HYDROX

Hydrox™ HCU Remote
Installation, operation and
maintenance instructions

Contents

1. Safety instructions

	Note
	Danger
	Harmful / irritating
	Use safety glasses
	Use protective footwear
	Use ear protection
	Use protective gloves
	Use protective clothing
	Use safety helmet
	Read user manual

Personnel

All hydraulic system installation, maintenance and repair work must be overseen by a supervisor and performed by a skilled hydraulic system fitter who is familiar with the operation and structure of the system. Anyone working with these systems must be made aware of the special requirements of the work, such as cleanliness.

General safety instructions

Hydraulic pipelines convey pressurized fluid. Any pipe, hose or coupling failure and the resulting oil burst can create a hazardous situation that may lead to serious injury.

Health hazards

Repeated skin contact with mineral oils and certain additives can cause eczema, rash or oil acne. Inhaled oil mist may also cause respiratory irritation, headache and nausea.

Oil mist spreading into the working area and oil leaking on the floor and other platforms increase the risk of slipping.

Noise level in hydraulic systems can be quite high. Always use hearing protection when in close vicinity of systems in operation. Use ear protection when noise level is over 85 dB.

Burn hazards

The temperature of oil may rise above 60°C. Oil as hot as this may cause burns.

Fire hazard

Oil mist mixed with air may explode even at temperatures below 200°C. Oil may also cause a fire when it comes into contact with hot machine parts. Oil leaking on the floor and machine frames and mixed with dust causes an extremely great fire hazard.

Oil jet hazard

Never handle pressurized hydraulic hoses and similar components with bare hands, since high-pressure leaks may penetrate the skin.

Always wear eye protection, particularly when working with systems in operation.

Hose impact hazard

Pressurized bent hoses tend to straighten and straight hoses start to yaw due to the reacting force of the free fluid discharge. Hoses are the weakest components of a hydraulic system. Always replace old hoses in due time.

Safety during maintenance and repair

The hydraulic system must primarily be depressurized for maintenance and repair. Maintenance during operation is permitted only where the hydraulic system is designed for such maintenance.

If the system includes pressure accumulators, disassemble the accumulators prior to starting any maintenance work.

When starting maintenance and repair work where the system is first depressurized, to avoid indirect damage, make sure that it is safe to stop the hydraulic system.

After stopping the pumps and prior to starting any work, always eliminate the possibility of accidental start-up by locking the safety switches of electric motors or, in the absence of safety switches, by removing the motor fuses. Always place nameplates at the secured safety switches and removed fuses, identifying the person who carried out the procedure. Safety locks may only be removed by the person who put them in place.

Prior to starting any work, make sure that the system section to be serviced is depressurized, i.e. the pressure accumulators, pipeline and actuators are unpressurized.

The system is not allowed to be under load during maintenance situations!

Use appropriate tools and methods for all repair and maintenance work. Avoid spilling oil on the floor and remove all oil from the floor immediately. Tighten disconnected pipe and hose couplings immediately after installation. Prior to completing your work, check and retighten all couplings of the system section that was serviced or repaired.

Prior to starting any pumps, make sure that the system is not undergoing any other maintenance work. Maintain a safety distance to the items repaired when starting up the pumps. Before switching the hydraulic system on, make sure that there are no open connections in the system anymore. Make sure also that no one is working between different parts because pressuring the system might cause movements in the system.

When the system is again under pressure, the repaired system section must be tested.

Check the system for possible leaks after repair. Do not tighten leaking couplings while the system is pressurized.

1.1. Oil storage and handling

Storage

New oils must be stored in a covered, dry and dust-free space that has a constant temperature. Containers must be tightly sealed during storage. Barrels must be stored in a horizontal position.

Oil grades must be clearly marked on the containers to avoid confusion.

Substances that will cause a hazardous reaction if they come into contact with each other must not be stored in the same storage room. The release of chemicals into a sewer system outside the storage room, or to any other areas where they might create a hazard, must be prevented in a reliable way.

All required absorption agents and other equipment needed to recover leaked chemicals and clean contaminated areas must be available.

Handling

Waste oil must be stored in accordance with general and mill-specific instructions on storing of hazardous waste.

Used hydraulic oil must be collected in separate containers. All waste oil transport containers must be sealable, and they must withstand normal storage and transportation. Transport containers must be clearly marked indicating the type of waste they contain.

All waste must be delivered to the appropriate collection points or for handling.

Used filters, research equipment, oil samples and waste oil must be handled in accordance with general and mill-specific instructions for handling of hazardous waste. Used filters and filter diaphragms used in analyses must be packed into containers. The containers must be marked in accordance with the applicable instructions on hazardous waste.

2. General information

2.1. General instructions

These instructions contain information relating to the installation of HCU Remote and its handling in order that the functionality and safety are ensured. For situations not covered by this manual please contact Vexve Oy. The manufacturer reserves the right to make technical changes and improvements. This instruction manual assumes that the user is thoroughly familiar with the control unit and its components. Installation of the control cabinet and related work should be carried out by a professional.

2.2. Important

Before the system is taken into operation, the following items should be taken into consideration:

· Make sure that the hydraulic system is not pressurised, and power is turned off before any work is carried out to the control unit or its components.

· Do not ever leave any part of the hydraulic system open to contamination to prevent damage to the internal components.

· The HCU Remote warranty period is one year from installation date. (The installation must be carried out within six months from the acquisition date. The control cabinet should be stored according to the instructions)

2.3. Risks

HCU Remote can be used only if the control cabinet is properly installed and serviced by a professional. The control cabinet user should be thoroughly familiar with these instructions. These instructions are in addition to existing regulations at the customer's premises regarding electricity, pipelines and work. It is also essential to use proper tools and safety equipment.

2.4. Handling

2.4.1. Delivery inspection

· Examine the control cabinet to ensure that it, or internal components have not been damaged during transport.

2.4.2. Storage instructions

· Protect the internal parts of the cabinet from dirt, dust, water and moisture or other contaminants.

· When the cabinet is supplied with a heater/cooler and either of these cannot be installed immediately, the cabinet should be stored at room temperature. This will avoid condensation/overheating which could damage electronic components.

· If the control unit is installed and it is not possible to connect power supply immediately, electricity should be applied to control unit for a while before operating any valves in order to heat up/cool down the components before use. Vexve does not take responsibility of any damage to the control unit resulting in the missing power supply in outside environment.

2.4.3. Preparations before installation

· Make sure that the hydraulic connections are clean.

· Check that all electrical connections are intact.

2.5. Regular inspections and maintenance

2.5.1. Oil level in the reservoir

The oil level should be high enough to operate all the actuators from open to close position and vice-versa, if problems are suspected due to lack of pressure or other problems, the oil level may be low.

2.5.2. Temperature and possible leakage of the pumps, motors and valves

The temperature of the pump, motor and valves is checked by hand contact. If the target is so hot that the hand cannot be held for longer than 1-2 seconds, temperature is too high. When the temperature is too high, pumps must be stopped. The reason for high temperature needs to be investigated and the fault repaired, or the component replaced before restarting the pump.

2.5.3. Condition of piping and hoses

The piping must be monitored for pipe and fitting tightness. If the attachment of the pipes has loosened, they must be tightened. If tightening does not securely fasten the pipe, the clamp must be replaced. The fitting must be tightened if the pipe fitting leaks. If tightening does not stop the leak, the fitting and possibly the pipe connected to it must be replaced.

When replacing the fitting and the pipe, they must be cleaned from the inside to be completely free of all impurities, including burrs prior to insertion. Replacement must be carried out with absolute purity.

When observing the hose, attention should be paid to the tightness of the attachment and possible abrasion.

If the hose attachment has become loose, they must be tightened immediately.

Hoses must be replaced if the tightening does not help. If rubbing is detected, it is necessary to secure them in such a way that they will no longer be rubbed.

The worst-scratched hoses must be replaced. Before installing a new hose, it must be cleaned from the inside until completely clean. Replacement must be carried out with absolute purity.

When changing pipes and hoses, open openings must be sealed with a clean plug. The plug is only removed as late as possible due to impurities in the ambient air, which must be prevented from accessing the open hydraulic circuit.

2.5.4. Sound of pumps and motors

The sound of pumps and motors is heard by ear. If the sound intensifies or its tone has changed, it may be a sign of possible damage of the component. The pumps must be stopped immediately, and the damaged component replaced.

3. HCU Remote introduction

At operational changes, or emergencies, it is necessary to quickly close the valves. Therefore there is a need to be able to remotely control valves from control centers. HCU Remote is meant for the most demanding locations where remote control is required. All components are located in a rugged metal enclosure and the electronics to electrical cabinet with high protection class.

HCU Remote is an electro-hydraulic control unit designed for remote and local operating of valves equipped with hydraulic actuators. The control unit is equipped with a hand pump, so that actuators can also be operated without electricity.

