REMAK

Modbus

Description of Modbus-RTU communication with frequency inverters

Control units

VCS

Table of Contents

1.1 History

Version	Date	Changes	Section	Page
2.0	27.06.2013	Danfoss		

1.2 Before You Start

Document Validity   This document is valid for the VCS control system.

Document Purpose   This document is intended for the following professionals:
- Service and professional companies
- Sales and Commissioning
- Remak Support and Sales Department employees
- System integrators (to get basic overview)

Application   This document provides:
- Overview of communication options with frequency inverters
- Brief guide of communication connection to frequency inverters

Prerequisite   It is expected that the target user group of this document is acquainted with ModBus RTU communication as well as with frequency inverter settings and administration. It is expected that the target user group of this document is technically qualified to operate and commission the air-handling devices.

1.3 Related documents

Ref.	Document Name	Document Type	Designation
	VCS Installation and Operating Instructions	Data sheet	

1.4 Explanatory Notes

Symbols Used   The following symbols are used in this document to highlight warnings and notes:

⚠   This symbol highlights safety instructions and warnings. Failure to follow these notes and warnings can result in personal injuries or damage to the device.

🛑   This symbol highlights those notes which must be followed to prevent damage to the device or improper operation.

ℹ   The notes marked with this symbol contain important information which requires close attention.

☀ This symbol highlights tips.

Abbreviations Used   The following abbreviations are used in the text or illustrations:

Abbreviation	Meaning
Climatix	A series of controllers providing the same features
AHU	**A**ir-**H**andling **U**nit
FM	**Frequency inverter**
SELV	**S**afety **E**xtra-**L**ow **V**oltage
MODBUS	Trademark
ModBus RTU	Communication protocol (Remote Terminal Unit)
Vacon	FM manufacturer
Vacon10	FM model series
VAcon100	FM model series
Danfoss Micro (FC51)	FM model series
Danfoss Basic (FC101)	FM model series
HMI	**H**uman **M**achine **I**nterface – control unit
ŘJ	Control unit

1.5   Safety Instructions

Application

VCS control units are designed solely to control and monitor ventilation, air-handling, air-conditioning and cooling units.

Proper Application

Properly carried-out transport, storage, installation, commissioning and careful handling are prerequisites for correct and trouble-free application and operation.

Electric Wiring

Protection, switching, conductor routing and grounding must fully comply with the local regulations applicable for wiring.

Conductor Routing ⚠

115/230 V AC must be strictly isolated from 24 V SELV AC. When working on the wiring, take the appropriate safety measures.

Commissioning and Maintenance

Climatix products must be prepared for application and commissioning by a qualified person.

Maintenance

VCS control units are designed as maintenance-free equipment, except for regular cleaning. Dust and dirt must be removed from the system components during regular service inspections.

Failures ⚠

Only authorized personnel are allowed to perform interventions to control units to remove device failures.

1.6   Trademarks and Copyright

Trademarks

The trademarks used in this document are listed below, including their owners. These trademarks are quoted from Siemens materials.

Trademarks	Legal owner
MODBUS®	The Modbus Organization, Hopkinton, MA, USA

Copyright

This document can only be copied with the permission of Remak a.s.

2   Frequency Inverter Application in Remak AHU

Frequency inverters are optionally used in Remak AHU to drive fans and rotary heat exchangers. Communication with frequency inverters is ensured using the RS485 bus communication and Modbus RTU protocol. The software used in the Climatix controllers has been created for VACON (VACON10 and VACON100) and Danfoss (Micro, Basic) frequency inverters. If other frequency inverters are used, it is necessary to adapt the Climatix controller's program due to the different data communication structure used by other manufacturers.

3 ModBus RTU

3.1 Generally

The Modbus is a worldwide recognized standard defined by Modbus Organization, Inc.
The Modbus Organization is a group of independent suppliers of automation devices, striving for the adoption of the Modbus communication protocol.
The Modbus Organization administers and develops communication systems for automation systems distributed across different market segments. The Modbus Organization also provides information to obtain and share information about the protocols, their application and certification to simplify implementation by users with the aim to reduce expenses for communication.
The Modbus Organization is a membership-based commercial association founded as "Modbus Organization. Inc." under the laws of the Commonwealth of Massachusetts, USA and recognized by the Internal Revenue Service as a non-profit organization under code 501.
For more information, please visit www.modbus.org

3.2 ModBus RTU Protocol

Modbus RTU is one of the Modbus protocols on a series line. Therefore, it is very important to use unique Modbus RTU identification!

