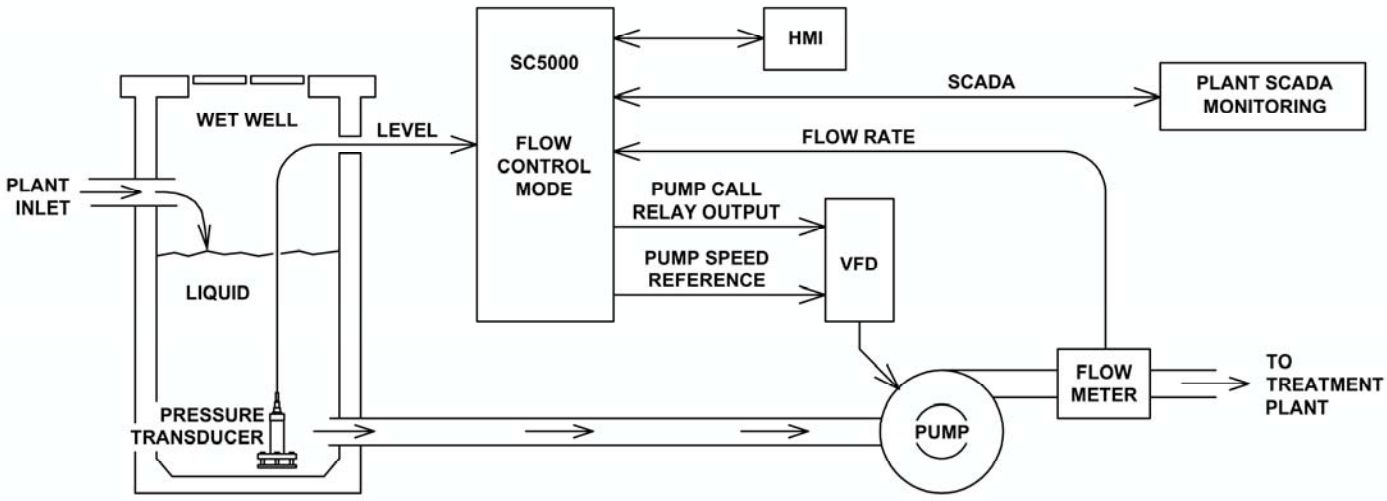
SC5000

INSTRUCTION MANUAL

SECTION 2

FLOW CONTROL



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SECTION 2
FLOW CONTROL

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FLOW CONTROL

DESCRIPTION OF FEATURES

General Description

With the Master Control Mode (Parameter P.091) set for “Flow Control” the SC5000 will function as a Flow Controller, and all logic pertaining to “Level Control”, “Pressure Control”, “Booster Discharge Pressure Control” and “Booster Supply Pressure Control” will be disabled.

In the Flow Control Mode, a PID Controller (Proportional, Integral, Derivative) is provided to regulate the pump speed in order to maintain the Flow Rate at the Flow Rate Setpoint.

The Flow Control logic also determines the number of pumps required to run in order to maintain the Flow Rate at the Flow Rate Setpoint.

The Flow Control logic also alternates the pumps and provides a First Pump Start Delay, Lag Pump Delay, Number of Pumps Required at Startup, Low Level Alarm, High Level Alarm, Low Flow Rate Alarm, High Flow Rate Alarm, and Pump Cutoff upon Low Level. It also has parameters in the menu that allow the operator to set the Number of Pumps Present, the Maximum Number of Pumps Allowed to Run At the Same Time, and the Maximum Number of Pumps Allowed to Run While On a Generator.

The Flow Control Mode requires that each pump have its own VFD.

The Flow Control Mode also requires that the Controller be ordered with an optional Analog Output for each pump for the VFD speed reference (see Ordering Information).