Technical properties:

Control unit

· Dimensions 1310 x 895 x 312mm (W x H x D)
· Control unit protection classification: IP34
· Inner electrical cabinet protection: IP65
· Fluid viscosity: 10-500 mm^2/s
· Filtration: ISO code 16/13;
  SAE class 4 or better
· Fluid temperature: -20 °C +80 °C ·
· Ambient temperature range: -25 °C +35 °C
  (heating, optional cooling)

Pump

· Motor 0,75kW
· Power supply voltage 400v/3-phase, 50 Hz
· Pump flow rate: 0,1 – 1,26 l/min
· Maximum recommended pressure 210 bar·
· Pressure limiter 150 bar (adjustable)

Oil reservoir

Capacity: 2 liters

Control valve block

· Number of valves: 2-6
· Max. pressure: 210 bar
· 3 valve positions (open – neutral – close)

Electrical cabinet

· Local and remote access switch, safety switch
· Control panel
· Common operating buttons: Open, close, stop, emergency stop

Control panel

· Size: 7'' Simatic
· Valve configuration window
· Position indication: Diode indication for position 0-100 % open and end positions
· Alarms: Active and old ones
· Diagnostics

Pressure gauge

· Range: 0…250 bar

The default closing time for each actuator size is calculated to give a slow closing to minimize the risk of water hammer in the pipe.

Hydrox model	Runtime 0-100% (s)
Hydrox 035BP	23
Hydrox 2	65
Hydrox 4	150
Hydrox 8	271
Hydrox 16	504
Hydrox 32	579
Hydrox 64	608

Table 1. Default operation times

Product numbers

Model	Flow rate	Product no.
Hydrox Control Unit (HCU) Remote	1,27 l/min	812100

Table 2. HCU Remote product number

Options	Product no.
Hydrox Control Unit (HCU) Remote - Locked control cabinet	812010
Hydrox Control Unit (HCU) Remote - Analogue pressure measurement	812011
Hydrox Control Unit (HCU) Remote - Wireless remote control	812012
Hydrox Control Unit (HCU) Remote - For six valves	812013
Hydrox Control Unit (HCU) Remote - For two valves	812014
Hydrox Control Unit (HCU) Remote - Cooling	812015

Table 3. Options and product numbers

4. Control cabinet overview

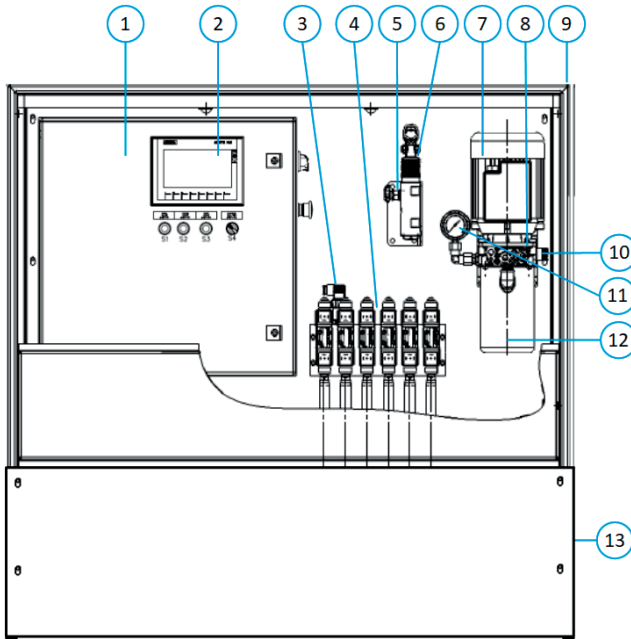## 4.1. Cabinet contents and its components

Figure 1. Cabinet overview

	Part
1	Electrical cabinet
2	HMI
3	Pressure transmitter (optional)
4	Valve block
5	Hand pump pressure adjustment
6	Hand pump
7	Electric Motor
8	Hydraulic Pump
9	System cabinet
10	Safety valve
11	Pressure gauge
12	Oil reservoir
13	Plinth (purchased separately)

Table 4. Contents and componets of cabinet

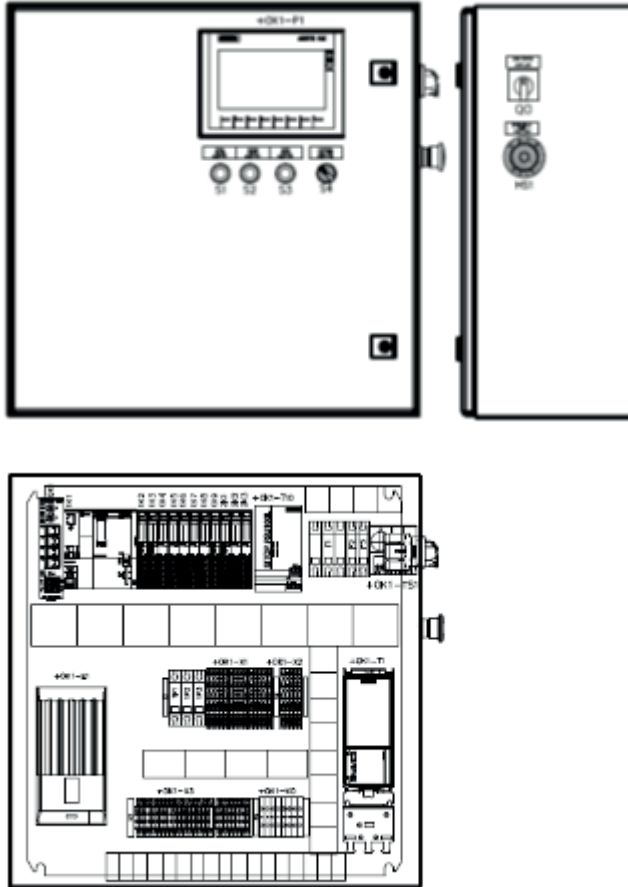## 4.2. Electrical cabinet overview

Figure 2. Electrical cabinet overview

5. Function description

5.1. Overview

The Hydrox HCU Remote is designed to control between 2 and 6 valves operated with hydraulic actuators and used in different applications. These actuators are operated by a semi-closed loop system which allows the operation of specific valves by opening/closing them in a controlled manner through the manipulation of oil pressure using an inverter-controlled pump. For control of the hydraulic pump and the solenoid valves by inverter, programmable logic is used. The operational behaviours of the valves are configurable.

The system is enclosed in a cabinet which is a compound hydraulic/electrical system. Inside this cabinet there is a pump with a small oil container and variable number of selector valves (2-6) as seen in section 4.

This unit can be controlled both locally and remotely. Local control relies on buttons located on electrical cabinet door and a Human Machine Interface (HMI) that allows monitoring of valve position as well as control and configuration of the system. For more information on how to control the system via HMI please refer to section 5.2. Remote control can be enabled through various means:

· Modbus Holding Registers (HR)

    - Through physical Modbus TCP connection

    - Through VPN Modbus TCP connection

· Physical remote I/O

· PLC WebApp directly available via VPN connection

For more information on remote control options, please refer to section 8.

5.2. Valve control and position indication

A Local/Remote selector can be found on the side of the electrical control cabinet. This allows the user to change the operational mode of the system. If "Local" is selected all remote operations are blocked, if "Remote" is selected the system may be operated remotely. Disabling remote operation when in "Local" operation is a critical safety feature for operating personnel.

Regardless of whether the user is controlling the system locally or remotely, there will be a "User Interface" (UI) available to the user. While some aspects of the UI may be different in different control modes; the manner of interaction will generally be the same. This section of the manual addresses only the general operation of valves, for specific details on the usage of the HMI or remote operations please refer to sections 7 and 8 respectively.

Only one valve may be operated at a time, which is selected via an HMI screen that provides an interface to the operator. Local control relies on buttons located on electrical cabinet door. There are common buttons for open, close and stop. Valve selection is usually achieved by clicking on the valve icon that the user wishes to operate or by pressing the button associated to said valve, regardless of the UI used. The UI will look similar to the image seen in Figure 3.

