VC Systems & Controls, Inc.

STARTUP GUIDE

2015

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VC Systems & Controls
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1-800-881-3121
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Version 1.0

VC Systems & Controls, Inc.

Standard Startup Procedure – PMV Series & ECO Series

1. Check to make sure the disconnect switch is in the OFF position. Do not engage power! Record on startup form if system has been powered on prior to authorized start up.
2. Check the voltage on the line side of the disconnect switch.
3. Verify line voltage against label on the inside of the control panel door. **If voltage is mismatched, do not proceed and call the factory.**
4. Verify with city water supply pressure. (Suction side)
5. Verify if there is a manual bypass and that it is 100% closed.
6. Verify required delivery pressure on the top floor. (If unknown, assume 35 to 40 PSI.)
7. Verify all butterfly valves are open. On system and on building side.
8. **PMV Only** – Place HOA switches into the OFF position.
9. With the controller door closed and locked. Turn the disconnect switch to the ON position.
10. **ECO Only** – Place the DRIVES into the Off Position via Drive keypad.
11. Silence any and all alarms present. Pump failed to start and low system pressure alarm will probably trip.
12. Determine the minimum speed required to make shut off pressure. **(Critical)**
    a. A simple way to do this is to operate the drive from the key pad in HAND, using the up and down arrow keys to adjust the speed until the desired system pressure is maintained. This should be done slowly and also allows time to bleed trapped air for the system.
13. From the HOME screen on the touch screen, use the arrow keys or pull down menu to adjust System Pressure to the desired Set Point.
14. Go to MENU > USER SET UP > Time and Date. Set the time and date to ensure that all event logs and X-Y trend data plots are recorded correctly.
15. Next, Select MENU > FACTORY SET UP then navigate to parameter **[157.x] (PMV)** **[152.x] (ECO)** Pump Speed Limits. Use the values recorded in step 11 as a general rule and set the parameters as follows.
    a. If login credentials are unknown, please contact the factory.
    b. **[157.1]** Maximum Output Speed = 100% **[151.6] ECO**
    c. **[157.2]** Pump Reject Speed = Value from Step 11 + 5% **[152.4] ECO**
    d. **[157.3]** Default Speed on Sensor Failure = Value from Step 11 **[152.5] ECO**
    e. **[157.4]** Minimum PID Output Speed = Value from Step 5 – 5%. Subtract 10% if overshoot is noticed when waking. **Wake speed [152.2] ECO**
    f. **[157.5]** Minimum Safe Speed = Less than or equal to **[157.4]** above. Note, if this value is less than 50%, the factory should be contacted for guidance as this could indicate a pump is oversized. In many cases, there is no problem, however, in other cases, speeds below 50% could cause mechanical damage.
16. Place HOAs and DRIVES back to AUTO. Wait 5 minutes after all changes have been made before powering off the system. Turning the power off prematurely could cause a loss in settings.
17. The system should enter Pressure Recovery mode and slowly fill the building. Upon fill and maintaining set pressure observe the system. If there is oscillation in the pressure observed, it will be necessary to fine tune the PID setting in the **[152.x] group for PMV** and the **[151.x] group on the ECO.**
    a. If you need assistance with the tuning of the PID please at this point contact the factory.

VC SYSTEMS FACTORY – 1-800-881-3123 or 1-813-987-2151

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VC Systems & Controls, Inc.

Official Start Up Report (1.1) *PMV/ECO*

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Factory Authorized Start Up Technician: _____ **Title:** _____

Voltage: L1)_____ L2)_____ L3)_____ L1+L2)_____ L1+L3)_____ L1+L3)_____

Model#: _____ **Serial#:**_____

Panel Model#: _____ **Panel Serial#:** _____

System Set Point: _____ **Suction Pressure:** _____

High System Alarm: _____ *[111.3] PMV* *[106.1] ECO*

Low System Alarm: _____ *[110.3]PMV* *[105.1] ECO*

Minimum Out: _____ *[151.3] ECO ONLY*

Proportional: _____ *[152.1] PMV* *[151.1] ECO*

Integral: _____ *[152.2] PMV* *[151.2] ECO*

Derivative: _____ *[152.3] PMV* *[151.3] ECO*

Reject Speed: _____ *[157.2] PMV* *[152.4] ECO*

Default Speed: _____ *[157.3] PMV* *[152.5] ECO*

Wake Speed: _____ *[157.4] PMV* *[152.2] ECO*

Min Speed: _____ *[157.5] PMV ONLY*

Run Data [Document data from VFD's while each pump is running and maintaining set point pressure]		
Pump #1	**Pump #2**	**Pump #3**
Speed:	Speed:	Speed:
Amps:	Amps:	Amps:
Volts:	Volts:	Volts:

NOTES:

_____

_____

_____

_____

_____

Signature: _____ **Date Completed:** ___ / ___ / ___

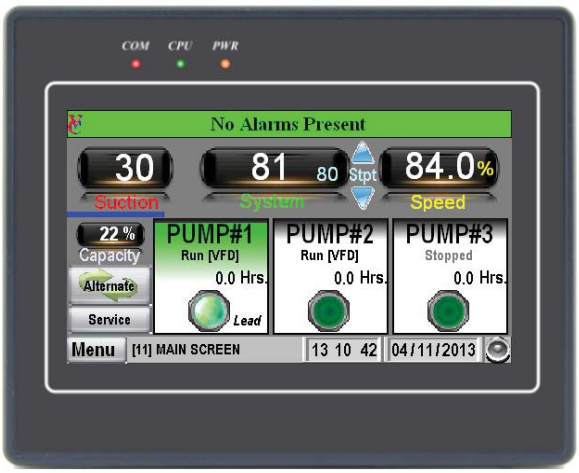
*Please send a copy of the startup report once completed to john.everhart@vcsystems.net .

ECO SERIES

ENERGY EFFICIENT VARIABLE SPEED PUMP CONTROLLERS

VC Controls, Inc.

VC Basic Control System Features



- 1-3 Equal Sized Variable Speed Pumps.
- Possible to add pumps in the future without reprogramming.
- Time of Day, Run Time, 1st On 1st Off Duty Cycle Alternation.
- Configurable for Suction pressure sensor or level switch. If suction switch input is not used, it can be configured for a system remote disable or generator lockout to limit number of pumps running under emergency power.
- Percent System Flow Capacity Indication
- Each alarm can be independently configured for behavior of pump shutdown, and reset modes.
-
- Advanced PID controls with "Kickstart" and "Stabilization" controls provide fast recovery upon starting the first pump.
- Power up restart delay and pressure recovery mode upon severe pressure loss. Safely and automatically refill empty pipes without water hammer.
- Interstage sequence timer provides better performance and fewer false starts and stops.
- Native MODBUS RTU RS485 2 Wire standard or Native BACNET MS/TP or IP via optional network module.
- 4.3" Color Touch Screen.
- Wide Screen Format provides with full interactive and animated graphics for a clear picture of the system operation.
- X-Y Plot of system operation. I plot sample per minute for up to 90 days.
- Event and History log with time date stamps and filter controls. Up to 1000 events.
- Parameter backup and restore utility. Quickly restore all settings to the last known working values at the touch of a button.
- Maintenance reminder message.

Basic Sequence

Controller can be configured for 1 to 3 pumps (variable or constant speed). This guide is universal for any number of pumps installed. All pressure and timer settings are user adjustable. Pressure is monitored and processed using an enhanced PID algorithm. The result of this calculation generates a speed signal that will modulate the pump speed to maintain a constant system pressure. Pumps are added and rejected based on the speed. The pump speed has a direct relationship to the flow capacity of the pump. This ultimately stages pumps on and off at the most effective points with minimal disturbance to the system pressure. It will inherently adapt as the pump impeller wears or clogs.

To prevent false starting and premature stopping of the pumps all timed sequences are interlocked. This means that a lag pump will not begin any start delay timers if the lead pump is not running. Similarly the lead pump stop delay timer will not begin timing out until the lag pump has stopped. By interlocking the pumps in this manner it is impossible for any pump to start or stop simultaneously under normal operating conditions. This also provides an orderly staging sequence upon power up or when returning to operation form a shutdown such as low suction. An interstage timer is also provided that allows the user to create a short time gap where pumps cannot be added or removed until the timer expires. This allows some setting time when pumps start and stop. The interstage timer is activated once with each pump start or stop event.

Typical operation example:
As the flow demand on the system increases the PID will speed the pump up to compensate. When the PID output reaches 100% (adjustable) the pump has achieved maximum capacity. Because we know that the pump is at full capacity we do not need to continue flowing beyond this point to induce a pump start via a pressure drop. Instead we begin the time delay (triggered by the PID output) for starting the next pump in line. When the next pump starts the PID will begin slowing as the next pump ramps up to speed and absorbs a portion of the system flow.