HMI Features

The **SC5000-CTS-HMI** is a **C**olor **T**ouch **S**creen HMI programmed with screens that show the Wet Well Level, Flow Rate, Pump Speed Reference, Pump Run Status, Pump Available for Service indication, High Level and Low Level alarms, High Flow Rate and Low Flow Rate alarms, Flow Rate Setpoint Override Active indication, Level Too Low For Pump Operation alarm, Low-Low Level Pump Cutoff Active alarm, Elapsed Run Time meters for each pump, and any Fault Codes that may be present. All the control and alarm settings are made readily available to the operator for viewing or changing. An operator may also perform Level Simulation, reset the Elapsed Run Time meters, and reset any Fault Codes.

Flow Rate Setpoint

The Flow Rate Setpoint (Parameter P.405) must be set by the operator for the desired flow rate that the liquid should be pumped at as it leaves the lift station.

At startup, the Flow Control logic will bring on the Number of Pumps Required at Startup (Parameter P.431). If number of pumps called at startup are unable to bring the Flow Rate up to the Flow Rate Setpoint, then another pump will be started. If the setpoint is still not reached, then the control logic will call another pump to run and then another until the Flow Rate Setpoint is met. Additionally, the logic will turn off any unneeded pumps.

The PID Controller will follow what is set on the Flow Rate Setpoint as it regulates the Flow Rate, except when the supply liquid level is either low or high. In either case the Controller may be setup to not strictly follow the setpoint, but rather decrease the Flow Rate if the supply liquid level is low, or increase the Flow Rate if the supply liquid level is high and follow the Flow Rate Setpoint when the liquid level returns to the normal range.

First Pump Start Delay

After power is applied to the Controller and after all the initial conditions are satisfied and the First Pump Start Delay (Parameter P.429) has expired, the Number of Pumps Required at Startup (Parameter P.431) will be started, and the Lag Pump Delay (Parameter P.430) will set the minimum time period between each pump call. The following are the initial conditions which must first be met for the First Pump Start Delay to begin timing out:

There must be an adequate supply of liquid in the wet well. The liquid level must be at or above what is set on the Pump Operation Enable Level (Parameter P.426).

The “All Pump Disable” Discrete Input (Discrete Input Function 17) must be open.

The “Pump Cutoff Low-Low Level” Discrete Input (Discrete Input Function 59) must be open and the delay set on the pump Re-enable Delay (Parameter P.153) must have expired.

At least one pump must be available for service (Not having its Pump Disable Discrete Input closed (Discrete Input Functions 11 - 16).

After all of the above conditions are met and the First Pump Start Delay times out, the first pump will be started.

FLOW CONTROL

Lag Pump Delay

The Lag Pump Delay (Parameter P.430) sets the minimum time period between the calling of pumps to run at startup. It is also used to delay the turning on of the replacement pump when an operating pump is suddenly disabled, or when a time based alternation of the pumps is performed.

Number of Pumps Required at Startup

The Number of Pumps Required at Startup (Parameter P.431) sets the minimum number of pumps that are initially turned on in order to meet the Flow Rate Setpoint. When the First Pump Start Delay (Parameter P.429) expires, the first of the required pumps will be turned on and each additional required pump will wait for the Lag Pump Delay (Parameter P.430) to expire.

Pump Turn On and Off

Operating Principal

After the Number of Pumps Required at Startup (Parameter P.431) are started, the Flow Control logic will then control the number of additional pumps that are required to run in order to maintain the Flow Rate at the Flow Rate Setpoint. The control logic determines when an additional pump is needed and when to turn off an unneeded pump based on the following operating principal:

> The number of pumps required to run is regulated so that the PID Controller does not drive the pump speed reference significantly higher than or lower than a predetermined pump speed range.

See the Flow Rate Versus Pump Speed graph on page 2-13.

Turning On Pumps

If at some point conditions in the system require that the pump speed be increased in order to maintain the Flow Rate Setpoint, then the pump speed reference will be increased as needed. If the pump speed reference were to be increased to the point that it were equal to or greater than what is set on the Pump Speed Upper Threshold (Parameter P.414), then one additional pump would be turned on, after the delay set on the Delay To Turn On One Pump (Parameter P.415) expires. This may be repeated again and again until all the available pumps are called to run, or until the pump speed becomes lower than the Pump Speed Upper Threshold (Parameter P.414).

