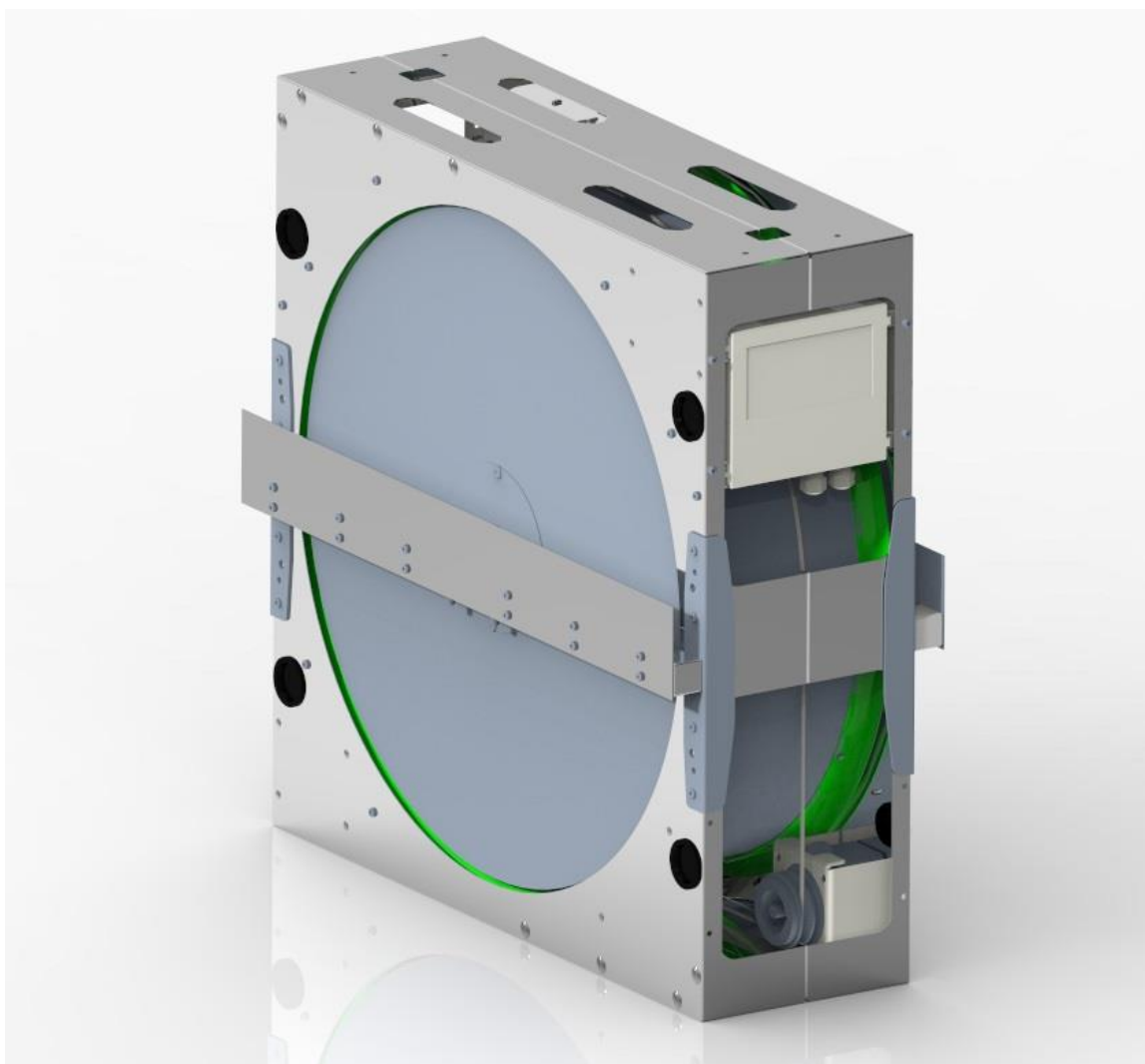




ENERGY RECOVERY WHEEL MOTOR MANUAL

OPERATION AND MAINTANANCE





Please read the following documentation carefully before performing installation, maintenance and operating of rotary heat exchangers motors. In case of doubts contact VTS official support. This manual must only be used by a qualified installer/service technician.

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1. GENERAL SAFETY



CAUTION! Electric Voltage: All motors described in the following manual can be operated, connected, installed, repaired and modified by qualified personnel only. Failure in performing in any of this operations may result in risk of fatal injury, electric shock, incorrect mounting or product damage. Installation should be carried out with usage of power lines, without short circuits and with proper grounding. Follow the connection diagrams dedicated to given motors.

WARNING: Do not open or disassemble the motor while power supply is connected to the device. It may result in fatal injury caused by electric shock. If it is necessary to open the motor, wait at least 5 minutes after disconnecting from the power supply.

NOTE: It is the user and the installer responsibility to provide the system with the proper grounding and protection in accordance with national and local standards. VTS is not responsible for any damages or injuries caused by incorrect installation, bad circuits or other failures.



Before installation and operating the motor please read entire instruction carefully! Follow the connection diagrams to perform successful installation.

2. PRODUCT DESCRIPTION & TECHNICAL SPECIFICATION

Rotary Heat Exchangers may be equipped with three different stepper motors configurations tailored to the needs and electrical requirements of our customers. Table 1 represents the general characteristics of stepper motors occurring in the series of Rotary Heat Exchangers.

Torque - Power	2.0 Nm – 55W	4.0 Nm – 110W	8.0 Nm – 260 W
Weight	≈ 2.4 kg	≈ 3.5 kg	≈ 5.0 kg
Dimensions	85 x 85 x 67	85 x 85 x 97	85 x 85 x 156
Shaft diameter	12 mm	12 mm	12 mm

Table 1 Stepper motors used in the series of Rotary Heat Exchangers

Table 2 represents configuration of motors in reference to the AHU size.

Motor	AHU Size
2 Nm – 55 W	VVS021-VVS055
4 Nm – 110 W	VVS075-VVS300
8 Nm – 260 W	VVS150-VVS300

Table 2 Available motor configurations

Note: Given setups are explanatory. VTS reserves the right to change those configurations without informing. Any modification or configuration changes other than proposed should be reported and consulted in details with VTS technical department first.

Tables below represent the technical specifications of the given motors with the correct identification numbers. The index number is a unique code identifying the suitable motor for the product.

Torque	2.0 Nm	4.0 Nm	8.0 Nm
INDEX NUMBER	7-1-0005-0082	7-1-0002-0083	7-1-0005-0084
PH	1	1	1
Voltage [V]	208-240	208-240	208-240
Stepper motor voltage [V]	3 x 0-200 V	3 x 0-200 V	3 x 0-200 V
RPM	0-400	0-400	0-400
Frequency [Hz]	50	50	50
HP	0,08	0,15	0,36
Power size (250 rpm)	55 W	110 W	260 W
Weight	≈ 2.4 kg	≈ 3.5 kg	≈ 5.0 kg
Sealing grade [IP]	54	54	54
Operating temperature	-40°C to +40°C	-40°C to +40°C	-40°C to +40°C
Storage temperature	-40°C to +70°C	-40°C to +70°C	-40°C to +70°C
Dimensions	85 x 85 x 67	85 x 85 x 97	85 x 85 x 156
Shaft diameter	12 mm	12 mm	12 mm
Electrical connection	4-pole Tyco MATE-N-LOK	4-pole Tyco MATE-N-LOK	4-pole Tyco MATE-N-LOK

