Modbus Interface Description

VAV-Universal
VRU-D3-BAC
VRU-M1-BAC
VRU-M1R-BAC

Controller for VAV/CAV and pressure applications

Edition 2024-12 / V1.04

BELIMO

Contents

Modbus general notes

General information

Date	19.08.2022
Product Name	VAV-Universal
Protocol	Modbus RTU over RS-485

Modbus RTU

Transmission Formats	1-8-N-2, 1-8-N-1, 1-8-E-1, 1-8-O-1 (Default: 1-8-N-2)
Baud Rates	9'600, 19'200, 38'400, 76'800, 115'200 Bd (Default: 38'400)
Address	1...247 (Default: 1)
Number of Nodes	Max. 32 (without repeater)
Terminating Resistor	120 Ω

Parametrisation

Tool	Belimo Assistant 2

Register implementation

All data is arranged in a table and addressed by 1..n (Register No.) or 0..n-1 (Address). No distinction is made between data types (Discrete Inputs, Coils, Input Registers and Holding Registers). As a consequence, all data can be accessed with the two commands for Holding Register. The commands for Discrete Inputs and Input Registers can be used as an alternative.

Supported commands

Read Holding Registers	[3]
Write Single Register	[6]
Read Discrete Inputs	[2]
Read Input Registers	[4]
Write Multiple Registers	[16]

Command “Read Discrete Inputs”

The command reads one or more bits and can alternatively be used for Register No. 105 (Malfunction and Service Information).

Example:

The start address to be used is 1664 -> **104** (Register Address) *** 16** (Bit) = **1664**

Interpret values in the registers

All values in the register are unsigned integer data types.
Exceptions are marked with ***)**. Signed integers are represented as two´s complement.

Example unsigned integer:	Example signed integer:
Read (Function 03, 1 Register) Value Register No. x = 0001 1010 1100 1000_2 = $6{,}856_{10}$	Read (Function 03, 1 Register) Value Register No. x = 1111 1101 1111 0010_2 = -562_{10}
Actual value = value * scaling factor * unit = 6,856 * 0.01 * unit = **68.56 unit**	Actual value = value * scaling factor * unit = -526 * 0.01 * unit = **-5.26 unit**

32-bit values in two registers

Values that exceed 65,535 are stored in two consecutive registers and have to be interpreted as "little endian byte swap" / LSW (Least Significant Word) first.

Note: While the regular "little endian" interpretation refers to the each Byte (8 bit Word) per register, the additional "byte swap" interpretation leads to where "little endian" refers to the 16 bit word of one register.

Both registers have to be written at once with function „Write Multiple Registers [16]". It cannot be written together with other registers.

Example:

Register No. x (AbsFlow LowWord)	Register No. x + 1 (AbsFlow HighWord)
= $14{,}551_{10}$	= 19_{10}
= $0011\ 1000\ 1101\ 0111_2$	= $0000\ 0000\ 0001\ 0011_2$

AbsFlow LowWord	**AbsFlow HighWord**
= 14,551	= 19
= $0011\ 1000\ 1101\ 0111_2$	= $0000\ 0000\ 0001\ 0011_2$

AbsFlow
= $0000\ 0000\ 0001\ 0011\ 0011\ 1000\ 1101\ 0111_2$
= $1{,}259{,}735_{10}$
= **1,259.735 unit**

Math formula:

AbsFlow = (AbsFlow HighWord * 65,536) + AbsFlow LowWord
AbsFlow = (19 * 65,536) + 14,551
= 1,259,735
= **1,259.735 unit**

Deactivated registers

If a register is not supported by a device or by a device setting, this is indicated by 65,535 ($1111\ 1111\ 1111\ 1111_2$).

Modbus register overview

Operation

No.	Address	Register		Access
1	0	Setpoint [%]		R / W
2	1	Override Control		R / W
3	2	Command		R / W
4	3	Actuator Type		R
5	4	Relative Position [%]		R
6	5	Absolute Position [°] [mm]		R
7	6	Relative Volumetric Flow [%]		R
8	7	Absolute Volumetric Flow [m3/h]		R
9	8	Sensor Value 1 [mV] [Ω] [-]		R
10	9	–		–
11	10	Absolute Volumetric Flow in selected units	LowWord	R
12	11		HighWord	
13	12	Analog Setpoint [%]		R
..	..	–		–
51	50	Relative Delta Pressure [%]		
52	51	Absolute Delta Pressure [Pa] **)		
53	52	–		–
54	53	Absolut Delta Pressure in selected units **)	LowWord	R
55	54		HighWord	