As the system flow reduces, the PID will begin reducing the pump speed to accommodate the reduction in system flow. When the speed drops below the minimum speed we know that the pump can no longer make enough pressure to open the check valve. At this point it is running at or near dead head. If we set the "PUMP REJECT SETPOINT" at this point then we can reject a pump and let the other pump(s) speed up to compensate for the change in the flow division. Obviously, speeding the pumps up again would cause the "PUMP REJECT SETPOINT" to be exceeded and therefore no additional pumps would be stopped.

Because the drives ramp the speed up and down slowly the PID will have time to adjust the speed of the drives as pumps are added or rejected from operation. For this reason there is little or no change in system pressure when pumps are added or removed.

Secondary control method
In the event a sudden pressure drop is detected and the pump has not already started from the primary sequence, the pressure drop would stage pumps on using traditional pressure based sequencing. These settings will be based on building minimums to allow more adjustable range on the primary system.

Lead pump Sleep Mode - Maximizing energy savings
A special sleep mode feature is provided that will constantly test for a zero flow condition. When no flow is detected, the lead pump will enter sleep mode, reducing the speed to 0% and effectively stopping the pump. Once the sleep mode has been entered, the pump will remain at 0 speed until a pressure drop is detected. In this way, the building static pressure can sustain small demands similar to the way hydro-pneumatic storage tanks work in many constant speed systems. If a pressure drop is detected, generally set several pounds below the normal operating pressure, the lead pump will ramp up and restore the system pressure. If the building demand is still low enough, the lead pump will return to sleep mode to conserve energy. Sleep mode is compatible on systems with or without hydro-pneumatic storage tanks. In some cases, a hydro-pneumatic storage tanks can be added to increase the amount of time the lead pump can remain in sleep mode.

One common problem with variable speed system is that they are very sluggish upon "waking" from a sleep state and that results in undesirable pressure fluctuations, often for 30 seconds or more. This is because in most cases, the first 50-70% of the pump speed has no impact on the system pressure. It simply requires that much speed to open the check valve and begin flowing water. While a PID is an excellent choice for speed control when everything is up and

running, it is blinded during the initial start of the lead pump. The PID will see no change as it speeds up the pump and react more aggressively to compensate. Then suddenly the pressure will spike as the pump crosses the threshold and begins flowing water. It's too late to do much at this point because the PID has ramped way beyond the speed required to make the minimum pressure and now has to reduce the speed to correct the huge error. If the water demand is very low, the excess pressure is often trapped and can even cause a high system pressure shutdown in severe cases. This problem requires a very careful and complex mathematical approach to resolve. VC Controls has developed a solution to this age old problem by creating a modified PID algorithm that transparently eliminates this overshoot. The software handles all the complex issues of getting the pump speed up to the threshold as quickly as mechanically possible, then seamlessly transitions into a full PID control scheme once the initial threshold has been overcome. In this way, the system response time is fast, accurate and produces no overshoot, even when starting into a closed valve (no flow) situation.

Pressure Recovery mode
When the pumps are offline for an extended period of time such as after a power outage or a system shutdown, the pressure can drop significantly and potentially create a dangerous hydraulic situation. If the pipes have drained and air has entered the system, simply restarting the system would cause the water to rush in at high velocities to refill the pipe. The very nature of the controller is to restore the pressure as quickly as possible. If the pipes are full, this is desirable, but if the pipes are empty, this can be disastrous. High velocities will eventually slam into the end of the pipe. Water does not compress like air and when it hits the end of the pipe, severe water hammer will occur. If the pipes are new and strong, everything may be fine, but over time as the pipes and fixtures weaken, this water hammer could cause serious damage and pipe breaks. This system has a pressure recovery mode feature that can be enabled to monitor the pressure while the pumps are off. In the event the pressure drops to unsafe levels, the recovery mode will refill the system slowly by ramping the lead pump speed up 1/2% per second until the system pressure returns to a normal operating range. In most cases the velocities will remain well under 1 foot per second until the pipes are refilled.

Alternation of pumps

The controller will change the order in which pumps start depending on programmed settings. This controller employs 3 different types of alternation than can be used independent or together as desired. Failed pumps are automatically removed from the sequence and a new alternation sequence is generated using the remaining pumps.

Duty Cycle (1st on 1st Off)
When pumps are added or removed from operation, this alternation mode will always attempt to remove the pump that has been operating the longest. In other words, the first pump started will be the first pump stopped. This alternation will generally keep a steady rotation through the pumps under normal circumstances. Actual run time is not controlled or balanced in this mode, but rather the objective of this alternator is to ensure a fresh pump is always used when adding and the pump that has been running longest is stopped first.

Time of Day Alternation
This alternation will automatically alternate the pumps at the preset time of day. This alternation causes a forced alternation regardless of any run time or stop/start cycles of the pumps. In the scenario where one pump runs continuously, a simple duty cycle alternation may never be induced. The Time of Day alternation will guarantee alternation one time per day minimum.

Excessive Run Time Alternation
Duty Cycle and Time of Day alternation cycle do little to balance the run time of the pumps but do a good job of making sure no pump gets all of the run time. In some cases it is desirable to limit the run time of a pump by switching to a new pump after the current pump has run for a preset time. This is very useful for system that have continuous and relatively stable demands that might cause a single pump to operate alone most of the time. Using the Run Time alternation would cause a new pump to be used every so often. The user may choose to set the run time so a new pump starts every 8 hours of actual continuous running time. This method of alternation can equalize the run time across the pumps if that is the desired goal.

Display Screens

The controller is provided with a 4.3" Wide Screen Format touch sensitive operator interface screen. Actual screens may vary slightly based on number of pumps or special features ordered, however this overview covers typical concepts and features provided with every system. The back light is automatically turned on when any part of the screen is pressed and will remain on for approximately 30 minutes if no buttons are pressed.

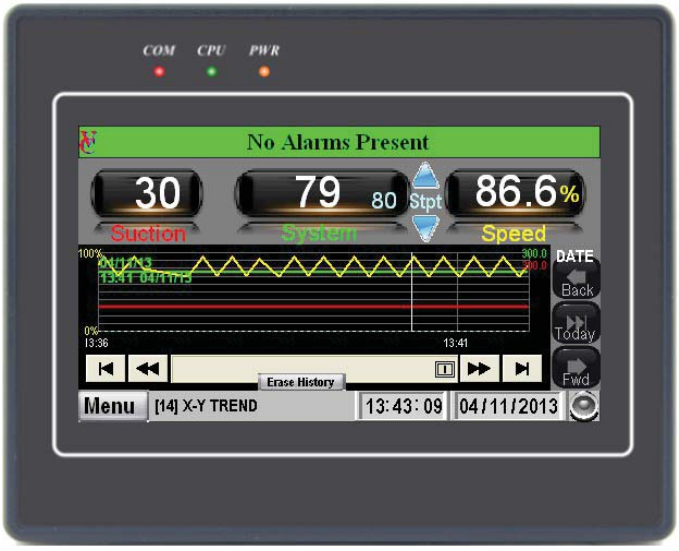
Under normal operation the display will show system operational data such as system and suction pressures or levels, PID output speed, pumps running, elapsed run time etc.

Many screens will have buttons that allow access to more help or information windows. Some icon such as the speaker in the bottom right hand corner are also buttons. Touching the speaker will mute the beeping sounds heard when pressing buttons. When muted, this icon changes to show if the sound is on or off. Screens that contain sensitive information such as configuration and parameter settings are protected by a password. Take some time to familiarize yourself with the screens available. The Menu button provides access to all major screens such as the main screen, the trending screen, the event log and parameters. Refer to "Controller Setup" for details on changing system settings.

Trending and Event Logs

This controller is provided with special data logging capabilities. These logs can be very useful when troubleshooting system operation.
All events such as pump alarms and actual pump run status are logged as they occur. The time that they occurred and the time that they ended are also recorded. Normal system events appear in a bold print as they occur and fade to a lighter color as they end. Active events can be double clicked to change the color so it is easy to identify new alarms that occur after current alarms are acknowledged. Alarm events will appear in the scrolling banner at the top of the screen that turns red when alarms exist, otherwise it will be green. All alarms will appear in the log as well. The first screen shows current alarms and events. A button on this screen opens a window that allows viewing of older events and alarms. To simplify viewing, alarms are indented and preceded with [!]. All events and alarms are backed up in EEPROM memory so they are retained even after a power loss.

In addition to the event log, a real time chart recorder is provided that will show the trend history of the system and suction pressures as well as the pump speed over the past 90 days or more. Each screen displays about 60 minutes of data and samples are approximately 1 minute apart.



Data from the current day can be accessed by simply using the arrow keys at the bottom of the chart recorder to scroll back and forth through time. You can skip from day to day using the DATE arrow buttons located near the right edge of the chart. Touching the chart will cause the date in the upper left corner of the chart to change to the date and time of the point you touched.