Modbus RTU communication is simple, functional and easy to monitor.
The Modbus RTU definition is available at www.modbus.org in the document Modbus over Serial Line Specification & Implementation Guide.

3.3 Topology

Line connection is the only possible connection of the series line. Branches or circuit connections are not allowed. The first and last device on the bus must be fitted with a terminal resistor.

Modbus RTU communication on a series line works in the so-called Master-Slave mode.

The master, in this case a Climatix controller, sends requests to the Slave devices – frequency inverters
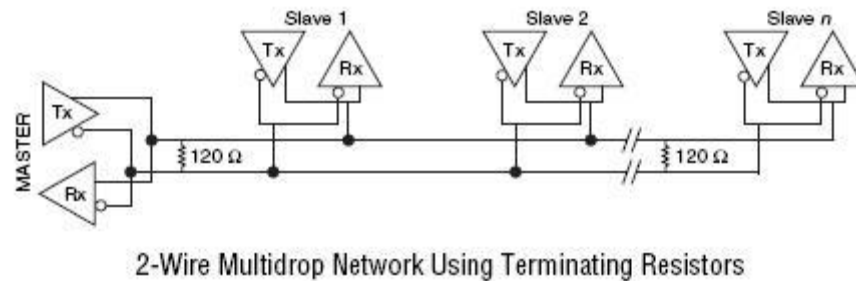 The Slave always replies to its specific message.
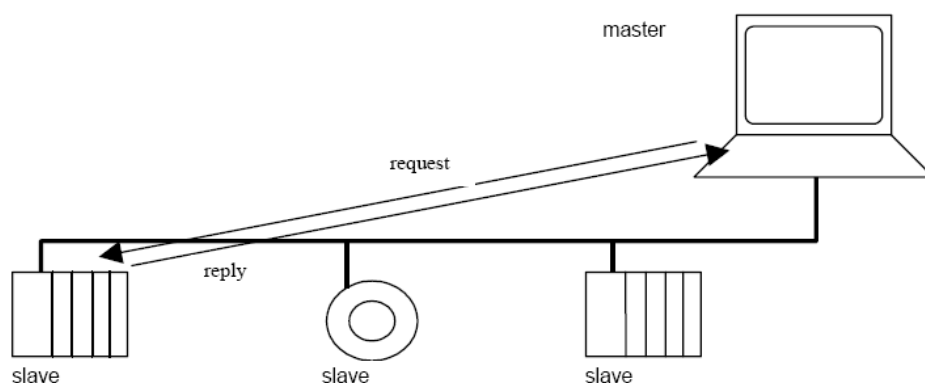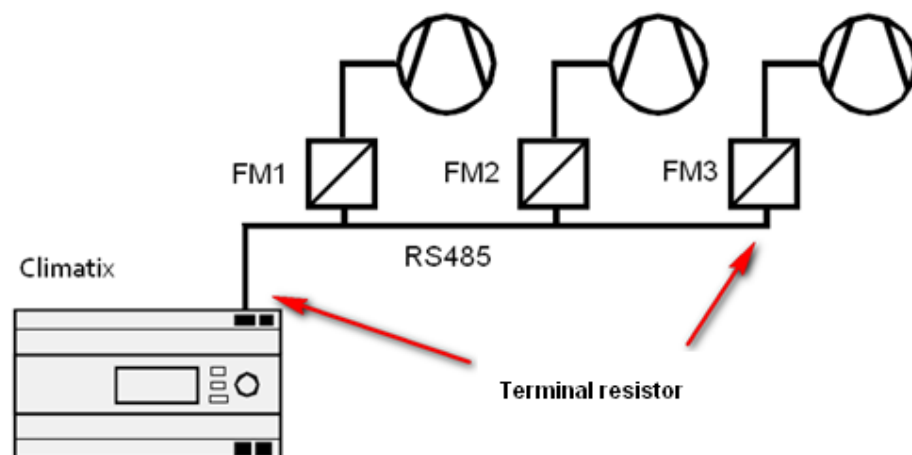

3.4 Wiring

The wiring defined by the Modbus Organization and their recommendations must be followed.

