Installation and Operation Instructions
VR15-3, VR20-3, VR25-3, VR30-3

OOe series

ECM HIGH-EFFICIENCY CIRCULATOR

CONTENTS

> ⚠ **WARNING!**
> Installation and use of this product requires experience and knowledge of this or similar products. Persons with reduced physical, mental or sensory capabilities must not use this product, unless
> properly instructed and supervised. Children must not be allowed to play with this product.

> ⚠ **WARNING!**
> Prior to installation and commissioning, read these instructions first. Installation and operation must comply with local regulations.

1. SYMBOLS AND CONVENTIONS USED IN THIS DOCUMENT

> ⚠ **WARNING!** Denotes that a failure to observe those instructions might cause damage to equipment or pose danger to the user.

1.1 ABBREVIATIONS AND CONVENTIONS USED IN THIS DOCUMENT

Abbreviation	Description
Baud, Baud rate	Serial communication speed, in bits per second including start, parity and stop bits.
CRC	Cyclic Redundancy Check, additional bytes used to confirm valid data transmission.
Ethernet	IEEE 802.3, mostly referring to 10BASE-T RJ-45 connector present on board.
H	Differential pressure, often called Head.
LED	Light Emitting Diode.
Modbus	A serial communication protocol used for device automation and remote access.
Q	Pump flow or flow rate.
RTU	Remote Terminal Unit.
RS-485	Multi drop serial network wiring, used to transfer Modbus data.

For Modbus use, this manual assumes that the reader is familiar with commissioning and configuring of Modbus devices. It is also assumed that an existing Modbus RTU network on RS-485 wiring with Modbus master is present.

For Ethernet and web interface use, this manual assumes that the reader knows how to configure or already has preconfigured Ethernet network.

NOTE:
- Data in this document are subject to change.
- Actual implementation might differ by pump model and software revision.
- Make sure you are using the right manual for your product.
- Always verify that the pump is operating as desired after setup is complete.
- Manufacturer cannot be held responsible for problems caused either directly or indirectly by the use of information in this manual.

2. INTRODUCTION

This manual is broken down into two sections and describes the installation, operation and control module for VR15-3 through VR 30-3 range of pumps. Section 1 describes the installation and operation features. Section 2 describes the control module and its functions.

Section 1. Installation and Operation

3. GENERAL INFORMATION, USES:

The 00e VR 15 - VR30 circulating pumps are used for the transfer of liquid media within a closed-looped hot-water heating or air-conditioning hydronic system. They are designed as single or parallel main/standby operation variable-speed pumps, where the speed is regulated by an on-board electronic device. They are to be used with a water or glycol/water mixture.

4 SAFETY:

These instructions should be studied carefully before installing or operating the pump. They are meant to help you with installation, use and maintenance and to increase your safety. Installation should be performed with regards to local or national standards. Only qualified personnel should maintain and service these products. Failure to comply with safety precautions could cause personal injury or machinery damage.

> **WARNING: Do not use in swimming pool or spa areas. Pump has not been investigated for these applications.**
> **AVERTISSEMENT: Ne pas utiliser dans une piscine ou un spa. La pompe n'a pas été étudiée pour ces applications.**

> **WARNING: To avoid electrical shock, disconnect the power supply to the circulator and the main electrical unit. Follow all local electrical and plumbing codes.**
> **AVERTISSEMENT: Pour éviter tout choc électrique, débranchez l'alimentation électrique vers le circulateur et l'unité électrique principale. Respectez tous les codes de plomberie et électriques locaux.**

> **WARNING: Hot surfaces can cause burns. The motor can also reach temperatures that could cause injury.**
> **AVERTISSEMENT: Les surfaces chaudes peuvent provoquer des brûlures. Le moteur peut également atteindre des températures qui peuvent entraîner des blessures.**

> **CAUTION: The addition of petroleum based fluids or certain chemical additives to systems using TACO equipment voids the warranty.**
> **ATTENTION: L'ajout de liquides à base de pétrole ou de certains additifs chimiques à des systèmes utilisant un équipement TACO annule la garantie.**

> **CAUTION: Use supply wires suitable for 90°C. ATTENTION: Employer des fils d'alimentation adeqauts pour 90°C.**

> **CAUTION: Misconnection or overload of electrical or signal connections could cause pump to shutdown or cause permanent damage.**
> **ATTENTION: Toute erreur de raccordement ou surcharge des connexions électriques ou de signalisation peut entraîner un arrêt de la pompe ou des dommages permanents.**

> **CAUTION: Do not operate pump without the electrical cover securely attached.**
> **ATTENTION: Ne pas actionner la pompe si le couvercle électrique n'est pas correctement fixé.**

> **CAUTION: Pump motor, electronics enclosure and condensate drain openings should not be thermally insulated as it could interfere with cooling and condensate drainage.**
> **ATTENTION: Le moteur de pompe, l'enceinte électronique et les ouvertures de drainage de condensat doivent être thermiquement isolés car il peut y avoir interférence avec l'évacuation de condensat et de liquide de refroidissement.**

5. PUMP DESCRIPTION:

The high efficiency, electronically commutated 00e VR15 - 30 model pumps consist of two main parts, the centrifugal pump and the electronic control. The hydraulic part is hermetically sealed from the motor assembly and has no mechanical seals. 00e pumps are powered by an electronically commutated permanent magnet motor (ECM) which does not consume energy to magnetize the rotor, providing superior energy efficiency.
The ECM motor is run by an on-board frequency converter. The converter estimates current flow and head from the motor load, information essential for differential pressure control.

6. USE:

All Taco 00e VR pumps are intended for circulation of solid-free fluid in pressurized, hot and chilled hydronic systems. The self-sensing ECM pump constantly calculates pressure and flow, and adapts its speed to the appropriate flow.

7. PUMPED FLUIDS:

Use water and water/glycol mixtures only. Water/glycol mixtures must be HVAC-system compatible and should have no more than 50% concentration of glycol. The fluid shall not consist of aggressive or explosive additives and mixtures of mineral oils and solid or fibrous particles. The pump should not be used for pumping flammable, explosive fluids, and in an explosive environment.

8. PUMP INSTALLATION:

The 00e(R) pump is protected with a double box during shipping. It can be lifted from the box with internal handles or by lifting it by the heat sink.

> ⚠️ **CAUTION: Pump may be heavy. Provide yourself help if needed.**
>
> **ATTENTION: La pompe est lourde. Veillez à deman-der de l'aide si nécessaire.**

Pumps are designed to be installed using standard ANSI class 125 flanges. It is recommended that the 00e pumps be installed with at least 5 to 10 pipe diameters of straight pipe on the inlet and outlet of the pump. Use all nuts and bolts to attach companion flanges to the pump flanges.

All VR model pumps should be installed with the axis in a horizontal position (see Figure 1). Failure to so may result in excessive noise and vibration.

Desired pump orientation can be achieved by rotating the pump casing. The pump is mounted to the volute with four screws. By unscrewing those the head can be turned. See detailed Motor Rotation Procedure 8.1 below.
Caution: When reassembling, care should be taken to avoid damaging the o-ring and insuring a tight seal

Figure 1:

RECOMMENDED INSTALLATION POSITIONS

UNAUTHORIZED INSTALLATION POSITIONS
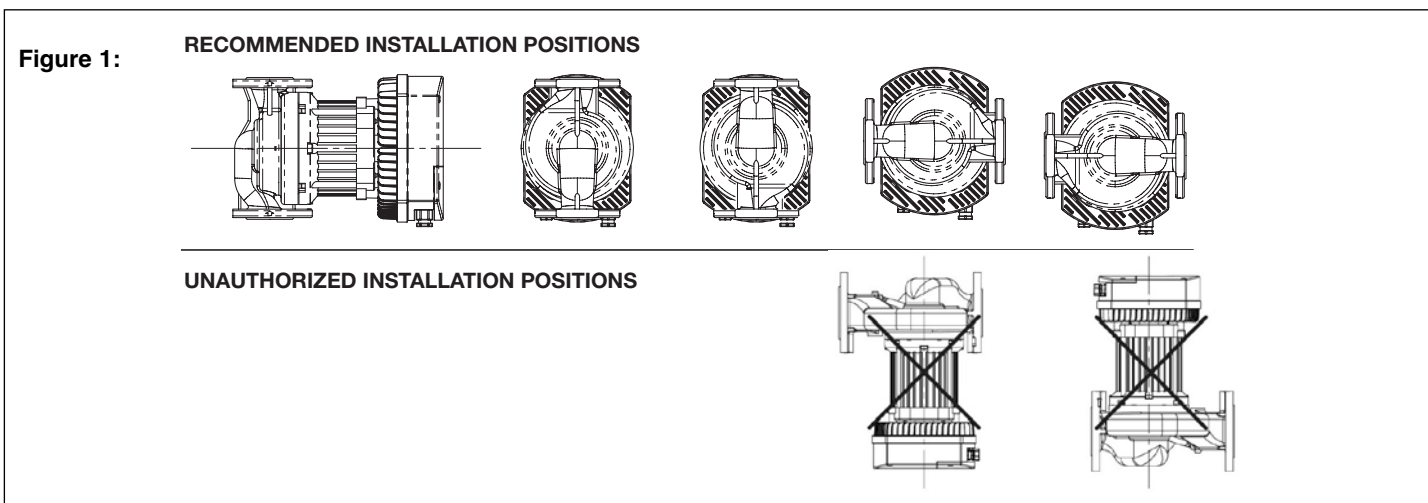
ATTENTION!!   Installing pumps in UNAUTHORIZED positions may result in voiding the warranty.

For replacement O-rings, use part number 975-001RP.

FLANGE BOLT SIZES	PUMP		CLASS 150 ANSI FLANGE			
Model/Flange Size	Bolt Hole Diameter	Flange Thickness	Bolt Hole Diameter	Flange Thickness	Minimum Bolt Size	Quantity
VR15 (1½")	0.63	0.715	0.62	0.688	½" x 2⅛"	4
VR 20 (2")	0.75	0.76	0.75	0.75	⅝" x 2³⁄₁₆"	4
VR25 (2½")	0.75	0.76	0.75	0.875	⅝" x 2⅝"	4
VR30 (3")	0.75	0.84	0.75	0.938	⅝" x 2½"	4

PERMITTED AMBIENT AND MEDIA TEMPERATURE:

Ambient Temperature [°F]	Fluid Temperature			Ambient Temperature [°C]	Fluid Temperature	
	Min. [°F]	Max. [°F]			Min. [°C]	Max. [°C]
Up to 75	36	230		Up to 25	2	110
85	36	212		30	2	100
95	36	203		35	2	90
105	36	175		40	2	80

ATTENTION!! Operation outside recommended conditions may shorten pump lifetime and void the warranty.

8.1 Motor Rotation Procedure   Caution: Motor is heavy!

Caution: If system is filled and pressurized, shut off valve before and after the 00e. Allow to cool if system fluid is hot.

