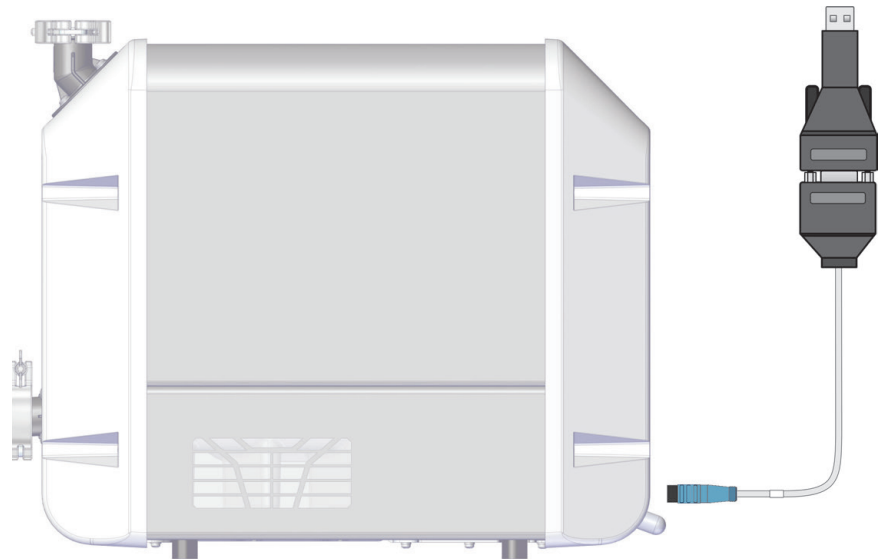




Technology for Vacuum Systems

INTERFACE VACUU·PURE

Modbus RTU



Instructions for use



Original instructions Keep for further use!

This manual is only to be used and distributed in its complete and original form. It is strictly the user's responsibility to carefully check the validity of this manual with respect to the product.

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*Thank you for purchasing this product from **VACUUBRAND GMBH + CO KG**. You have chosen a modern and technically high quality product.*

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1 Introduction

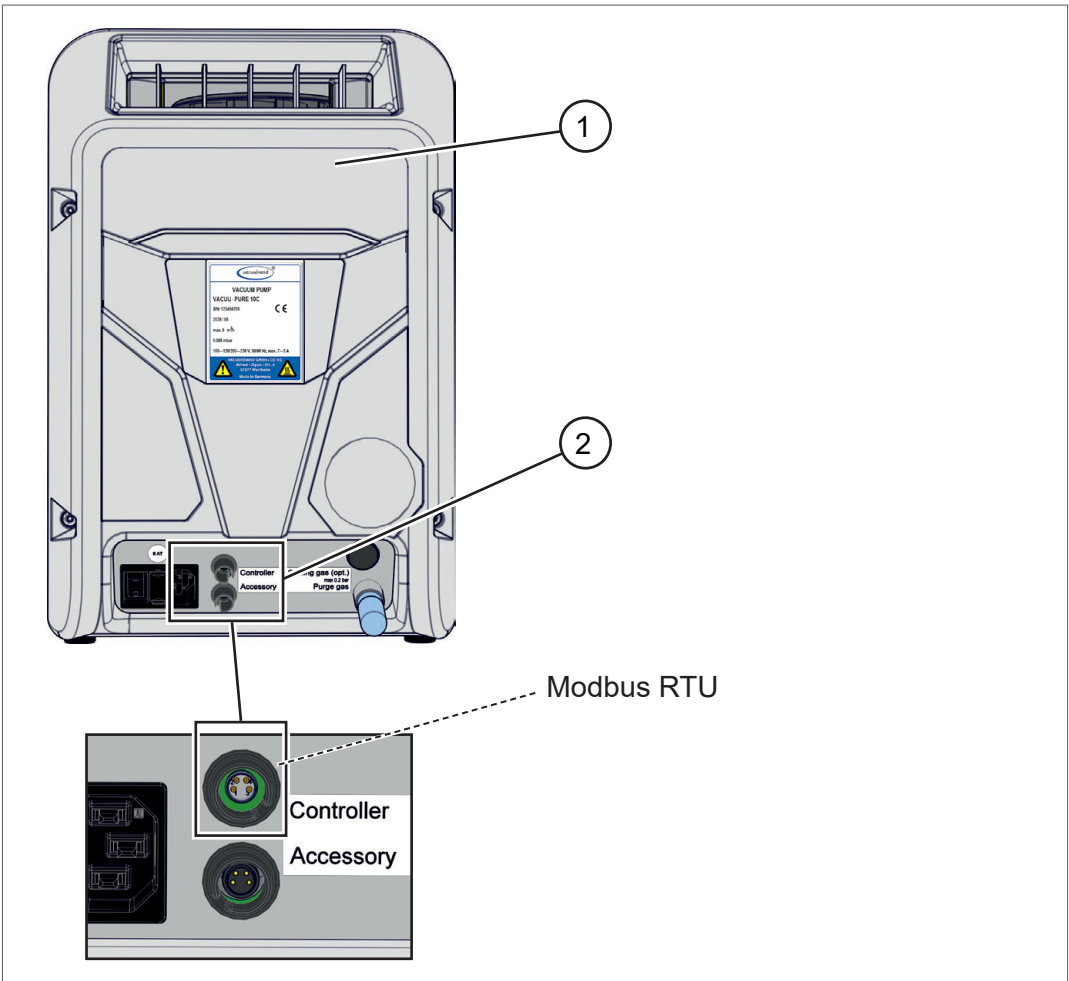
This document describes the general aspects of the communications protocols for Modbus RTU with **VACUU·PURE**® vacuum pumps.