**) signed integer

Service

No.	Address	Register		Access
100	99	Bus Termination		R
101	100	Series Number 1st part		
102	101	Series Number 2nd part		R
103	102	Series Number 4th part		
104	103	Firmware Version		R
105	104	Malfunction and Service Information		R
106	105	Min [%]		R / W
107	106	Max [%]		R / W
108	107	Sensor Type 1		R / W
109	108	Bus Fail Position		R / W
110	109	Communication Watchdog		R / W
111	110	V'_{nom} m^3/h		R
112	111	–		–
113	112	Nominal Volumetric Flow in selected units	LowWord	R
114	113		HighWord	
115	114	–		–
116	115	–		–
117	116	Control Mode		R
118	117	Unit Selection Flow		R / W
119	118	Setpoint Source		R / W
120	119	Operation Mode		R / W
121	120	–		–
122	121	–		–
123	122	–		–
124	123	Room Pressure Cascade		R
125	124	Application Selection		R
126	125	System Altitude		R / W
127	126	Nominal Delta Pressure in selected units		R
128	127	–		–
129	128	Nominal Delta Pressure in Pa		R
..	..	–		–
146	145	Unit Selection Pressure		R / W

All writeable datapoints with Register No. >100 (service data) are persistent and are **not** supposed to be written on a regular basis.

Modbus register description

No.	Address	Description Comment	Range, enumeration		Unit	Scaling	Access
1	0	**Setpoint** The setpoint refers to the demanded flow, pressure or damper position according to the selected application and control mode. The setpoint is active, if the setpoint is controlled by bus (if "Setpoint source" Register No. 119 = 1: Bus). The setpoint is always scaled between "Min" (Register No. 106) and "Max" (Register No. 107). If "Application Selection" Register No. 125 = 0: Flow control, the setpoint is related to the demanded volumetric flow. If "Application Selection" Register No. 125 = 0: Flow control, and "Control Mode" Register No. 117 =0: Position control, the setpoint is related to the damper position. If "Application Selection" Register No. 125 = 1: Pressure control, or = 2: Room pressure control, the setpoint is related to the demanded pressure.	0...10'000 Default: 0		%	0.01	R / W
2	1	**Override control** Override setpoint with defined values The override is active for the "Setpoint" Register No. 1 or the "Setpoint Analog" Register No. 13 according to the settings on the "Setpoint Source" Register No. 119.	0: None 1: Open 2: Close 3: Min 4: –	5: Max 6: – 7: – 8: Motor stop Default: 0	–	–	R / W
3	2	**Command** Initiation of actuator functions for service and testing. After a command has been executed, the register value returns to 0 (None).	0: None 1: Adaptation 2: Sync Default: 0		–	–	R / W
4	3	**Actuator type** If the selected application does not support a local actuator (flow measurement, room pressure cascade), the register is inactive (= 65'535).	1: Air / water 2: **VAV** / EPIV 3: Fire 4: Energy Valve	5: 6way EPIV	–	–	R
5	4	**Relative position** Related to the adapted mechanical range If the selected application doesn't support a local actuator (flow measurement, room pressure cascade), the register is inactive (= 65'535).	0...10'000		%	0.01	R
6	5	**Absolute position** Angular position according to the entire range of rotation If the selected application does not support a local actuator (flow measurement, room ressure cascade), the register is inactive (= 65'535).	0...9'600		°	0.01	R
7	6	**Relative volumetric flow** Related to the "Nominal volumetric flow in m^3/h" Register No. 111 If the selected application does not support flow measurement (pressure control, room pressure control), the register is inactive (= 65'535).	0...15'000		%	0.01	R
8	7	**Absolute volumetric flow** If the selected application does not support flow measurement (pressure control, room pressure control), the register is inactive (= 65'535).	0...65'535		m^3/h	–	R