8.1.1. **Notice! It is recommended to always change the orientation of the motor before installing pump in piping.**

- Tools Required:
  - 5/16" or 8mm ball-end hex wrench
  - ¼" or 3/8" flat tip screw driver
- With motor in a vertical position, remove the 4 bolts (ill.1)
- Using a flat tip screw driver, gently pry the motor and housing away from the pump housing
- Once loosened, lift the motor off the pump housing, leaving behind the rotor/shaft assembly and seal. (ill. 2)
- The motor is now ready to be rotated into the desired position.
- Before reinstalling the motor, check to make sure that the rotor/shaft is properly seated and the seal is properly positioned. (ill. 3)

  The flange of the rotor/shaft assembly must fit into the shallow groove (ill. 4) in the pump housing with the O-ring accessible without removing the rotor/shaft assembly.

- If you determine that the assembly has moved, completely remove the O-ring and the rotor/shaft assembly.
- Reinstall the rotor/shaft assembly into the shallow groove and place the O-ring seal in position as shown. (ill. 3) Spin the rotor, it should turn freely.
- Turn the motor so the control box is in the desired orientation. Lift the motor, line up the bolt holes and gently slip the motor over the rotor/shaft assembly being sure that the motor and rotor/shaft assembly are aligned. Once aligned the motor housing face will make contact with the pump housing face.
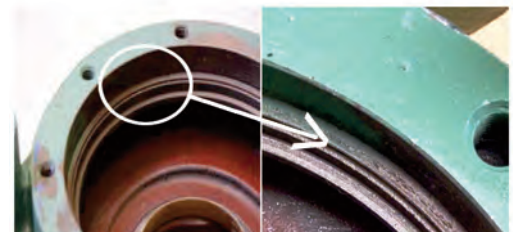
  NOTE:
  Clearances between the pump housing and the motor housing are very tight. To ensure proper fit it is important to gently manuver the motor housing into the casing. **DO NOT** use force to insert the motor housing into the pump housing!

- Insert the bolts and tighten in a cross pattern.
- Install into piping and skip to 8.1.3

ill. 1

ill. 2

ill.3

ill.4

8.1.2 **If the pump is already installed in the piping**

- Remove the 4 bolts (5⁄16" or 8mm hex wrench required) and try rotating the motor without backing it out from the pump casing. Try cracking the motor approximately .020" using a screwdriver between the motor and pump housing and try turning the motor.

- If motor will not move, remove motor completely. Remove impeller, rotor, and rotor can from the motor.
  Note: Rotor and impeller assembly will come out first. Remove rotor can from motor and put aside.

- Install impeller and rotor assembly into pump.

- While holding rotor, install O-ring in casing, and then slide rotor can over rotor and slide all the way in.

- Rotor and rotor can should stay in place while you pick up the motor. If they do not, start over to assure O-ring is properly located and have someone hold the assembly in place with a screwdriver on top of the plate.

- Pick up the motor with the terminals properly orientated and carefully start to slide the motor over the rotor can. The resistance of the sliding will keep the rotor and rotor can assembly in place and the screwdriver can be moved. **Note: Do not allow the motor to droop or the O-ring might move out of position.**

- Line up the bolt holes, reinstall the bolts, and tighten in a cross-pattern.

8.1.3. **After Installation into piping**

- Carefully open shutoff valves and check for leaks.
- Make sure that the electrical box cover is mounted and that all cable glands are installed to prevent dust and particles from contaminating the electrical box.
- Before starting the pump, the system (and pump) must be filled with fluid, and air completely bled out of the system. For proper operation, pressure must be maintained on the suction side of the pump. The pump does not have screws for bleeding the air, as it is automatically bled as a function of the design of the pump. Temporary air in the pump will generate noise that disappears after a short time.

WARNING!

- The maximum system pressure is 145 psi (1MPa or 10 Bar)
- The pump must always be filled with system fluid as it is water lubricated and water cooled
- The motor stator openings and stator housing (Figure 7) should not be insulated since the thermal insulation may prevent motor cooling and prohibit condensate from escaping from the motor housing when used in high humidity environments where the fluid temperature is below the motor temperature.

9. ELECTRICAL CONNECTIONS

Connection of the pump must comply with local electrical codes and be carried out by qualified personnel. Connection to the power supply is carried out with the enclosed connector, the mounting of which is shown in the picture accompanying the connector. When connecting the pump, the following must be considered:

- Liquid tight power connection required to maintain IP44 enclosure rating. Use supplied thread adapter option for flexible or armored cable installations.
- The power input cable must use a minimum wire size of 16AWG solid or multi-strand copper wire.
- Local or national electrical code requirements supersede Taco's specification.
- Install an electrical disconnect to comply with national electrical code.
- Connection of the power supply electrical cable must be done in a manner that ensures it does not contact the motor housing and volute of the device, due to potential high temperatures of both.

The pump has built-in over current fuse protection, temperature protection, and basic overvoltage protection. It does not require additional overload protection devices unless required by local electrical codes. Power supply cabling should be capable of carrying rated power and be properly fused. Grounding connection is essential for safety and should be connected first. Grounding is only meant for pump safety. System piping should be grounded separately.

10. SETUP AND OPERATION:

10.1 Control Panel Layout
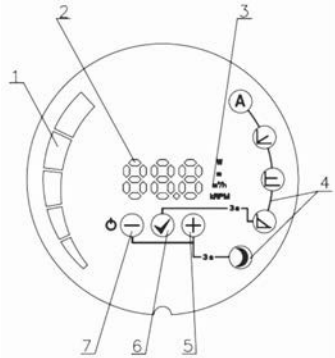
1. Bar Display of Values
2. Numerical Display of Values
3. Unit Display of the Currently Selected Parameter (Watts, Head Setting, Flow, or Speed)
4. Display of the Currently Selected Mode
5. **[+]** Button
6. **[✓]** Button
7. **[−]** Button

10.2 Switching the Pump On and Off

When the pump is powered for the first time, it operates with the factory default settings in automatic mode.

To switch the pump off, press and hold the **[−]** key for 5 seconds, until OFF is shown on the display. When the pump is switched off, the numerical display shows OFF.

To turn the pump on, press the **[−]** key briefly.

10.3 Pump Functions

[−] Key

Short press:
- Turn pump on
- Scrolling through parameters downwards, not changing parameter values.
- Scrolling through modes downwards when mode selection is selected.
- Changing parameters downwards when setting parameter values.

Long press:
- 3 seconds together with **[+]** key to select night setback mode.
- 5 seconds to switch off the pump.
- 5 seconds together with **[✓]** and **[+]** keys to restore pump to factory default settings.

[✓] Key

Short press:
- To confirm currently selected values of both mode and parameter.

Long press:
- 3 seconds to enable mode selection.
- 5 seconds together with long press on **[+]** and **[−]** keys to restore pump to factory default settings.

8

[+] Key

Short press:
- Scrolling through parameters upwards, not changing parameter values.
- Scrolling through modes upwards when mode selection is selected.
- Changing parameters downwards when setting parameter values.

Long press:
- 3 seconds together with [–] key to enable night setback mode.
- 5 seconds together with [✓] and [–] keys to restore pump to factory default settings.

10.4 Operation and Mode Selection

Once the desired mode is selected, the factory default parameter is displayed numerical display (except for Auto Mode). If required, the parameter value can be changed with the [+] or [–] key, then confirm the parameter setting by pressing the [✓] key. To activate or deactivate the night setback feature, simultaneously press and hold the **[+]** and **[–]** keys for 3 seconds.

To scroll through the parameter values within a mode, use the **[+]** or **[–]** keys. The desired parameter is selected (see individual mode) with the [✓] key. The parameter value is then selected using the **[+]** or **[–]** keys. The selected value is confirmed using the [✓] key.

10 5 Mode Descriptions

The pump can operate in 5 different modes. We can set the pump in the most appropriate mode, depending on the system where the pump operates.

The pump modes are:
- Automatic Mode (factory default)
- Proportional Pressure (increased differential head as flow increases)
- Constant Pressure (constant pressure as flow increased)
- Constant Speed (user selectable to match system requirements)
- Combined Mode (all mode indicators are off)

To switch between modes (except night mode) press and hold the **[✓]** key for 3 seconds then select **[+]** or **[–]** key. **Once desired mode is selected, press the [✓] key to confirm.**

Automatic Mode

In automatic mode the pump automatically sets the operating pressure, depending on the hydraulic system. By doing so, the pump finds the optimal operating position. The parameters cannot be set; they can only be scrolled through. This mode is recommended in most systems.

Proportional Pressure
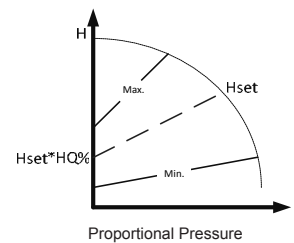
Proportional Pressure

The pump maintains the pressure with relation to the current flow. The pressure is equal to the set pressure (Hset on the drawing) at maximum power; at 0 flow it is equal to HQ % (default 50%, HQ % can be set on the pump webpage) of the set pressure. In between, the pressure changes linearly, relative to the flow. In regulated mode we can only set the pump pressure (Hset on the drawing). We can only scroll through the other parameters.
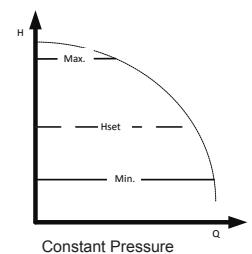
Constant Pressure

The pump maintains the currently set pressure (Hset on the drawing), from 0 flow to maximum power, where the pressure begins to drop. At constant pressure, we can only set the pressure (Hset on the drawing) which the pump will maintain. We can only scroll through the other parameters.

Constant Pressure

Constant Speed

The pump operates with the currently set speed (RPMset on the drawing). In the unregulated mode, we can only set the speed at which the pump will operate. We can only scroll through the other parameters.
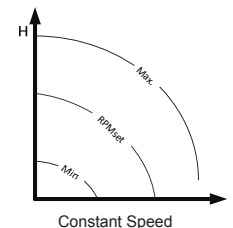
Combined Mode

Multiple limits can be set only over the web interface. None of the other modes are on.

Constant Speed

Night Mode

When the pump operates in night mode, it automatically switches between the selected operating mode and night curve. The transition to the night mode depends on the fluid temperature in the system. When the night mode is enabled, its icon illuminates and the pump operates in the selected operating curve of the mode. When the pump identifies the media temperature falling by 60 to 70 F° (15- 20 C°) over a 2 hour time period, the icon starts to blink and the pump switches to the night curve. When the fluid temperature rises again, the icon stops blinking and the pump switches to the operating curve in the selected operating mode. The night mode operates only in combination with the above indicated modes. It is not an independent operating mode.

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10.6 Restoring Factory Settings

To restore factory defaults, press and hold all three buttons for 5 seconds. The pump will be set to the automatic mode of operation. Any previously set values for pressure and RPM will be deleted.