Turning Off Pumps

If at some point in time the conditions in the system were to change such that a lower pump speed were required to maintain the Flow Rate Setpoint, then the pump speed reference would be decreased as needed. If the pump speed reference were to be decreased to the point were it was equal to or less than what is set on the Pump Speed Lower Threshold (Parameter P.416), then one of the pumps would be turned off, after the delay set on the Delay To Turn Off One Pump (Parameter P.417) expires. This may be repeated again and again until all but one pump is left running, or until the pump speed becomes higher than the Pump Speed Lower Threshold (Parameter P.416).

Pump Operation Enable / Disable

The pump operation in the Flow Control Mode requires that there be an adequate supply of liquid in the wet well. The following two parameters provide the operator with control over how low the supply liquid level is allowed to drop before turning off all the pumps and at what level pumping should be allowed to resume:

Pump Operation Enable Level

To allow any pumps to start, the liquid level must first rise up to or be above what is set on the Pump Operation Enable Level (Parameter P.426).

Pump Operation Disable Level

If the liquid level falls below what is set on the Pump Operation Disable Level (Parameter P.427) then all the pumps will be turned off.

Alarm Status

When pump operation is disabled, based on Parameters P.426 and P.427, the “Supply Level Too Low for Pump Operation” alarm status bit will be set and may be read from Modbus Coil 258 (Register 40017 Bit 1).

FLOW CONTROL

Controlling Setpoint

There are times when strictly following the Flow Rate Setpoint may be undesirable, the Flow Control logic has a Flow Rate Setpoint Override feature that allows the PID Controller to not directly follow the Flow Rate Setpoint, but rather follow the Controlling Setpoint. Where the Controlling Setpoint is allowed to deviate from the Flow Rate Setpoint based on the settings on Parameters P.420, 421, 423, 424 & P.428.

The current value of the Controlling Setpoint may be viewed from Parameter Fd.54.

See the description of the Flow Rate Setpoint Override feature below.

Flow Rate Setpoint Override

Controlling Setpoint - Start Up

At start up, the PID Controller is sent a Controlling Setpoint (Parameter Fd.54) that is slowly increased until it equals the Flow Rate Setpoint (Parameter P.405). The rate of the increase is set by the Flow Rate Ramp Rate (Parameter P.428).

See the Controlling Setpoint Versus Time After Start Up graph on page 2-15.

Controlling Setpoint - Normal Level

After start up, under normal conditions the PID Controller keeps the Flow Rate at or near what is set on the Flow Rate Setpoint (Parameter P.405) as entered by the operator, as long as the wet well level stays within an acceptable range.

See the Controlling Setpoint Versus Wet Well Level graph on page 2-14.

Controlling Setpoint - High Level

If the wet well level is high and at risk of an overflow, then the Flow Rate of the liquid being pumped out of the station will need to be increased above what is set on the Flow Rate Setpoint.

This is done by setting the Flow Rate Setpoint Override High Level (Parameter P.420) to the liquid level above which the Flow Rate should be increased. Additionally, the Controlling Setpoint Upper Limit (Parameter P.421) will need to be set to the maximum Flow Rate that should be allowed.

To disable the Flow Rate Setpoint Override High Level feature set Parameter P.420 to 231.0 feet.

Controlling Setpoint - Low Level

If the wet well level is low and at risk of running out of liquid to pump, then the Flow Rate of the liquid being pumped out of the station may need to be decreased below what is set on the Flow Rate Setpoint.

This is done by setting the Flow Rate Setpoint Override Low Level (Parameter P.423) to the liquid level below which the Flow Rate will need to be decreased. Additionally, the Controlling Setpoint Lower Limit (Parameter P.424) should be set to the minimum Flow Rate that should be allowed.

To disable the Flow Rate Setpoint Override Low Level feature set Parameter P.423 to 1.0 feet.

Alarm Status

If it becomes necessary to override what is set on the Flow Rate Setpoint, then the “PID Controller Set-point Override Active” alarm status bit will be set. Its status may be read from Modbus Coil 257 (Register 40017 Bit 0).