NOTE:
For simplicity, many other elements usually present in the UI were removed from the following figure. The reader can get acquainted with these elements in the aforementioned sections.
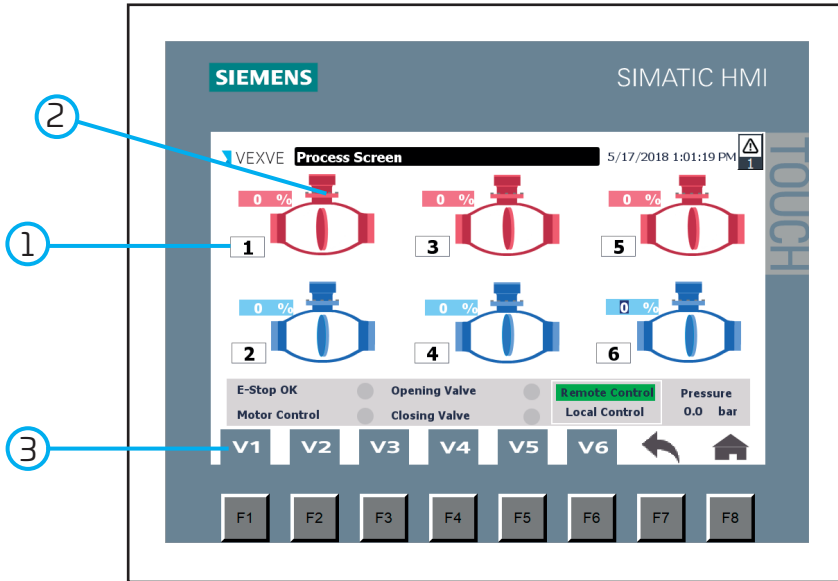
5.2.1. Valve Selection

Figure 3. Generic UI

	Element
1	Valve number
2	Valve representation
3	Valve button

Table 5. Generic UI description

Element 3 as in table 5 can be either a representation of a physical function button to press, as it would be in the case of the HMI, or an actual button to click on in the case of the WebApp. Clicking on either option will select the valve and enable access to the open/close functions.

5.2.2. Opening the valve:

1. Once the valve is selected, press the OPEN button.
2. The pump starts to open the valve according to the configured operational behaviour curve (see section 7.2.3).
3. The pump will automatically stop when the valve reaches the open position.

5.2.3. Closing the valve:

1. Once the valve is selected, press the CLOSE button.
2. The pump starts to close the valve according to the configured operational behaviour curve. (see section 7.2.3).
3. The pump will automatically stop when the valve reaches the closed position.

5.2.4. To stop valve movement

1. If you wish to stop the control process, press the STOP button.
2. The valve stops at its current position until a new signal is given (OPEN/CLOSE)*

*Hydraulic actuators, which are equipped with a control block.

5.2.5. Local buttons

In the case of local control, the OPEN/CLOSE/STOP buttons are physical and look as shown in figure 4.
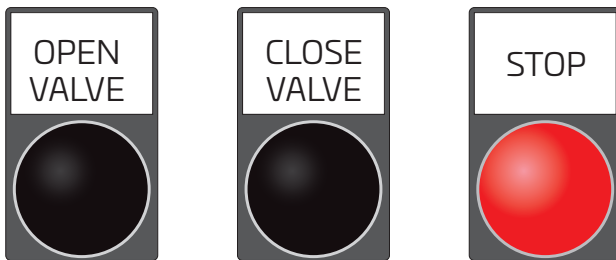

Figure 4. Local buttons

5.2.6. Remote control buttons

In the case of remote control (WebApp VPN), the OPEN/CLOSE/STOP buttons are virtual and look as shown in figure 5.

Figure 5. Remote buttons

5.2.7. Position indication

In a similar manner to valve control, position indication is addressed in the same way via different UI's. Figure 6 shows a generic view that will be available to the user for both local and remote (WebApp) visualization.
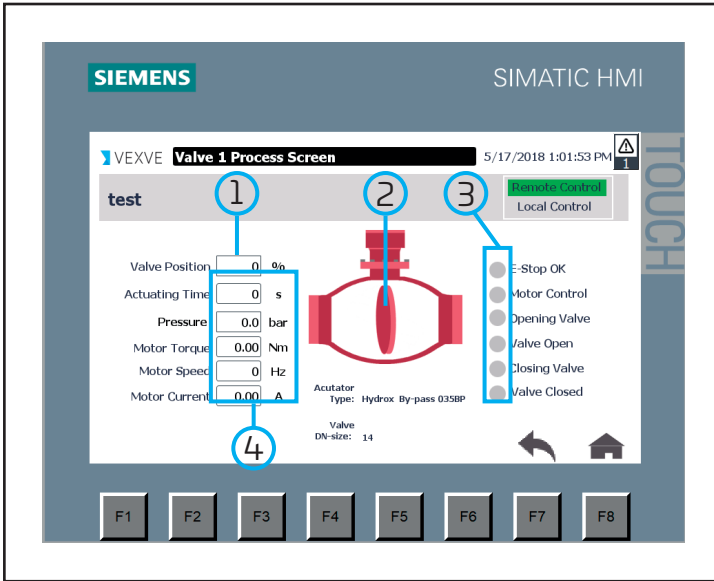

Figure 6. valve position indication

	Element
1	Valve open percentage (0-100%)
2	Valve open/close indicator flap
3	Valve and general status
4	Valve operational values

Table 6. Valve indicators

Valve indication can be observed mainly from elements 1 and 2. These elements show the percentage of valve opening as well as visually represent an approximation of the current position of the valve. The open/closed indicators in element 3 light up when the valve reaches its end position. The other elements show other relevant values of the valve during operation. These values are addressed in more detail in other sections of this document. Digital signals are used to stop the opening/closing cycle. The analogue position signal (4-20mA) is used for indicating the continuous position of the valve.

5.3. Using the manual pump

In the event of a power failure, or some other kind of partial control failure, valves can be operated locally using the manual pump. This is accomplished by using a hand operated pump and control lever located above the valve block and next to the hydraulic pump.

NOTE: The control levers are spring return and thus keep their position. The user must hold the push-pin nut in the desired position throughout the operation. This is a safety feature, which ensures that the directional control valve is returned to neutral position when the operating cycle is completed.

5.3.1. Opening the valve:

1. Select the desired valve.
2. Press the control push-pin nut on the top of the valve down, (See figure 7, arrow 1) towards the valve block and hold it.
3. Pump the hand pump.
4. The pressure increases significantly when the valve reaches the open position. Make sure that the valve has reached the end position by watching the position indicator in the HMI on the electrical cabinet. If there is no power, continue pumping for a brief period after the pressure has risen.

5.3.2. Closing the valve:

1. Select the desired valve.
2. Press the control push-pin nut on the bottom of the valve up, towards the valve block (see figure 7 arrow 2), and hold it.
3. Pump the hand pump.
4. The pressure increases significantly when the valve reaches the closed position. Make sure that the valve has reached the end position by watching the position indicator in the HMI on the electrical cabinet. If there is no power, continue pumping for a brief period after the pressure has risen.

5.3.3. To stop valve movement:

1. Stop pumping and release the control lever, if you want to stop valve movement.
2. The valve stops at its current position until operation of the hand pump continues. *

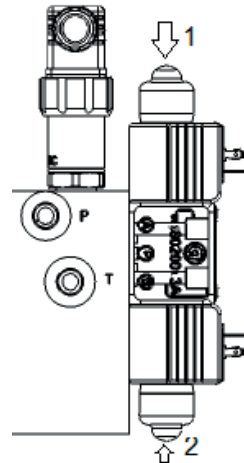* Hydraulic actuators, which are equipped with a control block

Figure 7. Control push-pin nut

5.4. Alarms, information and notifications

The HCU Remote system manages alarms, information and notification messages differently. Each of these provides a specific type of information and can be triggered by either a user action or a fault in the system. Depending on this category, an acknowledgment is required or not. Table 7 clarifies the difference between these three categories. Please note that these categories apply only to the Local HMI.

Message category	Acknowledgement required
Alarm	Yes
Notification	Yes
Information	No

Table 7. Message categories

5.4.1. Alarm messages

Alarms in the Hydrox HCU Remote system vary depending on the point of access. Table 8 shows the existing alarms, their descriptions and their availability depending on the remote installation, should it apply. Alarms must be acknowledged in the Local HMI and the WebApp, but not in remote applications. When an alarm is triggered a message will popup and the user must acknowledge the message by pressing the appropriate button. Only then will the message disappear from the screen. Troubleshooting, see section 9.

Alarm	Description	Local	Remote (WebApp)	Remote Modbus	Remote Physical
Global system fault alarm	There is some sort of error in the system			X	X
Global process fault alarm	There is some sort of error in the process			X	X
E-Stop Alarm	E-Stop button is triggered	X	X	X	p**
Motor Fault	A problem occurred with the motor	X	X	s*	s
Tmax Alarm	Maximum operating time when opening/closing valve has elapsed	X	X	p	p
Pmax Alarm	Maximum setup pressure exceeded	X	X	p	p
Duplicate Valve Operation	User attempted to operate another valve at the same time	X	X	s	s
Valve 1 position transmitter error	Error in sensor/connection	X	X	s	s
Valve 2 position transmitter error	Error in sensor/connection	X	X	s	s
Valve 3 position transmitter error	Error in sensor/connection	X	X	s	s
Valve 4 position transmitter error	Error in sensor/connection	X	X	s	s
Valve 5 position transmitter error	Error in sensor/connection	X	X	s	s
Valve 6 position transmitter error	Error in sensor/connection	X	X	s	s

Table 8. Alarm signals

S* = included in system alarms in remote system, operation of the valves possible

P** = included in process alarms in remote system, operation of the valves not possible until the alarm is reset

> **NOTE:**
> Please keep in mind that not all of the alarms listed above are always present. Which are depends on the configuration of HCU Remote installed.