Event history logs and x-y data plots share EEPROM memory so both are retained through a loss of power. When the memory is full, the oldest data is deleted as new data comes in. The ample storage should be enough to track down issues even if they have spanned over long periods of time.

Alarms and Indicators and other controls

The system will monitor the supply and discharge pressures as well as drives for proper operation. In the event of abnormal operation the controller will illuminate a common alarm lamp and display a message indicating the source of the problem. All systems are provided with a form C common alarm "dry" contact for remote monitoring. This contact will change state in the event of any alarm including loss of power. The "Silence" button may be pressed to quiet the audible alarm while problems are resolved. The local and remote alarms will remain active until the condition ceases.

Note: Each alarm can be configured as needed to cause a pump shutdown, manual or automatic restart of pumps as well as manual or automatic reset of the alarm. The configuration is limited to factory authorized personnel due to the possible dangers involved in some scenarios and to ensure warranties are not void.

All systems are provided with the following alarms and messages. Additional alarms and messages are provided in addition to those listed here. Related information to each alarm is provided at the touchscreen for all alarms.

LOW SYSTEM ALARM
If the pressure (level) fails to rise above the low pressure (level) alarm setting within the alarm delay timer setting, this alarm will be engaged to notify an operator of the condition. This alarm will automatically reset when the condition ceases to exist. Possible causes include pumps left in the off position, motor overloads or drives tripped or clogged pump impellers.

HIGH SYSTEM ALARM
If the discharge pressure (level) rises above the alarm pressure (level) setting for the duration of the alarm delay timer, all pumps in "AUTO" will be stopped to prevent damage to system piping. Some possible causes include a failure of a pressure sensor or excessively high supply pressure to the system, improper PID tuning or manual operation of the pump above the high pressure alarm setting. A pressure display that is higher than the range printed on the sensor can indicate a sensor failure or wiring problem. Note that it is more common for a sensor to fail to negative pressure than a high pressure.

LOW SUCTION ALARM
The water source to the system should have some positive pressure (level). If this pressure (level) is lost there is danger of damage to the pump caused by a lack of water to properly lubricate the pump bearings. If the pressure (level) drops below the alarm pressure (level) setting for the duration of the time delay then the pumps in "AUTO" will be stopped. The pumps will automatically return to operation when the water supply pressure returns. The alarm must be manually reset.

Note: The suction alarm can be configured for a variety of sensors. Systems that pump from a pressurized city water main will generally have a pressure sensor, where as a system that is fed from a reservoir tank might use a level sensor or possibly a level switch. This controller can be configured for each of these possibilities.

PUMP#[x] FAIL TO START (Where [x] = the pump number that has failed)
If any motor starter fails to engage when the controller calls it, this alarm is engaged to alert the operator that the system capacity is now reduced. System will continue to operate with the remaining pumps. This alarm can occur under drive failure, Drive Keypad switch in "Off" or if the drive has failed to start when called. On constant speed pumps or drive bypasses, this can also occur when an overload trips. The fail to start alarm must be manually reset.

Starting the system up for the first time

Each pump is provided with "HAND-OFF-AUTO" selector switches and run indication lamps. The "HAND" position is intended for attended use only. This mode will over-ride all alarms except the motor overload or drive trip. This can be useful for operating a system manually with failed components or for testing pump operation during startup. The "OFF" position will prevent a pump from being started in any mode. This is not a service lockout position. Always disable the power source to a pump before performing service. Failure to do so may result in personal injury or death. When preparing to start a system for the first time there are many things to be aware of. You need to familiarize your self with the controller, the required connections and the piping that the system is connected to. Never just walk up to a panel and throw the switch on and expect it to work. Doing so can cause serious damage to the system piping as well as the people around. Always assume all wires are live and practice safe electrical technique. Startup should only be performed by trained factory authorized personnel.

Controller Setup

All controller settings can be adjusted from the local control panel display only. Remote displays are not permitted to change parameters as this could cause a hazardous situation if a person is not present to monitor the reaction of the system to parameter changes.

To change parameters you will need to log in first to prevent unwanted tampering of the system parameters. Several security login levels are possible. Each parameter is assigned a security level. If your login level is not high enough, you will be prompted to log in at a higher level when a parameter is touched. It is not necessary to be logged in to view parameters, only to make changes
The panel is shipped with the password set as follows

User Levels allow changes to most parameters.
USER: 1111

Factory Representative Level can access all parameters except "Factory only" parameters and can view and change all passwords except Factory level.
Factory Reps are given their password by the factory.

Factory Level grants access to all parameters and all passwords. Factory level passwords are not published for obvious reasons.

To access the parameters simply touch the menu button and select the desired setup after you have logged in. You will be logged out automatically after 10 minutes, or if you press any of the logout buttons found in many locations. If you attempt to change a parameter that you do not have privileges to change, the login screen will pop up and prompt you to log in at a level that will permit changes. User passwords can be changed by logging in as a user with a higher or equal level or permissions. For example someone logging in as a Factory Representative would be able to change the password for "User" as the User is a lower level permission. Also note that there are 2 Factory levels that are for use only by factory authorized persons. It is suggested that new passwords be entered at startup to improve security. Simple default parameters are shown in the parameter lists below. A factory representative or factory person can change any password in the event all passwords are lost. For security reasons, the Factory passwords are not shown in this manual.

Touch the value of any parameter and a keypad will pop up to allow you to change that value.

Parameter Group [Screen ID]	Description *Value shown in brackets are factory default {###}*	Login Level Required	Field Setting
User [102.x]	[102.1] Wake Lead/Add Lag Dev. {-5} Seconds Setpoint {___} This delays the start of the lead pump. It is generally set to zero except when pressure swings are common when pumps are not running. [102.2] Delay on adding lag pumps {5} Seconds This delay is common to all lag pumps. The timer is not enabled until the interstage timer has expired, the next lag pump will then be available after this delay time. [102.3] Interstage Delay {5} Seconds This timer creates a gap between any start or stop pump action. By using this timer, it allows shorter start delays to be used for lag pumps as this timer will not require that the following pumps account for the ramp up and stabilization time.	USER	
User [103.x]	[103.1] Stop Delay {5} Seconds This only applies to lag pumps. Rejection happens based upon speed assuming pressure setpoint is satisfied. Since pump is ramped, there is no need to run ten minutes to ensure cooling time.	USER	

Parameter Group [Screen ID]	Description *Value shown in brackets are factory default {###}*	Login Level Required	Field Setting
User [104.x]	[104.1] Pump Overlap on Alternation {5} [104.2] Alternation Modes > 1st On 1st Off {On} > Time of Day {On} {Hr=22} > Run Time {On} {8 hrs} Refer to Alternation section of this sequence for details.	USER	
User [105.x]	Alarm Reset [105.1] Low Discharge Pressure {__} {__} [105.2] Alarm Delays - Seconds {5} {5}	USER	
User [106.x]	Alarm Reset [106.1] High Discharge Pressure {__} {__} [106.2] Alarm Delays - Seconds {5} {5}	USER	
User [107.x]	Alarm Reset [107.1] Low Suction Pressure {__} {__} [107.2] Alarm Delays - Seconds {5} {5}	USER	
User [108.x]	Alarm Reset [108.1] High Suction Pressure {300} {299} [108.2] Alarm Delays - Seconds {5} {5}	USER	
User [109.x]	[109.1] Exercise pumps that have not run for {24hrs} This feature will cause pumps that have no operated for a long time to be run for the time set in [102.2] [109.2] Exercise period {1min} This value is only used if the alarm is configured for automatic reset.	USER	
Factory[151.x] CRITICAL	PID Configuration 1 151.1 Proportional {0.04} [151.4] Sample Time {1x100ms} 151.2 Integral {0.09} [151.5] Min Out {50%} 151.3 Derivative {0.00} [151.6] Max Out {100%}	Factory	
Factory[152.x] CRITICAL	PID Configuration 2 152.1 Wake Dev {-5} [152.4] Reject Speed {70%} 152.2 Wake Speed {60%} [152.5] Default Speed {65%} 152.3 Wake Hold {5} [152.6] Stpt Limit {0 min} {300 max}		
Factory[153.x]	PID Configuration 2 152.1 Sleep Abort Deviation {-3} 152.2 Sleep Test Frequency {30sec} *Set to 0 to disable sleep mode* 152.3 Boost Deviation {3}		
Factory[154.x]	Scale System Sensor 152.1 Sensor Span {300} 152.2 Offset {0} *Adjust as needed to correct zero pressure reading*		
Factory[155.x]	Scale Supply Sensor 152.1 Sensor Type {Analog or Switch} 152.2 Sensor Span {300} 152.3 Offset {0} *Adjust as needed to correct zero pressure reading*		
Factory[156.x]	Scale Supply Sensor Low High 156.1 System {0} {2} 156.2 Suction {3} {0} Type Pump Stop Pump Restart Alarm Reset 0 No - Auto 1 No - Manual 2 Yes Manual Manual 3 Yes Auto Manual 4 Yes Auto Auto		