Table 3 Technical specification of available motor setups

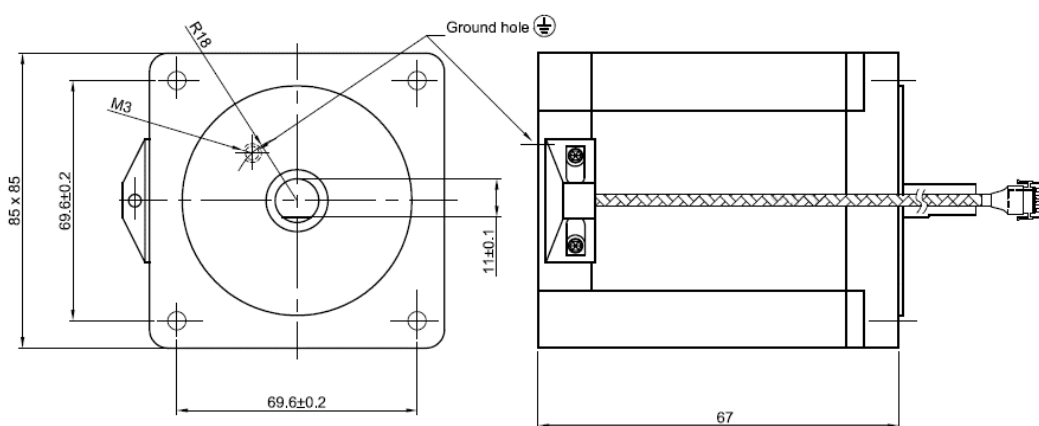


Figure 1 Stepper Motor 2.0 Nm (all dimensions are given in mm units)

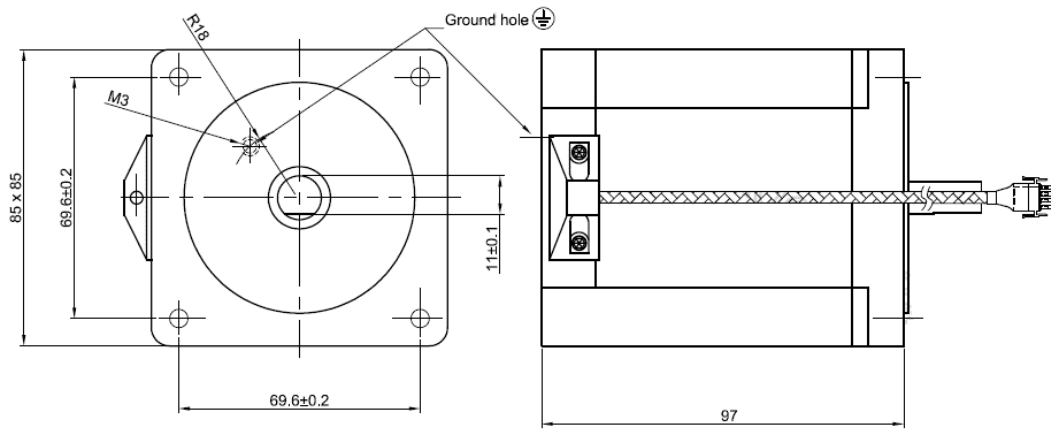


Figure 2 Stepper Motor 4.0 Nm (all dimensions are given in mm units)

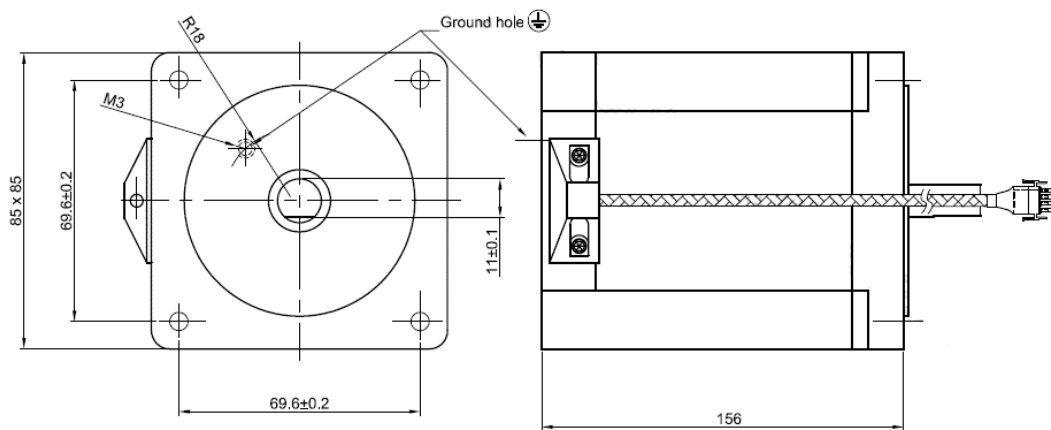


Figure 3 Stepper Motor 8.0 Nm (all dimensions are given in mm units)

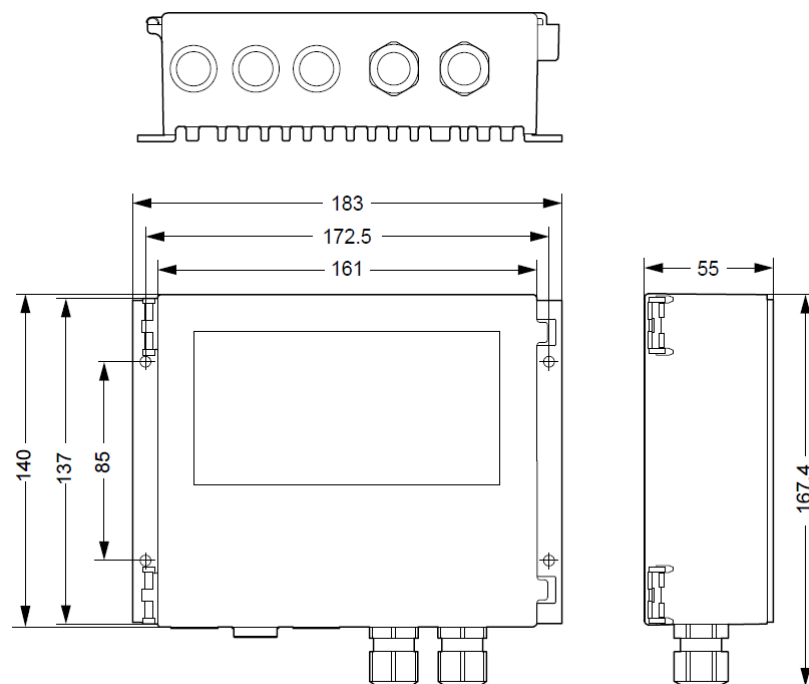


Figure 4 Dedicated controller (all dimensions are given in mm units)

3. INSTALLATION

3.1 Assembly and installation

Following illustrations and instructions presents the correct assembling of the motors and controller with the casing of the rotary heat exchanger. Motors are designated to be firmly attached to casing of the exchanger. Pulleys are selected to match the expected speed, efficiencies and performance of the motors. Please refer to the *Chapter 2 - Product Description and Technical Specification* to determine the correct set of components for the product. Pulley wheels must be firmly attached to the shaft of the motor.



Do not change the motor configurations. Follow the correctly selected setup given in the first chapter of this manual (see Table 2). Changing the settings is associated with poor performance of the rotary wheel and risk of incorrect attachment to the housing of the exchanger, and most importantly, the risk of motor damage, as well as electric shock due to incorrect connection.

Warning: Incorrect mechanical installation of the motor can be a cause of error alerts.

Following illustrations represents stepper motor assembly and installation methods. Each of the stepper motor model has its own way of assembly and may differ in according to Table 2 *Available motor configurations*.

Important notes:

- Stepper motor must be fixed firmly to a casing via dedicated motor holder.
- Stepper motor must be grounded.
- Do not use cables or connectors other than that included in the set with motor and controller.
- Do not change the size of the pulley wheel. Optimal pulley sizes were calculated and chosen to match the desired performance of the Rotary Heat Exchanger.
- Position the controller correctly to avoid overheating. Avoid exposure to direct sunlight.
- Check the specification plate on the motor and controller to confirm electrical configuration.