1.1 Remote control and interfaces

Communication with the vacuum pump is supported by Modbus RTU. This enables you to remotely monitor and control the vacuum pump from a central location, for example directly with a PC or via a PLC in a process control system with a host computer.

VACUU·PURE interface

Figure
Cut-on showing
interface for Modbus
RTU



Description

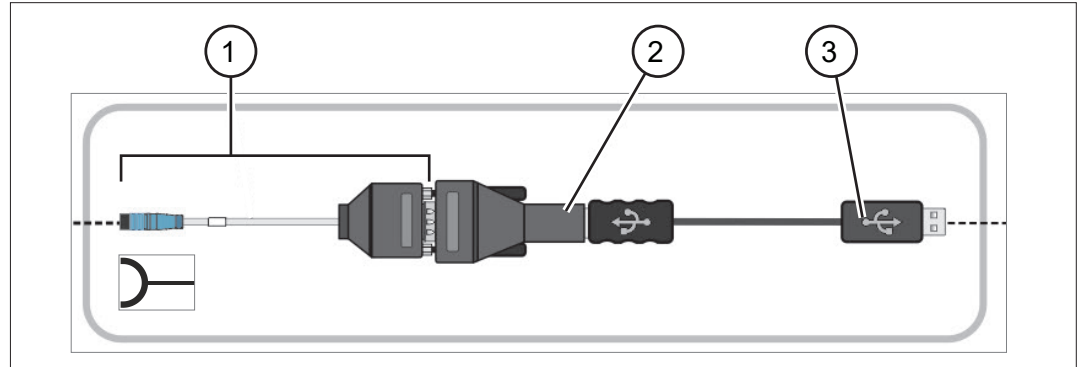
- 1 Rear view of VACUU·PURE vacuum pump
- 2 VACUU·BUS plug-in port: Modbus RTU

1.2 Communication kit

A communication cable is provided in the "Communication kit" (order number #20683230) for connecting the vacuum pump to the host computer, laptop or PLC.

VACUU·PURE communication cable

Figure
Communication cable
from communication kit



Description

- | | |
|---|---|
| 1 | VACUU·BUS socket with cable and RS-485 adapter (SUB-D 9pin, socket) |
| 2 | RS-485 / USB-A adapter |
| 3 | USB-A extension cable |

1.3 Abbreviations

Abbreviations

RTU	Remote Terminal Unit
RO	Read only
RW	Read / write
NA	No access
NaN	Not a number
ID	Identification number, e.g., of the connected vacuum pump(s)
VS-C	Vacuum sensor for rough vacuum range = atmospheric pressure – 1 mbar (atmospheric pressure – 0.75 Torr); e.g., VACUU·SELECT sensor, VACUU·VIEW, VSK 3000
VS-P	Vacuum sensor for fine vacuum range = 1 mbar – 0.001 mbar (0.75 Torr – 0.00075 Torr); e.g., VACUU·VIEW extended, VSP 3000
s	Seconds
PLC	Programmable logic controller
LSB	Least significant bit – bit with the lowest value
MSB	Most significant bit – bit with the highest value
min	Minutes
h	Hours
e.g.	For example

1.4 Target group description

IMPORTANT!