11. SPECIFICATIONS

11.1 Application:

- Maximum Operating Pressure: 175 PSI (12 bar)
- Water Temperature Range: 36º – 230ºF (2.2º – 110ºC)
- Ambient Operation Temperature Range: 32º – 104ºF (0º – 40ºC). Ambient temperature should be 104ºF (40ºC) or lower when fluid temperature exceeds 194ºF (90ºC).
- Relative Humidity: Max. 95%
- Designed for closed loop heating and cooling systems pumping water or a water/glycol mixture.
- NPSHr - Minimum static inlet pressure at pump suction to avoid damage to the bearing assembly:

FLUID TEMPERATURES	VR15 & VR20 (PSI/bar)	VR25 & VR30 (PSI/bar)
112ºF (50ºC)	7.3 / 0.5	4.35 / 0.3
176ºF (80ºC)	11.6 / 0.8	14.5 / 1.0
230ºF (110ºC)	20.3 / 1.4	23.2 / 1.6

- For indoor use only - employer uniquement a l'interieur.

11.2 Electrical Ratings:

Pump Ratings	1 phase, 110-240V, 47-63Hz (VR15 & VR20)
	1 phase, 230-240V, 47-63Hz (VR25 & VR30)
Power Consumption (HP)	VR15 = 0.027 - 0.68 HP
	VR20 = 0.035 - 1.088 HP
	VR25 = 0.054 - 1.496 HP
	VR30 = 0.054 - 2.175 HP
Power Consumption (W)	VR15 = 20 - 500W
	VR20 = 26 - 800W
	VR25 = 46 - 1100W
	VR30 = 40 - 1550W
Rated Current (1 phase, 230V)	VR15 = 5.6-2.8A
	VR20 = 7.2-3.6A
	VR25 = 5.3A
	VR30 = 7.2A
Current Limit (Max.)	VR15 & VR20 = 6A
	VR25 & VR30 = 8A
24V Supply Output	Max. Current up to 100 mA, Output Voltage of 24V±20%, Output Ripple under 1V
Relay Output:	8A, Max. Voltage 250VAC, 48VDC Max. Load upto 500VA
Digital Inputs:	Max. Input Voltage = 32VDC
	2 Inputs & 1 Output
	Logical »1« Voltage > 8V, Logical »0« Voltage < 2V
Ethernet:	Connector = RJ-45
	Services = http server and client, FTP server

11.3 Standards, Protection and Connection:

- Insulation:ClassH
- Enclosure:Class2,IP44
- Integrated Motor Protection (electronically protected)
- Continuous Duty
- UL778,1004-1,508C
- CAN/CSAC22.2#108,#100,#107.1EMC(89/366EEC):EN61000
- LVD(73/23/EC):EN60335-1,EN60335-2-51
- Machine Safety (98/37/EC): EN ISO 12100
- Flange Connections: ANSI 4-bolt

11.4 Materials of Constructin:

- Casing................Cast Iron, Cataphoresis Coated
- Impeller.............Stainless Steel
- Shaft....................Stainless Steel
- Bearing..............Metal Impregnated Carbon

Section 2. Controller Operation

12. FEATURES

This section describes the controller features for VR15-3 through VR 30-3 range of pumps. The controller is used for various remote control applications, including:

- Remote on/off
- Analog 0..10 V voltage control
- Modbus remote control
- Status relay feedback
- Web access over Ethernet

There are several possible connection configurations. Not all functions can be used simultaneously.

- on/off + 0..10 V + relay output
- Modbus RTU + Relay output
- Ethernet + on/off + 0..10
- Modbus RTU + Ethernet
- Ethernet + on/off + relay output

12.1 Specifications

Below is an overview of Controller specifications. For details, please refer to appropriate sections of this manual.

GENERAL DATA		
Ambient humidity	< 95 % relative, non-condensing	Also see appropriate pump data for other ambient specifications.
Power supply and connection	5 V @ 500 mA supplied by the pump	6-pin connector further extended for display.

MODBUS SPECIFICATIONS

|		
Data protocol	Modbus RTU	
Modbus connector	Screw-less terminals	2+1 pins. See section 16.3 "Connection to Modbus"
Modbus connection type	RS-485	
Modbus wire configuration	Two-wire + common	Conductors: A, B and COM (Common). See section 16.3 "Connection to Modbus".
Communication transceiver	Integrated, 1/8 of standard load	Connect either via passive taps or daisy chain.
Maximum cable length	1200 m	See section 16.5 "Termination".
Slave address	1-247	Default is 245, settable over Modbus. See section 16.4 "Speed, parity and address".
Line termination	Not present	Line termination is not integrated. For low speed/short distance, termination can be omitted. Otherwise, terminate the line externally on both ends.
Supported transmission speeds	1200, 2400, 4800, 9600, 19200, 38400 baud	Settable over Modbus register [default=19200].
Start bit	1	Fixed.
Data bits	8	Fixed.
Stop bits	1 or 2	1 stop bit minimum, up to 2 when parity not enabled [default=1]
Parity bit	Even/odd/none	[default=Even]
Modbus visual diagnostics	LED2	Flashing yellow when data reception detected. Combined (OR) with Ethernet ACT function.
Maximum number of Modbus devices	247	Limited by possible Modbus addresses to 247. 1/8 nominal load enables 256 devices.
Maximum Modbus packet size	256 bytes	Including address (1) and CRC (2) bytes.
Isolation	Common ground (COM) with SET1, SET2 and SET3.	Modbus shares common ground with other signals.

ETHERNET SPECIFICATIONS

Ethernet connector	RJ-45	10BASE-T, 10Mbit/s connection.
Connection type and services	- Web server (port 80) - Firmware update over web interface - Optional Modbus RTU over TCP/IP	
Default IP address	192.168.0.245	192.168.0.246 for right twin pump.
Ethernet visual diagnostics	LED1 / LINK	Slowly blinking when module is powered, permanently lid when link established.
	LED2 / ACT	Flashing yellow when data reception detected. Combined (OR) with Modbus data reception indication.

MODE SELECTION SWITCH

Adjustment	10 position rotary switch	Position read at power-on. Used for relay configuration and module configuration reset.

Analog signals (SET1, SET2, SET3)		
Input voltage range	-1 to 32 VDC	When used as input.
Output voltage range	0 to12 V	When used as output. 5 mA max. Load allowed per output.
Input resistance	~100 kΩ	0.5 mA load is added for most configurations.
Output current sink range	0 to 33 mA (4-20 mA)	Current sink to COM if configured as output.

Relay specifications		
Connection type	Screw-less terminals	
Rating	- 250 VAC, 8A	Potential free changeover contact.
	- 48VDC, Max Load Upto 500VA	

13. CONTROLLER LAYOUT
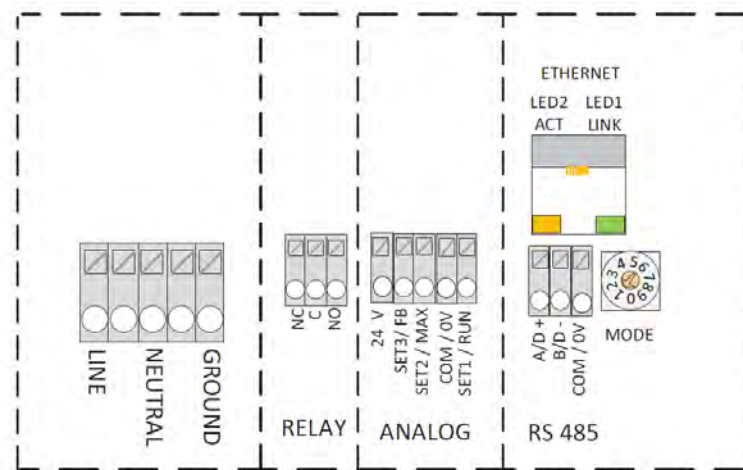
Terminal Designation	Description
MODE	Mode selection rotary switch. Used to configure mode of operation for the circuit. See section 14.3 "Module mode selection"
LED1 / LINK	Slowly blinking when module is powered. Blinking fast when Modbus Error. Permanently lid when Ethernet link established.
Ethernet	10BASE-T RJ-45 connector.
LED2 / ACT	Indicates Ethernet activity or Modbus activity.
B/D-	RS-485 negative data signal for Modbus.
A/D+	RS-485 positive data signal for Modbus.
SET1 / RUN	Control signal 1.
COM / 0V	RS-485 common and analog input common (ground).
SET2 / MAX	Control signal 2.
SET3 / FB	Control signal 3.
NC	Normally closed relay contact. Opens when relay is active.
C	Relay common contact.
NO / OK	Normally open relay contact. Closes when relay is active.

13.1 Connection Considerations

- All cables connected must be heat-resistant to at least +185 °F.
- All cables connected must be installed in accordance with The National Electric Code / NFPA 79 / EN 60204-1.
- All wires to the communications module must be connected to the terminals or cut. No loose wiring permitted.

WARNING!

- If voltages over 24 VAC/DC are possible on NO, C, NC terminals:
  - Wires should be routed so no wire crosses the center barrier.
  - Relay cable (NO, C, NC) must be separated from all other wiring with reinforced insulation.
  - Cable outer layer must not be stripped longer than 0.59 inches. See "Cabling preparation" below.

WARNING! Before performing any work on the module, make sure that the pump and module electricity supply has been switched off and that it can- not be accidently switched on.