No.	Address	Description Comment	Range, enumeration	Unit	Scaling	Access
9	8	**Sensor 1 value** Current value of sensor 1, depending on the setting of the sensor type (Register No. 108)	Voltage: 0...65'535 Resistance: 0...65'535	mV Ω 0/1	1	R
10	9	–	–	–	–	–
11	10	**Absolute volumetric flow** Absolute volumetric flow in the unit according to the settings on the "Unit Selection Flow" –► based on selection in Register No. 118. The register shows the LowWord. Lower 16 bit of 32 bit value. If the selected application does not support flow measurement (pressure control, room pressure control), the register is inactive (= 65'535).	0...500'000'000	UnitSel	0.001	R
12	11	**Absolute volumetric flow** –► see Register No. 11 The register shows the HighWord. Upper 16 bit of 32 bit value.				
13	12	**Analog setpoint** Shows the setpoint in % if the actuator is controlled by analog signal. I.e. the register is active if the "Setpoint Source" Register No. 118 = 0: Analog.	0...10'000	%	0.01	R
51	50	**Relative differential pressure** Related to the "Nominal Differential Pressure in Pa" in Register No. 129.	0...20'000	%	0.01	R
52	51	**Absolut differential pressure** **)	-1'000...10'000	[Pa]	0.1	R
53	52	–	–	–	–	–
54	53	**Absolut differential pressure in selected units** **) Unit according to the setting on "Unit selection differential pressure" –► based on selection in Register No. 146. The register shows the LowWord. Lower 16 bit of 32 bit value.	-10'000'000...100'000'000	UnitSel	0.001	R
55	54	**Absolut differential pressure** –► see Register No 54. The register shows the HighWord. Upper 16 bit of 32 bit value.				
100	99	**Bus Termination** Indicates if bus termination (120 Ω) is enabled. Bus termination can be set with service tools.	0: Disabled 1: Enabled Default: 0	–	–	R

**) signed integer

No.	Address	Description Comment	Range, enumeration	Unit	Scaling	Access
101	100	**Series number 1st part** Each device has an unambiguous series number, which is either impressed on or glued to the housing. The series number consists of 4 segments, although only parts 1, 2 and 4 are displayed on Modbus. Example 00839-31324-064-008 1st part: 00839 2nd part: 31324 4th part: 008	–	–	–	R
102	101	**Series number 2nd part**	–	–	–	R
103	102	**Series number 4th part**	–	–	–	R
104	103	**Firmware version**	–	–	–	R
105	104	**Malfunction and service information** If the specific condition disappears, the status is reset automatically.	Bit0: – Bit1: – Bit2: – Bit3: – Bit4: Error dP sensor Bit5: – Bit6: Airflow not reached Bit7: – Bit8: Internal activity (adaptation, synchronization in progress) Bit9: Gear train disengaged Bit10: Bus watchdog triggered Bit11: Actuator doesn't fit to application Bit12: Pressure sensor wrong connected Bit13: Pressure sensor not reached Bit14: Error dP sensor out of range	–	–	R
106	105	**Min** The min setpoint in % is related to the nominal flow, nominal differential pressure or to the adapted mechanical range of the actuator according to the selected application and control mode. "Min" cannot be set higher than the "Max".	0...Max Default: 0	%	0.01	R / W
107	106	**Max** The max setpoint in % is related to the nominal flow, nominal differential pressure or to the adapted mechanical range of the actuator according to the selected application and control mode. Max cannot be set lower than "Min" and must be at least 20%.	2'000...10'000 Default: 100	%	0.01	R / W
108	107	**Sensor 1 type** If setpoint source (Register 119) is analog (hybrid mode) the sensor type 1 can be set to active (1) in order to see the setpoint analog in mV.	0: None 1: Active 2: Passive 3: – 4: Switch Default: 0	–	–	R / W