Unfortunately, the terminals on a communication device are marked differently. Therefore, be very careful.

3.4.1 Two-wire Connection (half-duplex)

2-Wire Multidrop Network Using Terminating Resistors

3.4.2 Terminal resistor

To ensure correct functioning of the bus, the first and last device on the bus must be fitted with a terminal resistor.

The terminal resistor can either be an integral part of the device or placed between communication conductors (its impedance is usually 120 Ohm). For longer or more complex buses, the terminal resistor is determined by measuring the bus using an oscilloscope.

- The first device (VCS control unit) terminal resistor setting is performed using the software and is automatically pre-set at the REMAK factory.
- For frequency inverter terminal resistor settings, refer to the respective frequency inverter instructions.
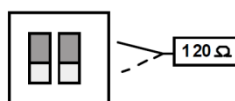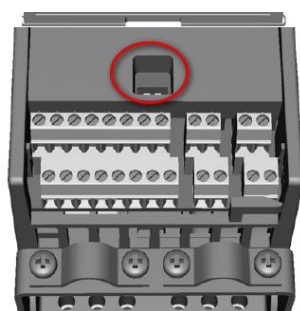- For the Danfoss Micro frequency inverter, the terminal resistor is set using a switch.

ON = Zakončeno
OFF = Rozpojeno

- For the Danfos Basic frequency inverter, the terminal resistor is set using a switch.
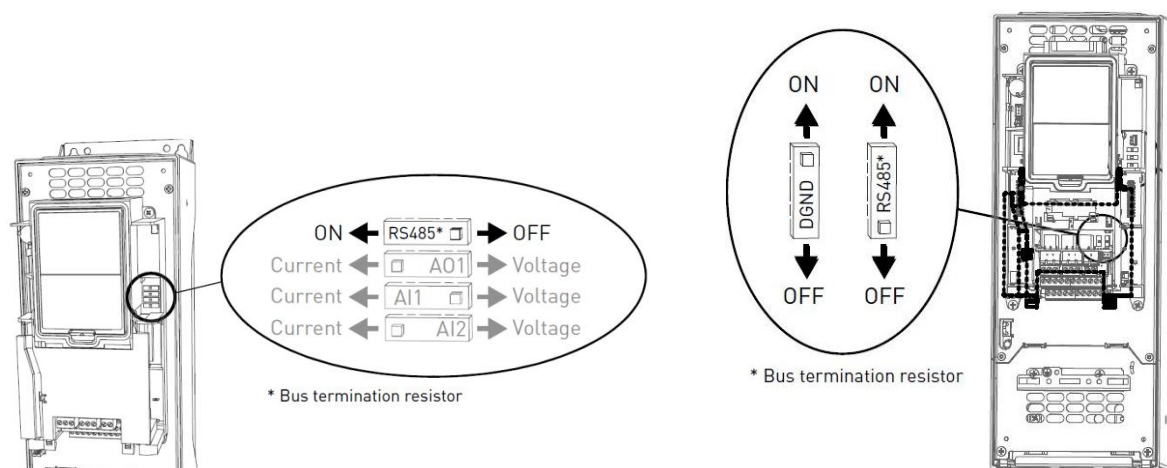

ON = Zakončeno
OFF = Rozpojeno

- For the VACON 10 frequency inverter, the terminal resistor is set using a switch.

120 Ω

- For the VACON 100 frequency inverter, the terminal resistor is set using a switch (two variants).

* Bus termination resistor

3.4.3 Installation of Conductors

The conductor type must be suitable for communication on a series line.
Conductor selection depends on the communication speed, length of the bus and conductor routing.
The conductor routing must be in accordance with EMC!

A shielded twisted pair of wires (not a cable) is used as a conductor for the Modbus RTU.
Example:
PAAR LiYCY or LiYCY (TP) 2 × number of pairs × 0.25 mm^2 or 0.5 mm^2
AWG24 baud rate 9600Bd, length 1000 m, cable class 5 length max. 600 m

If the distance is greater than the recommended conductor length, it is necessary to select larger wire cross-sections or lower baud rates. The maximum transfer distance depends on the baud rate!