Parameter Group [Screen ID]	Description *Value shown in brackets are factory default {###}*	Login Level Required	Field Setting
Factory[157.x]	Configure Pumps 157.1 Qty Pump Installed {__} 157.2 Pump Fail to Start Delay {5} 157.3 Generator Limit Qty Pumps Run {0} *Note: Set = 0 for remote disable*		
Factory[158.x]	Pump ETM's 158.1 Pump#1 Elapsed Run Time {0hrs} 158.2 Pump#1 Elapsed Run Time {0hrs} 158.3 Pump#1 Elapsed Run Time {0hrs}		
Factory[159.x]	System Restart and Pressure Recovery 159.1 System Delay on Restart {25sec} 159.2 Enter Pressure Recovery Mode Below {__} *Set to 0 to disable*		
Factory[165.x]	Passwords 165.1 User 165.2 Factory Representative 165.3 Factory 1 & Factory 2.		
Factory[166.x]	Factory Representative Information Name, Cisty, State, Zip & Phone		
Factory[167.x]	Maintenance Reminder 167.1 Date for Popup Reminder {Month = 0} {Day=0} *Set to 0/0 to disable*		
Factory[168.x]	Backup Utility Use this utility to make a copy of PLC parameters in the color touch screen. If the PLC ever replaced or loses it's parameters, the screen can be used to restore them instantly.		
Factory[169.x]	PLC Information General information about PLC operation and installed program.		
Factory[170.x]	HMI Information General information about the color touchscreen operation and installed program as well as an adjustable field for changing the backlight timeout delay.		

Remote Monitoring and interface

The controller is provided with a network connection for MODBUS RTU via RS485 (2-wire) to monitor the system operation. The default network settings are 9600,N,8,1 address 5 but they can be changed from the color touch screen as needed. The PLC is equipped with two MODBUS ports. One is dedicated to the operator interface and the other is for customer BAS connection. The open customer port is labeled Port 3 and is a screw terminal connection that is clearly labeled with connection details. The PLC does not have terminating resistors. If they are required, they must be installed externally.

An **OPTIONAL** BACnet communications gateway is available preconfigured per the table below. BACnet MS/TP communication parameters can only be downloaded into the gateway by the factory. BACnet IP settings can be configured through the network port using a web browser.

Refer to the wiring diagram on the enclosure door for connection details.

The following data can be read over the MODBUS connection.

MODBUS ADDRESS	BACNET ADDRESS	DATA	NOTES
40001	AV0	SYSTEM PRESSURE OR LEVEL	
40002	AV1	SUCTION PRESSURE OR LEVEL	
40003	AV2	Not used	
40004	AV3	Not used	
40005	AV4	PUMP #1 STATUS WORD 0 = Stopped [Enabled] 1 = Running 3 = Failed [Offline] 4 = Not Installed or present	
40006	AV5	PUMP #2 STATUS WORD *See Pump#1 Status word for description*	
40007	AV6	PUMP #3 STATUS WORD *See Pump#1 Status word for description*	

MODBUS ADDRESS	BACNET ADDRESS	DATA	NOTES
40008	AV7	Not used	
40009	AV8	Not used	
40010	AV9	Not used	
40011	AV10	PUMP#1 ETM [HRS x100] *Example: 100hours will return a value of 1*	
40012	AV11	PUMP#2 ETM [HRS x100] *Example: 100hours will return a value of 1*	
40013	AV12	PUMP#3 ETM [HRS x100] *Example: 100hours will return a value of 1*	
40014	AV13	Not used	
40015	AV14	Not used	
40016	AV15	Not used	
40017	AV16	COMMON ALARM STATUS 0 = No alarms present 1 = Alarms Exist	
40018	AV17	Not used	
40019	AV18	SYSTEM SENSOR STATUS (Discharge pressure/level sensor) 0 = OK 1 = Short Circuit [*Failed*] 2 = Open Circuit [*Failed or not present*]	
40020	AV19	SUCTION SENSOR STATUS (Supply pressure/level sensor) Not used when suction sensor type is configured for "Switch Input" 0 = OK 1 = Short Circuit [*Failed*] 2 = Open Circuit [*Failed or not present*]	
40021	AV20	Not used	
40022	AV21	DISCHARGE PRESSURE/LEVEL ALARM 0 = No Alarm (Pressure/Level is normal) 1 = Low alarm (Pressure/Level is below normal limits) 2 = High Alarm (Pressure/Level is above normal limits)	
40023	AV22	SUCTION PRSSURE/LEVEL ALARM 0 = No Alarm (Pressure/Level is normal) 1 = Low alarm (Pressure/Level is below normal limits) 2 = High Alarm (Pressure/Level is above normal limits) *Note: Depending on user configuration this alarm status can be common to all pumps or reflect one or more pumps.*	
40024	AV23	EXTERNAL SYSTEM DISABLE Not used when suction sensor type is configured for "Switch Input" 0 = System enabled 1 = System disabled or limited due to generator power (wired input to panel) 2 = System is disabled due to remote lockout (wired input to panel) *Note: System can be user configured to limit system operation to any number of pumps or a complete shutdown under generator power.*	
40025	AV24	PID OUTPUT (Pump) SPEED IN PERCENT (0-100%)	
40026-40032	AV25-AV31	Unused - Reserved for future use.	

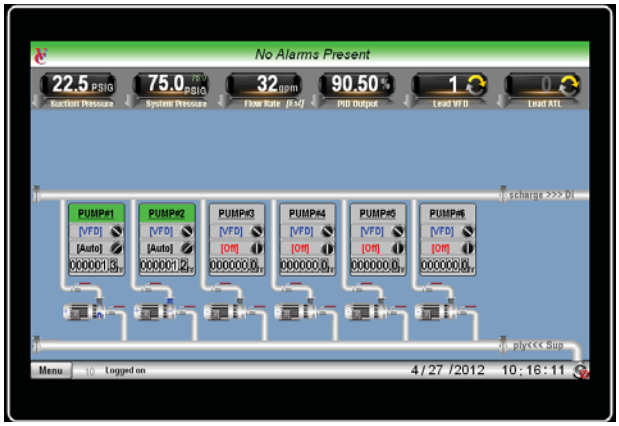
Note: A loss of communications indicates an active loss of power to the panel.

PMV SERIES

PREMIUM ENERGY EFFICIENT VARIABLE SPEED PUMP CONTROLLERS

VC Controls, Inc.

VC Advanced Control System Features



- 1-6 pumps Constant Speed or Variable Speed or any combination.
- Possible to add pumps in the future without reprogramming.
- Small Jockey pump mode possible for Pump#1. Can be configured to run with lags or stop when lags run.
- Time of Day, Run Time, 1st On 1st Off Duty Cycle Alternation.
- Configurable Suction sensor, pressure, level switch or even individual level switches per pump.
- Flow input standard, however controller can be closely estimate flow if sensor is not installed when variable speed pumps are available.
- Each alarm can be independently configured for behavior of pump shutdown, and reset modes.
- Advanced PID controls with "Kickstart" and "Stabilization" controls provide fast recovery upon starting the first pump.
- Power up restart delay and pressure recovery mode upon severe pressure loss. Safely and automatically refill empty pipes without water hammer.
- "Generator Lockout" for load shedding while under backup power.
- Remote System Disable via external "dry" contact.
- Interstage sequence timer provides better performance and fewer false starts and stops.
- Native MODBUS RTU RS485 2 Wire standard or Native BACNET MS/TP or IP via optional network module.
- Color Touch Screen available in 7" and 10". Optional 4.3" reduced feature screen available for cost sensitive applications.
- Wide Screen Format provides with full interactive and animated graphics for a clear picture of the system operation.
- X-Y Plot of system operation. I plot sample per minute for up to 90 days.
- Event and History log with time date stamps and filter controls. Up to 1000 events.
- Export Event Logs and X-Y Plots to Thumb Drive in universal CSV format for viewing in most spreadsheet programs or import into other programs..
- Parameter backup and restore utility with USB thumb drive. Quickly restore all settings to the last known working values at the touch of a button.
- Maintenance reminder message.
- User help available right from the screen so setting parameters does not require a printed manual in hand.