It is the operator's responsibility to apportion tasks according to the areas of competence and relevant qualifications listed in the *Responsibility matrix*.

Personnel qualification

Meaning Personnel qualification

Laboratory technician	Laboratory staff with professional qualification in the use of laboratory equipment and knowledge of applications and processes, as well as possible effects of remote access.
Electrician	Person with professional qualification in electrical, plant & control engineering.
IT expert	System technician in charge of network engineering, network administration and measures for network security and maintenance on the operator's side.

Responsibility matrix

Responsibility matrix and areas of competence

Activity	Laboratory technician	Electrician	IT expert
Connection of interface to vacuum pump	x	x	---
Connection to PLC	---	x	---
Connection to computer	x	x	x
Reconfiguration* after loading the factory settings	x	x	x
Troubleshooting	x	x	x
Operation	x	---	---
Remote control of vacuum pump	x	---	---
Advanced operation	x	---	---
Error report	x	x	x
Remedy	x	---	(x)
Responsibility for process security** during remote access	x	---	---

* Interface settings.

** Data transfer with Modbus RTU is not encrypted.

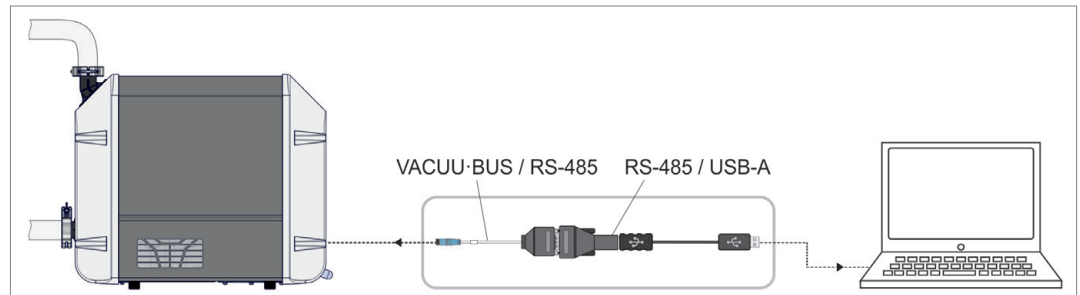
2 Modbus RTU

Modbus RTU is a communications protocol for communication with programmable logic controllers. For remote control via Modbus RTU, use the upper VACUU·BUS port at the back of the vacuum pump. A communication kit is provided as a communication adapter → see chapter: **1.2 Communication kit on page 6**.