The length of unshielded conductors must not exceed 10 mm. The conductors are connected to a single point.
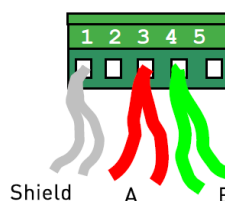
3.4.4 Marking of Terminals

Description of VCS control unit and frequency inverter terminals

| Signál RS 485 | VCS Terminals | frequency inverter terminals | | | |
	Reguláror (ŘJ VCS)	Vacon 10	Vacon100	Danfoss Micro	Danfoss Basic
Rx+, Tx+	A+	A	B	68	68
Rx-, Tx-	B-	B	A	69	69
GND	REF	DGND ⊕	DGND ⊕	61	61

3.4.4.1 Climatix

The VCS control unit communication terminals are marked with A+, B- and REF.

A+ for marking Rx+,Tx+
B- for marking Rx-,Tx-
The REF is the reference voltage for the signal detection. The REF terminal must always be connected between the communication parties on the bus.
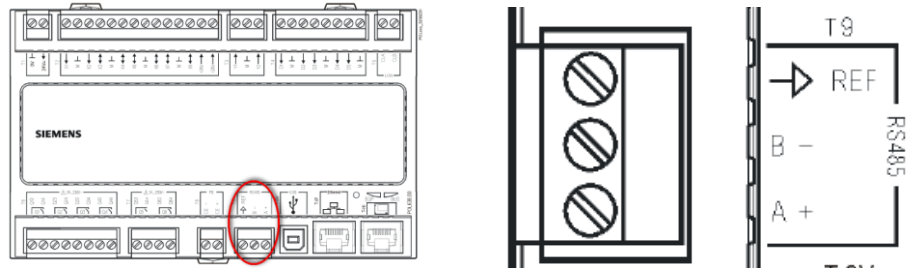
3.4.4.2 Danfoss Micro a Basic frequency inverter terminal designations
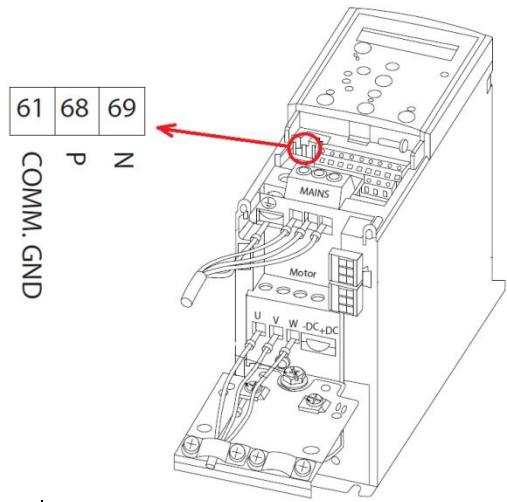
3.4.4.3 Vacon 10

The Vacon frequency inverter terminals are marked depending on the inverter type. The Vacon 10 frequency inverter communication terminals are marked with A and B.

A for marking Rx+,Tx+
B for marking Rx-,Tx-
GND is marking for data ground
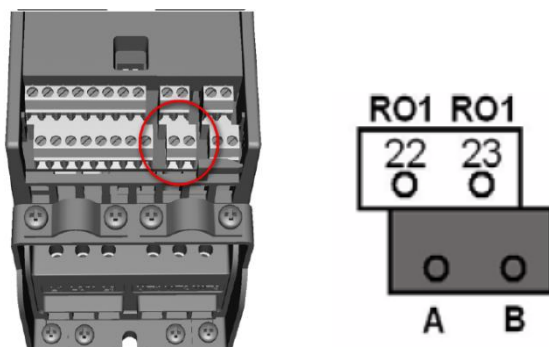
3.4.4.4   Vacon 100

The Vacon frequency inverter terminals are marked depending on the inverter type. The Vacon 100 frequency inverter communication terminals are marked with B and A.

WARNING:
The marking of the Vacon 100 terminals with A and B is reversed in relation to the bus polarity!

