DUSTHUNTER SP30 / SB30

Modbus® Protocol Implementation

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I. Purpose of this document

This document describes the implementation of the Modbus® protocol in the SENSOR.

II. Distribution list

Project group, SMU

III. History

Version	Changes	Date
0.1	Initial version	2017-06-30
0.2	Register 27001 from 2Bytes to 4 Bytes; FunctionCode 06 -> 16; Offset for all followed register 27002…27004 ➔ 27003…27005	2017-07-03
0.3	Set userlevel for changing parameter on reg. 2701 with the Code 0x347D339D	2017-10-18
0.4	if manual linearity measurement with control filter is active, the actual filter value can be read in the register 26034	2017-12-11
02.00.08	Modbus® implemented in device DH SB30M	2021-04-06
02.00.10	Register 27004 and Register 27005 needs for writing “Auth.Client”, was set with register 2701	2021-08-26
02.01.00	Register 10000, 10001 for customer priority signal device states	2021-12-20
02.06.00	Register 10001 additional Sub-States	2022-02-04
02.06.04	Register 10002 : additional Concentration synchonized with current on analog output Register 10004…10012 : Drift of control values after function check	2022-10-06
02.07.10	Register 10002 : correction of using: Register 10004…10026 are filled with new diagnosis values for MCU: Register 10036 – last function check started (since newstart device) Register 10050 - last function check ended (since newstart device)	2023-08-01
02.08.00	Register 26000… 26021 for internal diagnosis values	2023-10-16

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List of Abbrevations

RTU	Remote Terminal Unit
ASCII	American Standard Code for Information Interchange
ISO	International Standards Organization
OSI	Open Systems Interconnection
CRC	Cyclic Redundancy Check
LRC	Longitudinal Redundancy Check
EIA/TIA	Electronic Industries Alliance / Telecommunications Industry Association
USB	Universal Serial Bus
TCP/IP	Transmission Control Protocol / Internet Protocol
MBAP	Modbus® Application Protocol
PDA	Protocol Data Unit
ADU	Application Data Unit
TBD	To be done

1 General

1.1 References

This implementation guide is strictly orientated on the following documents:

- „**Modbus® Application Protocol Specification V1.1b**“
- „**Modbus® over Serial Line Specification an Implementation guide V1.02**“

by the Modbus® IDA Organization.

Text parts written in **gray color** describes functionality which is not implemented yet.

1.2 OSI Layer classification

The Modbus® protocol can compared to ISO/OSI reference model in the following way:

Table 1: OSI Layer classification

Layer	OSI meaning	Modbus® meaning
7	Application	Modbus® Application Protocol
6	Presentation	Empty
5	Session	Empty
4	Transport	Empty
3	Network	Empty
2	Data Link	Modbus® Serial Line Protocol
1	Physical	EIA/TIA -232

1.3 Modbus® RTU

This protocol is a fully binary protocol. Start of message and end of message are defined by specific communication timeouts. Error detection is done by a CRC-16 calculation.

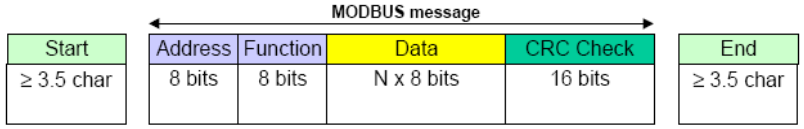

Figure 1: Modbus® RTU Framing

Important Notice:

For a stable and error-free communication with multiple slaves on one busline, it is strongly recommended to use a silent time of at least 50 ms after the Sensor´s reply before sending the next request to any slave on the bus!

1.4 Modbus® ASCII

Modbus® ASCII describes a fully ASCII orientated protocol, starting with „:“ and ending with CRLF. Each databyte is separated and transmitted as two ASCII bytes. Error detection is done here with a LRC check over the datablock.

Start	Address	Function	Data	LRC	End
1 char :	2 chars	2 chars	0 up to 2x252 char(s)	2 chars	2 chars CR,LF

Figure 2: Modbus® ASCII Framing

1.5 Modbus® Datatypes

With Modbus® communication, it is defined that all values transferred in registers 16-bit width. That means, e.g. that a float value is transferred in two registers. It is also defined that Modbus® uses BigEndian Datatransfer.

Datatype	Width	used registers	Remark	Abbrevations
(un)signed char	8 Bits	1		UI8, SI8
(un)signed int	16 Bit	1		UI16, SI16
(un)signed long	32 Bit	2		UI32, SI32
float	32 Bit	2	IEEE Format	FLOAT
string	n * 8 Bit	n>2: (n/2)	used flipped high and low bytes	STRING__

On the Modbus®**, the data is always represented in metric units, as described in the register list!**

2 Physical requirements

2.1 Modbus® ASCII / RTU via RS485 Interface

RS485 Connectors available on the Interface Module, marked as ‘A‘ and, ‘B‘.