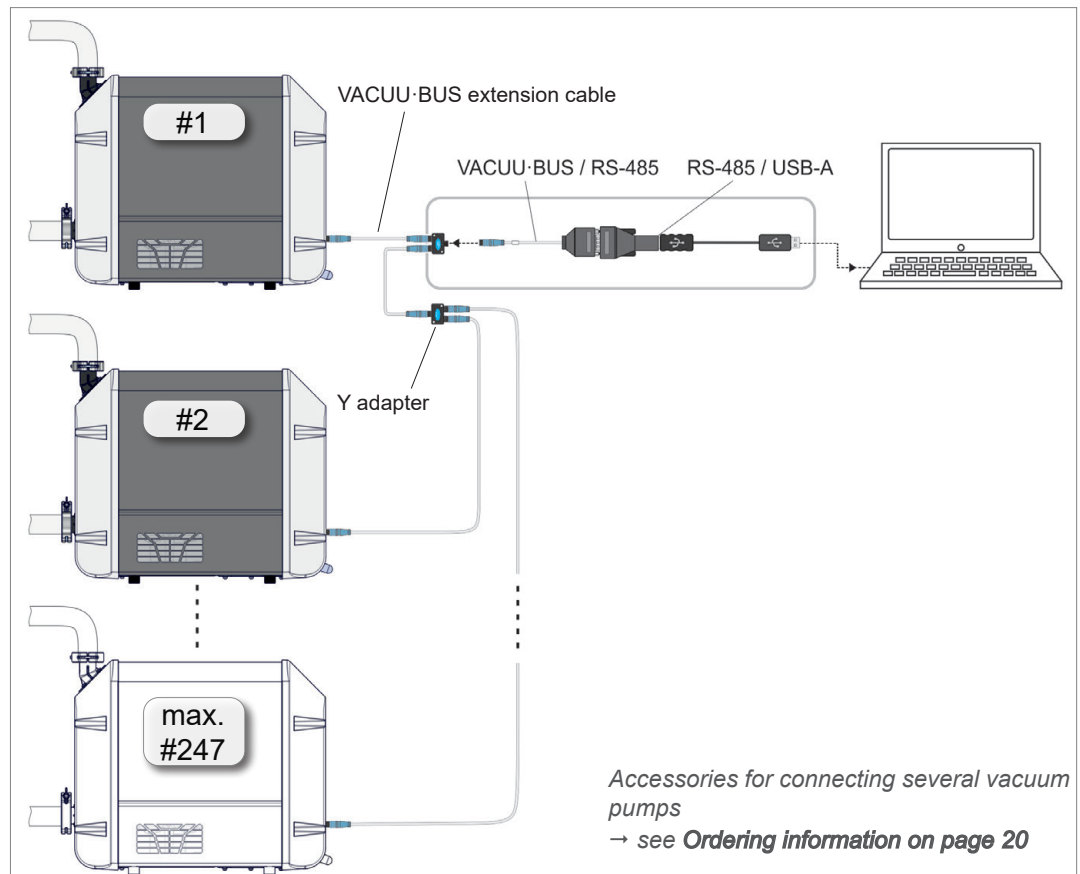
2.1 Modbus communication

2.1.1 Connection examples

→ Example
Vacuum pump with
Modbus RTU



→ Example
Several vacuum pumps
with Modbus RTU

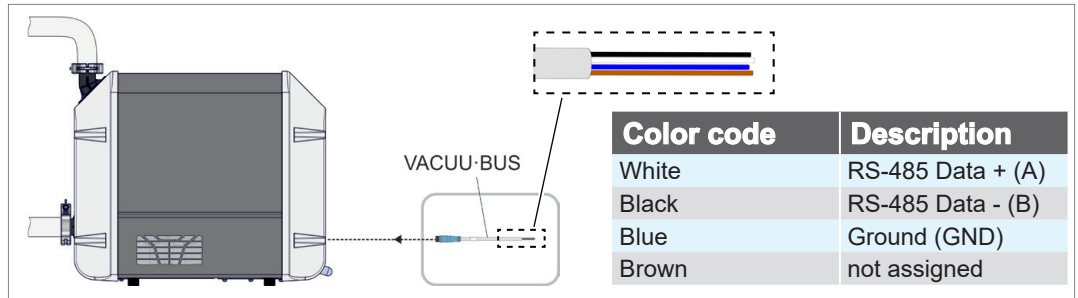


IMPORTANT!

When connecting several vacuum pumps via Modbus RTU, each vacuum pump must be assigned a unique address.

→ See register #40007 in chapter: **2.3.1 Common Model on page 13**

→ Example
Vacuum pump
connected directly to
PLC



2.1.2 Interface parameters

Modbus RTU default settings

Modbus RTU
communication settings

Important default settings relevant for Modbus RTU are as follows:

- Baud rate (19200)
- Number of data bits (8)
- Number of stop bits (1)
- Parity (none)
- Device address (default setting: 1; setting range: 1 – 247)

2.1.3 Supported function codes

Supported
function codes

Code	Description
03 (0x03)	Read Holding Registers For reading single or multiple successive register values.
06 (0x06)	Write Single Holding Register Exclusively for writing single register values (data types int16, uint16, enum16). If several registers are merged into a larger data type (e.g., int32, uint32, string, float32, or p), function code 16 must be used for writing. Overview of supported data types → <i>see chapter 2.1.4 Defined data types.</i>
16 (0x10)	Write Multiple Holding Registers For writing multiple successive registers that are merged into a larger data type or which require consistent adjustment → <i>see chapter 2.2 Representation of pressure values.</i>

2.1.4 Defined data types

Defined data types

The available Modbus registers described in chapter **2.3 Modbus Register Mapping** are based on the data types listed below. If certain functions are not supported by the vacuum pump, the associated Modbus registers are assigned NaN values.