Basic Sequence

Controller can be configured for 1 to 6 pumps (variable or constant speed). Pumps are automatically installed when the associated hardware is wired to the controller. This method creates the ability to provide a controller such that additional pumps can be added in the future. The controller will automatically reconfigure itself when the new pumps are detected. This guide is universal for any number of pumps installed. All pressure and timer settings are user adjustable. Pressure is monitored and processed using an enhanced PID algorithm. The result of this calculation generates a speed signal that will modulate the pump speed to maintain a constant system pressure. When variable speed pumps are enabled, pumps are added and rejected based on the speed. The pump speed has a direct relationship to the flow capacity of the pump. This ultimately stages pumps on and off at the most effective points with minimal disturbance to the system pressure. It will inherently adapt as the pump impeller wears or clogs. If all pumps are constant speed, then the controller will use traditional timer controls to start and stop the pumps based on pressure. Note, that a combination of variable and constant speed pumps is possible and the controller will automatically use speed or flow as needed to sequence the pumps.

To prevent false starting and premature stopping of the pumps all timed sequences are interlocked. This means that a lag pump will not begin any start delay timers if the lead pump is not running. Similarly the lead pump stop delay timer will not begin timing out until the lag pump has stopped. By interlocking the pumps in this manner it is impossible for any pump to start or stop simultaneously under normal operating conditions. This also provides an orderly staging sequence upon power up or when returning to operation form a shutdown such as low suction. An interstage timer is also provided that allows the user to create a short time gap where pumps cannot be added or removed until the timer expires. This allows some setting time when pumps start and stop. The interstage timer is activated once with each pump start or stop event.

Typical operation example:
As the flow demand on the system increases the PID will speed the pump up to compensate. When the PID output reaches 100% (adjustable) the pump has achieved maximum capacity. Because we know that the pump is at full capacity we do not need to continue flowing beyond this point to induce a pump start via a pressure drop. Instead we begin the time delay (triggered by the PID output) for starting the next pump in line. When the next pump starts the PID will begin slowing as the next pump ramps up to speed and absorbs a portion of the system flow.

As the system flow reduces, the PID will begin reducing the pump speed to accommodate the reduction in system flow. When the speed drops below the minimum speed we know that the pump can no longer make enough pressure to open the check valve. At this point it is running at or near dead head. If we set the "PUMP REJECT SETPOINT" at this point then we can reject a pump and let the other pump(s) speed up to compensate for the change in the flow division. Obviously, speeding the pumps up again would cause the "PUMP REJECT SETPOINT" to be exceeded and therefore no additional pumps would be stopped.

Because the drives ramp the speed up and down slowly the PID will have time to adjust the speed of the drives as pumps are added or rejected from operation. For this reason there is little or no change in system pressure when pumps are added or removed.

Secondary control method
In the event a sudden pressure drop is detected and the pump has not already started from the primary sequence, the pressure drop would stage pumps on using traditional pressure based sequencing. These settings will be based on building minimums to allow more adjustable range on the primary system.

Lead pump Sleep Mode - Maximizing energy savings
A special sleep mode feature is provided that will constantly test for a zero flow condition. When no flow is detected, the lead pump will enter sleep mode, reducing the speed to 0% and effectively stopping the pump. Once the sleep mode has been entered, the pump will remain at 0 speed until a pressure drop is detected. In this way, the building static pressure can sustain small demands similar to the way hydro-pneumatic storage tanks work in many constant speed

systems. If a pressure drop is detected, generally set several pounds below the normal operating pressure, the lead pump will ramp up and restore the system pressure. If the building demand is still low enough, the lead pump will return to sleep mode to conserve energy. Sleep mode is compatible on systems with or without hydro-pneumatic storage tanks. In some cases, a hydro-pneumatic storage tanks can be added to increase the amount of time the lead pump can remain in sleep mode.

One common problem with variable speed system is that they are very sluggish upon "waking" from a sleep state and that results in undesirable pressure fluctuations, often for 30 seconds or more. This is because in most cases, the first 50-70% of the pump speed has no impact on the system pressure. It simply requires that much speed to open the check valve and begin flowing water. While a PID is an excellent choice for speed control when everything is up and running, it is blinded during the initial start of the lead pump. The PID will see no change as it speeds up the pump and react more aggressively to compensate. Then suddenly the pressure will spike as the pump crosses the threshold and begins flowing water. It's too late to do much at this point because the PID has ramped way beyond the speed required to make the minimum pressure and now has to reduce the speed to correct the huge error. If the water demand is very low, the excess pressure is often trapped and can even cause a high system pressure shutdown in severe cases. This problem requires a very careful and complex mathematical approach to resolve. VC Controls has developed a solution to this age old problem by creating a modified PID algorithm that transparently eliminates this overshoot. The software handles all the complex issues of getting the pump speed up to the threshold as quickly as mechanically possible, then seamlessly transitions into a full PID control scheme once the initial threshold has been overcome. In this way, the system response time is fast, accurate and produces no overshoot, even when starting into a closed valve (no flow) situation.

Pressure Recovery mode
When the pumps are offline for an extended period of time such as after a power outage or a system shutdown, the pressure can drop significantly and potentially create a dangerous hydraulic situation. If the pipes have drained and air has entered the system, simply restarting the system would cause the water to rush into at high velocities to refill the pipe. The very nature of the controller is to restore the pressure as quickly as possible. If the pipes are full, this is desirable, but if the pipes are empty, this can be disastrous. High velocities will eventually slam into the end of the pipe. Water does not compress like air and when it hits the end of the pipe, severe water hammer will occur. If the pipes are new and strong, everything may be fine, but over time as the pipes and fixtures weaken, this water hammer could cause serious damage and pipe breaks. This system has a pressure recovery mode feature that can be enabled to monitor the pressure while the pumps are off. In the event the pressure drops to unsafe levels, the recovery mode will refill the system slowly by ramping the lead pump speed up 1/2% per second until the system pressure returns to a normal operating range. In most cases the velocities will remain well under 1 foot per second until the pipes are refilled.

Constant Speed Pumps and Bypass Operation

Normal operation of the pumps is using the variable frequency drives (VFD's). Variable Speed pumps are staged first, then across the line (or Bypass) pumps. Some systems are provided with Drive bypasses while others could use a combination of variable speed and constant speed pumps. The controller will automatically identify what is connected and create the best sequencing strategy possible.

On systems with Drive bypasses, the operator can still operate the pump if a drive fails by placing the failed drive in bypass mode. Bypass operation will run the pump at full speed (across the line, bypassing the drive completely) and pressure is regulated by the mechanical pressure regulating valve on the package to prevent over pressurization of the system. A switch is provided with each pump that is used to select BYPASS or VFD operation. Note that this switch is disabled if the pump is currently in operation. An amber lamp is illuminated to indicate that bypass has been selected. The actual pump run status is still indicated by the same green pump run lamp. To change the mode of a pump, the pump must be stopped, the mode changed and then the pump may be re-enabled.

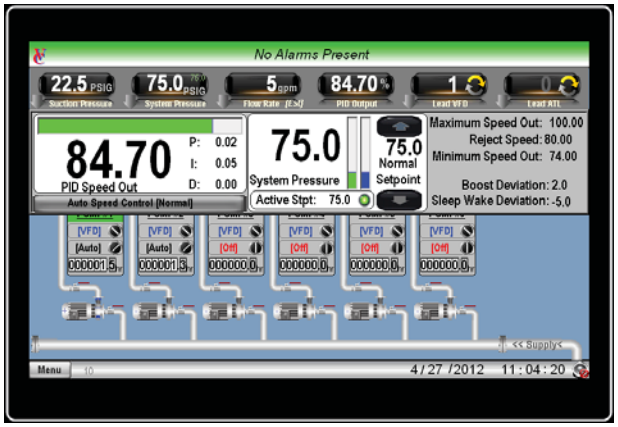
Alternation of pumps

The controller will change the order in which equal sized pumps start based on one of two methods depending on programmed settings. The controller alternation will automatically detect the mode of the pump and use VFD pumps first and constant speed pumps last. The controller will group the pumps according to the mode and alternate the pumps independently base on the groupings. This controller employs 3 different types of alternation than can be used independent or together as desired. Failed pumps are automatically removed from the sequence and a new alternation sequence is generated using the remaining pumps.

Duty Cycle (1st on 1st Off)
When pumps are added or removed from operation, this alternation mode will always attempt to remove the pump that has been operating the longest. In other words, the first pump started will be the first pump stopped. This alternation will generally keep a steady rotation through the pumps under normal circumstances. Actual run time is not controlled or balanced in this mode, but rather the objective of this alternator is to ensure a fresh pump is always used when adding and pump that has been running longest is stopped first.

Time of Day Alternation
This alternation will automatically alternate the pumps at the preset time of day. This alternation causes a forced alternation regardless of any run time or stop/start cycles of the pumps. In the scenario where one pump runs continuously, a simple duty cycle alternation may never be induced. The Time of Day alternation will guarantee alternation one time per day minimum.