B for marking Rx+,Tx+
A for marking Rx-,Tx-
GND is marking for data ground
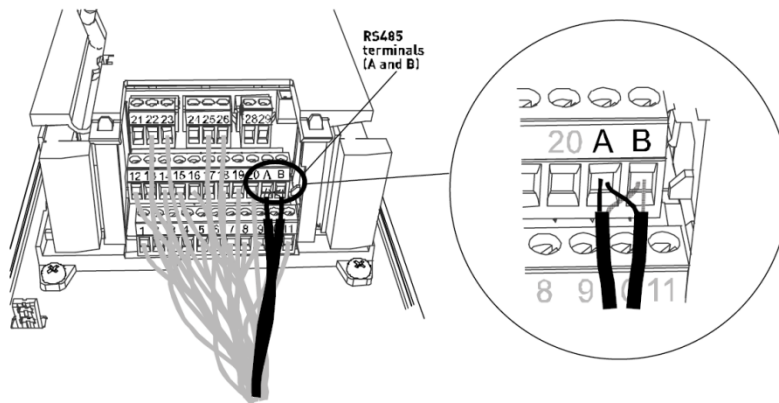
3.4.5   Bus Connection (shielding)

The connection of the RS485 bus between the VCS control unit frequency inverter must be performed exactly in accordance with the wiring diagram provided.

 An example of wiring using one Danfoss Micro frequency inverter and one Danfoss Basic frequency inverter:
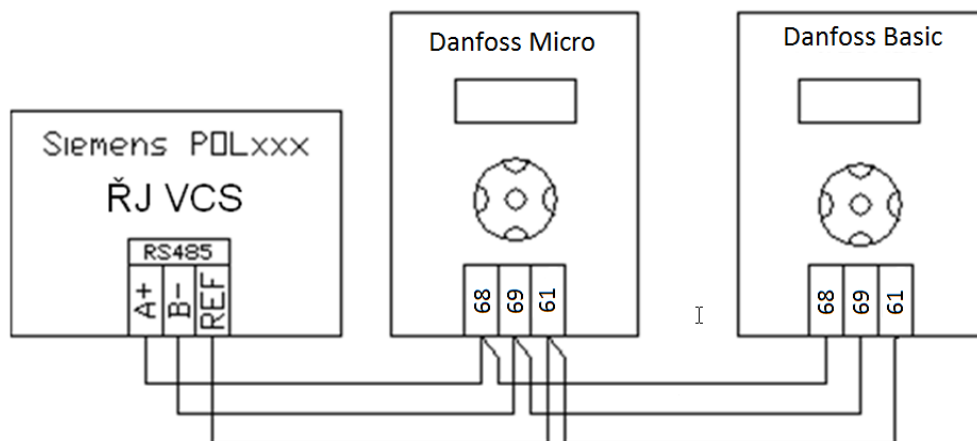
Example of connection to the Vacon 10 and Vacon 100 frequency inverters:

The correct connection of the shielding in the RS485 network is very important for proper operation.

The shielding connects the working grounding of the units. The cable shielding is connected to the REF terminal of the RS485 (ŘJ) connector and to the GND terminals (frequency inverter). It is connected to the distribution board's PE terminal only at one point (direct grounding). This is done in the factory.

ℹ️ Connection to the PE terminals of individual frequency inverters is not advisable. The condition to connect the PE terminal only at one point is fulfilled during production of the control unit.

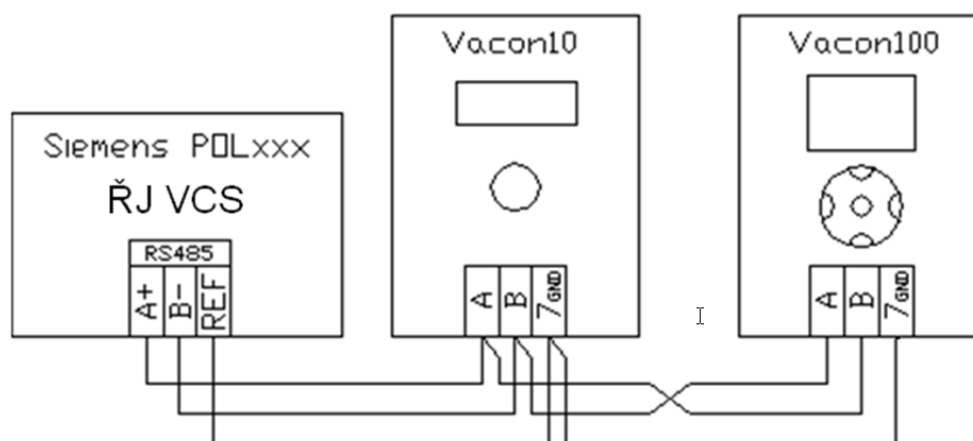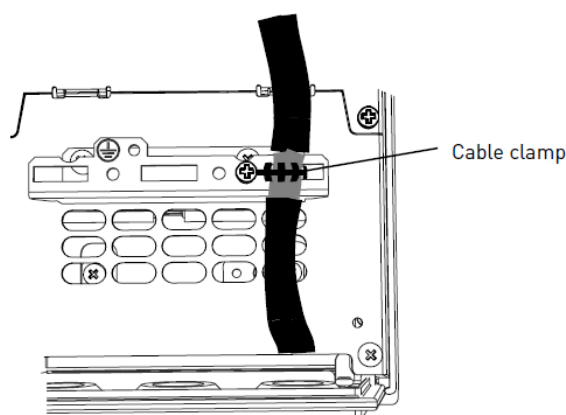However, be aware that this is not common practice. It is always necessary to take into account the local conditions and principles of the RS485 network shielding connection.