5.4.2. Notification messages

Notifications in the HCU Remote system are used to notify the user that an action has been completed. Notifications require acknowledgment by the user. In a similar manner to the alarm message the acknowledgement button must be pressed to remove the message window from the screen. Notifications in the HCU Remote system are only available in Local and Remote (WebApp) operation. Table 9 shows the existing notifications, their descriptions and their availability depending on the remote installation should it apply.

Alarm	Description	Local	Remote (WebApp)	Remote Modbus	Remote Physical
Opened Valve 1	Valve 1 has been opened	X	X		
Closed Valve 1	Valve 1 has been closed	X	X		
Opened Valve 2	Valve 2 has been opened	X	X		
Closed Valve 2	Valve 2 has been closed	X	X		
Opened Valve 3	Valve 3 has been opened	X	X		
Closed Valve 3	Valve 3 has been closed	X	X		
Opened Valve 4	Valve 4 has been opened	X	X		
Closed Valve 4	Valve 4 has been closed	X	X		
Opened Valve 5	Valve 5 has been opened	X	X		
Closed Valve 5	Valve 5 has been closed	X	X		
Opened Valve 6	Valve 6 has been opened	X	X		
Closed Valve 6	Valve 6 has been closed	X	X		

Table 9. Notification messages

5.4.3. Information messages

Information messages in the HCU Remote system are used to notify the user that an action they triggered was completed. Unlike Notifications, Information messages do not require acknowledgement, they will disappear on their own after a few seconds have elapsed. These messages are only used in the local HMI. Table 10 lists the available messages.

Alarm	Description	Local	Remote (WebApp)	Remote Modbus	Remote Physical
Curve values saved	Curve values have been saved to the PLC	X			
Curve default values saved	Default curve values have been loaded and saved.	X			

Table 10. Information messages

6. Installation and commissioning

6.1. General information

Keep the protective caps on all hydraulic connectors in place until assembly. This protects the components from contamination.

Check that all the bolts and hydraulic connectors are tight. The control cabinets are always pressure-tested and checked before delivery. However, during transport threaded connections can become loose and therefore it is necessary to check them before pressurizing the system.

6.2. Control cabinet installation

The control cabinet is meant to be mounted on a wall or plinth intended for it.

6.3. Power connection

All power connections must be made by a professional. Main power must be turned off before connecting the power supply to the cabinet. The power connection is done in accordance with the diagrams shown in Figure 8.

INCOMING SUPPLY
3 x 400/230V, 50 Hz
MAX 16A
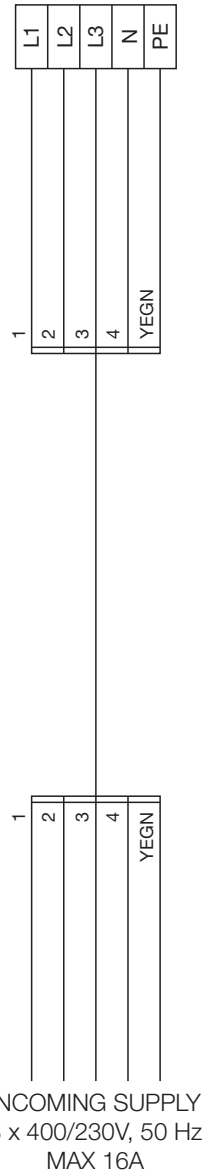
Figure 8. Connecting power supply

6.4. Installation of hydraulic hoses from control cabinet to actuator

1. Make sure that the hydraulic components have not been damaged in transport.

2. Remove the protective caps from the hydraulic connections and make sure the connections are and will remain protected from contamination until the installation.

3. Connect the hydraulic hoses to the control cabinet connections (A and B). The hoses are connected below the valve block. See figure 9 (cabinet overview). Hose B is connected to the front and hose A behind it. The control system is based on the operation of A and B as follows.

   a. Pressure to port A closes the actuator

   b. Pressure to port B opens the actuator
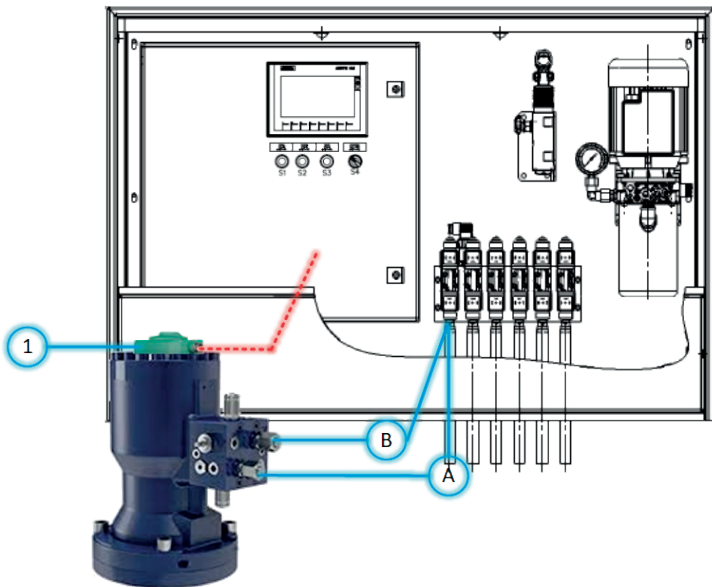
Figure 9. "A" and "B" ports in the control valve block

4. Connect the hoses to the hydraulic actuator according to the above information.

5. Fill the system with hydraulic fluid and bleed any air. (Bleeding can be accomplished in a number of different ways depending on the actuator, check the manual for the actuator). If the system contains air it will not function optimally. See section 6.5.

6. Connect the position transmitter (1) signal cable to the control cabinet's appropriate outgoing connector.

7. Test the system by operating the connected valves to fully open and fully closed, check their final positions.

8. Check that there is no fluid leakage and all hoses are securely attached.

6.5. Adding fluid and bleeding the system

1. The hydraulic fluid reservoir volume is 2 liters and should be filled to ¾ of its volume. The hydraulic fluid should be selected according to the hydraulic actuator supplier's recommendations.

2. Bleed all air from the system in accordance with the actuator supplier's instructions.

6.6. Position transmitter

Before the HCU Remote can operate, the hydraulic actuator position transmitters need to be calibrated. Calibration is done in accordance with the position transmitter instruction manual.

HCU Remote is based on the assumption that the actuators are equipped with position transmitters that send signals in accordance with the following:

· 2 digital signals at end positions (open / closed)

· An analog signal 4-20 mA, which covers the whole valve travel (4 mA = valve closed and 20 mA = valve open)

· The HMI display that shows the whole range from 0% and 100% of valve travel is defined to match the 4-20 mA signal from a 0-degree to a 90-degree turn. If the position detection does not work as desired, then the sensor needs to be recalibrated.

Position transmitters provided by Vexve for use with this control cabinet comply with the above definitions.

Position transmitter signal cables are connected to the M12 5-pin connectors that are available at the electrical cabinet of the Hydrox HCU Remote. These cables follow standard sensor wiring from M12 connectors as shown in figure 10 and table 11.

Pin	Color
1	Bn
2	Wh
3	Bu
4	Bk
5	Gy

Table 11. Wire colours for 5-pin connector
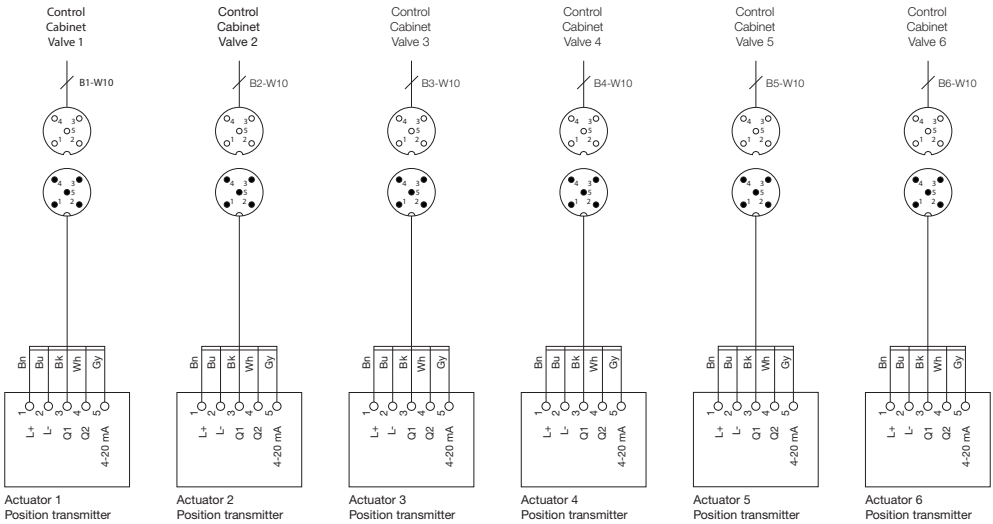
Figure 10. Position transmitter connections

If hydraulic actuators are equipped with position transmitters meeting the requirements outlined in section 6.6, there is no need for calibration. In cases where the 4-20 mA signals do not cover the whole area, the transmitters need to be recalibrated. Otherwise the position indication and valve control from the HMI will not work appropriately.