Excessive Run Time Alternation
Duty Cycle and Time of Day alternation cycle do little to balance the run time of the pumps but do a good job of making sure no pump gets all of the run time. In some cases it is desirable to limit the run time of a pump by switching to a new pump after the current pump has run for a preset time. This is very useful for system that have continuous and relatively stable demands that might cause a single pump to operate alone most of the time. Using the Run Time alternation would cause a new pump to be used every so often. The user may choose to set the run time so a new pump starts every 8 hours of actual continuous running time. This method of alternation can equalize the run time across the pumps if that is the desired goal.



Display Screens

The controller is provided with a touch sensitive operator interface screen. Actual screens may vary slightly based on number of pumps or special features ordered, however this overview covers typical concepts and features provided with every system. The back light is automatically turned on when any part of the screen is pressed and will remain on for approximately 30 minutes if no buttons are pressed. Three screens sizes are available depending on what is ordered. All screens are full color, touch sensitive wide screen format. The economy level screen is 4.3" and offers basic display of system functions. The more common 7" or 10" displays (shown to the left) offer far more functionality including full parameter backup to USB thumbdrive as well as the ability to export event logs and system x-y plot data samples to a standard CSV file that can be opened by most spreadsheet programs. Screens can also be ordered with an optional Ethernet port that can be configured to enable features such as full remote operation using a VNC server.

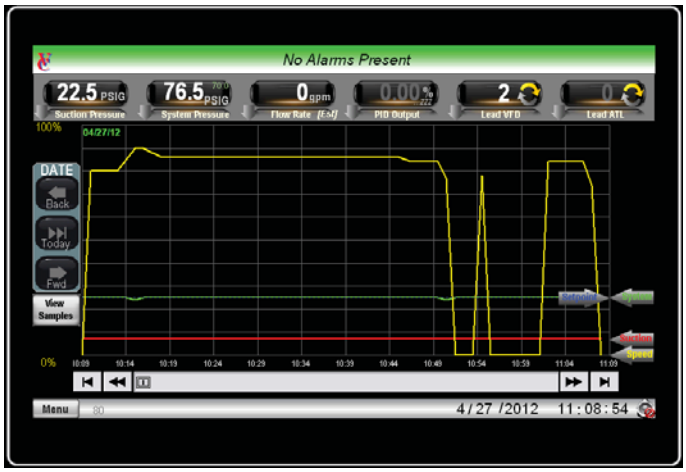
Under normal operation the display will show system operational data such as system and suction pressures or levels, PID output speed, flow rates, pumps running, elapsed run time etc. Each meter displayed across the top includes a drop down screen that provides more detailed information related to that meter. Pressing the down arrow under each meter will expand a drop down screen related to tha meter. The arrow will flash to indicate what meter the drop down is related to while it is open. Touching the arrow again will close the drop down. Pictured to the left, the drop down for the PID is expanded so the user can see all details related to speed control governed by the PID controller.

Many screens will have buttons that allow access to more help or information windows. Some icon such as the speaker in the bottom right hand corner are also buttons. Touching the speaker will mute the beeping sounds heard when pressing buttons. When muted, this icon changes to show if the sound is on or off. Screens that contain sensitive information such as configuration and parameter settings are protected by a password. Take some time to familiarize yourself with the screens available. The Menu button provides access to all major screens such as the main screen, the trending screen, the event log and parameters. Refer to "Controller Setup" for details on changing system settings.

Trending and Event Logs

This controller is provided with special data logging capabilities. These logs (pictured below right) can be very useful when troubleshooting system operation. All events such as pump alarms and actual pump run status are logged as they occur. The time that they occurred and the time that they ended are also recorded. Normal system events appear in a bold print as they occur and fade to a lighter color as they end. Active events can be double clicked to change the color so it is easy to identify new alarms that occur after current alarms are acknowledged. Alarm events will appear in the scrolling banner at the top of the screen that turns red when alarms exist, otherwise it will be green. All alarms will appear in the log as well. The first screen shows current alarms and events. A button on this screen opens a window that allows viewing of older events and alarms. To simplify viewing, alarms are indented and preceded with [!]. All events and alarms are backed up in EEPROM memory so they are retained even after a power loss.

In addition to the event log, a real time chart recorder (pictured below left) is provided that will show the trend history of the system and suction pressures as well as the pump speed over the past 90 days. Each screen displays about 60 minutes of data and samples are approximately 1 minute apart. Data samples are stored as in a table that can be exported to a USB thumb drive (7" & 10" screens only). A button is provided on the left edge for viewing the data sample table.



Data from the current day can be accessed by simply using the arrow keys at the bottom of the chart recorder to scroll back and forth through time. You can skip from day to day using the DATE arrow buttons located near the left edge of the chart. Touching the chart will cause the date in the upper left corner of the chart to change to the date and time of the point you touched.

Event history logs and x-y data plots share EEPROM memory so both are retained through a loss of power. When the memory is full, the oldest data is deleted as new data comes in. The ample storage should be enough to track down issues even if they have spanned over long periods of time.

Alarms and Indicators and other controls

The system will monitor the supply and discharge pressures as well as motor starters and/or drives for proper operation. In the event of abnormal operation the controller will illuminate a common alarm lamp and display a message indicating the source of the problem. All systems are provided with a form C common alarm "dry" contact for remote monitoring. This contact will change state in the event of any alarm including loss of power. The "Silence" button may be pressed to quiet the audible alarm while problems are resolved. The local and remote alarms will remain active until the condition ceases.

Note: Each alarm can be configured as needed to cause a pump shutdown, manual or automatic restart of pumps as well as manual or automatic reset of the alarm. The configuration is limited to factory authorized personnel due to the possible dangers involved in some scenarios and to ensure warranties are not void.

All systems are provided with the following alarms and messages. Additional alarms and messages are provided in addition to those listed here. Related information to each alarm is provided at the touchscreen for all alarms.

LOW SYSTEM ALARM
If the pressure (level) fails to rise above the low pressure (level) alarm setting within the alarm delay timer setting, this alarm will be engaged to notify an operator of the condition. This alarm will automatically reset when the condition ceases to exist. Possible causes include pumps left in the off position, motor overloads or drives tripped or clogged pump impellers.

HIGH SYSTEM ALARM
If the discharge pressure (level) rises above the alarm pressure (level) setting for the duration of the alarm delay timer, all pumps in "AUTO" will be stopped to prevent damage to system piping. Some possible causes include a failure of a pressure sensor or excessively high supply pressure to the system, improper PID tuning or manual operation of the pump above the high pressure alarm setting. A pressure display that is higher than the range printed on the sensor can indicate a sensor failure or wiring problem. Note that it is more common for a sensor to fail to negative pressure than a high pressure.

LOW SUCTION ALARM
The water source to the system should have some positive pressure (level). If this pressure (level) is lost there is danger of damage to the pump caused by a lack of water to properly lubricate the pump bearings. If the pressure (level) drops below the alarm pressure (level) setting for the duration of the time delay then the pumps in "AUTO" will be stopped. The pumps will automatically return to operation when the water supply pressure returns. The alarm must be manually reset.

Note: The suction alarm can be configured for a variety of sensors. Systems that pump from a pressurized city water main will generally have a pressure sensor, where as a system that is fed from a reservoir tank might use a level sensor or possibly a level switch. In some cases, the pumps my independently fed. This controller can be configured for all of these possibilities. The alarm(s) will reflect the sensor that the system has been configured for.

PUMP#[x] FAIL TO START (Where [x] = the pump number that has failed)
If any motor starter fails to engage when the controller calls it, this alarm is engaged to alert the operator that the system capacity is now reduced. System will continue to operate with the remaining pumps. This alarm can occur under drive failure, Drive Keypad switch in "Off" or if the drive has failed to start when called. On constant speed pumps or drive bypasses, this can also occur when an overload trips. The fail to start alarm must be manually reset.

Starting the system up for the first time

Each pump is provided with "HAND-OFF-AUTO" selector switches and run indication lamps. The "HAND" position is intended for attended use only. This mode will over-ride all alarms except the motor overload or drive trip. This can be useful for operating a system manually with failed components or for testing pump operation during startup. The "OFF" position will prevent a pump from being started in any mode. This is not a service lockout position. Always disable the power source to a pump before performing service. Failure to do so may result in personal injury or death. When preparing to start a system for the first time there are many things to be aware of. You need to familiarize your self with the controller, the required connections and the piping that the system is connected to. Never just walk up to a panel and throw the switch on and expect it to work. Doing so can cause serious damage to the system piping as well as the people around. Always assume all wires are live and practice safe electrical technique. Startup should only be performed by trained factory authorized personnel.

Controller Setup

All controller settings can be adjusted from the local control panel display only. Remote displays are not permitted to change parameters as this could cause a hazardous situation if a person is not present to monitor the reaction of the system to parameter changes.