13.2 Connection Examples

DEFAULT (FACTORY) CONFIGURATION
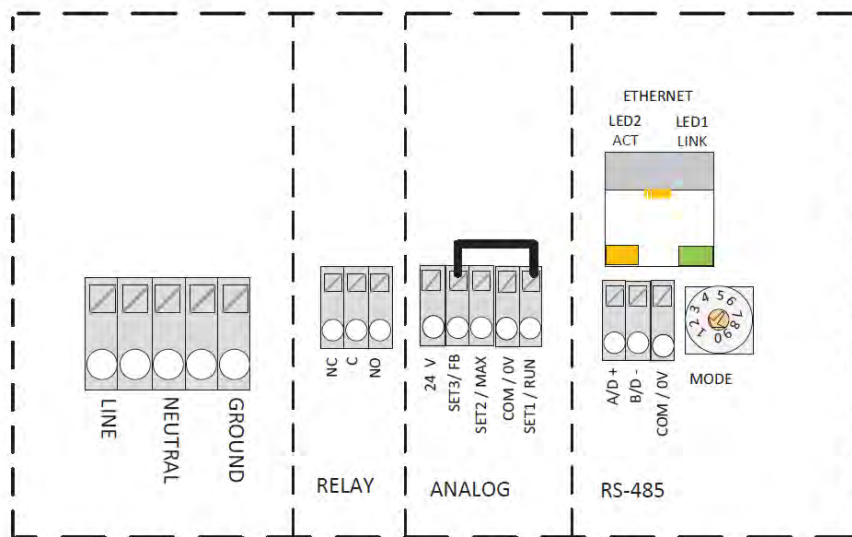
RELAY AND MODBUS CONNECTION
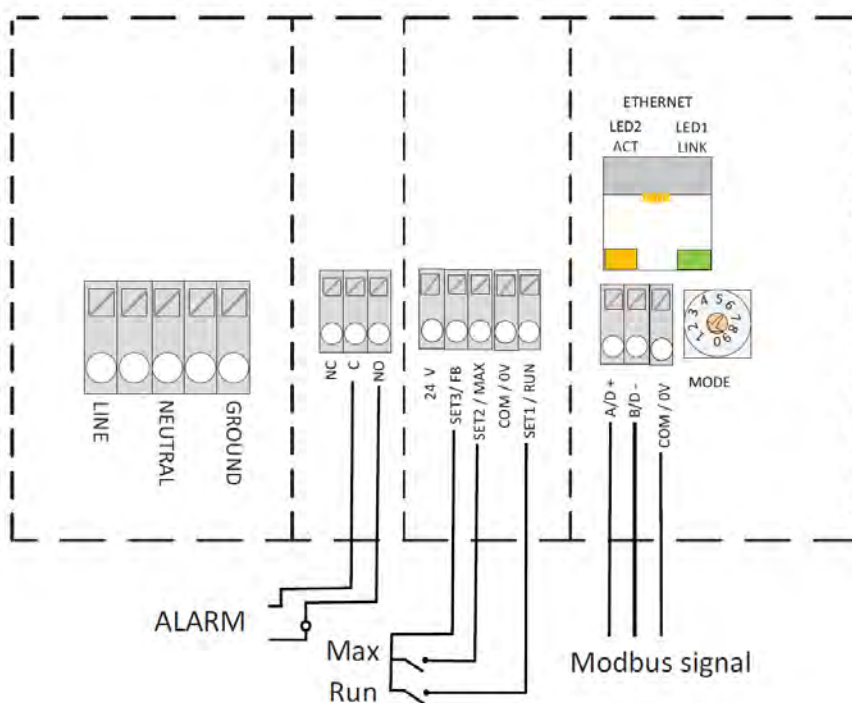
RELAY AND ETHERNET CONNECTION
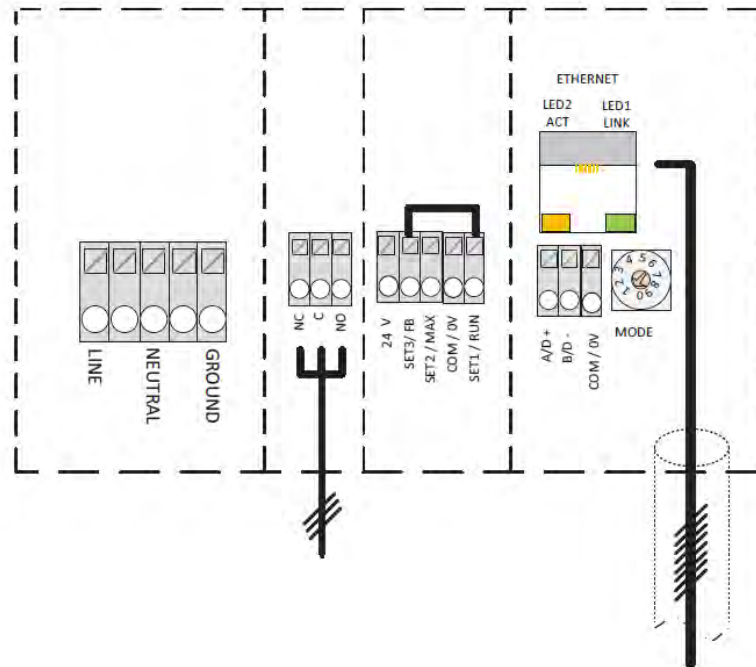
NOTE: 7/8" max length Ethernet connector recommended. The Ethernet connection has a sharp cable bend angle and reducing the connection terminal length reduces this problem.

NOTE: To maintain pump IP protection, the network cable should be pulled through the gland inlet and then crimped to a connector.

14. CONTROL MODES AND PRIORITIES

14.1 Setting Priority

Several signals will influence the pump operation. For this reason, settings have priorities as shown in the table below. If two or more functions are active at the same time, the one with highest priority will take precedence.

Priority	Pump control panel & Ethernet settings	External signals[1]	Modbus control
1	Stop (OFF)		
2	Night mode active[2]		
3	Max. RPM (Hi)		
4		Min. curve[4]	
5		Stop (Run not active)	
6		Max. curve[4]	Stop[3]
7		Set point setting[4]	Set point setting[3]
8	Set point setting[4]		

Examples:
- Stop on the pump display panel will stop the pump, regardless of external set point.
- If External Run input is inactive, the pump cannot be started over Modbus, but can be set to max RPM on the display panel.

14.2 Control Variables

Pump will respond to external controls according to selected pump operating mode. Consult proper pump operating manual for explanation.

Symbol	Regulation mode	Module set point controls:
Ⓐ	Auto mode	- (RUN ONLY)
	Proportional pressure	Maximum head
	Constant pressure	Maximum head
	Constant speed	Speed (RPM)
	Combined[5]	- (Web interface only)
☾	Night mode[6]	- (RUN only)

---

[1]Not all inputs are available in all modes.
[2]External and Modbus Stop signals become active in night mode. Due to possible confusion, use of night mode is discouraged while using external control.
[3]Only available when pump is bus controlled.
[4]Not available when pump is bus controlled.
[5]Multiple limits can be set. Not available on all pumps.
[6]Night mode is not independent regulation mode.

14.3 Module Mode Selection

> ⚠️ **WARNING!** Before performing any work on the module, make sure that the pump and module electricity supply has been switched off and that it cannot be accidently switched on.

There is a mode selection rotary switch in the terminal box. It can be rotated by gently inserting a screwdriver into the arrow mark on top and rotating the switch to desired value.

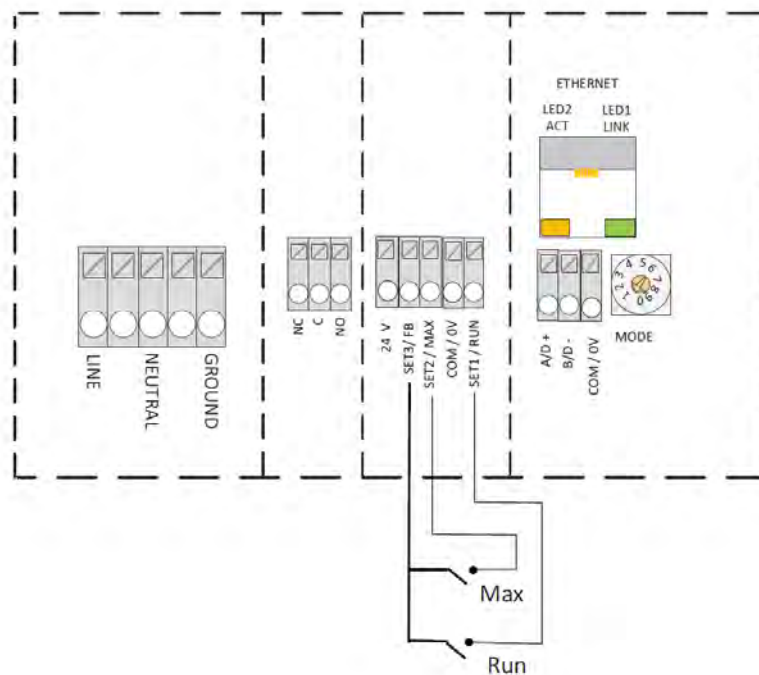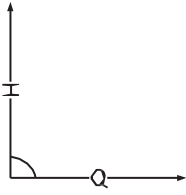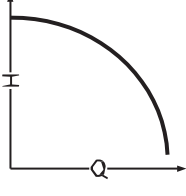| Mode switch position	Function	Description
0	Free configuration	Terminal functions are configured over Ethernet interface.
1	Mode 1 Factory Default	SET1 = RUN input SET2 = MAX input SET3 = FB (10.5 V) output, used to supply RUN and MAX inputs. External voltage source can also be used. RS-485 = Modbus interface. See section "14.4 Mode 1". **Application: 0-10 VDC Speed or head control, external OFF**
2	Mode 2	SET1 = RUN input SET2 = SPEED input SET3 = FB (10.5 V) output, used to supply RUN and MAX inputs. External 5-24 V voltage source can also be used. RS-485 = Modbus interface See section "14.5 Mode 2".
3...5	RESERVED	Reserved for future or customer specific use.
6	Show relay configuration	LED1 and LED2 will show relay configuration. See section "5 Relay output".
7	Change relay configuration	Relay configuration will be increased (0->1, 1->2, 2->0) when electricity is turned on. LED1 and LED2 will show current relay configuration. See section "5 Relay output".
8	Twin reset to factory	Same as Mode 9, with exception of: module IP address is set to 192.168.0.246 Twin IP address is set to 192.168.0.245
9	Reset to factory	This mode will set communication interface to default values. Main purpose is to restore default settings. **NOTE:** • Disconnect any SET1, SET2 and SET3 connections when using this mode to prevent possible harm to controller. SET1, SET2, SET3 will output test voltages of 10 V, 7 V and 5 V respectively. RS-485 port is actively driven. Relay will cycle. This is used for testing purposes. • It is recommended that all module wires are disconnected to prevent possible harm to external controllers.

14.4 Mode 1
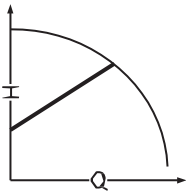
Mode 1 is most often used mode of operation. It has 2 pre-prepared inputs that can be used for either digital control or with analog control voltages. Additional 10.5V output provides voltage feedback for analog or digital control.

| Terminal designation	Signal function
SET1 / RUN	RUN input. Signal load 0.5 mA.
COM / 0V	Common ground for voltage input.
SET2 / MAX	MAX input. Signal load 0.5 mA
SET3 / FB	10.5 V feedback voltage for SET1 and SET2.