FLOW CONTROL

Pump Alternation

Automatic Alternation

In the Flow Control Mode the pump Alternation Sequence Mode (Parameter P.122) is fixed to always be in the Standard Alternation mode, and the pumps will be Alternated “First On First Off”. See page 2-9.

See the alternation sequence diagram on page 2-18.

Manual Pump Call Sequence

When manual control over the pump call sequence is desired, the operator can use the Forced Lead Pump Position feature (Parameter P.129) to set the Lead Pump Position. This sets the order the pumps are called in. The Lead Pump Position may also be set using a Lead Pump Selector switch that is connected to Discrete Inputs assigned to Functions 31 - 36. See page 2-9.

See connection diagrams on page A-13.

Time Based Alternation

Time Based Alternation is also available in the Flow Control Mode. The Time Based Alternation logic may be triggered by an Internal Time Clock or from an External Time Clock. The Internal Time Clock alternation period is menu selectable (Parameter P.131). The External Time Clock may be triggered to alternate from either a External Time Clock connected to a Discrete Input on the Controller (set for Function 21), or it may be part of a SCADA system’s logic, where the SCADA system would set Modbus Coil 95 (Register 40006 Bit 14) to force the alternation of the pumps. See page 2-9.

Pump Cutoff Low-Low Level

The Pump Operation Enable / Disable feature (setup on Parameters P.424 and P.425) monitors the Analog Level Input to determine if there is an adequate supply of liquid in the wet well. By using a Low-Low Level Float Switch connected to a Discrete Input a redundant pump cut off may also be implemented. This Pump Cutoff Low-Low Level feature also includes a Re-enable Delay to prevent the short cycling of the pumps.

The Low-Low Level Float Switch must be connected to a Discrete Input assigned to Function 59.

The Re-enable Delay (Parameter P.153) starts timing out when the Discrete Input opens. When the Re-enable Delay expires the Pump Cutoff Low-Low Level feature will no longer prevent pump operation.

The “Pump Cutoff Active Low-Low Level” status is available from Modbus Coil 131 (Register 40009 Bit 2).

While the Pump Cutoff Low-Low Level input is closed, the Low Level Alarm will also be activated. The contacts of a relay assigned to the Low Level Alarm (Function 7) will also close.

Level Input Select

The Flow Control Mode requires an analog 4-20mA Level Input be provided to monitor the liquid level in the wet well. The default Level Input is connected to Analog Level Meter ALM1. If a second or backup Level Input is desired then it must be connected to Analog Level Meter ALM2. The Level Input Select (Parameter P.133) allows for the selection between two Analog Level Meters ALM1 or ALM2 as the Level Input source (each Level Meter must be connected to its own Pressure Transducer). The second analog 4-20mA Level Input may be either manually or automatically switched into service as the controlling Level Input. See Section M.

Flow Rate Input Select

The Flow Control Mode requires that a Flow Rate Input be provided to the Controller to monitor the Flow Rate. The Flow Rate Input Select (Parameter P.401) is provided to allow for the selection one of three Analog Flow Meters AFM1, AFM2 or AFM3, or from one of three Pulse Flow Meters PFM1, PFM2 or PFM3. Before use, the selected Flow Meter must be setup and calibrated to match the calibration of the field device (Flow Meter) that measures the Flow Rate. See page 2-11.

FLOW CONTROL

Discrete Inputs

30 Discrete Inputs (D1 - D30) that may be setup to perform the following Functions:

- Pump Disable Inputs
- All Pump Disable - Phase Monitor Input
- On Generator - Limits number of pumps allowed to run
- Switch Between ALM1 & ALM2 for Level Input selection
- External Alternation - External Time Clock Input
- Sequence Inputs - Lead Pump Selector Switch Inputs
- Call Pump Last Inputs
- Pump Cutoff Low-Low Level Input
- High and Low Level Alarm Inputs
- Collection of Discrete Input Data for SCADA

Relay Outputs

12 Relay Outputs (ROX1 - ROX12) that may be setup to perform the following Functions:

- Up to Six Pump Call to Run Outputs
- High or Low Level Alarm Outputs
- High or Low Flow Rate Alarm Outputs
- SCADA Remote Control Outputs

