<tr><td></td><td>If Bit 8 = 0</td><td>If Bit 8 = 1</td></tr>
<tr><td>Bit 9</td><td>Condensate Value</td><td>Volume flow 1</td></tr>
<tr><td>Bit 10</td><td>Condensate Relay</td><td>Diff. Pressure 2</td></tr>
<tr><td>Bit 11</td><td>reserved</td><td>Volume flow 2</td></tr>
</table>
Bit 12: Illumination 1
Bit 13: Illumination 2
Bit 14: Atmospheric Pressure
Bit 15: Temperature 2</td></tr>
<tr><td>502</td><td>R / u16</td><td>Hardware version mother board</td><td rowspan="4">Example.: V 1.2 = 0x0102
Readability in hexadecimal</td></tr>
<tr><td>503</td><td>R / u16</td><td>Firmware version mother board</td></tr>
<tr><td>504</td><td>R / u16</td><td>Hardware version clip-on board</td></tr>
<tr><td>505</td><td>R / u16</td><td>Firmware version clip-on board</td></tr>
<tr><td>506</td><td colspan="3">reserved</td></tr>
<tr><td>507</td><td colspan="3">reserved</td></tr>
<tr><td>508</td><td>RW / u16</td><td>Minimal output voltage</td><td>Example: 1 = 1V</td></tr>
<tr><td>509</td><td>R / u16</td><td>Maximal output voltage</td><td>Example.: 10 = 10V</td></tr>
<tr><td>510</td><td>R / u16</td><td>Elapsed hour counter</td><td rowspan="3">Unit: hours

If the countdown is expired the value must be written in the register again</td></tr>
<tr><td>511</td><td>RW / u16</td><td>Service Countdown
Set a defined operating period – e.g. for rotational maintenance work</td></tr>
<tr><td>512</td><td>RW / u16</td><td>Calibration Countdown
Often sensors are used in extreme conditions. Thus, a regular calibration cycle is recommendable.</td></tr>
</table>

2.8 Display Configuration

Via the registers 600…699 display parameters can be adapted and the measuring values can be default.

Address	Access	Description	Note
600	RW / u16	**„LCD“** ON/OFF	0: ON 1: OFF
601	RW / u16	**„LCD“ Brightness**	0…100%
602	RW / u16	**„LCD“ Rotation**	0: 0° 1: 90° 2: 180° 3: 270° 
603	RW / u16	**„LCD“ activate traffic-light function**	0: deactivated 1: activated
604	RW / u16	**„LCD“ Service symbol enabled**	0: disabled 1= enabled
605	RW / u16	**„LCD“ Calibration symbol enabled**	
606	RW / u16	*reserved*	
607	RW / u16	**„LCD“ Channel 1** display/ do not display	0: do not display 1: display Corresponds to the channel assignment of the addresses 300..311 
608	RW / u16	**„LCD“ Channel 2** display/do not display	
609	RW / u16	**„LCD“ Channel 3** display/do not display	
610	RW / u16	**„LCD“ Channel 4** display/do not display	
611	RW / u16	**Channel assignment for traffic-light function**	Enter the channel number of the sensor value to be linked with the TLF in this register. (1..4, to be input in register 300 to 311)
612	RW / u16	**Traffic-light function** Colour range 1	0: off 1: green 2: yellow 3: red 4: blue 5: magenta 6: cyan 7: white
613	RW / u16	**Traffic-light function** Colour range 2	
614	RW / u16	**Traffic-light function** Colour range 3	
615	RW / s16	**Traffic-light threshold** Range 1→2	Setting of thresholds for colour change of the display illumination. The setting is made in the respective base unit. An exception applies to the volume flow values, here the corresponding scaling factor has to considered - see registers 9 and 11. Example: Change from **Blue** to **Green** at 20 °C. Change from **Green** to **Red** at 35 °C **Range 1, Register 612 = 4_{10}** **Range 2, Register 613 = 1_{10}** **Range 3, Register 614 = 3_{10}** **Threshold Register 615 = 20_{10}** **Threshold Register 616 = 35_{10}**
616	RW / s16	**Traffic-light threshold** Range 2→3	

617 618	RW / float32bit	**Traffic-light threshold** Range 1→2Bereich 1→2	*Available on v2.3 or higher.* As an alternative to registers 615/616, the threshold values can be specified as float values using registers 617… 620.
619 620	RW / float32bit	**Traffic-light threshold** Range 2→3	

3 Modbus Protocol

http://www.modbus.org/

3.1 Supported Control Commands

The following MODBUS control commands are supported by the device:

Description	Function Code	
Read Holding Register	03 (hex)	3 (dec)
Write Single Register	06 (hex)	6 (dec)
Write Multiple Register	10 (hex)	16 (dec)

3.2 Data Transmission

3.2.1 Master/Slave Protocol

One Master and one or several Slaves are connected to the serial bus. The communication between Master and Slave is solely controlled by the Master. Slaves are only allowed to send if they were called by the Master before. Slaves are only sending to a Master, never to another Slave.

3.2.2 Data Frame

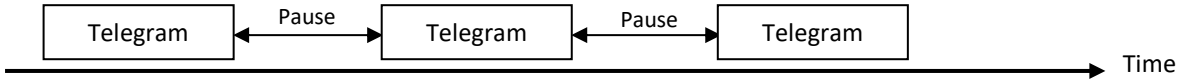
Data are sent to the bus in accordance with strictly defined defaults:

Address	Control Command	Data	Checksum

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

3.2.3 Transmission Mode RTU

In the transmission mode RTU telegrams are separated by transmission pauses.



The period of the transmission pauses for separation of telegrams is depending on the set baud rate and amounts to 3,5 * Word-Transmission Time (11 Bit). With 9600 Baud at least 4 ms and with 19200 at least 2ms must pass by between two telegrams.

3.2.3.1 Telegram Structure

Address 1 Byte	Control Command 1 Byte	Data 0 - 100 Byte	Checksum	
			Low	High

3.2.3.2 Calculation of CRC-Checksum

The CRC checksum (Cyclicyal Redundancy Check) is calculated by the sender by means of all bytes transmitted and is attached to the message. Then, the receiver calculates the CRC checksum again and compares the same with checksum received. If the values are not matching, a transmission error must be assumed and the data received are rejected. The low-order byte of the 16 bit checksum is sent in the telegram next to the last position and the high-order byte at the last position.

Calculation of Checksum (programming 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 polynominal for CRC16
        }
        return(crc_temp);
}
```