To change parameters you will need to log in first to prevent unwanted tampering of the system parameters. Several security login levels are possible. Each parameter is assigned a security level. If your login level is not high enough, you will be prompted to log in at a higher level when a parameter is touched. It is not necessary to be logged in to view parameters, only to make changes
The panel is shipped with the password set as follows

User Levels allow changes to most no critical parameters. All User level are equal and can view and change all user passwords
USER 1 - 4: 1111

Supervisors have more privileges than Users. Supervisors can view and change passwords of Users and Supervisors.
SUPERVISOR 1 - 2: 2222

Owners (presumably property owners) have access to most parameters and can view and change passwords of Users, Supervisors and Owners.
OWNER 1 - 2: 3333

A special login for the Network Admin allows BAS personnel to configure the communications for their networks but prevents any changes to the pump related parameters.
NETWORK ADMIN : 4444

Factory Representative Level can access all parameters except "Factory only" parameters and can view and change all passwords except Factory level. Factory Reps are given their password by the factory.

Factory Level grants access to all parameters and all passwords. Factory level passwords are not published for obvious reasons.

Parameters are split up into two categories, USER and FACTORY, however the actual parameters found on each screen are individually access protected. Twelve different users levels exist and you must log in at a user level that allows access to change a parameter. For example, you might need supervisor permissions to change the time and date, but a general user would only be able to view the time and date. In this way it is possible to protect the time and date stamps from being tampered with by lower level users. To access the parameters simply touch the menu button and select the desired setup after you have logged in. You will be logged out automatically after 10 minutes, or if you press any of the logout buttons found in many locations including a menu selection button. If you attempt to change a parameter that you do not have privileges to change, the login screen will pop up and prompt you to log in at a level that will permit changes. User passwords can be changed by logging in as a user with a higher or equal level or permissions. For example someone logging in as a Supervisor would be able to change the password for "Supervisor" and "User" as the User is a lower level permission. Also note that there are 2 Owner and 2 Factory levels. Both owner levels have the same level or permissions. The second is built in for redundancy so that if one of the owners cannot remember their password, the other owner can log in and retrieve and/or change it. The same logic applies for the two factory logins. It is suggested that new passwords be entered at startup to improve security. Simple default passwords are shown in the parameter lists below. A factory representative or factory person can change any password in the event all passwords are lost. For security reasons, the Factory passwords are not shown in this manual.

Touch the value of any parameter and a keypad will pop up to allow you to change that value.

Parameter Group [Screen ID]	Description *Value shown in brackets are factory default {###}*	Login Level Required	Field Setting
User [101.x]	[101.1] Start Lead Pump after {0} Seconds This delays the start of the lead pump. It is generally set to zero except when pressure swings are common when pumps are not running. [101.2] Interstage Delay {10} Seconds This timer creates a gap between any start or stop pump action. By using this timer, it allows shorter start delays to be used for lag pumps as this timer will not require that the following pumps account for the ramp up and stabilization time. [101.3] Start Lag Pump after {10} Seconds This delay is common to all lag pumps. The timer is not enabled until the interstage timer has expired, the next lag pump will then be available after this delay time.	USER 1-4	
User [102.x]	[102.1] Stop Variable Speed Pumps After {10} Seconds This only applies to lag pumps running in variable speed mode. This is the minimum run time that a pump must run after it is started. Variable speed pumps only need some time to provide settling of the speed. Rejection happens based upon speed. Since pump is ramped, there is no need to run ten minutes to ensure cooling time. [102.2] Stop Constant Speed Pumps After {10} Minutes When pumps are running across the line, it is necessary to ensure they do not start more than 6 times per hour to allow proper cooling time between starts. The controller will use this value for any pump running in constant speed mode. This value is also used for the pump exerciser feature [106.x].	USER 1-4	

Parameter Group [Screen ID]	Description *Value shown in brackets are factory default {###}*	Login Level Required	Field Setting
User [103.x]	[103.1] Target System Pressure (Setpoint) is {} This is the pressure that the system should maintain. The PID controller will modulate the pump speed as needed to cause system to match this value. For constant speed systems, this would be the pressure that the regulating valve is set at. [103.2] Pumps are added when pressure drops below the setpoint (103.1) value by this value {-5} This is the pressure that will cause pumps to be added based on a pressure drop. In variable speed modes, this is a backup to the primary speed based sequencing. In constant speed systems this is the start pressure for all pumps.	USER 1-4	
User [104.x]	[104.1] Delay on pump Fail to Start Alarm {5} On systems that monitor the motor starter or variable speed drive run status, this needs only a few seconds to prove operation. If a pressure switch is used to prove pump operation, then 30 seconds or more may be needed. [104.2] Reset Delay for pump fail to start alarm {5} This value is only used if the alarm is configured for automatic reset.	USER 1-4	
User [105.x	[105.1] Alternate pump at specific hour of day{ENABLED} {Hr=00} Refer to Alternation section of the sequence for details. This enables this mode of alternation. [105.2] Alternate pump upon excessive run time {ENABLED} {86400sec} Refer to Alternation section of the sequence for details. This enables this mode of alternation. [105.3] Alternate pump on duty cycle {ENABLED} Refer to Alternation section of the sequence for details. This enables this mode of alternation.	USER 1-4	
User [106.x]	[106.1] Enable or disable pump exerciser {Off} This feature will cause pumps that have no operated for a long time to be run for the time set in [102.2] [106.2] Exercise pump that have not run for {48} Hours This value is only used if the alarm is configured for automatic reset.	USER 1-4	
User [107.x]	[107.1] Pop up a maintenance Reminder on this date each year {00} / {00} MM / YY Setting to zero will disable the feature. Entering a valid date will cause a reminder to pop up. No actual impact on the system will occur. The message can be closed by the user when it pops up.	USER 1-4	
User [108.x]	[108.1] MODBUS [Port MSB1] {1} {9600} {8} {None} {1} This sets up communications for the MODBUS port used by the building automation computers. Only a network administrator should set these and only they will know what they need them to be. [108.2] BACnet [Network Slot] {Dev Instance} {Mac ID} {Info Frames} {Max Master} {2} This sets up communications for the optional BACnet port used by the building automation computers. Only a network administrator should set these and only they will know what they need them to be.	NETWORK ADMIN	
User [109.x]	[109.1] Current Time in 24 Hour Format {00}{00}{00} HH:MM:SS This is how to set the system time. System time is used on all event and alarm logs as well as the X-Y Plots. It is strongly recommended to set the date and time. [109.1] Current Date MM/DD/YYYY {01}{01}{2012} This is how to set the system date. System date is used on all event and alarm logs as well as the X-Y Plots. It is strongly recommended to set the date and time.	SUPERVISOR	

Parameter Group [Screen ID]	Description *Value shown in brackets are factory default {###}*	Login Level Required	Field Setting
User [110.x]	LOW SYSTEM ALARM [110.1] Delay on Alarm {5} Seconds Alarm condition must exist for this period of time before it can engage. [110.2] Reset Delay {5} Seconds This value is only used if alarm is configured for automatic reset. The reset will occur when the condition has cleared for this period of time.. [110.3] Low System Alarm Below {75} Alarm Threshold [110.4] Low System Alarm Resets Above {75} Alarm reset Threshold	USER 1-4	
User [111.x]	HIGH SYSTEM ALARM [111.1] Delay on Alarm {5} Seconds Alarm condition must exist for this period of time before it can engage. [111.2] Reset Delay {5} Seconds This value is only used if alarm is configured for automatic reset. The reset will occur when the condition has cleared for this period of time.. [111.3] High System Alarm Above {125} Alarm Threshold [111.4] High System Alarm Resets Below {125} Alarm reset Threshold	USER 1-4	
User [112.x]	LOW SUCTION ALARM [112.1] Delay on Alarm {5} Seconds Alarm condition must exist for this period of time before it can engage. [112.2] Reset Delay {5} Seconds This value is only used if alarm is configured for automatic reset. The reset will occur when the condition has cleared for this period of time.. [112.3] Low Suction Alarm Below {5} Alarm Threshold [112.4] Low Suction Alarm Resets Above {6} Alarm reset Threshold	USER 1-4	
User [113.x]	[113.1] Maximum Pumps to run on Generator Power {1} This value will limit the system operation to the number of pumps while running under generator power. This feature requires that a generator run status contact is wired to the panel. [113.2] Delay on system enable after power restored {30} In most cases, it is desirable to allow a little time to prove that power is stable before restarting pumps. This delay will allows this delay to be adjusted as needed. Factory default of 30 seconds allows plenty of time for the screen to fully reboot . The PLC will actually begin operation in as little as 3-5 seconds after power is applied so if immediate restart is required, this delay can be set to zero.	USER 1-4 SUPERVISOR	
User [114.x]	[114.1] Pressure Recovery Mode engages below {1} Pressure recovery mode can only engage if the pumps are off. If the pressure drops to this preset level then a pump call to start occurs, the recovery mode will prevent the lag pumps from starting and ramp only the lead pump, starting at the minimum safe operating speed, until the system pressure is restored to the normal wake level. If the speed reaches 100%, then the mode is canceled and the system will allow lag pumps to start. It is assumed there is a possibly a fire hose open or a broken pipe if this occurs. In this case, manual shutdown would be required as it would be beyond the sensor capability to determine why the system demand was so high. [114.2] Pressure Recovery Mode Delay Time {5} This delay prevents false engagement of the recovery mode.	USER 1-4	