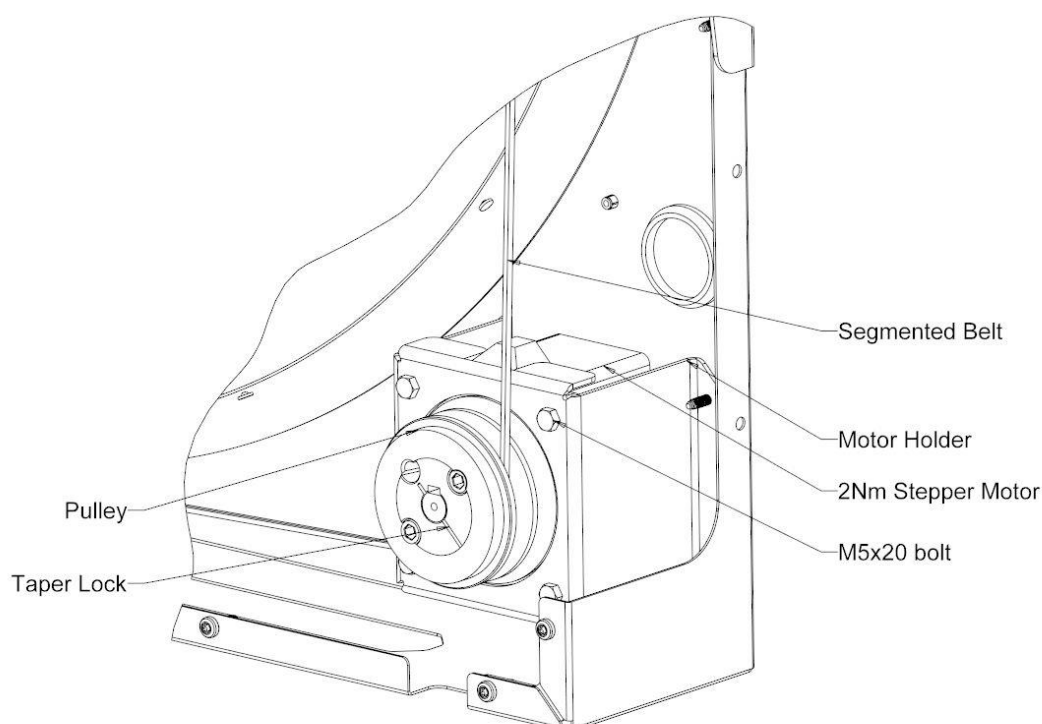


Figure 5 Stepper Motor 2Nm assembly schematic

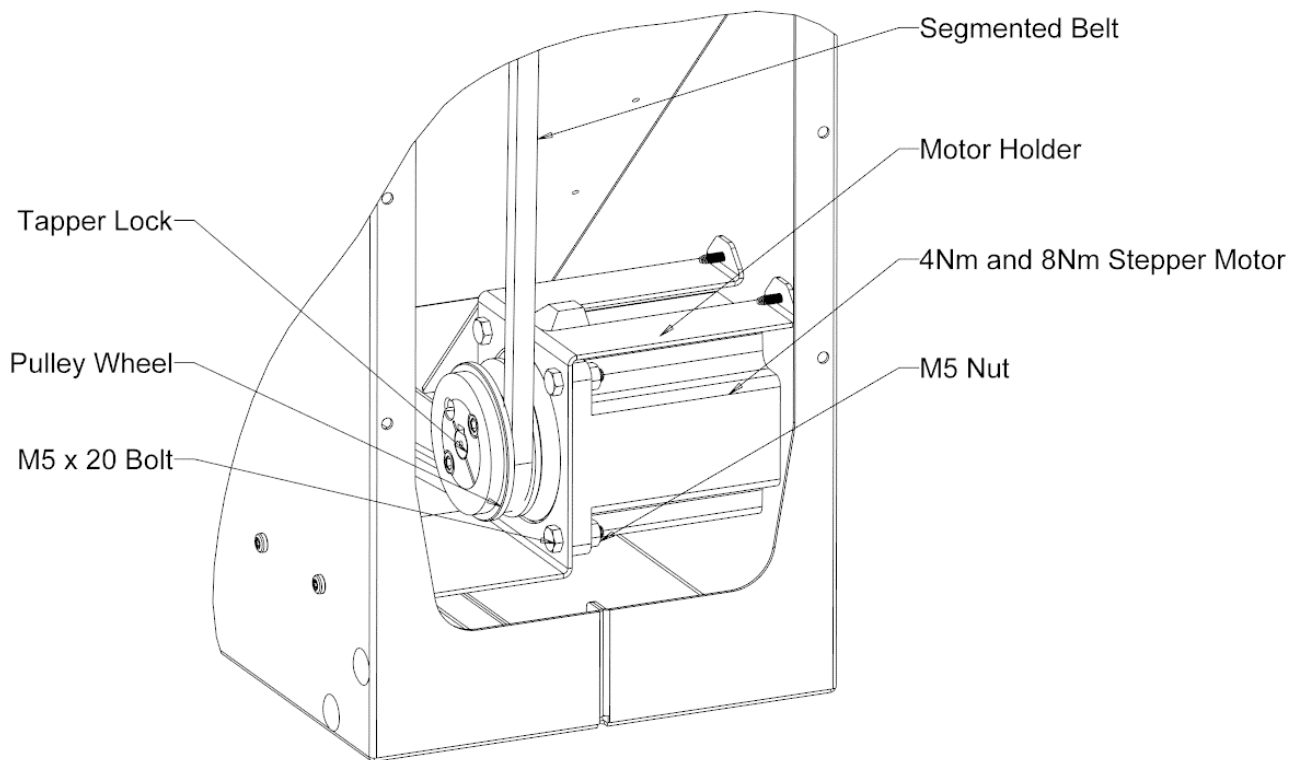


Figure 6 Stepper Motor 4Nm and 8Nm assembly schematic

3.2 Connection and wiring



To perform the correct setup, please refer to the following diagrams representing possible ways of motor connection. Installation and connection can be done by qualified personnel only. Failure in performing in any of this operations may result in risk of fatal injury, electric shock, incorrect mounting or product damage.

WARNING: Do not open or disassemble the motor nor controller while power supply is connected to the device. It may result in fatal injury caused by electric shock. If it is necessary to open the motor, wait at least 5 minutes after disconnecting from the power supply.

Notes on proper installation:

- Use fuses at power line.
- Check the wires condition before operating. Make sure that there are no short circuits.
- Use cables fulfilling the voltage, current, load and insulation installation requirements.
- Use only high quality hard wire or fiber copper wire with ferrule.
- Use shield cable.
- Make sure that motor label plate specification matches the operating supply voltage. Use cables that are adapted to work with the desired current.

Stepper motors used in series of VTS Heat Exchangers (Figure 7) are connected and powered via controller responsible for basic operational parameters. Motor itself is equipped with male type terminal which characteristic are described below in the Figure 8.