Each individual 16-bit register is represented in little endian byte order. For 32-bit data types consisting of two 16-bit registers, the lower register address represents the least significant part of the entire data type.

Data types composed of more than one Modbus register must be written with function code 16 → *see chapter 2.1.3 Supported function codes.*

Modbus data types and NaN values

Type	Description	NaN value
int16	Signed Integer Value (16 bit)	0x8000
int32	Signed Integer Value (32 bit)	0x80000000
uint16	Unsigned Integer Value (16 bit)	0xFFFF
uint32	Unsigned Integer Value (32 bit)	0xFFFFFFFF
float32	Floating-point number, simple accuracy, IEEE-754 (32 bit)	0xFFFFFFFF
enum16	Number code (16 bit). The breakdown of the possible codes can be accessed directly in the relevant Modbus registers.	0xFFFF
string	String (multiples of 2 bytes). A character string ending in zero or a value of fixed length. The possible values are listed in the description of the respective Modbus register in section xy.	0x0000
p	Representation of pressure values as floating-point numbers or integers. For more information → <i>see section 2.2 Representation of pressure values.</i>	<i>see 2.2</i>

Communication examples

The following tables show examples of Modbus RTU read and write sequences.

IMPORTANT!

To ensure reliable device operation, a pause time of at least 250 milliseconds must be observed between two consecutive commands.

All settings adjusted by means of write commands are permanently saved by the pump.

Read

In the *Read* example, three registers are read from base register #40406 using function code 03.

Start	Master Request ADU					End
≥ 3.5 Character Times Pause	Address	PDU			Check	≥ 3.5 Character Times Pause
	Slave Address*	Function Code	Data		CRC	
			Starting Address	Qty. of Registers		
0x 01	0x 03	0x 9D D6	0x 00 03	0x CB 9F		

Start	Slave Response ADU					End
≥ 3.5 Character Times Pause	Address	PDU			Check	≥ 3.5 Character Times Pause
	Slave Address*	Function Code	Data		CRC	
			Starting Address	Qty. of Registers		
0x 01	0x 03	0x 06	0x 30 CD 00 F8 00 BF	0x C9 14		

Write (single register)

In the *Write* example, register #40402 is written using function code 06, e.g., to start or stop the vacuum pump.

Start	Master Request ADU					End
≥ 3.5 Character Times Pause	Address	PDU			Check	≥ 3.5 Character Times Pause
	Slave Address*	Function Code	Data		CRC	
			Register Address	Qty. of Registers		
0x 01	0x 06	0x 9D D2	0x 00 01		0x C7 9F	

Start	Slave Response ADU					End
≥ 3.5 Character Times Pause	Address	PDU			Check	≥ 3.5 Character Times Pause
	Slave Address*	Function Code	Data		CRC	
			Register Address	Qty. of Registers		
0x 01	0x 06	0x 9D D2	0x 00 01		0x C7 9F	

Write (multiple registers)

The *Write multiple* example shows a maintenance interval being reset using function code 16 (Modbus registers #41312 to #41313) → see chapter 2.3 *Modbus Register Mapping*.

Start	Master Request ADU							End
≥ 3.5 Character Times Pause	Address	PDU					Check	≥ 3.5 Character Times Pause
	Slave Address*	Function Code	Data				CRC	
			Starting Address	Qty. of REGIS- ters	Byte Count	Register Values		
0x 01	0x 10	0x A1 60	0x 00 02	0x 04	0x 00 00 00 00		0x 00 10	

Start	Slave Response ADU					End
≥ 3.5 Character Times Pause	Address	PDU			Check	≥ 3.5 Character Times Pause
	Slave Address*	Function Code	Data		CRC	
			Starting Address	Qty. of Registers		
0x 01	0x 10	0x A1 60	0x 00 02		0x 62 2A	

*) The device address is set by default to 1 and can be changed via register #40007.

2.2 Representation of pressure values

Representation of
pressure values

Pressure values, such as set and actual pressures, can be represented either with floating point arithmetic or with integer values → *see Modbus register #40511*. In the data models → *see chapter 2.3 Modbus Register Mapping*, a pressure value always occupies three Modbus registers, which are assigned differently depending on the selected representation.