2.2 Bus timing

After the response of a device, there must be silence on the bus of at least 50ms before next request can be send to any device on the bus.

If devices of foreign vendors are installed on the same serial bus, they must provide an option like “Send delay” to provide the necessary silence on the bus.

3 Protocol specification

3.1 Supported commands

3.1.1 Functioncode 0x03: Read Holding Registers

The „Read Holding Registers“ command is used to **read out parameters and other static data** from the SENSOR.

Request to the SENSOR:

Request functioncode:	1 byte	0x03
Starting address:	2 byte	0x0000..0xFFFF
Quantity of registers:	2 byte	0x0000..0x007D

Response from the SENSOR:

Functioncode:	1 byte	0x03
Byte count:	1 byte	(2 * register count)
Register value:	N bytes	

Error signalling:

Error code:	0x83
Exception code:	0x01, 0x02, 0x03 or 0x04

3.1.2 Functioncode 0x04: Read Input Registers

The „Read Input Register“ command is used to **read out measured values and diagnostic data** from the SENSOR.

Request to the SENSOR:

Request functioncode:	1 byte	0x04
Starting address:	2 byte	0x0000..0xFFFF
Quantity of registers:	2 byte	0x0000..0x007D

Response from the SENSOR:

Functioncode:	1 byte	0x04
Byte count:	1 byte	(2 * register count)
Register value:	N bytes	

Error signalling:

Error code:	0x84
Exception code:	0x01, 0x02, 0x03 or 0x04

3.1.3 Functioncode 0x06: Write single register

Request to the SENSOR:

Request functioncode:	1 byte	0x06
Register address:	2 byte	0x0000..0xFFFF
Register value:	2 byte	0x0000..0xFFFF

Response from the SENSOR:

Functioncode:	1 byte	0x06
Register address:	2 byte	0x0000..0xFFFF
Register value:	2 byte	0x0000..0xFFFF

Error signalling:

Error code:	0x86
Exception code:	0x01, 0x02, 0x03 or 0x04

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3.1.4 Functioncode 0x10: Write multiple registers

Request to the SENSOR:

Request functioncode:	1 byte	0x10
Starting address:	2 byte	0x0000..0xFFFF
Quantity of Registers:	2 byte	0x0000..0x007B (0...123)
Byte count:	1 byte	(2* register count)
Register values:	N byte	

Response from the SENSOR:

Functioncode:	1 byte	0x10
Starting Address:	2 byte	0x0000..0xFFFF
Quantity of Registers:	2 byte	0x0000..0x007B (0...123)

Error signalling:

Error code:	0x90
Exception code:	0x01, 0x02, 0x03 or 0x04

3.1.5 Functioncode 0x2b: Encapsulated Interface Transport (for VDI4201 support)

Request to the SENSOR:

Request functioncode:	1 byte	0x2B
MEI Type:	1 byte	0x0E
Device ID code :	1 byte	0x01 / 0x02 / 0x03 / 0x04
Object ID:	1 byte	0x00…0xFF

Response from the SENSOR:

Functioncode:	1 byte	0x2B
MEI Type:	1 byte	0x0E
Device ID code :	1 byte	0x01 / 0x02 / 0x03 / 0x04
Conformity level:	1 byte	0x01 or 0x02 or 0x03 or 0x04 or 0x81 or 0x82 or 0x83
More Follows	1 byte	0x00 / 0xFF
Next Object Id	1 byte	Object ID Number (if More Follows == 0xFF) otherwise = 0x00
Number of objects	1 byte	
List Of		
Object ID	1 byte	
Object length	1 byte	
Object value	<object length> depending on the object ID	

Error signalling:

Error code:	0xAB (= 0x2B+0x80)

3.2 Exception codes

0x01 Illegal function

The function code received in the query is not an allowable action for the SENSOR. This may be because the function code is only applicable to newer devices and was not implemented in the unit selected. It could also indicate that the SENSOR is in the wrong state to process a request of this type, for example because it is unconfigured and is being asked to return register values.

0x02 Illegal data address

The data address received in the query is not an allowable address for the SENSOR. More specifically, the combination of reference number and transfer length is invalid. For a controller with 100 registers, the PDU addresses the first register as 0, and the last one as 99. If a request is submitted with a starting register address of 96 and a quantity of registers of 4, then this request will successfully operate (address-wise at least) on registers 96, 97, 98, 99. If a request is submitted with a starting register address of 96 and a quantity of registers of 5, then this request will fail with Exception Code 0x02 “Illegal Data Address” since it attempts to operate on registers 96, 97, 98, 99 and 100, and there is no register with address 100.