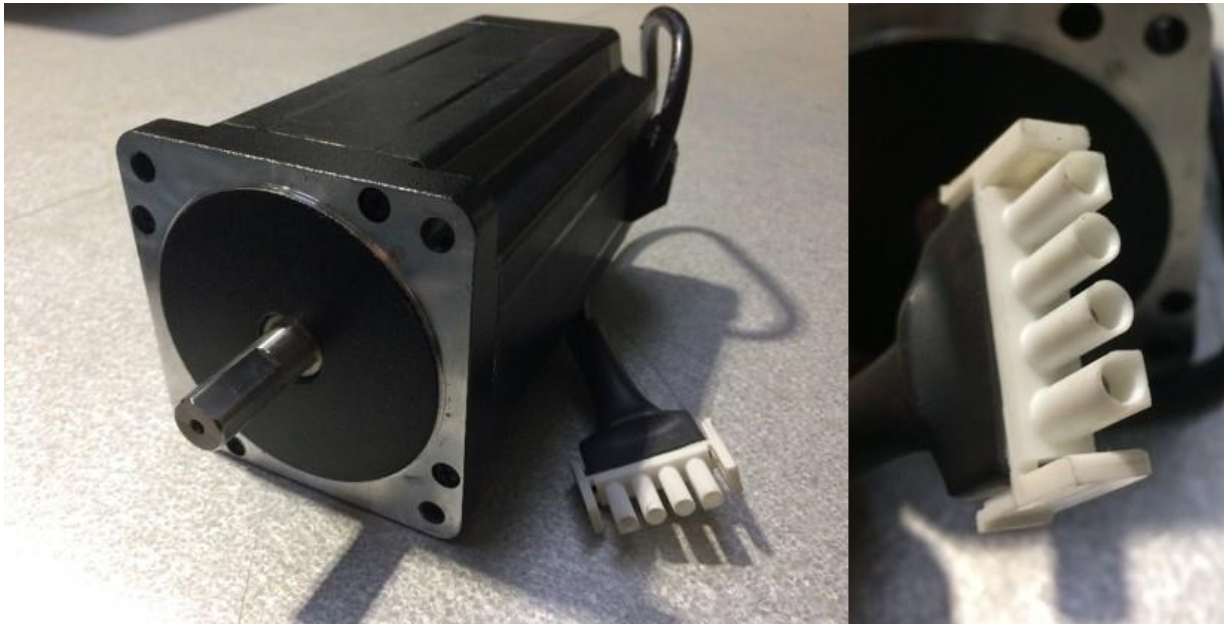


Figure 7 Stepper motor with male type terminal

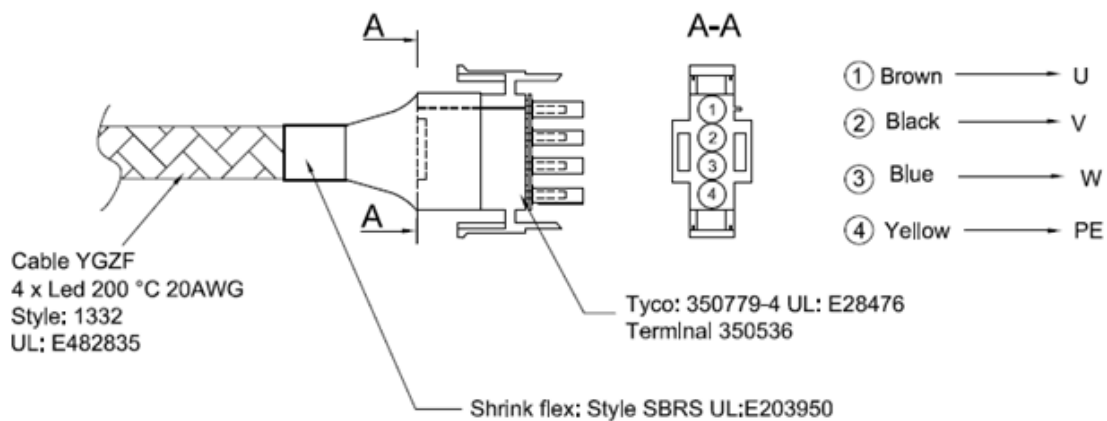


Figure 8 Connection cable with dedicated terminal

Due to length of the motor cables, extension cables connecting motor with the controller are supplied additionally. Extension cable is equipped with 4 pole connectors sleeves fitting terminal of the motors (Figure 11).

Lengths of the cables differs depending on the size of the Rotary Heat Exchanger. Figure below represents the cable connection with proper wiring description.

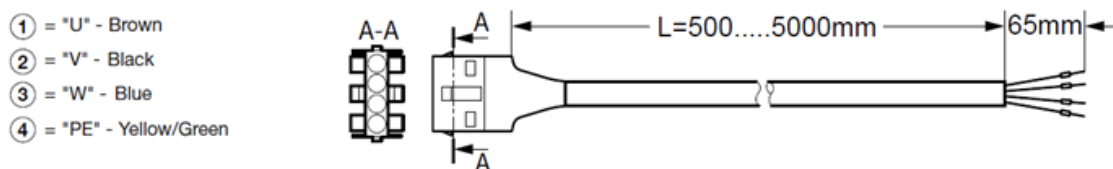


Figure 9 Extension cable

Stepper motors are operated via designated controller connected with the motor by the up mentioned cables. Figure 14 represents the slot description of the controller. Wires of the motor must be connected according to the following figures - start with opening the cover of the controller by unscrewing it.



WARNING! Wait at least 3 minutes after disconnecting the main voltage before opening the cover of controller. Be sure that supply voltage is disconnected before opening.

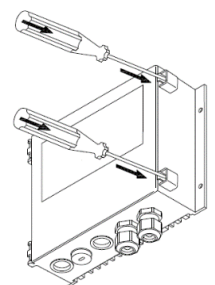


Figure 10 Opening controller by removing screws

To make the wiring process easier it is possible to remove the cover completely by detaching it from the controller. It will provide an easy access to the wiring slots. Hinged brackets allow to detach the doors by light pull (Figure 11). Despite that, cover doors can be opened at approximately 135°.

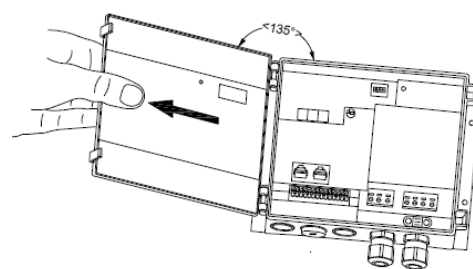


Figure 11 Controller cover

Electronic circuits of the controller (PCB) is protected by additional plastic cover (Figure 12) - it is forbidden to remove by unqualified personnel. This cover can be opened only to perform specialized service repairs. Do not attempt to perform any repairs by your own. Manufacturer warranty will not be void until the cover has traces of opening.

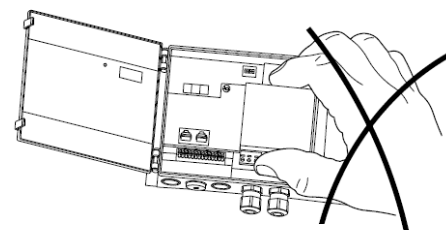


Figure 12 PCB cover

Controller is equipped with spring terminals to make the installation faster. Spring-loaded terminal allows to easily insert the wire into the desired slot by pushing it inside – no tools required. It is compatible with an multi-core cables/leads with additional core sleeves/end sleeves. Maximum and minimum dimensions of the wires are given in the Table 5. Wire ends or end sleeves must be between 8 – 10 mm. To detach the wire – press the terminal carefully with the screwdriver.