6.7. Configuration

6.7.1 Safety valve

The purpose of the safety valve is to protect the internal components from too high pressure. The valve is pre-set at the factory to 150 bar and secured so that the pressure limit cannot be accidentally changed during installation or use. The safety valve can be adjusted between 0-250 bar. Safety valve adjustment should not be made without consulting the valve, actuator, and control cabinet suppliers.

7. HMI & Control

The Hydrox HCU Remote is controlled automatically by a Programmable Logic Controller. This controller can be interacted by means of a Human Machine Interface (HMI) connected to it. This section briefly explains how the control architecture is set up, while the following section focuses on the functions that the HMI provides to the user of the system to interact with the capabilities of the PLC.

7.1. Control architecture

Figure 11 highlights how every component is connected and controlled by the PLC. The PLC communicates with the HMI and the motor drive via ProfiNET. The user can interact with the HMI and additional physical control buttons as shown in section 5.2. of the previous section. The PLC controls the speed of opening/closing the valve by regulating the speed of the motor (and therefore the flow rate exerted on the valve actuator). Based on the position transmitter the PLC regulates the operation speed of the closing and opening of the valves (depending on the size of the valve).
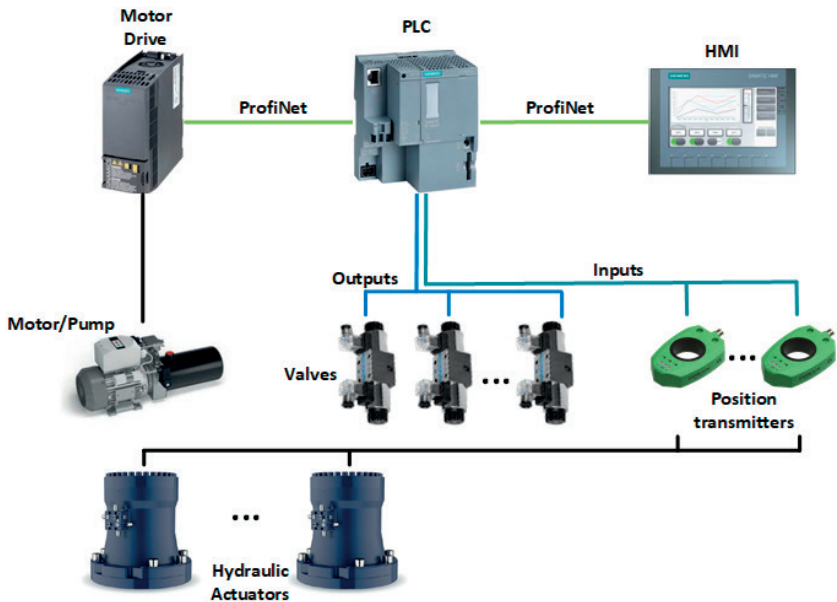
Figure 11. Control architecture

7.2. HMI Navigation and usage

This section discusses how you can navigate and use the Human Machine Interface (HMI) to change settings or values and control the Hydrox HCU Remote. The HMI is a 7" inch Touch Screen Display. The HMI has 8 function keys shown with a red box in Figure 12.
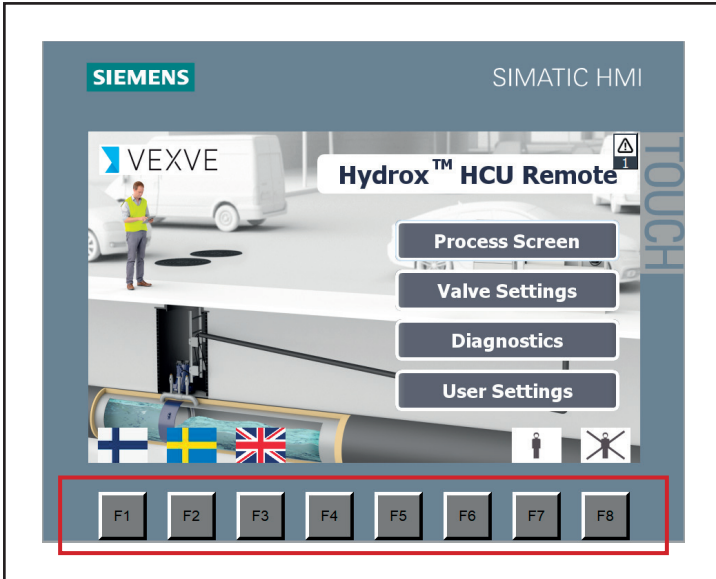
Figure 12. Human Machine Interface

The F1 to F8 keys highlighted inside the red box in Figure 12 are available from all the screens in the Human Machine Interface (HMI). Table 12, shown on next page, provides the functions assigned to each of the button on different screens. The function keys have different functions in each screen.

	F1, F2, F3 are used to change between available languages. This option is only available in the home screen.
	F7 with the return icon takes you back to previous screen.
	F8 with home icon takes you to the home/main screen.
	F7 is used to login as an Admin or a user. F7 Opens a window to provide user name and password. F8 logs out user/admin from system. This option is only available in the home screen.
	F1 to F6 are used to select valve 1 to valve 6 in the process screen. The V in V1 to V6 i is an abbreviation of Valve.
	These icons used for F1 and F2 in the valve settings screen, helps you to load parameters of different valves.
	F4, with save icon in the valve settings screen is used to save the values of selected valve.

Table 12 Function Keys

7.2.1. Home screen

The Home Screen mainly contains the navigation buttons to four screens. You can navigate to the Home Screen by using the F8 Button from any Screen (See table 12). A red box is used in Figure 13 to represent the location of 4 buttons in the Home Screen. Table 13 provides the property of the screens' respective of buttons.
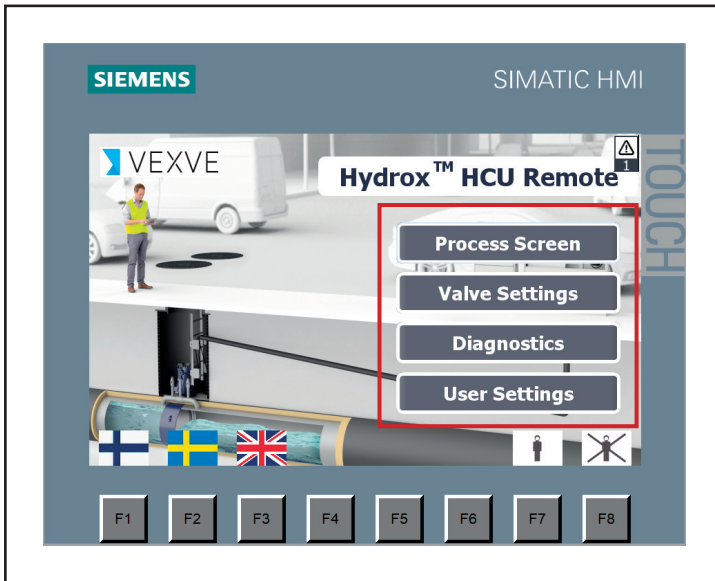
Figure 13. Home screen

Process Screen	Shows indicators and sensor values with the valve selection button. The valve can only be controlled from this screen. One can also navigate to a valve specific page from this screen.
Valve Settings	In this screen, you can change the valve control parameters.
Diagnostics	This button takes you to the sub menu for motor diagnostics, rack diagnostics, active alarms, old alarms and device information screen
User Settings	User settings page.

Table 13 Home Screen Buttons

7.2.2. Process diagram and valve information

The process diagram provides the information about the major sensor values and status. There are four types of indicators used in the Process Diagram page. The green box around the valve shows the selected valve. The valve position is indicated using value indicators seen with the black dotted box in figure 14. Each valve image acts as a button to activate valve information window. The valves can also be selected using the function button under images V1 to V6 shown in Figure 14. Please note that the screen will be different depending on which configuration has been acquired.
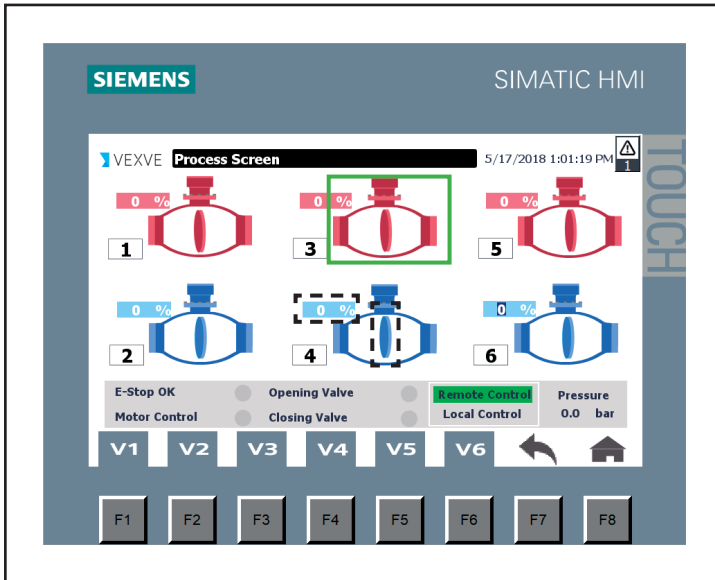
Figure 14. Process diagram

Once the valve is selected, you can use the open or close control button shown in Figure 4 to open or close valve. The stop button will stop any valve that is being actuated even if the selected valve is changed after the actuation start.