0x03 Illegal data value

A value contained in the query data field is not an allowable value for server (or slave). This indicates a fault in the structure of the remainder of a complex request, such as that the implied length is incorrect.

This code is also used, if a parameter cannot be set because write condition is not activated (user level and/or maintenance) or the value is out of specification (minimum, maximum, part of a list).

0x04 Slave device failure

An unrecoverable error occurred while the server (or slave) was attempting to perform the requested action.

3.3 Special communication requirements

3.3.1 SOPAS ET requirements

As shown before, it´s essential to set the proper user level before write operations. Therefore, the SetAccessMode and CheckPassword functions are provided over the Modbus®.

Operation sequence:

1. Set Maintenance (Fct Code 0x06, Register 27000, Value: 0x01)
2. Set User Level (Fct Code 0x06, Register 27001, Value: 0x347D339D)
3. Write Parameter (Fct Code 0x06, any register and value)
4. Set Operation (Fct Code 0x06, Register 27000, Value: 0)

The user level is reset by going off maintenance, or by setting the Access level to another value.

3.3.2 General Register Definition

R_FMIN = -1000000000.0f

R_FMAX = 1000000000.0f

Table 2: Registers

Reg. Nr.	Supported Function Code	R/W	Counts		Default value or Example	Low	High	Type	Description	Phy. Unit
	03 (0x03) - Read Holding registers 04 (0x04) - Read Input Registers 06 (0x06) - Write Single Register 16 (0x10) - Write Multiple Registers		Bytes	Register (2 Byte)						
Device Information										
0	03 ; 04	RO	32	16	"EHS"			STRING32	VendorName - manufacturer name	
16	03 ; 04	RO	32	16	"Sensor_SP"			STRING32		
32	03 ; 04	RO	32	16	"00.00.00"			STRING32	MajorMinorRevision - Software version of measuring system	
48	03 ; 04	RO	32	16	"DH SP30" / "DH SB30M"			STRING32	ProductName - device name	
64	03 ; 04	RO	32	16	"00008700"			STRING32	SerialNumber - serial number of measuring system	

Actual measured value										
1000	03 ; 04	RO	4	2	0.0f			FLOAT	Dust concentration	mg/m³
1002	03 ; 04	RO	4	2	0			UINT32	status information (hexadecimal) Bit 00: (0000 0001) Failure Bit 01: (0000 0002) Maintenance Bit 02: (0000 0004) Maintenance Request Bit 03: (0000 0008) Out of Spec Bit 04: (0000 0010) Component Simulation_Value active Bit 16: (0001 0000) Testmode active (Test AO and DO with fixe settings) Bit 17: (0002 0000) Check cycle active (determine control value and AO control value) Bit 18: (0004 0000) Filter Mode active Bit 19: (0008 0000) Meas Component hold (during check cycle determine control value) Bit 20: (0010 0000) One Component Value over Limit value Bit 25: (0200 0000) CheckCycle Start enable (No Testmode and no Filtermode active) Bit 26: (0400 0000) FilterMode Start enable (No Testmode and no Checkcycle active) Bit 27: (0800 0000) Access level 1 : Authorized User is set Bit 28: (1000 0000) Access level 2 : Authority is set (always together with Bit 27) Bit 29: (2000 0000) Access level 3 : Service is set (always together with Bit 27 and Bit 28) Bit 30: (4000 0000) No software lock for parameter (only internal used) Bit 31: (8000 0000) No hardware lock for parameter (only internal used)	
1004	03 ; 04	RO	4	2	0.0f			FLOAT	Scattered light	
Actual check cycle control values										
1200	03 ; 04	RO	4	2	0.0f			FLOAT	Zero point calculated during check cycle	%
1208	03 ; 04	RO	4	2	0.0f			FLOAT	Span value calculated during check cycle	%
1216	03 ; 04	RO	4	2	0.0f			FLOAT	Filter value during activated filter mode for measuring control filter	%
Test data and diagnosis data										
2400	03 ; 04 ; 06; 16	RW	2	1	12345			UINT16	Hex value : 0x3039	
2401	03 ; 04; 16	RW	4	2	123456789			UINT32	Hex value : 0x75bcd15	
2403	03 ; 04; 16	RW	4	2	123.45678	R_FMIN	R_FMAX	FLOAT	Hex value : 0x42f6e9df	
2405	03 ; 04;	RO	4	2		0		UINT32	Seconds since start sensor	s
2407	03 ; 04;	RO	4	2	0	0		UINT32	Operation time in hours	h