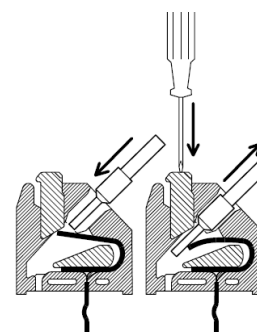


Figure 13 Spring terminals

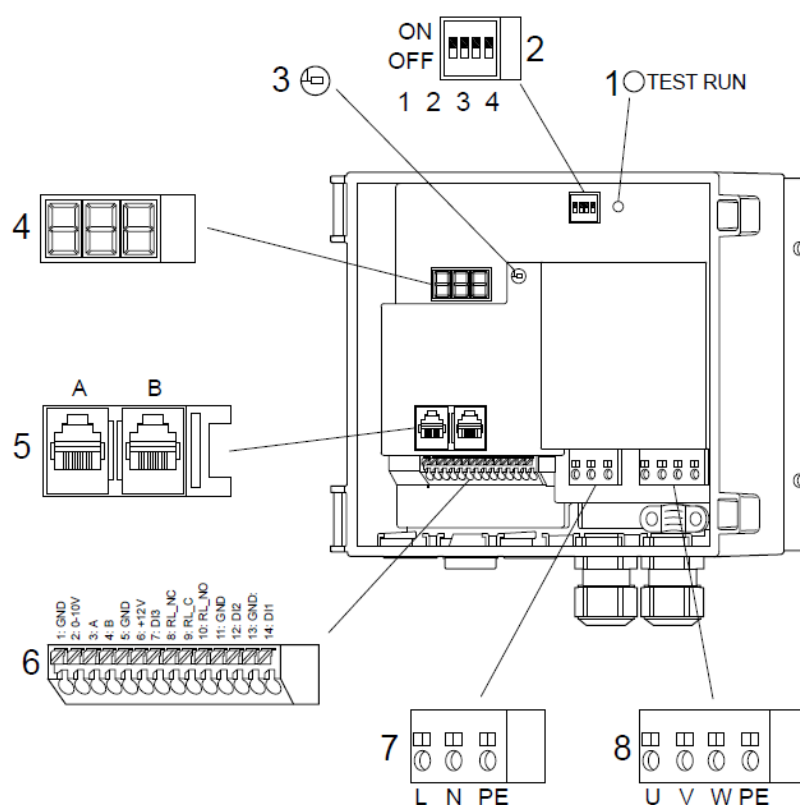


Figure 14 Stepper motor controller - wiring slots

No.	Description
1	Test button
2	4-pole DIP switch
3	LED
4	3 x 7 -segment display – depending on version
5	RJ12 Modbus connector (2 x RJ12)
6	A/D control and signal terminals, depending on version
7	Supply terminals (L, N, PE)
8	Connection terminals for stepper motor (U, V, W, PE)

Table 4 Controller slots description

3.2.1 Main voltage and stepper motor wiring

The power supply of the controller is 230V AC; +/- 10%. Cable of the power supply should be connected on the terminals marked with letters “L”, “N” and “PE” (see Figure 15). Cables should be inserted via dedicated cable entries/glands. After the wiring is performed, remember to re-tighten the cable glands and avoid pulling out or twisting.

Stepper motor is assembled with the integrated cable and connected to the controller via dedicated extension cable. Both of them are ended with the 4-pole connectors allowing for quick connection. Locking pawl of terminals will ensure the firm installation of both cables.