Analog Inputs

2 Standard Analog Inputs (AIX1 - AIX2) and up to 8 more Optional Analog Inputs (A1 - A8).
The Analog Inputs may be setup to perform one of the following Functions:

- Analog Level Meter ALM1 or ALM2
- Analog Flow Meter AFM1, AFM2 or AFM3
- Analog Pressure Meter APM1 or APM2
- Analog Current Meter ACMA, ACMB or ACMC
- Collection of Analog Input Data for SCADA

Analog Outputs

1 Standard Analog Output (AOX1) and up to 6 more Optional Analog Outputs (AO1 - AO6).
The Analog Outputs may be setup to perform one of the following Functions:

- Analog Signal for Pumps 1 - 6 Speed Reference
- Analog Signal for Pumps Speed Reference any Pump (Always Active)
- Analog Signal that is a Copy of Wet Well Level

Pulse Counter Inputs

Option for up to 3 Pulse Counter Inputs (DPC1 - DPC3) that may be used to perform the following:

- Pulse Counter Input for Pulse Flow Meter PFM1, PFM2 or PFM3

FLOW CONTROL

User / Operator Info.			SCADA	
Parameter	Default Value	Current Value	Register Address	Description of Parameters and SCADA Notes
Master Control Mode				
P.091	1		40091	Master Control Mode 1 = Level Control 2 = Flow Control **Must Be Set On "2" for Flow Control** 3 = Pressure Control 4 = Booster Discharge Pressure Control 5 = Booster Supply Pressure Control
Pump Setup				
P.092	6		40092	Number of Pumps Present 1 = 1 Pump 2 = 2 Pumps 3 = 3 Pumps 4 = 4 Pumps 5 = 5 Pumps 6 = 6 Pumps
P.093	6		40093	Maximum Number of Pumps Allowed to Run at the Same Time 1 = 1 Pump 2 = 2 Pumps 3 = 3 Pumps 4 = 4 Pumps 5 = 5 Pumps 6 = 6 Pumps
P.094	6		40094	Maximum Number of Pumps Allowed to Run While On Generator 1 = 1 Pump 2 = 2 Pumps 3 = 3 Pumps 4 = 4 Pumps 5 = 5 Pumps 6 = 6 Pumps Note: Must Connect Transfer Switch Contact to Discrete Input assigned to Function 18.

FLOW CONTROL

User / Operator Info.			SCADA	
Parameter	Default Value	Current Value	Register Address	Description of Parameters and SCADA Notes
Pump Alternation Setup				
P.122	1	1	40122	Alternation Sequence Mode 1 = Standard Alternation of Pumps 1 - 6 See page 2-17. Note: With the Master Control Mode set on Flow Control the Alternation Sequence Mode will be fixed on Standard Alternation.
P.129	0		40129	Forced Lead Pump Position 0 = Normal Alternation X = Pump X as Lead
P.131	0		40131	Time Based Alternation Range: 0 - 65535 minutes 0 = Disabled 60 = 1 hour 480 = 8 hours 1440 = 24 hours Note: Pump Alternation may be triggered using the Internal Time Clock setup using Parameter P.131, or it can also be triggered by an External Time Clock, which may be either a hardware device connected to a Discrete Input setup to perform Function 21, or it may be triggered by having the SCADA system set Bit 14 in Register 40006.
Pump Alternation Status				
Ad.01	-	-	41888	Current Lead Pump Shows the number of the current Lead Pump.