Additional customer special register

* summery status information										
10000	03 ; 04	RO	2	1	0			UINT16	**Main status** 1 : automatic measurement (sub state reg 10001 = 0) 2 : Auto check cycle (cycle time controlled, not in maintenance state) 5 : maintenance (higher priority as fault) 6 : fault (Failure, malfunction, errors)	
10001	03 ; 04	RO	2	1	0			UINT16	**Sub status** 0 no maintenance and no malfunction ***** for main status maintenance (5) 2 manual calibration ➔ control filter measurement is activ 3 manual modify range ➔ check box in Sopas parameter menue has to be activated 5 Manual cycle active ➔ check cycle started in maintenance with Sopas-command 1 ready for maintenance ➔ Hardware or Software maintenance is activ ***** for main status fault (6) 11 EEPROM hardware access 12 Amplifier not found 13 Overflow meas value 14 Self control 15 Blower 16 Filter measurement, signal too low 17 Laser current 18 Mean light to much 19 Span test error > 2% 20 Monitor value too low 21 Zero point 22 U24V < 18V 23 U24V > 30V 24 U24 hardware control 25 RTC not found 40 Device / values out of spec 45 Maint_Request - EEPROM restored from backup 47 Maint_Request - EEPROM restored from factory setting 48 Maint_Request - Default values 49 Maint_Request - Testmode activ 50 Maint_Request - U24V too low 51 Maint_Request - U24V too high 52 Maint_Request - Laser current 53 Maint_Request - Passwords restored from backup 54 Maint_Request - blower flow too high 55 Maint_Request - internal 56 Maint_Request - blower flow too low 57 Maint_Request - Triggerpoint laser is not adjustable 58 Maint_Request - Analog output (20mA) is deactivated by hardware 59 Maint_Request - meas value can not output with to 4…20mA 60 Maint_Request - Overflow scattered light 70 meas value over limit1 or limit2	
10002	03; 04	RO	4	2	0.0			FLOAT	Dust concentration synchronized with current of analog output control values that means, an output of control values (for instance 15.2 mA for Span1) recalculated in a concentration, which has the same output of 15.2 mA only during during mA-output control values (Span, Zeropoint, Filter value, Test-Current) the concentration will be recalculated, otherwise it's the measured concentration value	mg/m³
* 12 special calculated values for using in various world regions (the same used in MCU with connected sensor)										
10004	03; 04	RO	4	2	0.0			FLOAT	Not used; (*reserved for absolute drift Contamination with other Dusthunter)*	
10006	03; 04	RO	4	2	0.0			FLOAT	Absolute Drift Span1 value calculated during check cycle; see also register 1208 (= new_value – old_value)	%
10008	03; 04	RO	4	2	0.0			FLOAT	Not used; (*reserved for absolute Drift Span2 [%] with other Dusthunter)*	
10010	03; 04	RO	4	2	0.0			FLOAT	Absolute Drift Zero point calculated during check cycle; see also register 1200 (= new_value – old_value)	%

10012	03; 04	RO	4	2	0.0			FLOAT	Set_value_ZeroPoint_mg; referenced to the upper limit of meas range Set_value_ZeroPoint_mg = Set_ZeroPoint[%]/100[%] * Upper_range[mg]	mg/m³
10014	03; 04	RO	4	2	0.0			FLOAT	Linear Correction value K = SetSpan1[%] / Span1 [%] (if no span error)	
10016	03; 04	RO	4	2	0.0			FLOAT	Absolute Correction value B = ZeroPoint[%] / 100[%] * (Upper_range[mg] – Lower_range[mg])	mg/m³
10018	03; 04	RO	4	2	0.0			FLOAT	Span1_mg – measured Control value Span1[%] referenced to meas range Span1_mg = Lower_range[mg] + Span1[%]/100[%] * (Upper_range[mg] – Lower_range[mg])	mg/m³
10020	03; 04	RO	4	2	0.0			FLOAT	*not used; reserved for Span2_mg with other dusthunter*	
10022	03; 04	RO	4	2	0.0			FLOAT	ZeroPoint_mg - measured Control value ZeroPoint[%] referenced to meas range ZeroPoint _mg = Lower_range[mg] + ZeroPoint [%]/100[%] * (Upper_range[mg] – Lower_range[mg])	
10024	03; 04	RO	4	2	0.0			FLOAT	Set_value_Span1_mg – referenced on the upper limit of meas range Set_value_Span1_mg = Set_Span1[%]/100[%] * Upper_range[mg]	mg/m³
10026	03; 04	RO	4	2	0.0			FLOAT	*not used; reserved for Set_value_Span2_mg with other dusthunter*	
* 2 register for start- and end time function check (since restart device)										
10036	03; 04	RO	14	7				STRING14	Start time last function check Y Y Y Y M M D D h h m m s s Read 7 register values (hexadecimal) : 3230 3233 3038 3031 3132 3231 3235 means “2023-08-01 12:21:25”	
10050	03; 04	RO	14	7				STRING14	End time last function check Y Y Y Y M M D D h h m m s s Read 7 register values (hexadecimal) : 3230 3233 3038 3031 3132 3232 3235 means “2023-08-01 12:22:25”	