4   Failures Detected by Modbus RTU

- Fan thermo-contact
- Fan operation control using the differential pressure sensor
- Frequency inverter internal failure
- Modbus RTU communication error

The baud rate settings of all frequency inverters on the communication line must be the same.

A higher baud rate means greater sensitivity to noise.

High demands are set for the wiring harness (recommended cables close to 120 Ohm impedance must be used), communication line connections, 120 Ohm terminal resistor connections and conductor routing away from possible noise sources.

4.1 Fan Thermo-Contact

This must be connected to the DI 29 FM Danfoss and FM DI3 Vacon output. If the fan is not equipped with a thermo-contact, the output must be short-circuited. A failure can be indicated with a user adjustable delay. The wiring must be performed in accordance with the applicable documentation (wiring diagram) provided with the VCS control unit

4.2 Differential Pressure Sensor

In some cases, the differential pressure sensor is used to detect a failure. It must be connected to the DI 29 FM Danfoss a FM DI2 Vacon input. The wiring must be performed in accordance with the applicable documentation (wiring diagram) provided with the VCS control unit

The differential pressure sensor is used for belt-driven fans or backup fans. If incorrect pressure difference is detected, the AHU will be shut down, or the backup fan will be started (depending on the AHU type).

4.3 Frequency Inverter Internal Failure

The frequency inverter can also detect its own internal failure. This internal failure detection is sent to the control unit, which will evaluate and indicate it. The AHU will be shut down, or the backup fan will be started depending on the AHU type.

4.4 Modbus RTU Communication Error

If the communication message fails, it will be repeated depending on the setting for failed communication message repetitions. If the communication message is not transferred after the pre-set number of repetitions has been carried out, a communication failure will be indicated. The control unit will evaluate this state as a fan failure and stop the AHU. For settings of the number of repetitions of failed messages, refer to the Data Points, ModBus, VCS Control Unit.

The communication error is also monitored by the frequency inverter. If communication is lost, it will set the communication error with a pre-set delay (See Frequency Inverter Data points.) and stop the fans.

4.5 Backup Fan

The backup fan will be started if the main fan fails. If the backup fan fails, the air-handling unit will be shut down.

4.6 Pair of Service Fans

If one of the pair of service fans fails, the air-handling unit will be shut down.

4.7 Backup Pair of Service Fans

If one of the pair of service fans fails, the backup pair of fans will be started. If one of the backup pair of fans fails, the air-handling unit will be shut down.

4.8 Fan Failure Reset

Once the failure has been removed, resetting of the failure in the control unit must be done using one of the HMI controllers. Thus a possible failure in the frequency inverter can also be reset.

A failure reset from the frequency inverter panel is not sufficiently effective as the failure state still remains active in the control system registers.

5 Modbus RTU – Frequency Inverter Settings

5.1 Address Settings

The device on the Slave bus (frequency inverters) is distinguished by the device address. This address must be unique for the bus. If more devices use the same communication address, the system will not work correctly.