DIGITAL (SWITCH) CONTROL

COMMON MODE 1 CONNECTION CONFIGURATIONS (SWITCH)

Contact position		Function	Description
RUN	**MAX**		
SET 3/FB SET 1/RUN	SET 3/FB SET 2/MAX	Stop the pump	The pump is stopped
SET 3/FB SET 1/RUN	SET 3/FB SET 2/MAX	Start the pump	The pump will run with internal set point
		Minimum curve	The pump will run with minimal speed for selected regulation mode
		Maximum curve	The pump will run with maximum speed form selected regulation mode

ANALOG (SWITCH) CONTROL

OPTIONAL MODE 1 CONNECTION CONFIGURATIONS (ANALOG)
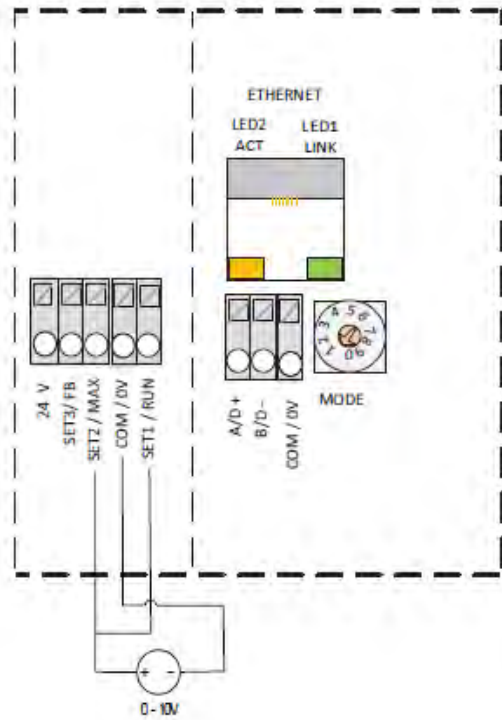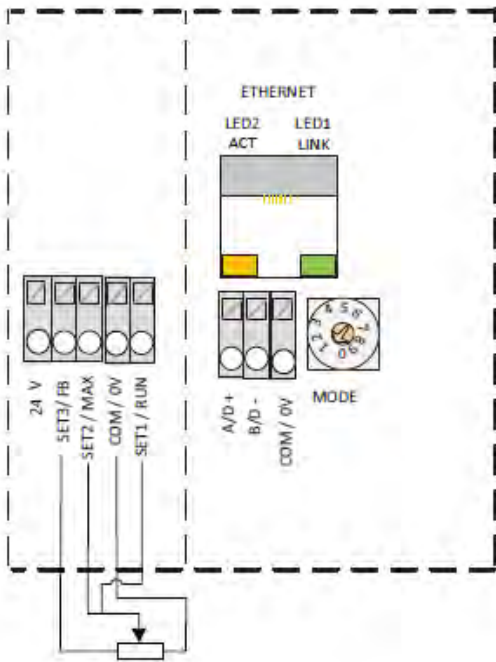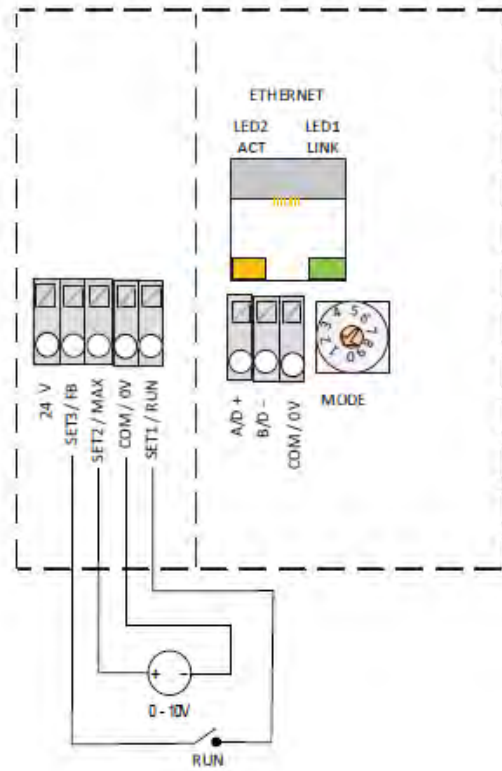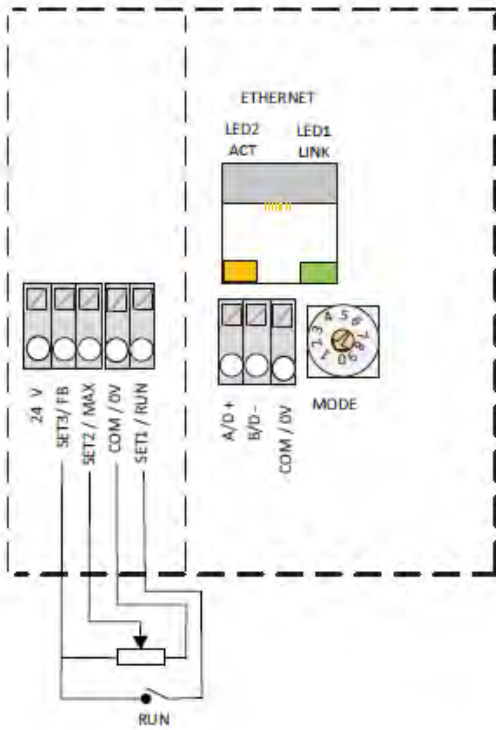
RUN voltage	MAX voltage	Function
< 2 V	< 1 V	Pump stopped
> 3 V	< 1 V	Internal regulation
< 2 V	2..10 V	Minimum curve
> 3 V	2..10 V	

Figure 1: External 2..10 V transfer curve for Mode 1

Figure 2: External 0..10 V transfer curve for Mode 1

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14.5 Mode 2

Mode 2 is used for external 0..10V voltage control.

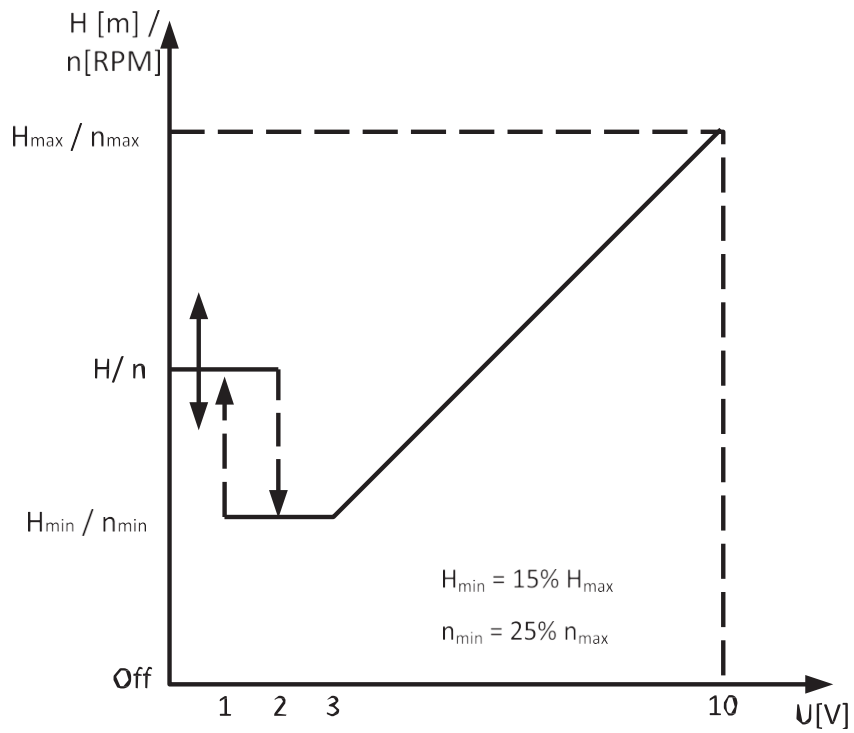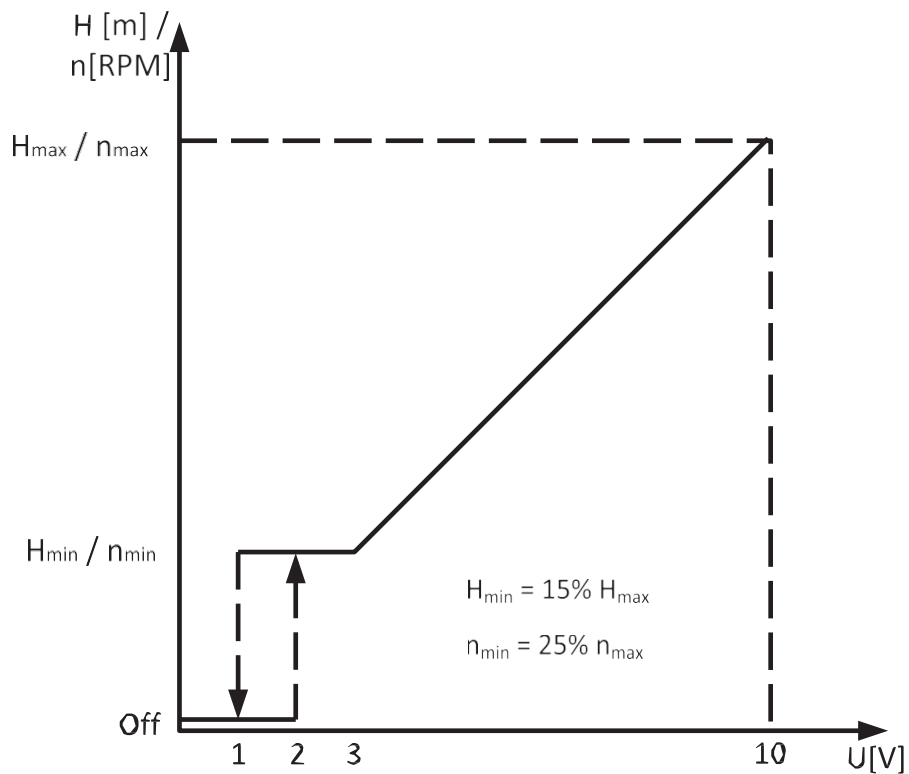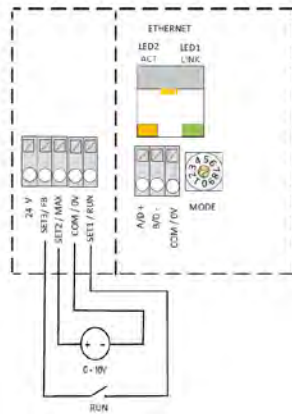| Terminal designation	Signal function
SET1 / RUN	RUN input. Signal load 0.5 mA.
COM / 0V	Common ground for voltage input.
SET2 / MAX	SPEED input. Signal load 0.5 mA
SET3 / FB	10.5 V feedback voltage for SET1 and SET2.

MODE 2 CONNECTION CONFIGURATIONS

RUN voltage	MAX voltage	Function
< 2 V	0..10 V	Pump stopped
> 3 V	0..10 V	

Figure 3: External 0..10 V transfer curve for Mode 2
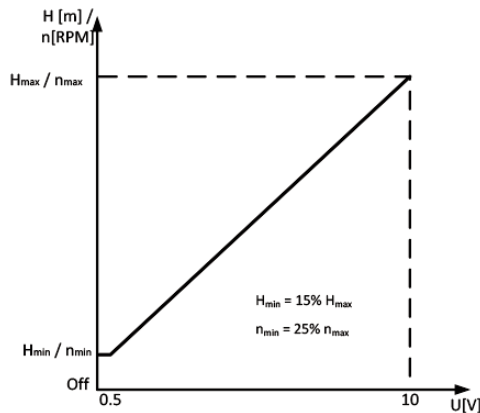
15. RELAY OUTPUT

Terminal designation	Terminal description
MODE	Mode selection rotary switch. Used to show and configure mode of operation for relay.
LED1 / LINK	Slowly blinking when module is powered, permanently lid when link established[7].
LED2 / ACT	Flashing yellow when data reception detected. Combined (OR) with Modbus data reception indication [7].
NC	Normally closed relay contact. Opens when relay is active.
C	Relay common contact.
NO / OK	Normally open relay contact. Closes when relay is active.

The module contains one status relay, used to signal pump operation or malfunction. See table following for functionality.