Actual diagnosis values										
26000	03 ; 04	RO	4	2		0	22	FLOAT	Actual Analog Output	mA
26002	03 ; 04	RO	4	2	4	0	5	FLOAT	Monitor value	V
26004	03 ; 04	RO	4	2		0	100	FLOAT	Laser current	mA
26006	03 ; 04	RO	4	2		0	5	FLOAT	Mean light value	V
26008	03 ; 04	RO	4	2		-40	60	FLOAT	Device temperature	°C
26010	03 ; 04	RO	4	2		15	35	FLOAT	Power supply (24V)	V
26012	03 ; 04	RO	2	1	250	150	250	UI16	Laser output byte	
Saved filter values for control filter measurement										
26013	03 ; 04	RO	4	2	0	0	100	FLOAT	Filter1 value	%
26015	03 ; 04	RO	4	2	0	0	100	FLOAT	Filter2 value	%
26017	03 ; 04	RO	4	2	0	0	100	FLOAT	Filter3 value	%
26019	03 ; 04	RO	4	2	0	0	100	FLOAT	Filter4 value	%
26021	03 ; 04	RO	4	2	0	0	100	FLOAT	Filter5 value	%
Actual values for filter break detection										
26023	03 ; 04	RO	4	2				FLOAT	Dust concentration during filter break detection with own response time (T90) and own limit value	mg/m3
26025	03 ; 04	RO	2	1				UI16	Actual filter bag number since start filter clean cycle (see Reg 27004 or DI4)	
26026	03 ; 04	RO	4	2				UI32	Bit 31…0 referenced to filter bag no. 128…97; if bit equal '1' ==> Filter is broken (concentration above limit value)	
26028	03 ; 04	RO	4	2				UI32	Bit 31…0 referenced to filter bag no. 96…65; if bit equal '1' ==> Filter is broken (concentration above limit value)	
26030	03 ; 04	RO	4	2				UI32	Bit 31…0 referenced to filter bag no. 64…33; if bit equal '1' ==> Filter is broken (concentration above limit value)	
26032	03 ; 04	RO	4	2				UI32	Bit 31…0 referenced to filter bag no. 32…1; if bit equal '1' ==> Filter is broken (concentration above limit value)	
26034	03 ; 04	RO	4	2				F32	Actual filter value [%] if filter mode is On (siehe Reg. 27004)	%