FLOW CONTROL

User / Operator Info.			SCADA	
Parameter	Default Value	Current Value	Register Address	Description of Parameters and SCADA Notes
Level Input Setup				
P.133	1		40133	Level Input Select 1 = Analog Level Meter - ALM1 - Single Transducer 2 = Analog Level Meter - ALM2 - Single Transducer 3 = Analog Level Meter - ALM1 & ALM2 - Dual Transducers - Manual Switching 4 = Analog Level Meter - ALM1 & ALM2 - Dual Transducers - Automatic Switching Selection 1 - Level Input is from ALM1. See Section M. Selection 2 - Level Input is from ALM2. See Section M. Selection 3 - Level Input is Manually switched from ALM1 to ALM2. See Section M. Selection 4 - Level Input is Automatically switched from ALM1 to ALM2. See Section M.
Level Input Data				
Ld.01	-	-	42143	Level Input Data - For Numerical Display Note: This is the value of the Level input selected on Parameter P.133 scaled into feet and 1/10 of feet for numerical display.
Ld.02	-	-	42144	Level Input Data - For Bar Graph Display of Level Note: This is the value of the Supply Level Input selected on Parameter P.133 scaled for display on a bar graph. It is scaled to a range of 0 - 4095. The Bar Graph Display scaling setup on the HMI device must be set for 0 - 4095.
Ld.03	-	-	42145	Level Input Source Status 1 = Analog Level Meter - ALM1 2 = Analog Level Meter - ALM2 3 = Level - Simulated

FLOW CONTROL

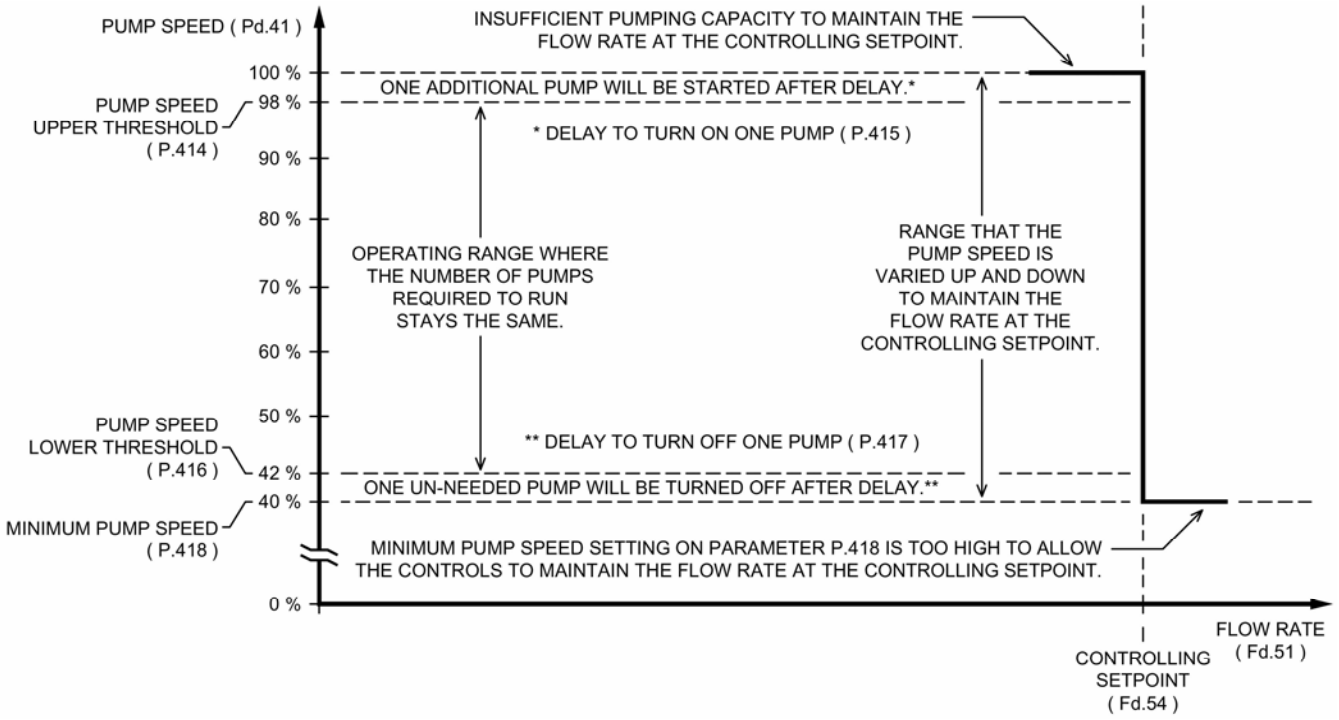
User / Operator Info.			SCADA		
Parameter	Default Value	Current Value	Register Address		Description of Parameters and SCADA Notes
Flow Rate Input Setup					
P.401	1		40401		Flow Rate Input Select 1 = Analog Flow Meter AFM1 - See page K-1. 2 = Analog Flow Meter AFM2 - See page K-2. 3 = Analog Flow Meter AFM3 - See page K-3. 4 = Pulse Flow Meter PFM1 - See page J-1. 5 = Pulse Flow Meter PFM2 - See page J-2. 6 = Pulse Flow Meter PFM3 - See page J-3. Note: This parameter establishes which Flow Meter's Flow Rate will be used as the Process Variable (PV) that goes into the PID Controller used for Flow Control. The Flow Rate data selected here is available to be read from Parameter Fd.51.
P.403	1,000 gallons / minute		40403	Least Significant of 32-Bit Number	Flow Rate Input Bar Graph Span Range: 30 - 107,000,000 gallons / minute Note: This parameter sets the span of the Flow Rate Data for Parameter Fd.53.
			40404	Most Significant of 32-Bit Number	
Flow Rate Input Data					
Fd.51	-	-	42151	Least Significant of 32-Bit Number	Flow Rate Input Data - For Numerical Display Note: This is the Flow Rate data selected by Parameter P.401.
			42152	Most Significant of 32-Bit Number	
Fd.53	-	-	42153		Flow Rate Input Data - For Bar Graph Display Note: This is the value of the Flow Rate input selected on Parameter P.401 scaled for display on a bar graph. It is scaled to a range of 0 - 40 by using the Flow Rate Input Bar Graph Span (Parameter P.403). The Bar Graph Display scaling setup on the HMI device must be set for 0 - 40.