No.	Address	Description Comment	Range, enumeration	Unit	Scaling	Access
109	108	**Bus Fail Position** In the event of a breakdown in communication, the actuator drives to the given position. The position setpoint relates to the adapted mechanical range and is independent of Min/Max settings. The bus monitoring controls the Modbus communication. If neither the setpoint (Register No. 1) nor the override control (Register No. 2) is renewed before the Timeout for bus watchdog (Register 110), the actuator controls to the "Bus Fail Position". Triggered bus monitoring is indicated in the malfunction and service information (Register No. 105). In hybrid mode, the bus monitoring is inactive.	0...10'000 Default: 0	%	0.01	R / W
110	109	**Communication watchdog** Timeout until bus fail is detected. If bus fail position (Register 109) is different from 0, then the timeout is by default 120s (parametrisable).	0...3'600 0: Disabled Default: 0 (120)	s	1	R / W
111	110	**Nominal volumetric flow**	0...60'000	m^3/h	1	R
112	111	–	–	–	–	–
113	12	**Nominal volumetric flow** Unit according to the setting on "Unit selection flow" –► based on selection in Register No.118. The register shows the LowWord. Lower 16 bit of 32 bit value.	0...60'000'000	UnitSel	0.001	R
114	113	**Nominal volumetric flow** –► see Register No. 113 The register shows the HighWord. Upper 16 bit of 32 bit value.	–	–	–	–
115	114	–	–	–	–	–
116	115	–	–	–	–	–
117	116	**Control mode** Visualization of the control mode selected by the damper manufacturer. Available if Register No.125: Application = 0: Flow control 0: The Min/Max limits are related to the adapted mechanical range of the actuator. 1: The Min/Max limits are related to "Nominal volumetric flow in m^3/h".	 0: Position control 1: Flow control Default: 1	–	–	R
118	117	**Unit selection flow** The selected unit is valid for the "Absolute volumetric flow in selected unit" Register No. 11 / 12.	0: – 1: m^3/h 2: l/s 3: – 4: – 5: – 6: cfm Default: 1	–	–	R / W
119	118	**Setpoint source** Defines whether the setpoint is controlled by the analog input signal on wire 3 or the by bus signal on the serial communication line D+/D- (Modbus RTU). If the "Setpoint source" Register No.119 = 0: Analog, the "Setpoint analog" Register No. 13 is active. If the " Setpoint source" Register No. 119 = 1: Bus, the "Setpoint" Register No. 1 is active.	0: Analog 1: Bus Default: 1	–	–	R / W

No.	Address	Description Comment	Range, enumeration	Unit	Scaling	Access
120	119	**Operation mode** Selection is only available for actuator type VRU-M1R-BAC. It changes the room pressure from positive pressure (default) to negative pressure.	0: Negative pressure 1: Positive pressure Default: 1	–	–	R / W
..	..	–	–	–	–	–
124	123	**Room pressure cascade** If the room pressure cascade is enabled, the sensor input S1 will be set as input signal for the room pressure cascade (0-10V). The room pressure cascade is only available if the "Application selection" Register No.125 = 0: Flow control or = 2: Room pressure control. The "Enable Fast" is only available for the VRU-M1R-BAC with a fast running actuator connected.	0: Disabled 1: Enabled 2: Enabled fast Default: 0	–	–	R
125	124	**Application selection** Visualisation of the application selected by the damper manufacturer. VRU-D3-BAC / VRU-M1-BAC: – Flow control – Pressure control – Flow measurement VRU-M1R-BAC: – Room pressure control	0: Flow control 1: Pressure control 2: Room pressure control 3: Flow measurement Default: 0	–	–	R
126	125	**System altitude** (m.a.s.l. / MüNN)	0...3'000 Default: 0	m	1	R / W
127	126	**Nominal differential pressure in selected unit** → see Register No. 129 for more information Unit according to the setting on the "Unit selection differential pressure" → based on selection in Register No. 146.	–	UnitSel	0.1	R
128	127	–	–	–	–	–
129	128	**Nominal differential pressure in Pa** The nominal differential pressure is set according to the range of the implemented sensor element. According to the selected application, the nominal differential pressure serves as dp@Vnom, or as a max. limitation for the differential pressure measurement. If "Application selection" Register No.125 =0: Flow control, the setting represents the nominal differential pressure at the nominal volumetric flow in the "Nominal volumetric flow in m^3/h" Register No. 111. If "Application selection" Register No.125 =1: Pressure control or = 2: Room pressures control, the setting serves as a maximum limitation for the measured differential pressure.	D3: 0...5'000 M1: 0...6'000 M1R: 0...750	Pa	0.1	R
..	..	–	–	–	–	–
146	145	**Unit selection differential pressure** The selected unit is valid for the "Nominal differential pressure in selected unit".	0: Pascal 1: – 2: Inches of water Default: 0	–	–	R / W

Description access: R = Read, W = Write

All inclusive.

Belimo is the global market leader in the development, production, and sales of field devices for the energy-efficient control of heating, ventilation and air-conditioning systems. The focus of our core business is on damper actuators, control valves, sensors and meters.

Always focusing on customer value, we deliver more than only products. We offer you the complete product range for the regulation and control of HVAC systems from a single source. At the same time, we rely on tested Swiss quality with a five-year warranty. Our worldwide representatives in over 80 countries guarantee short delivery times and comprehensive support through the entire product life. Belimo does indeed include everything.

The “small” Belimo devices have a big impact on comfort, energy efficiency, safety, installation and maintenance.

In short: Small devices, big impact.

- 5-year warranty
- On site around the globe
- Complete product range
- Tested quality
- Short delivery times
- Comprehensive support

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