Table 14 has the list of digital input signals used in the process screen with its status based on the colour of indication.

	🔴 🟢	🟢
Emergency Stop	Activated	OK
Motor Control	OFF	ON
Opening valve	OFF	ON
Closing valve	OFF	ON

Table 14. Process diagram, digital signals

The valve information window displays detailed information of each valve based on the selection. Additional information includes motor parameters like torque, speed (control value) and current being used. It also displays the current pressure, if pressure transmitter option is selected. Table 15 has the list of digital input signals used in the valve information screen with its status based on the colour of indication. Note! The valve can not be operated with the push buttons from this screen.
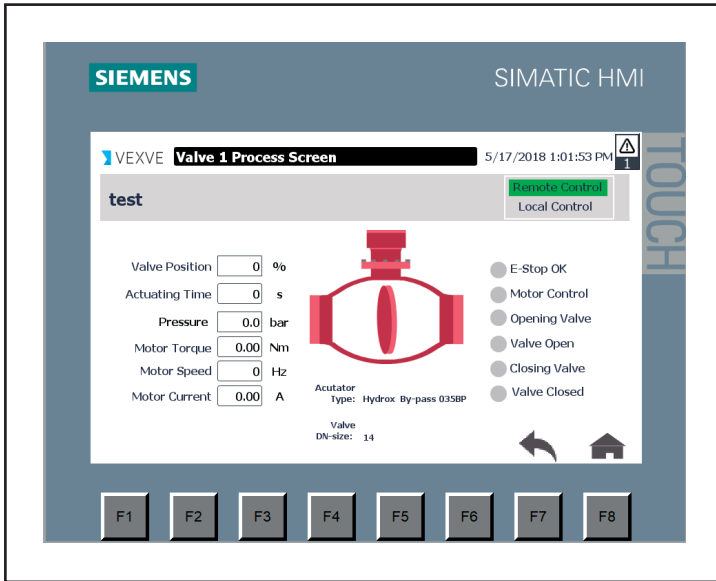
Figure 15. Valve information screen

	🔴 🟢(light)	🟢
Emergency Stop	Activated	OK
Motor Control	OFF	ON
Opening valve	OFF	ON
Closing valve	OFF	ON
Valve Open	OFF	ON
Valve Closed	OFF	ON

Table 15. Valve information screen Indicator Status

7.2.3. Valve characteristics and curve settings

Valve characteristics curve and settings of each valve can be loaded to this page using the function keys F1 and F2 with left and right arrow icons. You can use the load defaults button, to load defaults of that actuator type. Once changes have been made, use the F4 button to save changes before changing valve selection, otherwise the changes will be discarded.
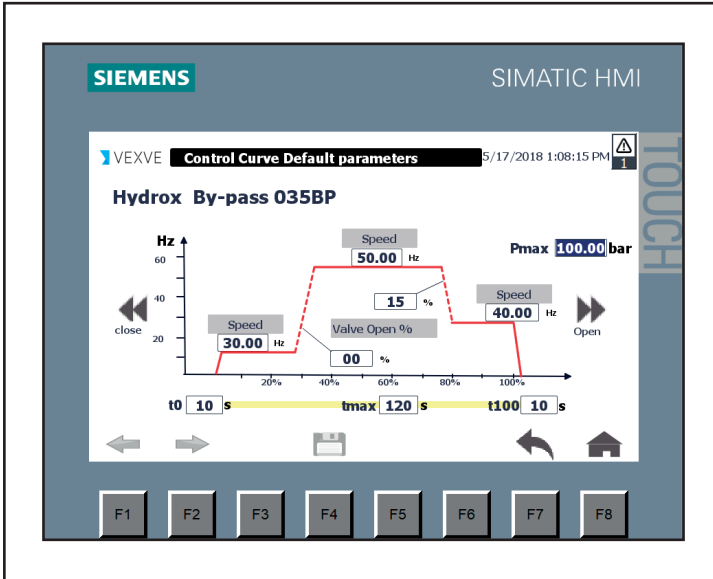
Valve characteristics have three main components Time (t), Speed and valve open percentage. The time t0 is the valve close wait time, t100 valve open wait time and tmax is the maximum time after which the PLC will switch off the pump control even if the valve is not opened/closed. tmax acts as added safety feature, so that pump does not run longer than required in case of failing to open or close a valve.

Times t0 and t100 are delays. After a successful valve open or close action from the PLC the motor switch-off is delayed by the configured waiting times. The speed of the motor/pump can have three different values as shown in above picture and they are dependent on the actuator type, size and valve open percentage.

Pmax or maximum pressure is also a safety logic. If pressure goes over that, the PLC will generate an error and switch off the pump control even if valve is not open/closed. **Note! This functionality is only present if analog pressure measurement option is selected.**

These variables can be adjusted as necessary, but the recommended and factory default settings can be seen from table 16 on next page.

Variable	035BP	2	4	8	16	32	64
t0 (S)	10	10	10	10	10	10	10
t100(S)	10	10	10	10	10	10	10
Tmax(S)	35	100	225	400	750	850	900
Velocity 1(Hz)	10	10	10	10	10	15	20
Valve Position 1(%)	33	33	33	33	33	33	33
Velocity 2(Hz)	10	15	15	15	20	25	55
VALVE Position 2(%)	95	95	95	95	95	95	95
Velocity 3(Hz)	10	10	10	10	10	15	30
Maximum Pressure(Bar)	150	150	150	150	150	150	150

Table 16. Default factory values

7.2.4. Diagnostics

From this screen, you can navigate motor diagnostics, rack diagnostics, active alarms, old alarms and device information screens using the icons shown in figure 17.
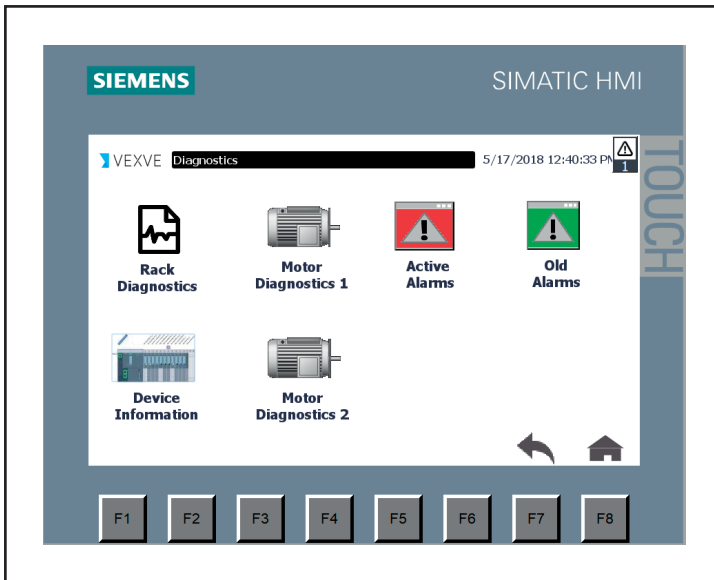

Figure 17. Diagnostics Sub Menu

Rack diagnostics

The rack diagnostics window can be accessed using the 'Rack Diagnostics' button on the 'Diagnostics' sub menu window. This window provides information regarding the error log of the PLC. This screen provides information like PLC start/stop, reboot, communication and other PLC specific error details.
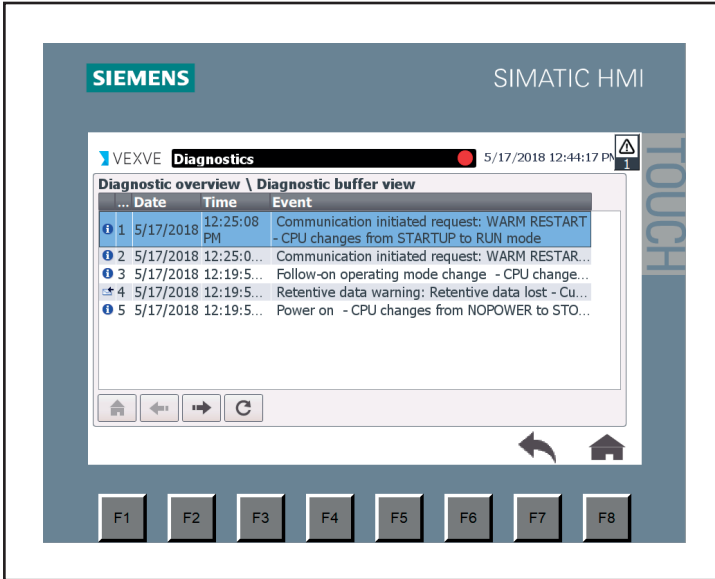