Integer representation (factory setting)

Integer representation
(factory setting)

The values are represented with a mantissa (uint32) and a signed exponent (int16). A pressure value is obtained with the following calculation formula:

$$\text{Pressure value} = \text{mantissa} * 10^{\text{exponent}}$$

Examples: $123 * 10^{-3} = 0.123 \text{ mbar}$
 $500 * 10^0 = 500 \text{ mbar}$

Register	Assignment	Data type
0	Mantissa	uint32
1		
2	Exponent	int16

Floating-point representation

Floating-point
representation

The value is represented as float32. Only two of the three registers are used in this version. Read commands must be executed accordingly on the first two registers.

Register	Assignment	Data type
0	Pressure value	float32
1		
2	---	---

2.3 Modbus Register Mapping

2.3.1 Common Model

Address	Size	Name	Data type	Description	Access
40000	4	VACUUBUS_ID	string(8)	VACUU·BUS Modbus identifier. Unique identifier for a VACUU·BUS Modbus register map. Fixed value = "VACUUBUS" (0x564143555425553)	RO
40004	1	VACUUBUS_MID	uint16	VACUU·BUS Modbus model block identifier. Unique identifier for the VACUU·BUS Modbus common model block. Fixed value = 0x0001	RO
40005	1	VACUUBUS_Length	uint16	Length of the block in 16-bit registers. Value = 18	RO
40006	1	Protocol Version	uint16	VACUU·BUS Modbus protocol version	RO
40007	1	Device Address	uint16	Unique device address or Modbus unit ID	RW
40008	1	Manufacturer ID	enum16	Device manufacturer ID. Possible values: 1 = VACUUBRAND GMBH + CO KG	RO
40009	1	Product ID	enum16	Product ID*. Possible values: 5 = VACUU·PURE	RO
40010	10	Serial Number	string(20)	Device serial number	RO
40020	1	Software Version #1	uint16	Device software version The software version of the device, displayed as an integer. Examples: V1.00 = 0x0064 V2.34 = 0x00EA	RO
40021	1	Hardware Version #1	uint16	Device hardware version The MSB displays a letter of the alphabet and represents the board layout revision. The LSB specifies the equipment version. Examples: A.01 = 0x0101 D.12 = 0x040C	RO
40022	1	Software Version #2**	uint16	See description of #40020	RO
40023	1	Hardware Version #2**	uint16	See description of #40021	RO

* Product ID legend – common model is found in all VACUUBRAND Modbus-enabled devices. Only the ID of the connected product is displayed.

** 2x as the common model is intended to be universal for multiple and future devices.

2.3.2 Operation model

Address	Size	Name	Data type	Description	Access
40400	1	VACUUBUS_MID	uint16	VACUUBUS Modbus model block identifier. Unique identifier for the model block operation vacuum pump.	RO
40401	1	VACUUBUS_Length	uint16	Length of the block in 16-bit registers. Value = 9	RO
40402	1	Pump Operating State	enum16	Current pump operating state. Possible values: 0 = stop 1 = start 2 = regeneration	RW
40403	2	Pump Operating State Information	uint32	Information on the current operating state of the system. This bit field contains the following data: Warnings*	RO
40403	2	Pump Operating State Information	uint32	Information on the current operating state of the system. This bit field contains the following data: Errors*	RO
40405	1	Remote Control Mode	enum16	Remote control mode. Possible values: 0 = control panel unlocked 1 = control panel locked 2 = control panel locked, except for STOP button	RW
40406	1	Actual Speed	uint16	Actual speed [rpm]	RO
40407	1	Temperature Bearing Shield	uint16	Temperature on the bearing plate [°C]. Needs to be multiplied by the scaling factor 10 ⁻¹ .	RO
40408	1	Motor Power	uint16	Apparent motor power [VA]	RO
40409	1	Autostart Enable Mode	enum16	Autostart activation mode (continue with last operating mode after switching on). Possible values: 0 = deactivated 1 = activated	RW
40410	1	Regeneration mode Active Time	uint16	Regeneration mode duration. Possible values: 0 = unlimited 1 – 3600 = pre-defined time [s]	RW

*A warning with bit 0 starts with 1x flash signal, bit 1 with 2x flash signals, bit 2 with 3x flash signals, etc. An error with bit 16 starts with 1x flash signal, bit 17 with 2x flash signals, bit 18 with 3x flash signals, etc. For a text display of the warnings and errors, see the causes of the corresponding errors in the vacuum pump manual.