For the VCS control unit, the frequency inverters of the corresponding motors (fans and rotary heat exchanger) are assigned a firm address, see the table below:

Inlet Fan
Inlet Fan	Address 1
Backup or twin fan	Address 2
Backup twin fan 1	Address 3
Backup twin fan 2	Address 4

Outlet Fan
Outlet Fan	Address 5
Backup or twin fan	Address 6
Backup twin fan 1	Address 7
Backup twin fan 2	Address 8

Auxiliary Fan
Auxiliary Fan	Address 9
Twin fan	Address 10

Rotary regenerator
Rotary heat exchanger motor	Address 11

These values can be set on the frequency inverter – for more information, refer to the FM Data Point Settings

5.2 Bus Settings

Settings of all Modbus RTU parameters of all devices on the bus must be the same. The serial Modbus RTU basic communication parameters of each party on the bus communication must be set.
The following parameters are especially important:

- Baud rate
  (usual setting: 300, 600, 1200, 2400, 4800, 9600, 19200, 38400) [b/s]

- Parity (Even, Odd , None)

- Stop Bits (One - 1 Stop Bit, Two - 2 Stop Bits)

- Response timeout (usually in [ms])

- Data Bits – standard is 8 bits (neither the VCS control unit nor the Vacon FM allows other settings)

The following settings for the VCS control unit and frequency inverter communication have been selected:

Baud Rate - 9600,   Parity - None,   Stop Bits - Two,
Settings of all Modbus RTU parameters of all devices on the bus must be the same.

5.3 Data point Settings for Modbus Communication of Individual Frequency Inverters.

The data point settings are done at the factory (REMAK). In some cases, it is necessary to check or reset these settings. The Modbus communication settings are done using data points according to the frequency inverter instructions.

It is necessary to take into account that frequency inverters connected to a common communication line must have the same baud rate, parity and number of stop bits while having different addresses (corresponding to the controller settings). The tables above indicate only one possible connection of frequency inverters on the same communication line. The highest baud rate at which the Vacon 10 and Vacon 100 on the same communication line can communicate is 9600bd.

Danfoss frequency inverter telephone technical support (non-stop):
Hot Line CZ +420 283 014 111
Hot Line E-mail: danfoss.cz@danfoss.com Web: www.danfoss.cz

Vacon frequency inverter telephone technical support (non-stop):
Hot Line CZ +420 777 784 075 E-mail: vacon.czech@vacon.com Web: www.vacon.cz
Hot Line E-mail: vacon@vacon.com Web: www.vacon.com

5.3.1   Danfoss Micro and Basic Frequency Inverter Data Point Settings

FM designation	Parameter name	Value	Note
8-01	Type of control	2	Control word only
8-02	Control word source	1	RS485 (FC Port)
8-03	Control word timeout time	60s	
8-04	Control word timeout time function	2	Stop
8-30	Protocol	2	ModBus RTU
8-31	Slave address	*	Unique for the bus
8-32	Baud rate	2	9600bd
8-33	Parity, number of stop bits	3	No parity, 2 stop bits
Possible terminal resistor settings			

5.3.2   Vacon 10 Frequency Inverter Data Point Settings

FM designation	Parameter name	Value	Note
P2.1	Control spot	2	Bus
P3.3	I/O reference	2	Communication
P13.1	Parameters hidden	0	All parameters visible
P5.8	Pre-set baud rate	0	Not used
S2.2	Bus communication protocol	1	Modbus
S2.3	Slave address	*	Unique for the bus
S2.4	Baud rate	5	9600bd
S2.5	Number of stop bits	1	2 stop bits
S2.6	Parity	0	None
S2.7	Communication timeout	60	
Possible terminal resistor settings			

*For the settings, refer to the article 5.1 Address Settings

- No parity can be set for the Vacon 10; a baud rate higher than 9600bd cannot be set.
- The Vacon 10 can be operated on the same communication line as the Vacon 100 from the Vacon 10 firmware version No. č.FW010005V019R003!

If the STOP button is pressed and held for 5 seconds (you must be in the main menu), all settings, including the motor settings, will be deleted!

5.3.3   Vacon 100 Frequency Inverter Data Point Settings

The data point settings are done at the factory (REMAK). In some cases, it is necessary to check or reset these settings. The Modbus communication settings are done using data points according to the Vacon frequency inverter manuals.

FM designation	Parameter name	Value	Note
P1.10	Reference selection	Bus	I/O reference selection
P1.15	Remote control place	Bus control	
P3.2.1	Remote control place	Bus control	
P1.16	Automatic reset	Forbidden	
P5.7.1.1	Protocol	ModBus RTU	Communication protocol
P5.7.3.1.1	Slave address	*	Unique address on the bus
P5.7.3.1.2	Baud rate	6	9600bd
P5.7.3.1.3	Parity	0	None
P5.7.3.1.4	Communication timeout	60	
P5.7.3.2.1	Fieldbus protocol status	1	Stopped
Possible terminal resistor settings			

For the settings, refer to article 5.1 Address Settings

Note: The Vacon 100 with parity setting "None", 2 stop bits firmly assigned!