Figure 18. PLS Diagnostics window

Device information

This screen provides information about the device that will help to identify model, parts and manufacturer specific details. These details can be used to identify the device in question.
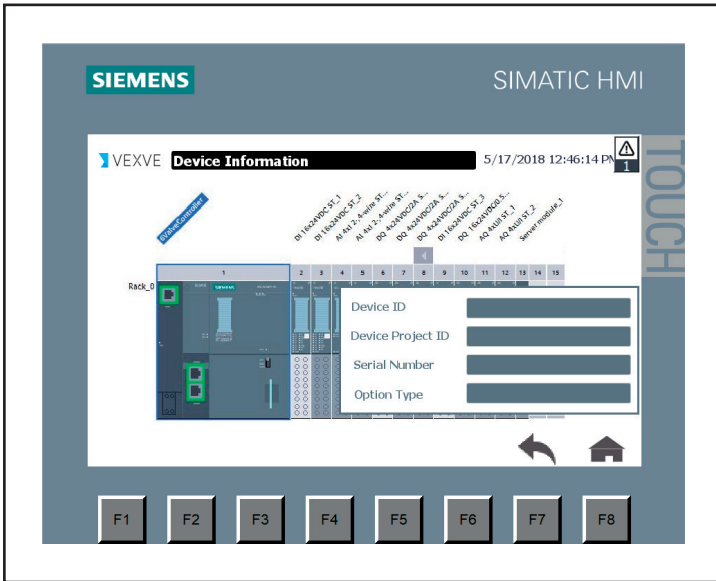

Figure 19. Device information

Motor diagnostics 1 and 2

Motor Diagnostics 1 and 2 provide trends/plots to analyse the system characteristics like pressure generated, torque and current of motor during the valve operation against the valve position. Note! Pressure is only available if analog pressure measurement option is selected.

NOTE:
Please keep in mind that not all of the values listed above are always present.
Which are present depends on the configuration of the installed HCU Remote.
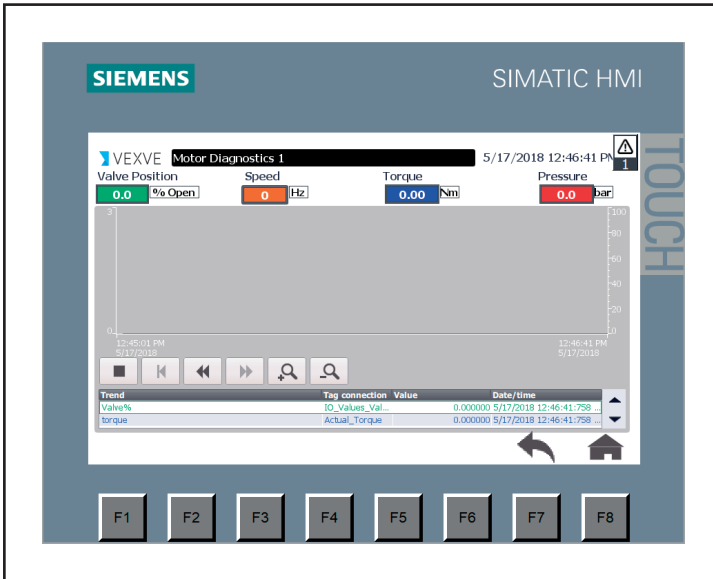

Figure 20. Motor diagnostics
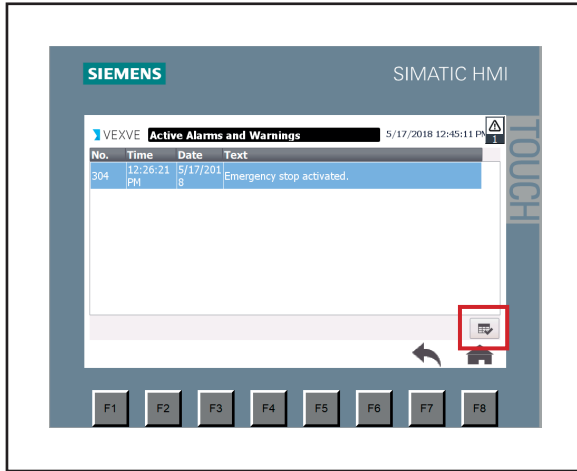
Alarms and Information
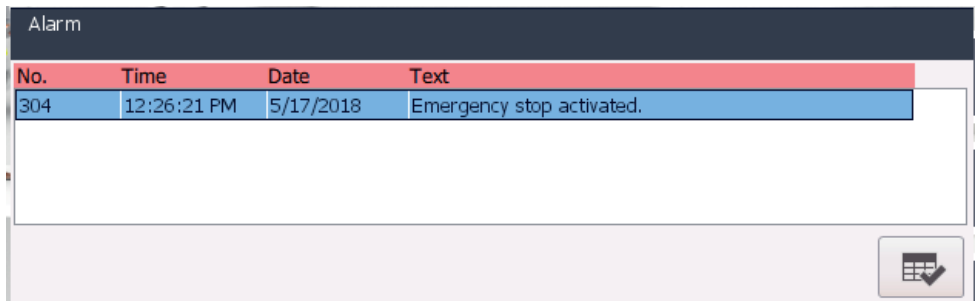

Figure 21. Active and old alarm window

There are two windows for alarms, the active alarm window and the old alarm windows. Both can be reached from the diagnostics sub menu. The active alarm window will only show errors while the alarms are active and not acknowledged. The button highlighted with the red box in Figure 21 is used to acknowledge all alarms. However, the old alarms and warnings window will record a log of alarms and events that have happened since the last power cycle.

Figure 21 highlights old alarms and warnings. The "status" column marked with the red square shows the status of each old alarm/warning. 'I' stands for incoming, 'A' for acknowledged and 'O' for outgoing. These statuses are cumulative depending on what happened when the alarm/warning was triggered (i.e. 'IA' was an incoming alarm that was acknowledged, 'I' was incoming but not acknowledged).

Information pop-up screens

The info screens are global windows, which will pop up every time there is an event like user login, or valve open or close.

There are three types of information popup screens called Alarm, Notification, and Info. The Alarm window shown in Figure 22, displays un-acknowledged alarms. The button with tick mark can be used to acknowledge the alarms, once acknowledged the alarms will disappear from this screen but will be visible in the Active alarms window. The list of alarms is shown in table 8.

No.	Time	Date	Text
304	12:26:21 PM	5/17/2018	Emergency stop activated.

Figure 22. Alarm popup screen

The notification window displays events that are less critical than alarms, such as opening a valve. The list of notifications are shown in Table 9. The notification screen has a table header that is yellow, compared to the red in an active alarm pop-up screen.
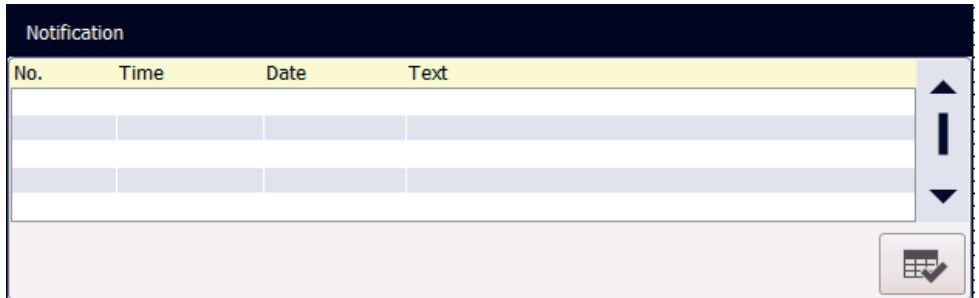

Figure 23. Notification popup screen

The info screen pop up is used for displaying information that are not important to the process, this window will automatically close after a set period of time. The list of notifications are shown in Table 10. As seen from Figure 24, the info screen has a green table header.
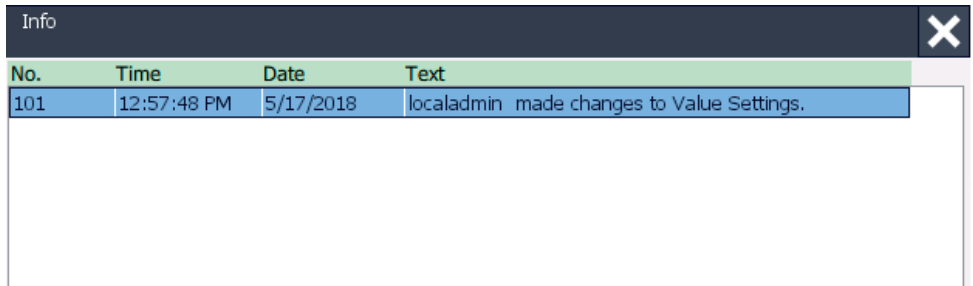

Figure 24. Info popup screen

7.2.5. Administrator / User operation level

There are two type of login settings. One for Operator and another for Administrator. Function button F7 (See table 12) is used to open the Login window as shown in Figure 25. Function button F8 can be used to logoff (See table 12).
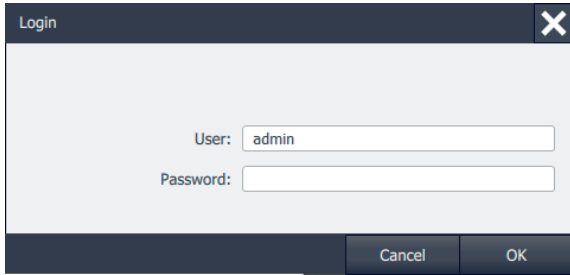

Figure 25. Admin or user Login window

Administrator authentication is cancelled automatically if no operation is performed in 60 minutes or configured time. The table 19 below provides the settings for each type of user while navigating from the Home Screen to respective screens.