2.3.3 Accessory model

Address	Size	Name	Data type	Description	Access
40500	1	VACUUBUS_MID	uint16	VACUUBUS Modbus model block identifier. Unique identifier for the model block vacuum pump accessories. Value = 0x0006	RO
40501	1	VACUUBUS_Length	uint16	Length of the block in 16-bit registers. Value = 34	RO
40502	2	Accessory Connection Information	uint32	Information on the connected accessory. The bit field contains the following data: Bits 0:3 = in-line solenoid valve 1-4 Bits 4:7 = coolant valve 1-4 Bits 8:11 = level sensor 1-4 Bits 12:15 = vacuum sensor (ceramic) VS-C 1-4 Bits 16:19 = vacuum sensor (Pirani) VS-P 1-4 Bits 20:31 = reserved	RO
40504	2	Accessory Warning State Information	uint32	Warning status of connected accessory. This bit field contains information on pending warnings (bit set). The allocation corresponds to that of #40502.	RO
40506	2	Accessory Error State Information	uint32	Error status of connected accessory. This bit field contains information on pending errors (bit set). The allocation corresponds to that of #40502.	RO
40508	1	Delay Time of Coolant Valves	uint16	Coolant valve delay time [s]. Possible values: 0 – 3600	RW
40509	1	Delay Time of Liquid Level Sensors	uint16	Level sensor delay time [s]. Possible values: 0 – 3600	RW
40510	1	Delay Time of Inlet Valves	uint16	In-line solenoid valve delay time [s]**. Possible values: 0 – 3600	RW
40511	1	Data Type of Pressure Values	enum16	Data type pressure values*. Possible values: 0 = integer (mantissa + exponent) 1 = floating point	RW
40512	3	Sensor Value VS-C 1	p	Vacuum sensor VS-C 1, current pressure value* [mbar]	RO
40515	3	Sensor Value VS-C 2	p	Vacuum sensor VS-C 2, current pressure value* [mbar]	RO
40518	3	Sensor Value VS-C 3	p	Vacuum sensor VS-C 3, current pressure value* [mbar]	RO
40521	3	Sensor Value VS-C 4	p	Vacuum sensor VS-C 4, current pressure value* [mbar]	RO
40524	3	Sensor Value VS-P 1	p	Vacuum sensor VS-P 1, current pressure value* [mbar]	RO
40527	3	Sensor Value VS-P 2	p	Vacuum sensor VS-P 2, current pressure value* [mbar]	RO
40530	3	Sensor Value VS-P 3	p	Vacuum sensor VS-P 3, current pressure value* [mbar]	RO
40533	3	Sensor Value VS-P 4	p	Vacuum sensor VS-P 4, current pressure value* [mbar]	RO