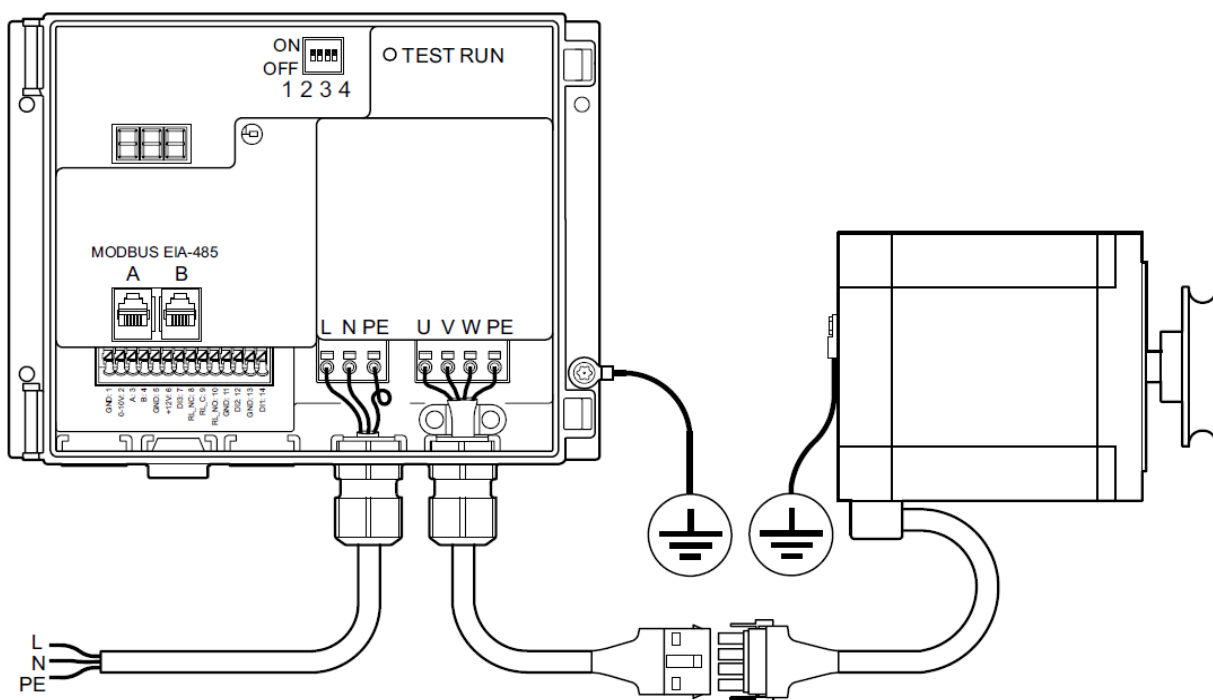


Figure 15 Power supply connection

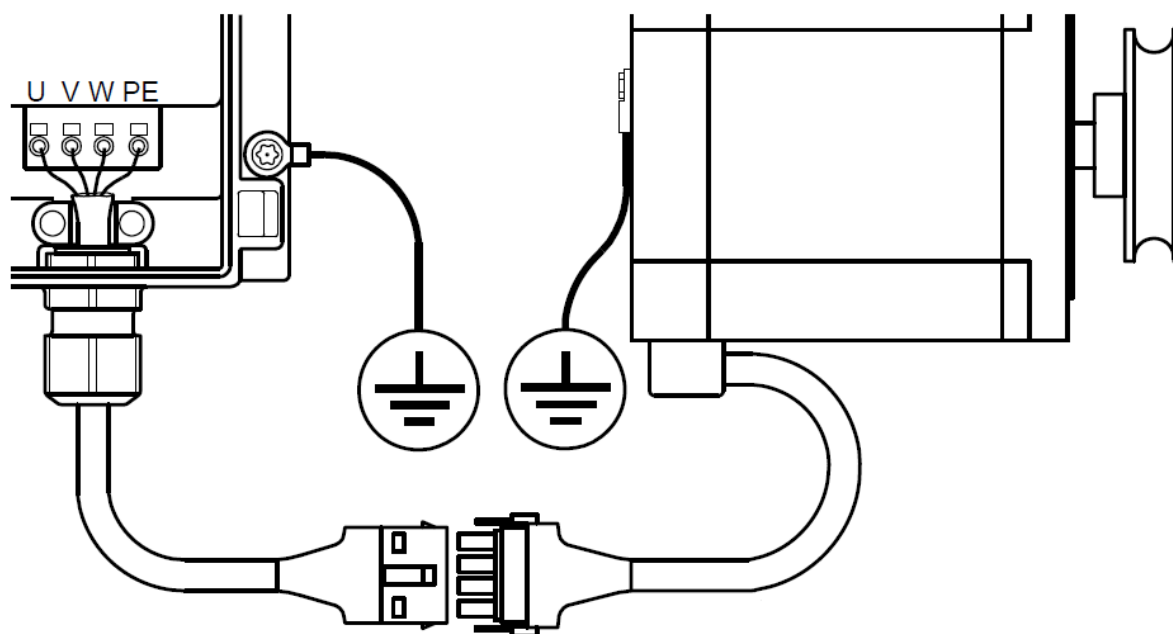


Figure 16 Stepper motor connection

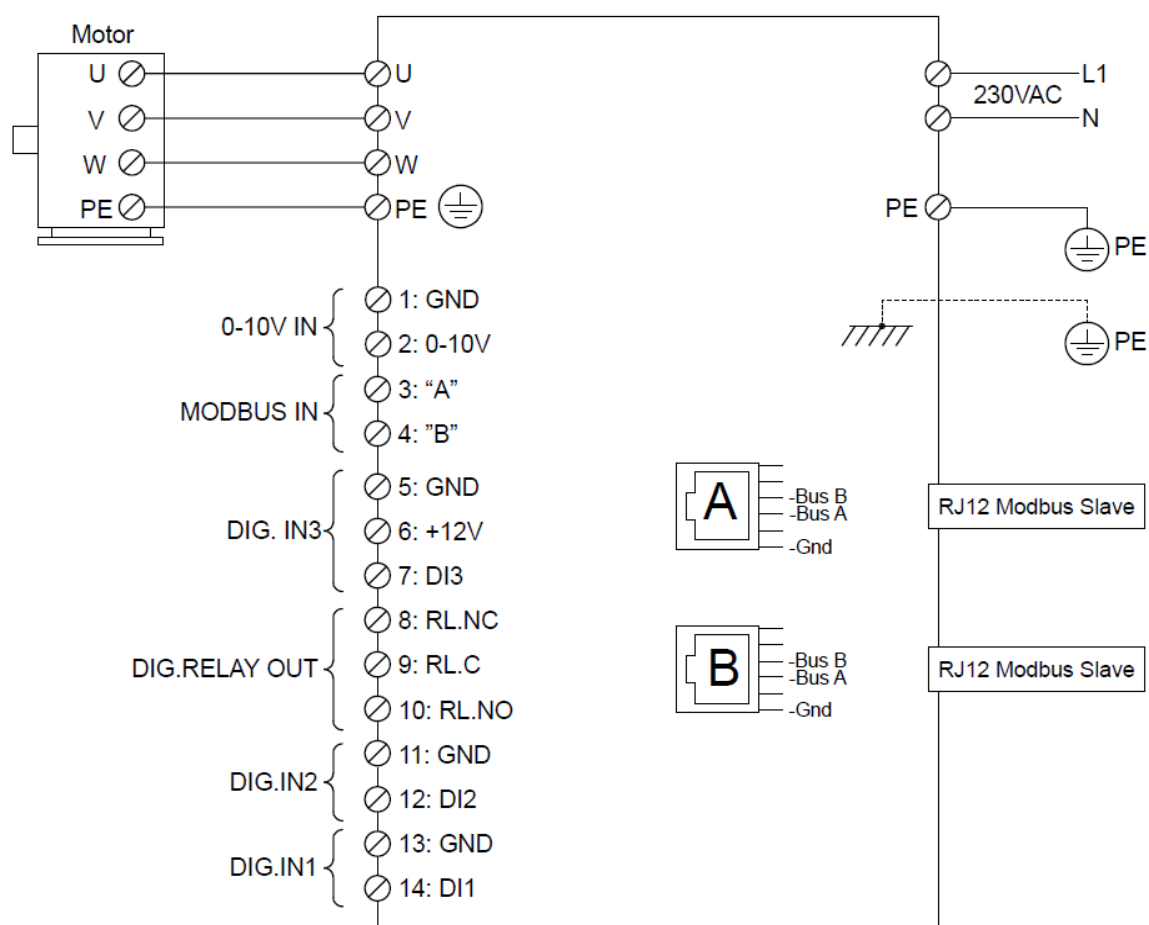


Figure 17 Controller schematic

3.2.2 Cable requirements

Before performing the installation, make sure that your setup fulfills the following list of requirements:

- All cables and leads must comply with the local and national regulations.
- Cable dimensions for PG9 connectors should be within the range of 3-8mm
- Cables meet the dimension requirements given in the Table 5.
- Copper wires are recommended.
- Modbus cable can be 6-wire unshielded, 30 AWG/0,066 m² or similar.

Control wires and cables	Minimal Conductor Dimension	Maximum Conductor Dimension	Cable dimension
Solid wires	0.08 mm ²	1.5 mm ²	3-8 mm
Multi-core wires	0.14 mm ²	1.0 mm ²	3-8 mm
Power leads and cables			
Solid wires	0.2 mm ²	4.0 mm ²	3-8 mm
Multi-core wires	0.2 mm ²	2.5 mm ²	3-8 mm

Table 5 Cable and wires dimension requirements

3.3 Elements of the controller panel

3.3.1 Test button

The driver is provided with a test function in the form of a built-in test push-button. The test button is located inside the drive in the upper right corner and must be operated with the drive open. The test button has different functions, depending on how long the button is pressed in:

1. Short press < 1sec.: The drive will enter test mode and stay in test mode until the button is pressed again. The rotor will start rotating in a sequence from 0–100 rpm according to the selected ramp-up time and remain at 100 rpm. Pressing the button a second time will cause the drive to leave test mode and stop the rotor according to the selected ramp-down time.
2. Pressing and holding the button will cause the drive to enter test mode where it will remain until the button is released. The signal to the rotor will override to 100 rpm according to the selected ramp-up time.

Please note, that when pressing the test button for more than 20 sec. the calibration function off the internal rotorguard may be triggered.

The test button also works when Modbus control is activated.

3.3.2 Dip switch

The driver is equipped with 4 DIP switches for setting the stepper motor size (see Table 6) and maximum motor speed (Table 7).

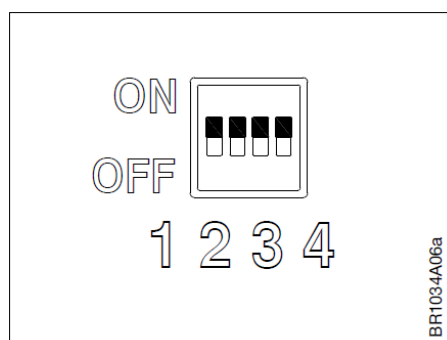


Figure 18 DIP switch

Note – motor size and speed settings of the device delivered with the VTS AHU are prepared by the manufacturer for optimal operation and should not be changed.

	DIP1	DIP2
Stepper motor = 2Nm	OFF	OFF
Stepper motor = 4Nm	ON	OFF
Stepper motor = 8Nm	OFF	ON

Table 6 Stepper motor size setting

	DIP3	DIP4
Max RPM = 250	OFF	OFF
Max RPM = 200	ON	OFF
Max RPM = 170	OFF	ON
Max RPM = 150	ON	ON

Table 7 Max RPM settings

3.3.3 LED Indicator

The driver is fitted with a LED indicator - see Figure 19. The LED diode can be seen with both open and closed cover.

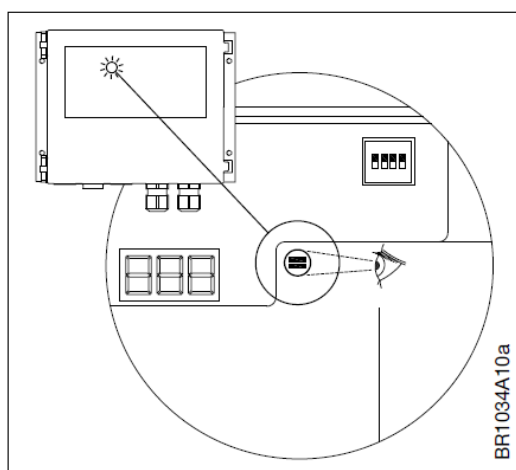


Figure 19 LED indicator

The statuses of the indicator are shown in Table 8 below. **Note:** Flashing means that the LED is off for 100 ms and on for min. 100 ms (ms=milliseconds).

LED	State
OFF	No voltage
Green ON	Voltage is present
Flashing green	Valid Modbus communication
Red ON	Rotor stopped due to critical alarm
Flashing red	Operating with reduced power
Orange ON	Test function activated
Flashing orange	Purging function activated

Table 8 LED indicator statuses

3.3.4 Display

Display is visible with open and closed cover. The display shows current status for drive, stepper motor and rotor.