Relay configuration	Output status	Description	Relay position	LED status[7]	
				LED 1	LED 2
0	Error [default]	Only active when the pump is powered up and detects a problem with operation.	NC NO C	LED on	LED off
1	Ready	The relay signal is active when the pump is ready for operation.	NC NO C	LED off	LED on
2	Operation	The relay signal is active as long as the pump is operating. If the pump comes to a stop or an error occurs, relay will deactivate.	NC NO C	LED on	LED on
-	-	Relay output not active.	NC NO C		

Relay configuration number can be modified by either the web interface, Modbus register 012 or the Mode switch.

16. . ETHERNET

Terminal designation	Description
MODE	Can be used to reset network configuration
LED1 / LINK	Slowly blinking when module is powered, permanently lid when link established.
Ethernet	10BASE-T RJ-45 connector.
LED2 / ACT	Indicates Ethernet activity or Modbus reception.

The communications module has a built in web server which allows you to access your pump directly from an existing Ethernet network. Direct connection to a computer is also possible with a crossover cable.

The web server uses HTML pages to set/view:
• Regulation mode settings
• Regulation parameters (power, RPM, head, flow, efficiency)
• Relay settings
• External control inputs
• Current and previews error
• Pump statistics (power consumption, run time and other).

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[7]When mode Mode 6 or Mode 7 is selected, LED1 and LED2 will show relay configuration. See section "4.3 Module mode selection"

LED is on

LED is off

16.1 Bus Topology
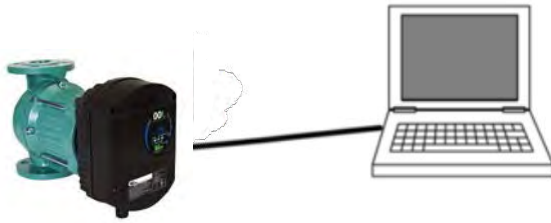
Figure 4: connecting to a computer with a crossover cable

Figure 5: connecting to a network via router

16.2 Connection to a Pump Ad-Hoc

When connecting directly with the computer, Ethernet must be used to connect with the pump. The pump can then be accessed by typing IP address "192.168.0.245" or "00e" (or "192.168.0.246" or "00e2" if it is a left twin pump) in to your web browsers address bar.
The computer must be set up to have a dynamic IP address.

16.3 Connection to a Pump via Router

When connecting via a router, Ethernet must be used to connect with the pump. The pump can then be accessed by typing IP address "192.168.0.245" or "00e" or "192.168.0.246" or "00e2" if it's a left twin pump in to your web browser's address bar. The computer must be set up to have a dynamic IP address.

16.4 Pump Configuration over Ethernet

Pump configuration is possible via HTML pages that offer different options:
1. **Overview** (default page when you connect to the pump, web page OVERVIEW) displays pump operation summary i.e.:
    • Operating mode,
    • Power consumption,
    • Head,
    • Estimated flow,
    • RPM
    • Estimated efficiency,
    • Priority set point,
    • Mode switch position
    • Input/output status
    • Replay status
    • Error code
    • Twin pump status
    • Night mode status
    • Motor temperature
    • Heat sink temperature,
    • Number of restarts.

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2. **Pump settings** (web page PUMP) is meant to provide regulation and control (input and output) settings. It has control over:
   - Operation mode
   - Head limit(depending on pump mode)
   - RPM limit (depending on pump mode),
   - Ratio between head and flow HQ (depending on pump mode)
   - Input/output control.
   - Relay control.

Setting can be saved to permanent memory by pressing the SAVE button.

3. **Network settings** (web page NETWORK) provide a way to change network configuration:
   - NetBIOS name - is a local network name service. Instead of '192.168.0.245' you can for example use 'http://00e'. Default: 00e,
   - Pump IP address - is a pump network address. The pump is seen as http server on this address, default: 192.168.0.245,
   - DHCP server - provides lease for "point to point" connection (cross-over cable to computer for example). Will disable itself if another DHCP server is found,
   - DHCP client will automatically acquire DHCP address from the network,
   - Default gateway – provides connection route to larger networks. This is usually a router address, default: 192.168.0.1,
   - Subnet mask - sets subnet address range that is on the same subnet and can be reached directly. The rest of communication goes over the gateway, default: 255.255.255.0,
   - Twin mode with IP - will connect two pumps for alternating operation. When two pumps are configured for twin mode, they will switch about once per day. Setting this field to inexistent IP will disable this option! Set it so the first pump references the second and vice versa. Default: 192.168.0.246.

Setting can be saved to permanent memory by pressing the SAVE button.

4. **Log** (web page LOG) displays possible previous and current errors.

5. **MORE** (web page MORE) has link to additional manuals and tools that might be available. Has an option to update NMTC modules software, by user inputted software file (available at your local serviceman or our webpage).

17. MODBUS

17.1 Modbus Related Interface

Designation	Description
MODE	Can be used to reset network configuration.
LED2 / ACT	Indicates Ethernet activity or Modbus reception.
B/D-	RS-485 negative data signal for Modbus.
A/D+	RS-485 positive data signal for Modbus.
COM/0V	RS-485 common and analog input common (ground).

17.2 Bus Topology

The VR Control is a Modbus slave, connected directly to a Modbus RTU network. Connection can be made in either daisy chain style (if cabling allows such a connection) or a limited length passive tap. Schematic example is in Figure 6.
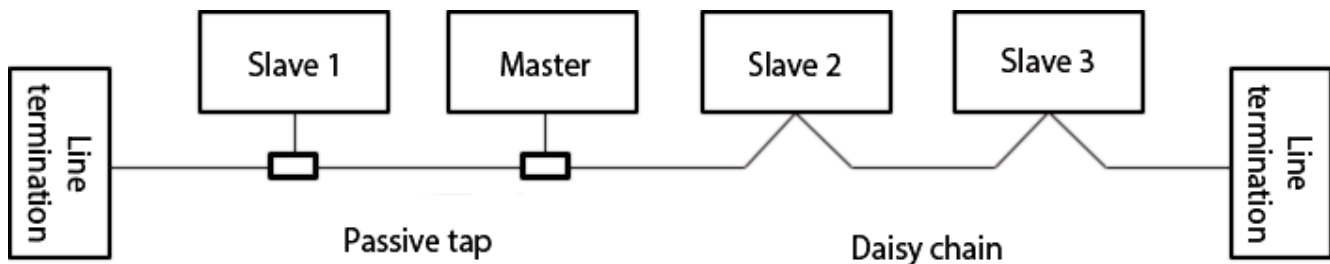
Figure 6: Example of Modbus network

Typically, only one master device is connected to the serial bus, and one or several slaves are also connected to the bus. Slaves do not communicate with each other and will never transmit data without receiving a proper request from the master device.
Up to 32 single load devices can be connected to one RS-485 Modbus
system without using a repeater. As this module is a 1/8 load device, up to 256 modules can be connected to the bus. Repeaters can be used to extend the maximum transmission distance and increase device count if needed.

17.3 Connection to Modbus

A screened, twisted-pair cable should be used. The cable screen must be connected to the COM terminal and connected to safety ground at one point.

17.4 Speed, Party and Address

By default, each device is set to 19200-E-1 (even parity), address 245.
Properly set registers in section "7.7 Controller Configuration register block" to configure each device before connecting it to existing network. Optionally power each device one by one, configuring the settings before adding an- other one.
There are several ways to restore forgotten Modbus connection settings:
    1) Configure the module over Web interface. See section 6 "Ethernet".
    2) Reset the module to factory defaults. See Mode 9, section "4.3 Module mode selection".
    3) If only address is unknown, Modbus "broadcast" (0x00) address can be used to write new address. Use care-
       fully as the value will be written to all connected devices.

17.5 Termination

Control module contains neither termination nor bias circuitry. RS-485 wiring should be externally terminated if needed.

For short wiring and/or low baud rate, interface can operate without termination. However it is recommended that termination (~150 ohm resistor) is added on both ends of bus wiring. There are wiring length limits regarding to speed and termination:

Maximum speed [baud]	Maximum cable length [ft]
38400	4000, terminated cable
9600	4000
19200	1800
38400	900

NOTE: Any branch/derivative cable is considered unterminated. Keep them short, below 250m combined for maximum speed and reliability.

17.6 Register Block Overview

Controller Modbus RTU registers are grouped in the following register blocks:

Start address	Register block	Readable/Writable	Description
001	Controller configuration	R/W	Configuration of the Controller module.
021	Controller status	R	Status registers for the Controller module.
101	Pump control	R/W	Pump control registers.
201	Pump status	R	Status data from the pump.
301	Pump data	R	Measured data from the pump.

All addresses contain 16 bit (one Word) registers. Some are bit interpreted while others are combined for a 32 bit value.
NOTE**:** All register addresses are 1-based. Address 001 is thus transmitted over bus as 0x0000.

17.7 Controller Configuration Register Block

Registers in this block are read with either function codes 0x03 or 0x04. They can be written as holding registers with function codes 0x06 and 0x10.

NOTE: All values in this block are stored in nonvolatile memory immediately after write.

NOTE: See section "4.3 Module mode selection" and use Mode 8 or 9 to restore default settings if you cannot access the controller after writing to these registers.

Address	Register name	Range	Resolution	Description
001	SlaveDelay	0..10000	1 ms	Delay in milliseconds for slave reply. This delay will be added to every Modbus reply [default = 0].
002	RESERVED			
003	ModbusAddress	1..247	1	Modbus address [default = 245].
004	BitRate	0..5	1	Modbus transmission speed enumeration. 0 = 1200 baud 1 = 2400 baud 2 = 4800 baud 3 = 9600 baud 4 = 19200 baud [default] 5 = 38400 baud
005..008	RESERVED			
009	Parity	0..2	1	Parity setting to be used for communication. 0 = No parity 1 = Even parity [default] 2 = Odd parity
010	StopBits	1..2	2	Stop bits used for communication. 2 stop bits will only be used when "Parity" is set to 0. 1 = 1 stop bit [default] 2 = 2 stop bits
011	RESERVED			
012	RelayControl	0..2	1	Configures module relay output. 0 = indicates fault 1 = indicates pump ready 2 = indicates pump operation See section "5 Relay output".

17.8 Controller Status Register Block

Registers in this block are read with either function codes 0x03 or 0x04. They are read-only. This block can be used for various kinds of fault finding.