Activate sensor functions										
27000	06	WO	2	1	0	0	1	UINT16	**1 = Maintenance on; 0 = Operation** (the same like activation DI1) ;	
27001	16	RW	4	2	0	0	4	UINT32	Read Access Level 1 = Operator 2 = Auth. Client 3 = Authority 4 = Service Set Access Level : 0 ==> Reset access level to Operator 0x347D339D ==> Set level to Authorized User	
27003	06	WO	2	1	0	0	1	UINT16	**Start CheckCycle** - cannot stop if started! (the same as activation with DI2 in measurement mode) ;	
27004	06	WO	2	1	0	0	1	UINT16	**1 = Start control filter measurement or set reference to 100% ; 0 = End filter mode** (the same as activation with DI2 in maintenance mode) start only in maintenance mode and checkcycle is not active and "Auth.Client" was set with register 27001	
27005	06	WO	2	1	0	0	1	UINT16	**1 = Start a new filter cleaning cycle to detect filter breaks** (if enabled with Sopas ET) (the same as activation DI4); "Auth.Client" was to be set with register 27001 it will be automatically stopped after the last filter bag is detected	
Parameter (write only possible if maintenance set (see Reg 27000) and the corrected Modbus® password to set access level 2 was set (see also Reg 27001) - to see the actual state (Reg 1002)										
28000	03 ; 04 ; 16	RW	4	2	0			FLOAT	cc2 for calibration curve (selection 1)	
28002	03 ; 04 ; 16	RW	4	2	1			FLOAT	cc1 for calibration curve (selection 1)	
28004	03 ; 04 ; 16	RW	4	2	0			FLOAT	cc0 for calibration curve (selection 1)	
28006	03 ; 04 ; 16	RW	4	2	0	0	10000	FLOAT	Lower range : the value of concentration that forces Live Zero output (if selection 1 and meas range not fixed)	mg/m³
28008	03 ; 04 ; 16	RW	4	2	100	0	10000	FLOAT	upper range : the value of concentration that forces Live 20mA output (if selection 1 and meas range not fixed)	mg/m³
28010	03 ; 04 ; 16	RW	4	2	50			FLOAT	Limit value for Concentration (if selection 1 and meas range not fixed)	mg/m³
28012	03 ; 04 ; 16	RW	4	2	0			FLOAT	cc2 for calibration curve (selection 2)	
28014	03 ; 04 ; 16	RW	4	2	1			FLOAT	cc1 for calibration curve (selection 2)	
28016	03 ; 04 ; 16	RW	4	2	0			FLOAT	cc0 for calibration curve (selection 2)	
28018	03 ; 04 ; 16	RW	4	2	0	0	10000	FLOAT	Lower range : the value of concentration that forces Live Zero output (if selection 2 and meas range not fixed)	mg/m³
28020	03 ; 04 ; 16	RW	4	2	100	0	10000	FLOAT	Upper range : the value of concentration that forces Live 20mA output (if selection 2 and meas range not fixed)	mg/m³
28022	03 ; 04 ; 16	RW	4	2	50	0,2		FLOAT	Limit value for Dust Concentration (if selection 2 and meas range not fixed)	mg/m³
28024	03 ; 04 ; 16	RW	4	2	60	0,1	600	FLOAT	Response time for Dust Concentration	s
28026	03 ; 04 ; 06; 16	RW	2	1	480	0	14400	UINT16	0 = internal time controlled start check cycle is off; <"off" ==> expected value [min] =0 > < "T_5_min" ==> expected value [min] =5 > < "T_10_min" ==> expected value [min] =10 > < "T_30_min" ==> expected value [min] =30 > < "T_60_min" ==> expected value [min] =60 > < "T_90_min" ==> expected value [min] =90 > < "T_2_h" ==> expected value [min] =120 > < "T_5_h" ==> expected value [min] =300 > < "T_8_h" ==> expected value [min] =480 > < "T_12_h" ==> expected value [min] =720 > < "T_18_h" ==> expected value [min] =1080 > < "T_24_h" ==> expected value [min] =1440 >	m (=Minutes)
28027	03 ; 04 ; 16	RW	2	1	1	0	1	UINT16	0 = FALSE; 1 = TRUE - Output the control values after function check to analog output	

3.3.3 Additional Register Definition for function code 43 (0x2b)

Reg. Nr.	Supported Function Code			R/W	Name	Counts		Default value or example.	Low	High	Type	Description	Phy. Unit
	01 (0x01) - Read Coils (bit decoding) 03 (0x03) - Read Holding registers 04 (0x04) - Read Input Registers 06 (0x06) - Write Single Register 15 (0x0f) - Write Multiple Coils (bit setting) 16 (0x10) - Write Multiple Registers 43 (0x2b) - Encapsulated Interface Transport					Bytes	Register (1Reg = 2Byte)						
VDI 4201 requests													
FunctionCode_43 "Base_FC43_1"													
	Function Code	for FunctionCode = 43 (0x2b) and MEI-Type 14 (0x0e)											
		Supported ID-Code 0x01 - stream basics 0x02 - stream regular 0x03 - stream extended 0x04 - individual access	Object ID (hex)										
	Basic (ID-Code 01) "												
0	03 ; 04 ; 43	0x01 ; 0x04	0x00	RO	VendorName	32	16	"EHS"			STRING32	VendorName - manufacturer name	
16	03 ; 04 ; 43	0x01 ; 0x04	0x01	RO	ProductCode	32	16	"Sensor_SP"			STRING32	Vorschlag zur Unterscheidung für Modbus®Master, ob Sensor oder IO als Slave angeschlossen ist	
32	03 ; 04 ; 43	0x01 ; 0x04	0x02	RO	MajorMinorRevision	32	16	"00.00.00"			STRING32	MajorMinorRevision - Software version of measuring system	
	Regular (ID-Code 02)												
48	03 ; 04 ; 43	0x02 ; 0x04	0x04	RO	ProductName	32	16	"DH SP30"			STRING32	ProductName - device name	
	Extended (ID-Code 03)												
64	03 ; 04 ; 43	0x03 ; 0x04	0x80	RO	SerialNumber	32	16	"00008700"			STRING32	SerialNumber - serial number of measuring system	
80	03 ; 04 ; 43	0x03 ; 0x04	0x81	RO	ComponentNumber	2	1	2	0	22	UINT16	ComponentNumber - number of measurands	
81	03 ; 04 ; 43	0x03 ; 0x04	0x82	RO	BasisM	2	1	4000			UINT16	BasisM - basic register address of measurand blocks	
82	03 ; 04 ; 43	0x03 ; 0x04	0x83	RO	BasisS	2	1	4200			UINT16	BasisS - basic register address of the simulation data; begins mind. (72*4)=288 Register nach BASE-M	
83	03 ; 04 ; 43	0x03 ; 0x04	0x84	RO	BasisR	2	1	4400			UINT16	BasisR - basic register address of the reference material data; begins mind. (72*4)=288 Register nach BASE-S	
84	03 ; 04 ; 43	0x03 ; 0x04	0x85	RO	Component1_Name	32	16	"Concentration"			STRING32	Component1_Name - name of this measured component	
100	03 ; 04 ; 43	0x03 ; 0x04	0x86	RO	Component1_AO_Lower_range	4	2	0.0			FLOAT	Component1_Range_Start - lower limit of output range of this component	mg/m³
102	03 ; 04 ; 43	0x03 ; 0x04	0x87	RO	Component1_AO_Upper_range	4	2	3000.0			FLOAT	Component1_Range_End - upper limit of output range of this component,	mg/m³
104	03 ; 04 ; 43	0x03 ; 0x04	0x88	RO	Component1_Unit	32	16	"mg/m3"			STRING32	Component1_Unit - unit of this measured component	
120	03 ; 04 ; 43	0x03 ; 0x04	0x89	RO	Component2_Name	32	16	"Scattered light"			STRING32	Component2_Name - name of this measured component	
136	03 ; 04 ; 43	0x03 ; 0x04	0x8a	RO	Component2_AO_Lower_range	4	2	-10000.0			FLOAT	Component2_Range_Start - lower limit of output range of this component	
138	03 ; 04 ; 43	0x03 ; 0x04	0x8b	RO	Component2_AO_Upper_range	4	2	10000.0			FLOAT	Component2_Range_End - upper limit of output range of this component,	
140	03 ; 04 ; 43	0x03 ; 0x04	0x8c	RO	Component2_Unit	32	16	""			STRING32	Component2_Unit - unit of this measured component	