Code	Description
	Current stepper motor speed is displayed when the stepper motor is running and no rotor or pulley diameter has been entered via respective corresponding Modbus registers.
	Current rotor speed is displayed when the stepper motor is running and rotor and pulley diameter have been entered via respective corresponding Modbus registers. Display toggles between torque and speed with 2 sec toggle intervals.
	Current torque (Nm) Display toggles between torque and speed with 2 sec toggle intervals.
	Fault codes - see the importance of the individual fault codes in the Table 10.
	Reduced performance operation due to current overload, overheating or other failure or overload. Read out the current fault/alarm via Modbus – Table 13.
	Purging function activated.
	Test function is activated and stepper motor is receiving control signal for max. RPM rotations.
	Hold function is activated (Holding).
	Stepper motor is in "STOP" mode.

Table 9 Display statuses

The driver has a built-in alarm monitor, which monitors optimal fault-free operation and triggers an alarm if operating or performance problems are observed. Alarms are either "Critical" or "Non-critical". "Critical" alarms stop the stepper motor. "Non-critical" alarms reduce stepper motor performance. The built-in alarm monitor stops the device. If the alarm situation passes, the alarm is automatically reset and the driver is restarted. If the maximum number of restarts (5 times/60 min) is exceeded, the alarm must be reset. The alarm can be reset by means of a Modbus command. The alarm is automatically reset if the power is disconnected for longer than 60 seconds. Alarm/fault code is shown on the display. Alarms can also be read via Modbus – see Table 13.

Fault code	Alarm overview	Alarm priority
E01	Alarm from rotor guard	"C"
E02	Excessive supply voltage	"C"
E03	Insufficient supply voltage	"C"
E04	Power to the motor increased at a critical level, e.g. short-circuiting cable, connector or motor	"C"
E05	Excessive temperature inside OJ-DRHX (>95°C)	"NC"
E06	Blocked motor	"C"
E07	No valid Modbus communication >10 sec.	"C"
E08	Phase fault on stepper motor power supply (U, V, W)	"C"
E09	Internal hardware error	"C"

Table 10 Fault codes

3.4 Modbus and 0-10V control

Rotary Wheel driver can be controlled via Modbus RTU, according to the Modbus protocol or via analogue 0-10 V input signal. The device is factory-set for 0-10 V control – after detection of a start signal or speed setpoint via Modbus, it will automatically shift temporarily to control via Modbus RTU (the "0-10 V" signal is then ignored). The function is automatically reset when the device is restarted.

3.4.1 Modbus control

Modbus can be connected to the controller via the two RJ12 connectors (connectors "A" and "B" are internally parallel connected and it is therefore optional which connector is used) or via spring terminals in the terminal strip. For RJ12 connectors, we recommend the use of telecom cable, 6-wire, unshielded, 30 AWG/0.066mm² (flat/telecom cable) and round communications cable (like twisted pair cables) for the spring terminal connectors.

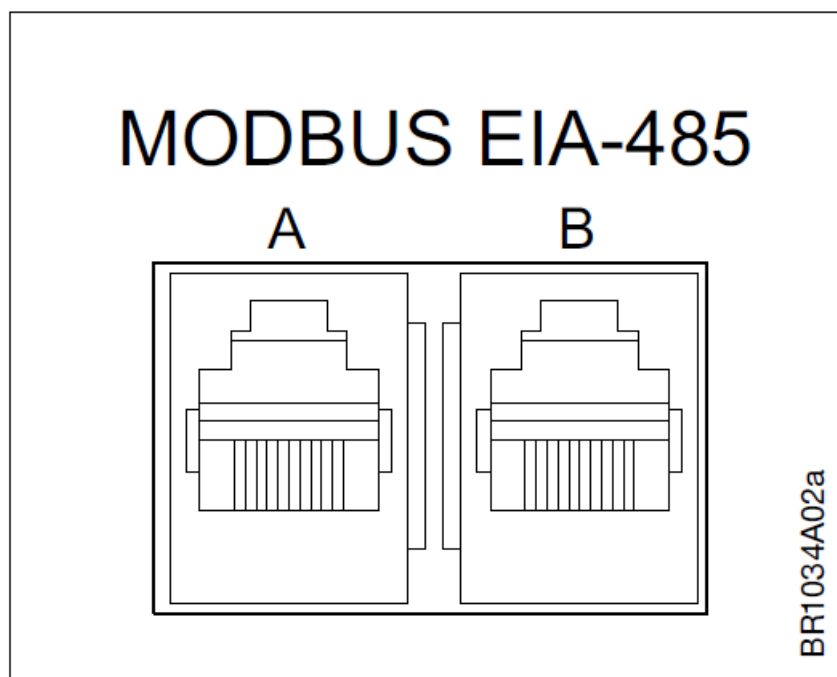


Figure 20 RJ12 Modbus connectors

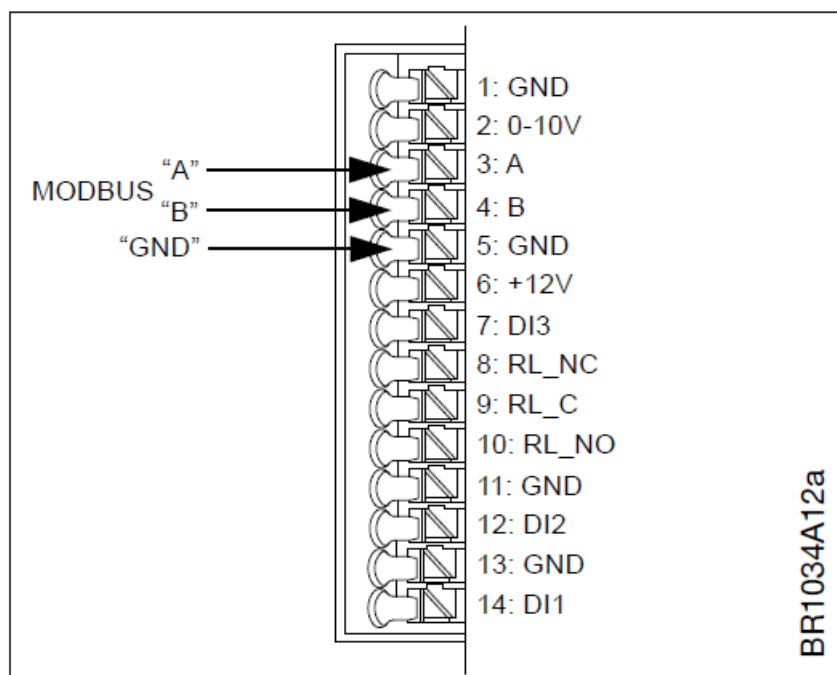


Figure 21 Spring terminal Modbus connector

After 10 seconds without receiving a valid Modbus request with the default parameters, the controller will try to detect a Modbus request with the alternative parameters (see Table 15 to see which registers are responsible for alternative communication parameters).

The default values of the parameters responsible for the communication between the controller and AHU are unchangeable - only the alternative parameters are to be changed.

Note - the settings of the device delivered with the VTS AHU are prepared by the manufacturer for optimal operation and should be changed only in justified cases.