Address	Register name	Resolution	Description
021..022	RESERVED		
023	SoftwareVersion	0.1	Module software version
024..029	RESERVED		
030	ProductVersion	1	Product version [32x for NMTC module, x denotes hardware revision]
031	RESERVED		
032	SoftwareVersion	0.1	Module software version [10 = 1.0]

17.9 Pump Control Register Block

Registers in this block are read with either function codes 0x03 or 0x04. They can be written as holding registers with function codes 0x06 and 0x10

Address	Register name	Range	Description
101	ControlReg	b0: RemoteAccess	Control bit that sets local or remote control. Setting this bit will enable pump control over Modbus. 0 = Local 1 = Remote (controlled by Modbus master).
		b1: OnOffReq	Control bit that switches the pump on or off. 0 = Off (stop) 1 = On (start).
		b2..15: RESERVED	-
102	AltControlMode		Alternative Control mode. Use of register 108 is preferred. Sets the control mode enumeration. 0 = ConstantRPM 1 = ConstantRPM 3 = ConstantHead 4 = ConstantHead 5 = ConstantHead 6 = ProportionalHead 128 = AutoHeadMode **NOTE**: values outside this range reserved.
103	OperationMode		RESERVED
104	SetPoint	0.. 10000	Sets desired pump set point. 0 will stop the pump. 10000 will set the pump to maximum output for desired mode. Values outside of valid range will cause the pump to operate with front panel set values.
105	RelayControl	0..2	Configures relay output. 0 = indicates fault 1 = indicates pump ready 2 = indicates pump operation See section "5 Relay output".
106...107	RESERVED		
108	ControlMode	0..3	Sets the pump control mode. 0 = AutoHeadMode (Automatic head mode) 1 = ProportionalHead (Head proportional to flow) 2 = ConstantHead (Head is kept constant) 3 = ConstantRPM (Speed is kept constant) **NOTE**: values outside this range reserved. See section "4.2 Control variables" for exact parameter to be controlled.

17.10 Pump Status Register Block

Registers in this block can be read by means of function codes 0x03 and/or 0x04. They are read-only.

Address	Register name	Description
201	StatusReg	
	b0..b5: RESERVED	-
	b6: Rotation	Indicates if the pump is rotating (running) or not. 0 = No rotation 1 = Rotation.
	b7: RESERVED	
	Bit 8: AccessMode	Indicates if the pump is locally or remotely controlled. 0 = Local (a source with higher priority controls the pump) 1 = Remote (controlled by Modbus master).
	Bit 9: IsOn	Indicates if the pump is on or off. 0 = Off 1 = On It not necessarily indicate rotation as an error might stop the pump.
	Bit 10: Error	Indicates if there is a problem with proper operation. 0 = No problem 1 = Error present. Pump might still run.
	Bit 11: RESERVED	-
	Bit 12: RESERVED	-
	Bit 13: NearMaxSpeed	Indicates if the pump is running near maximum speed. 0 = No 1 = Yes. This flag is set when power or speed is over 95% of rated maximum.
	Bit 14: RESERVED	-
	Bit 15: NearMinSpeed	Indicates if the pump is running near minimum speed. 0 = No 1 = Yes. This flag is set when speed falls below 1/3 of rated maximum.
202	RESERVED	(TBD)
203	ControlMode	Indicates the actual control mode. 0 = ConstantRPM 1 = ConstantRPM 3 = ConstantHead 4 = ConstantHead 5 = ConstantHead 6 = ProportionalHead 128 = AutoHeadMode.
204	RESERVED	
205	ErrorCode1	Current first error code. 0 - when pump is operating without problems. This value will always be non-zero when there is an error present. See section "8.1 Error codes" for code details.

206	ErrorCode2	Second error code. Non-zero when there is more than one error. See section "8.1 Error codes" for code details.
207	ErrorCode3	Third error code. Non-zero when there is more than two errors. See section "8.1 Error codes" for code details.
208	Control Mode	Indicates the actual control mode. 0 = AutoHeadMode (Automatic head mode) 1 = ProportionalHead (Head proportional to flow) 2 = ConstantHead (Head is kept constant) 3 = ConstantRPM (Speed is kept constant). NOTE: values outside this range reserved. See section "4.2 Control variables" for exact parameter to be controlled.

17.11 Pump Data Register Block

Registers in this block can be read by means of function codes 0x03 and/or 0x04. They are read-only.

Modbus address	Register name	Range	Resolution	Description
301	Head		0.01 m	Pump head estimation in meters of water column.
302	Flow		0.1 m³/h	Pump flow estimation.
303	Efficiency		0.01 %	Estimated pump efficiency.
304	Speed		1 rpm	Motor speed.
305	Frequency		0.1 Hz	Motor frequency [100.0 Hz for 3000 rpm and 4 pole motor].
306..307	RESERVED			
308	ActualSetPoint	0..10000	0.01 %	Indicates actual set point of the pump. (-1 for internal pump regulation). tbd
309..311	RESERVED			
312 313	PowerHI PowerLO	$0..2^{32}$	1 W	Total power consumption of the system.
314..317	RESERVED			
318	CircuitTemp	-5500.. 16000	0.01 °C	Power electronics hotspot temperature.
319	MotorTemp	-5500.. 16000	0.01 °C	Motor compartment temperature.
320..321	RESERVED			
322	LiquidTemp	-5500.. 16000	0.01 °C	Liquid temperature.
323..326	RESERVED			
327 328	OperationTimeHI OperationTimeLO		1 hour	Total operation time (above zero speed) of the pump.[8]
329 330	TotalPoweredTimeHI TotalPoweredTimeLO		1 hour	Total power-on time of the module.[8]
331	RESERVED			
332 333	EnergyHI EnergyLO		1 kWh	Total energy consumption of the system.[8]

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[8] Not available on all models.
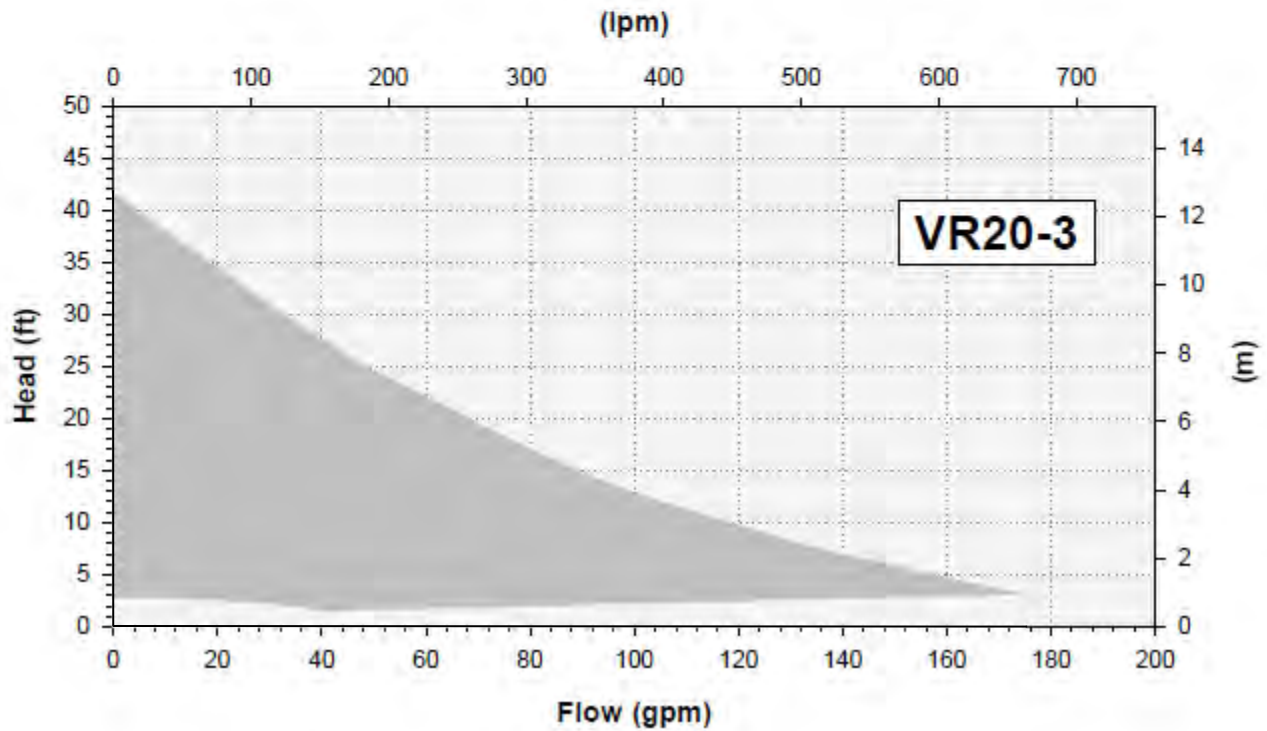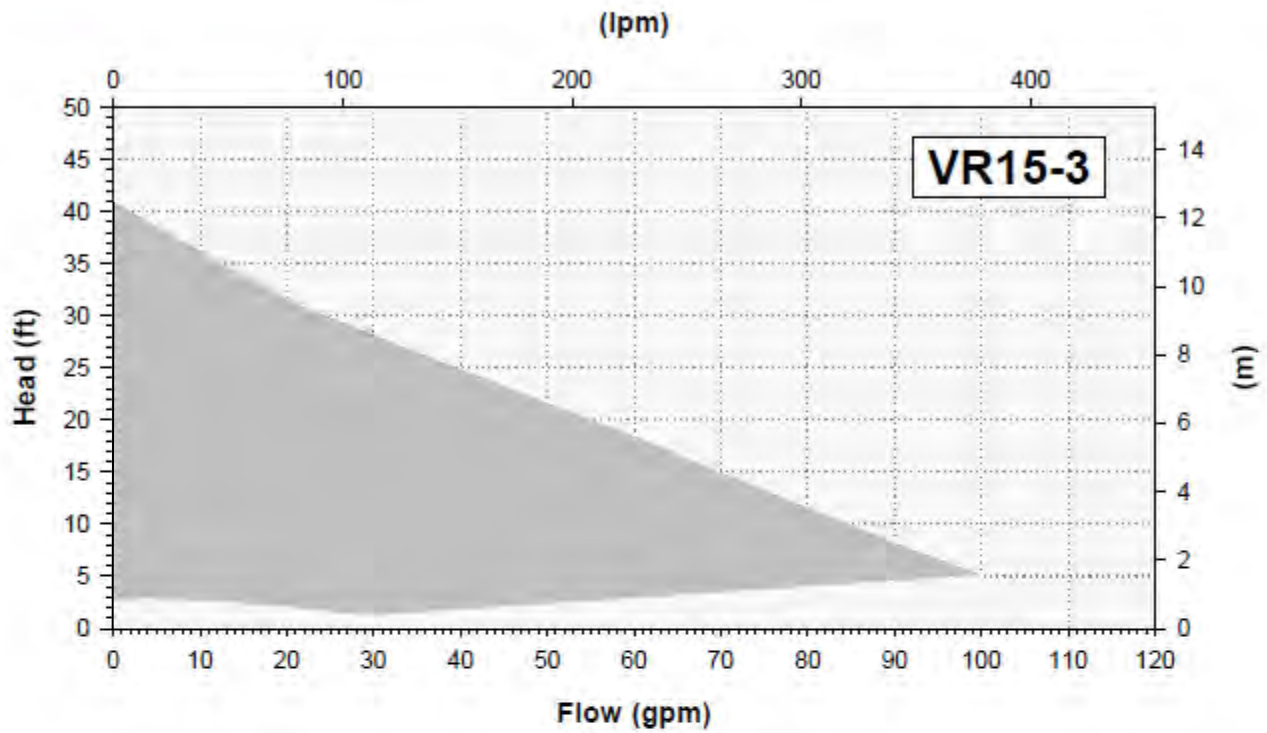
18. FAULT FINDING

19.1 Error Codes

The following codes will show up on display panel and on the appropriate Modbus registers to help you diagnose the cause of improper operation.