Data like <Measured data "Base_M"> but absolute value (not referenced to range or 10000);											
1000	03 ; 04	RO	Component1_Value	4	2	0.0f			FLOAT	Dust concentration absolut	mg/m³
1002	03 ; 04	RO	Component1_Value_Status	4	2	0			UINT32	status information	
1004	03 ; 04	RO	Component2_Value	4	2	0.0f			FLOAT	Scattered light absolut	
1006	03 ; 04	RO	Component2_Value_Status	4	2	0			UINT32	status information Bit 00: (0000 0001) Failure Bit 01: (0000 0002) Maintenance Bit 02: (0000 0004) Maintenance Request Bit 03: (0000 0008) Out of Spec Bit 04: (0000 0010) Component Simulation_Value active Bit 16: (0001 0000) Test mode active (Test AO and DO with fixe settings) Bit 17: (0002 0000) Check cycle active (determine control value and AO control value) Bit 18: (0004 0000) Filter Mode active Bit 19: (0008 0000) Meas Component hold (during check cycle determine control value) Bit 20: (0010 0000) One Component Value over Limit value Bit 25: (0200 0000) CheckCycle Start enable (No Testmode and no Filter mode active) Bit 26: (0400 0000) FilterMode Start enable (No Test mode and no Checkcycle active) Bit 27: (0800 0000) Access level 2 : Authorized User is set Bit 28: (1000 0000) Access level 3 : Authority is set (always together with Bit 27) Bit 29: (2000 0000) Access level 4 : Service is set (always together with Bit 27 and Bit 28) Bit 30: (4000 0000) No software lock for parameter (Korea-Mode not active) Bit 31: (8000 0000) No hardware lock for parameter (no fixed parameter settings by hard-ware jumper)	
Drift / Reference points											
1200	03 ; 04	RO	RP1_ActualValue	4	2	0.0f			FLOAT	Zero point absolut	%
1202	03 ; 04	RO	RP1_SetPoint	4	2	0.0f			FLOAT	Zero point set value	%
1204	03 ; 04	RO	RP1_Timestamp	4	2	0			UINT32		
1206	03 ; 04	RO	RP1_ReferenceTyp	2	1	0x0008			UINT16	Bit3=1 ==>Typ: zero point	
1207	03 ; 04	RO	RP1_Component number	2	1	1			UINT16	Reference to concentration	
1208	03 ; 04	RO	RP2_ActualValue	4	2	0.0f			FLOAT	Span absolut	%
1210	03 ; 04	RO	RP2_SetPoint	4	2	70.0f			FLOAT	Span set value	%
1212	03 ; 04	RO	RP2_Timestamp	4	2	0			UINT32		
1214	03 ; 04	RO	RP2_ReferenceTyp	2	1	0x0010			UINT16	Bit4=1 ==>Typ: reference point	
1215	03 ; 04	RO	RP2_Component number	2	1	1			UINT16	Reference to concentration	
1216	03 ; 04	RO	RP3_ActualValue	4	2	0.0f			FLOAT	Filter value absolute during control filter measurement is active (see also Reference material Bit04/05)	%
1218	03 ; 04	RO	RP3_SetPoint	4	2	0.0f			FLOAT	not used	%
1220	03 ; 04	RO	RP3_Timestamp	4	2	0			UINT32		
1222	03 ; 04	RO	RP3_ReferenceTyp	2	1	0x0001			UINT16	Bit0=1 ==>Typ: externe reference	
1223	03 ; 04	RO	RP3_Component number	2	1	2			UINT16	Reference to scattered light	
Diagnosis-and system data											
2400	03 ; 04 ; 06; 16	RW	ui16TestValue	2	1	12345	0	0	UINT16	0x3039	
2401	03 ; 04; 16	RW	ui32TestValue	4	2	123456789	0	0	UINT32	0x75bcd15	
2403	03 ; 04; 16	RW	fTestValue	4	2	123.45678	R_FMIN	R_FMAX	FLOAT	0x42f6e9df	
2405	03 ; 04;	RO	Current date and time	4	2				UINT32	Seconds since start sensor (no real time clock exist)	
2407	03 ; 04;	RO	Operating hours	4	2	0	0		UINT32	Number of working hours since factoring (will be increased after every 60 minutes of work-ing after start)	