6   Modbus RTU – VCS Control Unit Settings

Set at the factory – no changes normally needed.
For proper operation of the Remak air-handling unit, the correct application settings and correct settings of the bus parameters must be ensured.

6.1 Slave Device Address Settings

The correct addresses must be set to ensure correct communication.
The Slave device (FM) address must be unique for the bus and the same address number must be set in the Master device (VCS control unit) for the given Slave device. Thus, the Master-Slave connection is established. The VCS control unit (Master) includes all addresses used in the Slave devices.
If address 2 for the inlet fan is assigned to the frequency inverter then address 2 for the inlet fan must also be assigned to the VCS control unit. Otherwise, communication will not run properly.

Default values:

Inlet Fan
Inlet Fan   Address 1
Backup or twin fan   Address 2
Backup twin fan 1   Address 3
Backup twin fan 2   Address 4

Outlet Fan
Outlet Fan   Address 5
Backup or twin fan   Address 6
Backup twin fan 1   Address 7
Backup twin fan 2   Address 8

Auxiliary Fan

Auxiliary Fan   Address 9
Twin fan   Address 10

Rotary regenerator

Rotary heat exchanger motor   Address 11

These values can be changed using the HMI controller, see the Data Points. **(However, changes are not recommended!!!)**

Due to the REMAK factory pre-set addresses of the control unit and frequency inverters, it is not possible to change the inverter position between the fan sections (even if they are equipped with the same motor). Each frequency inverter has a firmly assigned number of the corresponding section with which the frequency inverter is associated. For information about frequency inverter association with a corresponding section, refer to the figure.

Order number   Section number
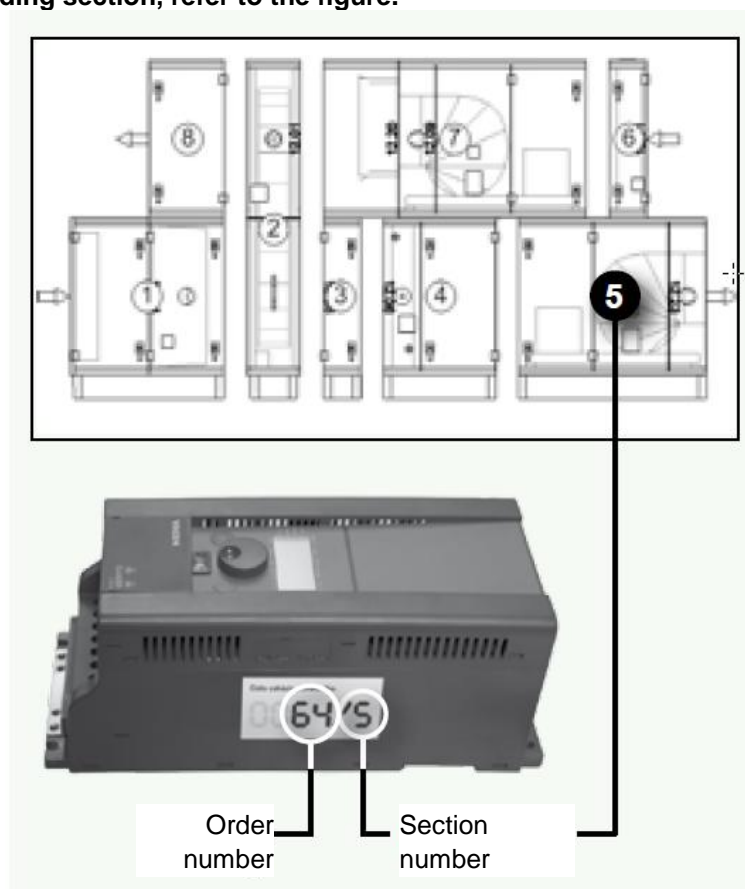
6.2 Settings of Modbus RTU parameters

The following settings for the Climatix controller and frequency inverter communication have been selected:

⚠ **Baud Rate - 9600, Parity - None, Stop Bits - Two,**
If needed, changes can be made using the HMI controller, see the Data Points. **(However, changes are not recommended!!!)**

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