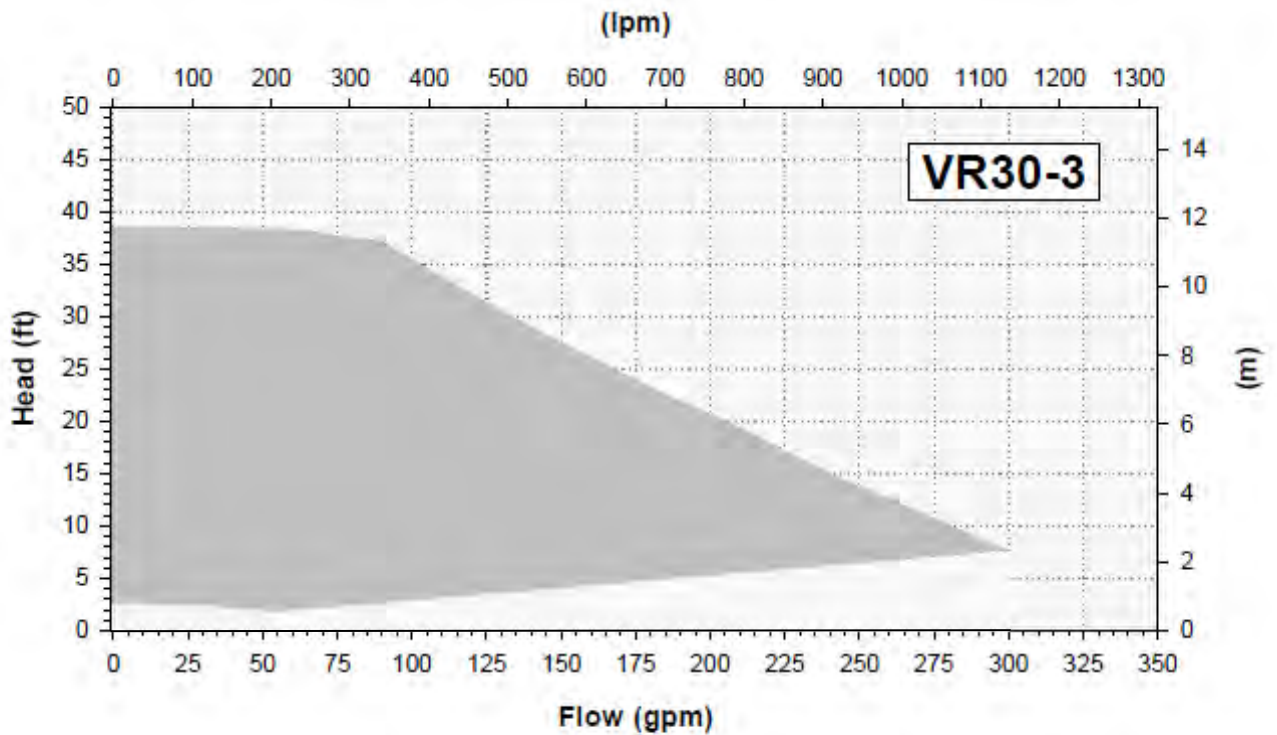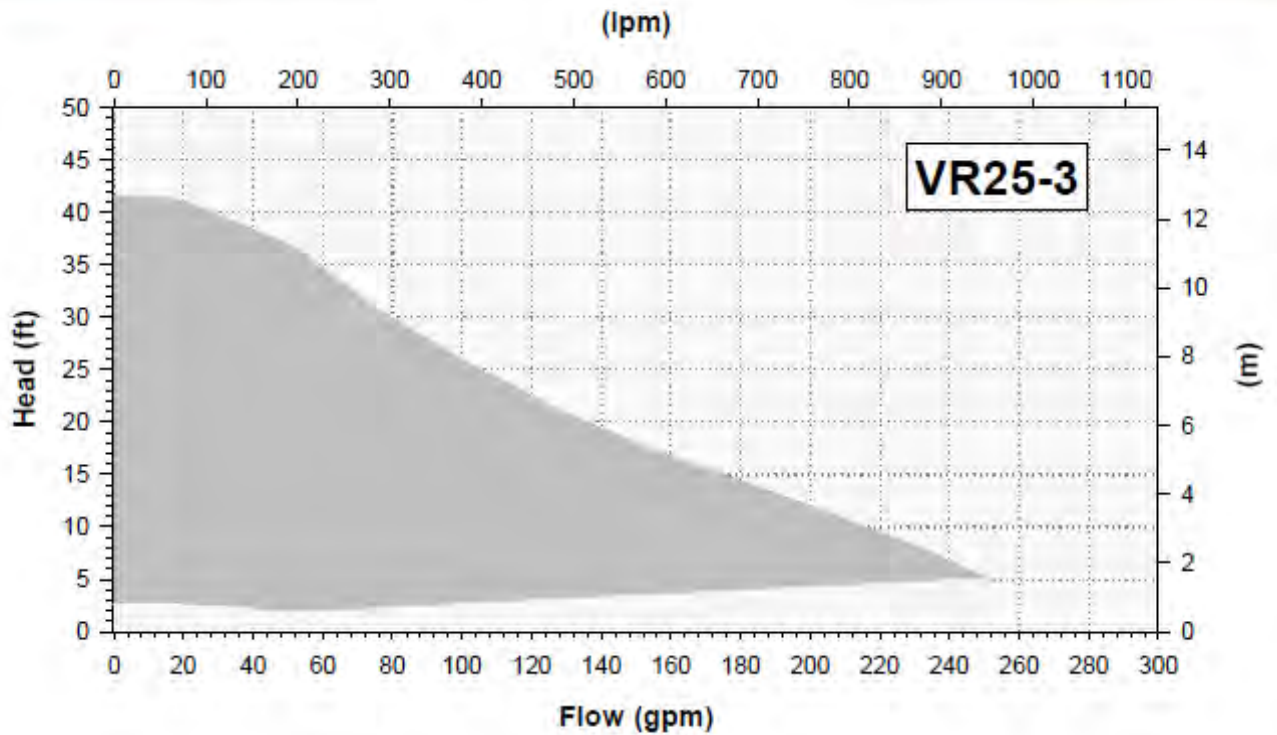| Error code	Description	Probable cause
E1x	*Load errors*	
E10 (drY)	Low motor load	Low load detected. Pump is running dry.
E11	High motor load	Motor might be faulty or viscous medium is present.
E2x	***Protection active***	
E22 (hot)	Converter temperature limit	Circuit is too hot and power was reduced to less than 2/3 of rated power.
E23	Converter temperature protection	Circuit is too hot to run, pump stopped.
E24	Converter overcurrent	Hardware overcurrent protection triggered.
E25	Overvoltage	Line voltage is too high.
E26	Undervoltage	Line voltage is too low for proper operation.
E3x	*Pump errors*	
E31	Software motor protection active	Average motor current was too high, pump load is much higher than expected.
E4x	***Device specific error codes***	***Electrical circuitry did not pass self-test.***
E40	General frequency converter error	One of the display segment diodes is faulty (open/short).
E42 (LED)	LED faulty	Display board does not detect proper connection to main board, but power supply is present.
E43 (con)	Communications failed	Voltage on DC link shunt (R34) not in expected range.
E44	DC link current offset	During MFG. TEST, this is 10 kΩ, 1% resistor for 10 °C..30 °C During operation, expected values are -55 °C..150 °C.
E45	Motor temperature outside limits	During MFG. TEST, this is 0 °C..50 °C. During operation, expected values are -55 °C..150 °C.
E46	Circuit temperature outside limits	During MFG. TEST, this is 0 °C..50 °C. During operation, expected values are -55 °C..150 °C.
E47	Voltage reference outside limits.	Comparison between internal references does not match.
E48	15V outside limits	15 V supply not 15 V.
E49	Test load does not match	No test load detected or current measurement does not work properly (MFG. TEST).
E5x	***Motor error codes***	
E51	Motor parameters out of range	Motor does not operate as expected.
E52	Thermal Protection Active	Motor Temperature is too high. Pump not operating
E53	Invalid Model Selected	Pump model not valid or out of range

00e VR15-30-3 **ECM** High-Efficiency Circulators

Taco
Comfort Solutions™
A Taco Family Company

PERFORMANCE

00e
series
ECM HIGH-EFFICIENCY CIRCULATORS

(lpm)

VR15-3

Head (ft)

(m)

Flow (gpm)

(lpm)

VR20-3

Head (ft)

(m)

Flow (gpm)

VR25-3

VR30-3

NOTES:

LIMITED WARRANTY STATEMENT

Taco, Inc. will repair or replace without charge (at the company's option) any product or part which is proven defective under normal use within one (1) year from the date of start-up or one (1) year and six (6) months from date of shipment (whichever occurs first).

In order to obtain service under this warranty, it is the responsibility of the purchaser to promptly notify the local Taco stocking distributor or Taco in writing and promptly deliver the subject product or part, delivery prepaid, to the stocking distributor. For assistance on warranty returns, the purchaser may either contact the local Taco stocking distributor or Taco. If the subject product or part contains no defect as covered in this warranty, the purchaser will be billed for parts and labor charges in effect at time of factory examination and repair.

Any Taco product or part not installed or operated in conformity with Taco instructions or which has been subject to misuse, misapplication, the addi-tion of petroleum-based fluids or certain chemical additives to the systems, or other abuse, will not be covered by this warranty.

If in doubt as to whether a particular substance is suitable for use with a Taco product or part, or for any application restrictions, consult the applicable Taco instruction sheets or contact Taco at [401-942-8000].

Taco reserves the right to provide replacement products and parts which are substantially similar in design and functionally equivalent to the defec-tive product or part. Taco reserves the right to make changes in details of design, construction, or arrangement of materials of its products without notification.

TACO OFFERS THIS WARRANTY IN LIEU OF ALL OTHER EXPRESS WARRANTIES. ANY WARRANTY IMPLIED BY LAW INCLUDING WARRANTIES OF MERCHANTABILITY OR FIT-NESS IS IN EFFECT ONLY FOR THE DURA-TION OF THE EXPRESS WARRANTY SET FORTH IN THE FIRST PARAGRAPH ABOVE.

THE ABOVE WARRANTIES ARE IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR STATUTORY, OR ANY OTHER WARRANTY OBLIGATION ON THE PART OF TACO.

TACO WILL NOT BE LIABLE FOR ANY SPE-CIAL, INCIDENTAL, INDIRECT OR CONSE-QUENTIAL DAMAGES RESULTING FROM THE USE OF ITS PRODUCTS OR ANY INCIDENTAL COSTS OF REMOVING OR REPLACING DE-FECTIVE PRODUCTS.

This warranty gives the purchaser specific rights, and the purchaser may have other rights which vary from state to state. Some states do not allow limitations on how long an implied warranty lasts or on the exclusion of incidental or consequential damages, so these limitations or exclusions may not apply to you.