Measured data "Base_M"										Value = Value_actual / (upper_range - Lower_range) *10000	
4000	03 ; 04	RO	Dust concentration	4	2	0.0f	0.0f	0.0f	FLOAT	referenced to range and -10000…+10000	
4002	03 ; 04	RO	Dust concentration Status	4	2	0	0	0	UINT32	status information	
4004	03 ; 04	RO	Scattered light	4	2	0.0f	0.0f	0.0f	FLOAT	referenced to range and -10000…+10000	
4006	03 ; 04	RO	Scattered light Status	4	2	0	0	0	UINT32	status information	

Simulation data "Base_S"										Simulation value (referenced to range and -10000…+10000)	
4200	03; 04; 16	RW	concentration_Simulation_Value	4	2	0.0f	0.0f	0.0f	FLOAT	Concentration_actual = concentration_Simulation_Value * 10000	
4202	03 ; 04 ; 16	RW	concentration_Simulation_Request	4	2	0	0	0	UINT32	System : 0x01 = Err; 0x02 = Maint; Componente1_Status : 0x10 = Test/Simulation	
4204	03; 04; 16	RW	Scattered light_Simulation_Value	4	2	0.0f	0.0f	0.0f	FLOAT	ScatteredLight_actual = Scattered light_Simulation_Value * 10000	
4206	03 ; 04 ; 16	RW	Scattered light_Simulation_Request	4	2	0	0	0	UINT32	System : 0x01 = Err; 0x02 = Maint; Componente2_Status : 0x10 = Test/Simulation	

Reference material "Base_R"											
4400	03 ; 04	RO	Material_Status	4	2	0	0	0	UINT32	Meaning of the Bits **Check cycle :** *Bit 00: (0000 0001) CheckCycle active -meas contamination (not used in this sensor)* Bit 01: (0000 0002) CheckCycle active - Measuring or AO-output of Zero Point Bit 02: (0000 0004) CheckCycle active -Measuring or AO-output of Span1 (70%-value) *Bit 03: (0000 0008) CheckCycle active -Measuring or AO-output of Span2 (50%-value; not used in this sensor)* **Linearity control filter measurement:** Bit 04: (0000 0010) control filter measurement active Bit 05: (0000 0020) control filter value output on AO **Filter break monitoring during filter clean cycle :** Bit 06: (0000 0040) Filter break monitoring is active **Output reference material on AO :** Bit 07: (0000 0080) Output reference material on AO (Check value or filter value) Remark: If check cycle is running, one of the Bits 00-03 is set	
4402	03 ; 06 ; 16	WO	Material_Initiate	4	2	0	0	0	UINT32	**Check cycle :** Bit 01: (0000 0002) Start CheckCycle Bit 02: (0000 0004) Start CheckCycle If check cycle is started , it is not possible to stop it manual ! **Linearity control filter measurement:** Bit 04 : (0000 0010) Start control filter measurement or set the actual value to 100% Bit 04/05: (0000 0030) Send the actual filter value to AO (snap shot) Start control filter measurement only in maintenance and check cycle is off. It can be finished with Bit 04 = 0 or reset maintenance The filter value for analog output is scaled : (0...100% ==> LZ...20mA) and will be frozen up to the next Initiate **Filter break monitoring during filter cleaning cycle :** Bit 06: (0000 0040) like DI2 - Restart filter break monitoring (if enabled) - all filter numbers are set to ok	