Parameter Group [Screen ID]	Description *Value shown in brackets are factory default {###}*	Login Level Required	Field Setting
Factory[151.x]	[151.1] Pump #1 Installed {Not Installed} or {Installed} [151.2] Pump#1 Jockey Pump Mode {Normal} or {Jockey} [151.3] Pump#1 Run Mode (When Jockey) {Run with Lag} or {Stop on Lag} *This parameter is only used when pump is configured as small jockey* [151.4] Pump #2 Installed {Not Installed} or {Installed} [151.5] Pump #3 Installed {Not Installed} or {Installed} [151.6] Pump #4 Installed {Not Installed} or {Installed} [151.7] Pump #5 Installed {Not Installed} or {Installed} [151.8] Pump #6 Installed {Not Installed} or {Installed} [151.9] *through* [151.14] Reset or preset elapsed time meters for each pump.		
Factory[152.x] CRITICAL	**[152.1] Proportional [kP]** [152.2] Integral [kI] [152.3] Derivative [kD] [152.4] Sampling Time [ms] [152.5] PID Kickstart Hold Time [ms] (Add time for systems with excessive air) [152.6] Drive Ramp Time [Sec] [152.7] Boost Deviation [152.8] Wake Deviation [152.9] Limit Setpoint Minimum [152.10] Setpoint [152.11] Limit Setpoint Maximum [152.12] Sleep Test Abort Deviation (Set to 0 to disable) [152.13] Sleep Test Frequency		
Factory[153.x]	[153.1] Low System Alarm Behavior {} [153.2] High System Alarm Behavior {} [153.3] Low Suction Alarm Behavior {} [153.4] Pump Fail To Start Alarm Behavior {} [153.5] System Sensor Failure Alarm Behavior {} [153.6] Suction Sensor Failure Alarm Behavior {} [153.7] Flow Sensor Failure Alarm Behavior {}		
Factory[154.x]	[154.1] System Pressure/Level Sensor Units of Measure {} [154.2] System Pressure/Level Sensor Scale Minimum {} [154.3] System Pressure/Level Sensor Scale Maximum {} [154.4] System Pressure/Level Sensor RAW Offset {} [154.5] System Sensor Analog Output Type {}		
Factory[155.x]	[155.1] Suction Pressure/Level Sensor Units of Measure {} [155.2] Suction Pressure/Level Sensor Scale Minimum {} [155.3] Suction Pressure/Level Sensor Scale Maximum {} [155.4] Suction Pressure/Level Sensor RAW Offset {} [155.5] Suction Sensor Configuration {} [155.6] Suction Sensor Analog Output Type {}		
Factory[156.x] CRITICAL	[156.1] System Flow Sensor Units of Measure {} [156.2] System Flow Sensor Scale Minimum {} [156.3] System Flow Sensor Scale Maximum {} [156.4] System Flow Sensor RAW Offset {} [156.5] System Sensor Analog Output Type {} [156.6] Flow Sequencing Reject Percentage {} (Set to 0 to disable flow sequencing) **[156.7] Use sensor or estimate flow from speed.** **Max P1 Flow {}** **Max P2-6 (ea) {}** Flow *Total can be reset from this screen*		
Factory[157.x] CRITICAL	[157.1] Maximum Output Speed {100%} **[157.2] Pump Reject Speed {}** **[157.3] Default Speed {}** **[157.4] Minimum PID Output Speed {}** **[157.5] Minimum Safe Speed {}**		
Factory[196.x]	[196.1] *through* [196.12] Login Passwords		
Factory[197.x]	[SPECIAL] BACKUP UTILITY SCREEN		
Factory[198.x]	[SPECIAL] FACTORY REPRESENTATIVE INFORMATION SCREEN		
Factory[199.x]	[SPECIAL] FACTORY MAINTENANCE SCREEN		

Remote Monitoring and interface

The controller is provided with a network connection for MODBUS RTU via RS485 (2-wire) to monitor the system operation. The default network settings are 9600,N,8,1 address 5 but they can be changed from the color touch screen as needed. The PLC is equipped with two MODBUS ports. One is dedicated to the operator interface and the other is for customer BAS connection. The open customer port is labeled MBS1 and is an RJ45 connection.
Pins 4(A+), 5(B-) and 8 (0v) are the only pins with internal connections. If this is the end of the network, the PLC has DIP switches located near the port that can switch in the terminating resistor for the network. Turn DIP Switch 1 to ON (Down) to terminate the network.

Controller may also be provided with a native Network Slot for BACnet communications. BACnet MS/TP communication parameters can be adjusted from the Color touch screen as needed. BACnet IP settings can be configured through the network port using a web browser. The default IP address of the module is 192.168.2.44. You will be prompted for a user name and password to gain access. The user name cannot be changed and is USER. The default password is also USER but can be changed once logged in.

Refer to the wiring diagram on the enclosure door for connection details.

The following data can be read over the MODBUS connection.

MODBUS ADDRESS	BACNET ADDRESS	DATA	NOTES
40001	AV0	SYSTEM PRESSURE OR LEVEL	
40002	AV1	SUCTION PRESSURE OR LEVEL	
40003	AV2	FLOW RATE	
40004	AV3	FLOW TOTAL [x100,000]	
40005	AV4	PUMP #1 STATUS WORD 0 = Stopped [Enabled] 1 = Running VFD 2 = Running ATL 3 = Failed [Offline] 4 = Not in Auto or not present	
40006	AV5	PUMP #2 STATUS WORD *See Pump#1 Status word for description*	
40007	AV6	PUMP #3 STATUS WORD *See Pump#1 Status word for description*	
40008	AV7	PUMP #4 STATUS WORD *See Pump#1 Status word for description*	
40009	AV8	PUMP #5 STATUS WORD *See Pump#1 Status word for description*	
40010	AV9	PUMP #6 STATUS WORD *See Pump#1 Status word for description*	
40011	AV10	*PUMP#1 ETM [HRS x100]*	
40012	AV11	*PUMP#2 ETM [HRS x100]*	
40013	AV12	*PUMP#3 ETM [HRS x100]*	
40014	AV13	*PUMP#4 ETM [HRS x100]*	
40015	AV14	*PUMP#5 ETM [HRS x100]*	
40016	AV15	*PUMP#6 ETM [HRS x100]*	
40017	AV16	COMMON ALARM STATUS 0 = No alarms present 1 = Alarms Exist	
40018	AV17	AUDIBLE ALARM HORN STATUS 0 = Alarm horn is off 1 = Alarms horn is on	
40019	AV18	SYSTEM SENSOR STATUS (Discharge pressure/level sensor) 0 = OK 1 = Short Circuit [*Failed*] 2 = Open Circuit [*Failed or not present*]	
40020	AV19	SUCTION SENSOR STATUS (Supply pressure/level sensor) 0 = OK 1 = Short Circuit [*Failed*] 2 = Open Circuit [*Failed or not present*]	
40021	AV20	FLOW SENSOR STATUS	

MODBUS ADDRESS	BACNET ADDRESS	DATA	NOTES
		0 = OK 1 = Short Circuit [*Failed*] 2 = Open Circuit [*Failed or not present*] *Note: Flow can be user configured to be estimated if no senor is installed.*	
40022	AV21	DISCHARGE PRESSURE/LEVEL ALARM 0 = No Alarm (Pressure/Level is normal) 1 = Low alarm (Pressure/Level is below normal limits) 2 = High Alarm (Pressure/Level is above normal limits)	
40023	AV22	SUCTION PRSSURE/LEVEL ALARM 0 = No Alarm (Pressure/Level is normal) 1 = Low alarm (Pressure/Level is below normal limits) 2 = High Alarm (Pressure/Level is above normal limits) *Note: Depending on user configuration this alarm status can be common to all pumps or reflect one or more pumps.*	
40024	AV23	EXTERNAL SYSTEM DISABLE 0 = System enabled 1 = System disabled or limited due to generator power (wired input to panel) 2 = System is disabled due to remote lockout (wired input to panel) *Note: System can be user configured to limit system operation to any number of pumps or a complete shutdown under generator power.*	
40025	AV24	Unused	
40026	AV25	Unused	
40027	AV26	Unused	
40028	AV27	Unused	
40029	AV28	Unused	
40030	AV29	Unused	
40031	AV30	Unused	
40032	AV31	Unused	

Note: A loss of communications indicates an active loss of power to the panel.