* → For settings, see section **2.2 Representation of pressure values**

** The delay time is only active when transitioning to start mode.

2.3.4 Service Model

Address	Size	Name	Data type	Description	Access
41300	1	VACUUBUS_MID	uint16	VACUU·BUS Modbus model block identifier. Unique identifier for the VACUU·BUS Modbus service model block. Fixed value = 0x000E	RO
41301	1	VACUUBUS_Length	uint16	Length of the block in 16-bit registers. Value = 32	RO
41302	2	Pump Up Time	uint32	Pump operating time since it was switched on [min].	RO
41304	2	Pump Operating Time Total	uint32	Pump operating time, total [min].	RO
41306	2	Pump Operating Time Start	uint32	Pump operating time in start mode [min].	RO
41308	2	Pump Operating Time Regeneration	uint32	Pump operating time in regeneration mode [min].	RO
41310	2	Pump Last Service Time	uint32	Pump operating time (sum of start and regeneration) since last maintenance [min].	RO
41312	2	Pump Service Interval Counter	uint32	Pump operating time (sum of start and regeneration) since last maintenance [min]. Writing the value 0 automatically sets the time of the last maintenance activity (see #41310).	RW
41314	1	Number of Errors Appeared	uint16	Number of errors that occurred. The last 30 errors are stored (see #41315 to #41320).	RO
41315	1	Error Log Entry: Read Index	uint16	Specifies the index that should be read from the saved error log. Possible values: 0–29 or 0xFFFF to call up the latest error log.	RW
41316	1	Error Log Entry: Number	uint16	Consecutive number error log entry.*	RO
41317	1	Error Log Entry: Code	uint16	Error code. For possible values see #40403*	RO
41318	2	Error Log Entry: Operating Time	uint32	Total operating time of the pump when error occurs [min].*	RO
41320	2	Error Log Entry: Up Time	uint32	Duty cycle (= current runtime) when error occurs [min].*	RO
41322	1	Number of Warnings Appeared	uint16	Number of warnings that occurred. The last 30 warnings are saved (see #41323 to #41328).	RO
41323	1	Warning Log Entry: Read Index	uint16	Specifies the index that should be read from the saved warning log. Possible values: 0 – 29 or 0xFFFF to call up the latest warning log.	RW
41324	1	Warning Log Entry: Number	uint16	Consecutive number warning log entry.*	RO
41325	1	Warning Log Entry: Code	uint16	Warning code. For possible values see #40403*	RO
41326	2	Warning Log Entry: Operating Time	uint32	Total operating time of the pump when warning occurs [min].*	RO
41328	2	Warning Log Entry: Up Time	uint32	Duty cycle (= current runtime) when warning occurs [min].*	RO

41330	1	Error Count: Read Index	uint16	Specifies the error code whose occurrence should be displayed (see #40404). Possible values: 0 – 6	RW
41331	1	Error Count: Value	uint16	Total number of occurrences of the specified error (see #41330).*	RO
41332	1	Warning Count: Read Index	uint16	Specifies the index that should be read from the saved warning log. Possible values: 0 – 6	RW
41333	1	Warning Count: Value	uint16	Total number of occurrences of the specified warning (see #41332).*	RO

* The relevant read index must be rewritten to update the data.

2.4 Sample application

Activate remote control

Application example

Address	Value	Description
40405	1	<i>Remote Control Mode</i> Control panel locked
40405	2	<i>Remote Control Mode</i> Control panel locked, except STOP

Start the pump

Address	Value	Description
40402	1	<i>Pump Operating State</i> Start the pump

Activate regeneration mode

Address	Value	Description
40405	2	<i>Pump Operating State</i> Set pump to regeneration mode. By default, regeneration mode ends automatically after 60 minutes. The pump is then in STOP.

Stop the pump

Address	Value	Description
40405	0	<i>Pump Operating State</i> Stop the pump

Deactivate remote control

Address	Value	Description
40405	0	<i>Remote Control Mode</i> Control panel unlocked

While the process is running, the following Modbus registers can for example serve to monitor the process flow:

Address	Description
40402	<i>Pump Operating State</i> Current operating state of the pump
40403	<i>Pump Warning State Information</i> Pump warnings
40404	<i>Pump Error State Information</i> Pump errors
40406	<i>Actual Speed [rpm]</i> Current speed of the pump

Application example

40407	<i>Temperature Bearing Shield [°C 10]</i> * Current temperature at the bearing plate
40408	<i>Motor Power [VA]</i> Current apparent power consumption of the motor

* Actual temperature is indicated value divided by 10.

3 Service

Technical support

Service contact For technical assistance, please contact our [Service Department](#)¹.

Ordering information

Ordering information for accessories

Accessories	Order no.
Communication kit	20683230
VACUU·BUS Y adapter	20612875
Extension cable VACUU·BUS, 0.5 m	20612875
Extension cable VACUU·BUS, 2 m	20612552
Extension cable VACUU·BUS, 5 m	20612931
Extension cable VACUU·BUS, 10 m	22618493
Connection cable VACUU·BUS (plug and wire end ferrules), 2 m	20612586

Sources of supply

International sales offices and distribution

Purchase original accessories and original spare parts from a subsidiary of **VACUUBRAND GMBH + CO KG** or your local distributor.



- ⇒ Information about our complete product range is available in the current [product catalog](#).
- ⇒ Your local distributor or **VACUUBRAND GMBH + CO KG** [sales office](#) is available to assist you with orders, questions on vacuum control and optimal accessories.

¹ -> Phone: +49 9342 808-5660, fax: +49 9342 808-5555, service@vacuubrand.com

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Technology for Vacuum Systems

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