Function code	Description
1	Read Coil Status
2	Read Input Status
3	Read Holding Registers
4	Read Input Registers
5	Force Single Coil
6	Preset Single Registers
8	Diagnostics. Sub-function 00 Only – Return Query Data (loop back)
15	Force Multiple Coils
16	Preset Multiple Registers

Table 11 Available functions

Adress	Function	Range	Active state
0	Motor ON/OFF	0 - 1	1 = ON
1	Reset Alarms	0 - 1	1 = Reset
3	Rotation direction	0 - 1	1 = CounterClockWise
7	Control mode	0 - 1	0 = Modbus, 1 = 0-10V
8	Use altern. comm. settings	0 - 1	1 = Alternative
9	Autodetect communication	0 - 1	1 = Enable
10	Analog start signal	0 - 1	1 = Enable
11	Autodetect control mode	0 - 1	1 = Enable
12	Disable internal rotor guard	0 - 1	1 = Disabled
13	Enable external rotor guard	0 - 1	1 = Enabled
14	High speed resolution	0 - 1	0 = Resolution = 0.1 RPM 1 = Resolution = 0.01 RPM
15	K-factor for Modbus	0 - 1	1 = K-factor not used for Modbus
16	Enable auto saving of UDF	0 - 1	1 = UDF stored automatically

Table 12 Available Coil Statuses

Adress	Function	Range	Active state
0	Rotorguard Alarm	0 - 1	1 = Alarm
1	V LO Alarm	0 - 1	1 = Alarm
2	V HI Alarm	0 - 1	1 = Alarm
3	I HI Alarm (Motor out short)	0 - 1	1 = Alarm
4	Temperature High	0 - 1	1 = Warning
8	Rotorguard Signal	0 - 1	1 = Pulse
9	Overload / I_Limit	0 - 1	1 = Warning
10	Internal Stop	0 - 1	1 = Alarm (Stop)
11	Rotor Blocked	0 - 1	1 = Alarm
12	EEPROM error	0 - 1	1 = Warning
13	Communication error MOC	0 - 1	1 = Alarm
14	Motor Phase Error	0 - 1	1 = Alarm
15	Ripple	0 - 1	1 = Warning
16	Digital Input 1	0 - 1	1 = HI
17	Digital Input 2	0 - 1	1 = HI
18	Ext. 24V supply overload	0 - 1	1 = Overload
19	MOC in bootloader	0 - 1	1 = Alarm
20	Digital Input 3	0 - 1	1 = HI
21	Digital Input 4	0 - 1	1 = HI
22	Communication error IOM	0 - 1	1 = Warning
23	Rotation OK	0 - 1	1 = OK
24	Test function active	0 - 1	1 = Active
25	Purging active	0 - 1	1 = Active
26	IO Config mismatch	0 - 1	1 = Warning

Table 13 Available Input Statuses

Adress	Function	Range	Resolution	Unit
0	DHX Type	0 - 14	1	-
1	AOC SW version	0 - ?	0.01	-
2	PrcOut	0 - 10000	0.01	%
3	Intern Temp	-5000 - 15000	0.01	°C
4	Motor Speed Out	0 - 40000	0.01	RPM
5	V In	0 - 300	1	V
6	I Out (RMS)	0 - 10000	1	mA
7	Power In	0 - 1000	1	W
8	ExternSet	0 - 10000	1	mV
9	Operation Day	0 - 9999	1	Day
10	Operation Minutes	0 - 1439	1	Min.
11	I Ripple	0 - 10000	1	mA
12	V Ripple	0 - 100	1	V
13	Config file variant	AA - ZZ	2 ASCII characters	
14	Config file version	100 - 32000	0.01	-
15	MOC SW version	0 - ?	0.01	-
16	Rotor Speed Out	0 - 40000	0.01	RPM
17	Torque	0 - 1500	0.01	Nm
17	SW variant	-	-	-
18	AOC Boot SW	0 - ?	0.01	-
19	MOC Boot SW	0 - ?	0.01	-
20	Motor Cfg. Var.	0 - 65535	1	-
21	Motor Cfg. Ver.	0 - 65535	0.01	-
22	Rotor Cfg. Var.	0 - 65535	1	-
23	Rotor Cfg. Ver.	0 - 65535	0.01	-
24	User Data Var.	0 - 65535	1	-
25	User Data Ver.	0 - 65535	0.01	-
26	IOM SW version	0 - ?	0.01	-
27	V DC Bus (Peak)	0 – 400	1	V
28	V Motor (Peak)	0 – 400	1	V
29	ExternSet2 (IOM)	0 - 10000	1	mV

Table 14 Available Input Registers

Adress	Function	Range	Resolution	Unit
0	Setpoint / PrcSet	0 - 10000	0.01	%
1	Min. Motor Speed	100 - Max.	0.01	RPM
2	Max. Motor Speed	Min. - 40000	0.01	RPM
3	Start I Out (Boost)	0 - ?	1	mA (RMS)
4	Start Time (Boost)	0 - ?	1	Sec.
8	Prc Holding Torque	0 - 1000	0.1	% of max
9	UpRampTime	15 - 300	1	Sec.
10	DownRampTime	15 - 300	1	Sec.
11	SwitchMode	0	(Auto)	
		1	8	kHz
		2	10	kHz
12	DHX Type	0 - ?	1	-
13	Alternative Modbus ID	1 - 247	1	-
14	Alternative BaudRate	0	9600	bps
		1	19200	bps
		2	38400	bps
		3	57600	bps
		4	115200	bps
15	Alternative Parity	0	None	-
		1	Odd	-
		2	Even	-
16	Alternative Stop Bits	0	INVALID	-
		1	1	-
		2	2	-
17	Number of retries	-1 - 100	1	-
18	Modbus Timeout	0 - 240	1	Sec.
19	Pulley size (diameter)	0 - 1000	1	mm.
20	Rotor size (diameter)	0 - 10000	1	mm.
21	Pulses per rotation	0 - 10	1	-
22	K factor	0-10000	-	-
23	DigIn1 config	0	Disabled	-
		1	Start/stop	-
		2	AlarmReset	-
		3	Rotation direction	-
		4	Test function	-
		5	Ext. rotor guard signal	-
		6	Enable ext. rotor guard	-

24	DigIn2 config	0	Disabled	-
		1	Start/stop	-
		2	AlarmReset	-
		3	Rotation direction	-
		4	Test function	-
		5	Ext. rotor guard signal	-
		6	Enable ext. rotor guard	-
24	DigOut config	0	Disabled	-

Table 15 Available Holding Registers

3.4.2 0-10V control

The Rotary Wheel driver is factory-configured for 0-10 V control, which is automatically deactivated when the signal is received via the Modbus protocol, so there is no need for additional configuration when choosing analog control.

The motor starts when there is a control signal over 1.1 V and stops when control signal is less than 0.6 V. The motor runs at maximum speed (predefined by the manufacturer for optimal work) when there is a control signal over 9.5 V.

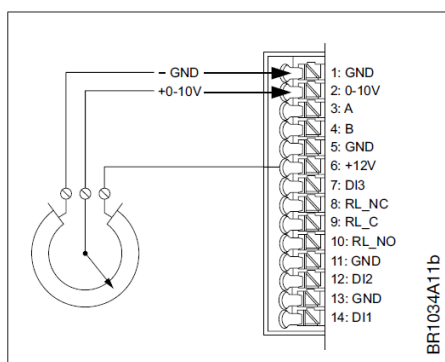


Figure 22 Spring terminal 0-10 V control connectors using internal 12V output

3.5 Adaptation of the new OI RRG controller (SPR) to work with VTS AHU

In order to adapt the brand new RRG controller (ordered as a spare part) to work with the automation of VTS AHUs, you should:

- connect to the RRG controller using a USB-RS485 converter and a PC with software that enables reading and writing of the Modbus slave devices registers (e.g. Modbus Poll) - the default communication parameters of the new controller are as follows: **address 79, baudrate 38400, no parity check, 2 stop bits**
- set the Holding Registers number 13-16 in accordance with the target communication parameters of the uPC3 controller: **address 4, baudrate 9600, no parity check, 1 stop bit** - see Table 15 (relevant registers are marked in blue in the table)

Access to the registers of the rotary exchanger controller settings is done without the use of a password. The password is also not required to save the settings after they have been changed.

To enable uPC3 - RRG OI cooperation, the RRG motor type selected on the IO3 configuration screen of the uPC3 controller must be set to OI.