Screen	Logged Off	Operator	Admin
Process Screen	x	x	x
Valve Settings		x	x
Diagnostics			x
User Settings			x

Table 19. Admin or User Login settings for each screen

User administration

The User Administration window can be used to maintain the user list and passwords. You can create a new user by pressing an empty line or change the password of a present user by pressing on the respective user password field. You need to have administrator rights to create a new user and see all users in the system. If you do not have administrator rights you will only be able to see your data alone and thereby only change your password. Figure 26 shows the user settings window.

Figure 26. User settings window

NOTE:
Please notice that the required length of the password is exactly 8 characters.

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8. Remote-control connection

8.1. Physical remote control

All important signals in the Hydrox HCU Remote have a duplicate signal available for connection to a remote-control system. All remote I/O connections are made directly to terminal block X3. These connections can be divided into three different categories: inputs, outputs and analogue outputs. Digital inputs are only available when the electrical cabinet selector switch is in the remote operating position. Outputs are always available in the remote control system, which means that the status of the valves can be monitored remotely during local control.

Digital inputs are connected to outputs in the remote-control system. Those outputs activate operations locally when connected to the appropriate inputs. Figure 27 shows how these connections should be made.
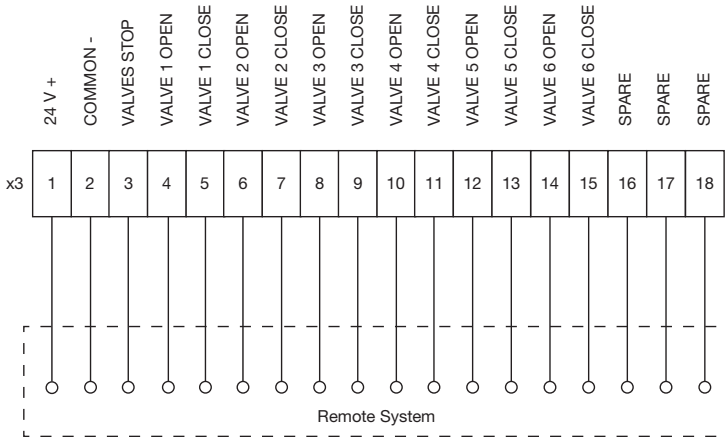

Figure 27. Remote input terminal connections

Digital outputs are connected to inputs in the remote-control system. Those inputs receive information regarding the state of the local system when connected to the appropriate outputs. Figure 28 on next page shows how these connections should be made.
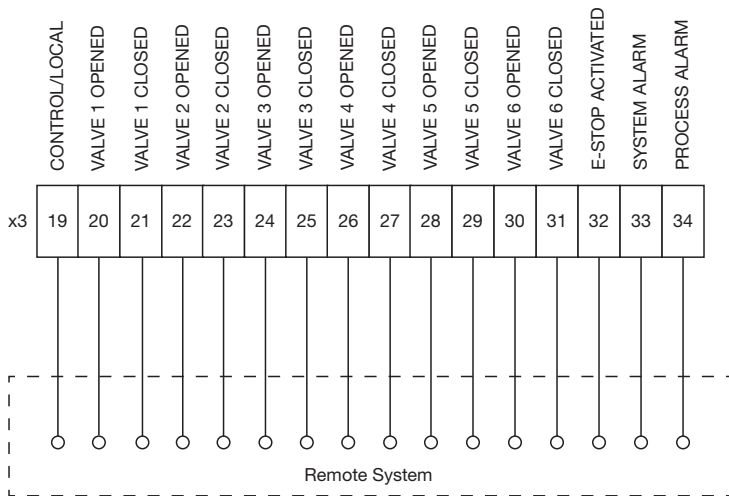
Figure 28. Remote outputs terminal connections

Analogue outputs are connected to analogue inputs in the remote-control system. Those inputs receive information regarding the state of the local system when connected to the appropriate outputs. In this case, the connections are 4-20mA signals, and each signal requires two terminals to be connected. Figure 29 shows how these connections should be made.
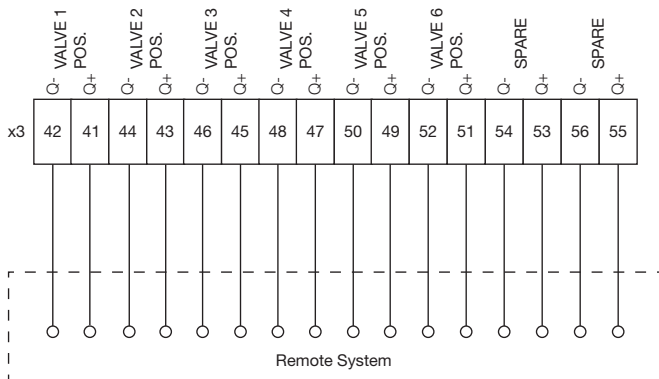

Figure 29. Remote analogue signals

NOTE:
Please keep in mind that not all of the signals listed above are always present. Which are present depends on the configuration of the installed HCU Remote.

NOTE:
Valve open and valve close commands should not be always on. For example, when opening the valve, valve open command is at value 1 for 3 seconds. After 3 seconds the value should be 0.

8.2. Modbus TCP remote control

In a similar manner to physical remote-control, all relevant signals are available for connection via Modbus TCP using the Holding Registers (HR). For more information of Modbus TCP Holding Registers, please contact the manufacturer.

> **NOTE:**
> Please keep in mind that not all of the signals listed above are always present.
> Which are present depends on the configuration of the installed HCU Remote.

> **NOTE:**
> Valve open and valve close commands should not be always on. For example, when opening the valve, valve open command is at value 1 for 3 seconds. After 3 seconds the value should be 0.

8.3. WebApp remote control

The WebApp remote-control – if included in the installation – only requires a VPN setup to be used. Please contact the manufacturer for more information.

9. Troubleshooting

The following table shows the most common and generic failures that may present themselves. If any other problems occur, please contact Vexve Oy.

Alarm signal	Explanation	Possible fault	Verification and measurement
Motor alarm			
Maximum cycle time	The valve does not reach the end position within maximum time.	Low / non-existent hydraulic pressure, which means that the valve does not reach the end position	Confirm pressure by studying the pressure gauge. If the pressure is low: check the control cabinet, the hoses and the actuator that there are no leaks.
		Electric motor failure	Check the motor rotation direction (the direction of the arrow on motor). If the engine is running: try to close the valve with the hand pump to determine if the problem is in the engine.
		Actuator Fault / Something stuck in the system	If the pressure gauge shows 150 bar (maximum pressure): visually check that the valve moves. If the valve is stuck in the middle position, check the operation of the actuator by disconnecting it from the control cabinet. Check pipes to see that the valve is not stuck from any other reason.
		No position detection of open/close position	The valve is fully open or fully closed, but the position signal is not. First, check the wiring. Then calibrate the position transmitter.
		Maximum cycle time exceeded	Make sure that the maximum operating time is long enough for the pump and actuator combination.
Position sensor error		Position sensor is not connected to the valve. Position sensor is broken.	Confirm that all the valves are active in the system. Confirm the operation and connection of the sensor.
Max pressure reached			Confirm that Pmax for each valve is set to a correct value. Else there might be a restriction causing valve actuation hindrance. This can be due to contamination in hydraulic oil or blockage of the valve.
Duplicate valve operation	Trying to use more than one valve operation at a time.	User activation.	Only one valve operation is allowed with this system and all other user operations regarding the valve actuation will be discarded.
Emergency Stop (E-Stop) Activated			Someone has pressed the Emergency Stop button in the cabinet. Release the button and acknowledge the error.

Table 20. Troubleshooting

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