FLOW CONTROL

User / Operator Info.			SCADA	
Parameter	Default Value	Current Value	Register Address	Description of Parameters and SCADA Notes
Flow Rate Setpoint				
P.405	600 gpm		40405	Flow Rate Setpoint (SP) Range: 30 - 65,000 gpm Note: This is the parameter that sets the desired flow rate of the liquid being pumped out of the lift station.
Fd.54	-	-	42154	Controlling Setpoint Note: During normal operation the Controlling Setpoint is set equal to the Flow Rate Setpoint. However, to prevent the wet well from either overflowing or being pumped down too low, the Controller's logic increases or decrease the value of the Controlling Setpoint as needed, based on what is set on Parameters P.420 - P.424 & P.428.
While the Controlling Setpoint is lower or higher than the Flow Rate Setpoint, the "PID Controller Setpoint Override Active" status bit will be set. Its status may be read from Modbus Coil 257 (Register 40017 Bit 0).				
PID Controller Tuning				
P.411	6.40		40411	Controller Gain (Kc) Range: 0.01 - 30.00 Note: This parameter is used to tune the proportional component of the PID Controller's Pump Speed Reference output.
P.412	0.02 minutes / repeat		40412	Integral Time (Ti) Range: 0.01 - 60.00 minutes / repeat Note: This parameter is used to tune the integral component of the PID Controller's Pump Speed Reference output. Changes to this parameter may result in significant changes to the Pump Speed Reference. Therefore, it is recommended that only small changes are made to this parameter while the system is in operation.
P.413	0.00 minutes		40413	Derivative Time (Td) Range: 0.00 - 2.00 minutes Note: This parameter is used to tune the derivative component of the PID Controller's Pump Speed Reference output.
Pump Speed Reference Data				
Pd.41	-		41877	Pump Speed Reference Data Range: 0.0 - 100.0 percent Notes: 1. The Pump Speed Reference is determined by the PID Controller and is sent to the VFDs, as a 4-20mA signal, to control the pump speed 2. All operating pumps receive the same Speed Reference. 3. Parameter Pd.41 is the Pump Speed Reference as a percent of full speed.

FLOW CONTROL

Turning On / Off Pumps

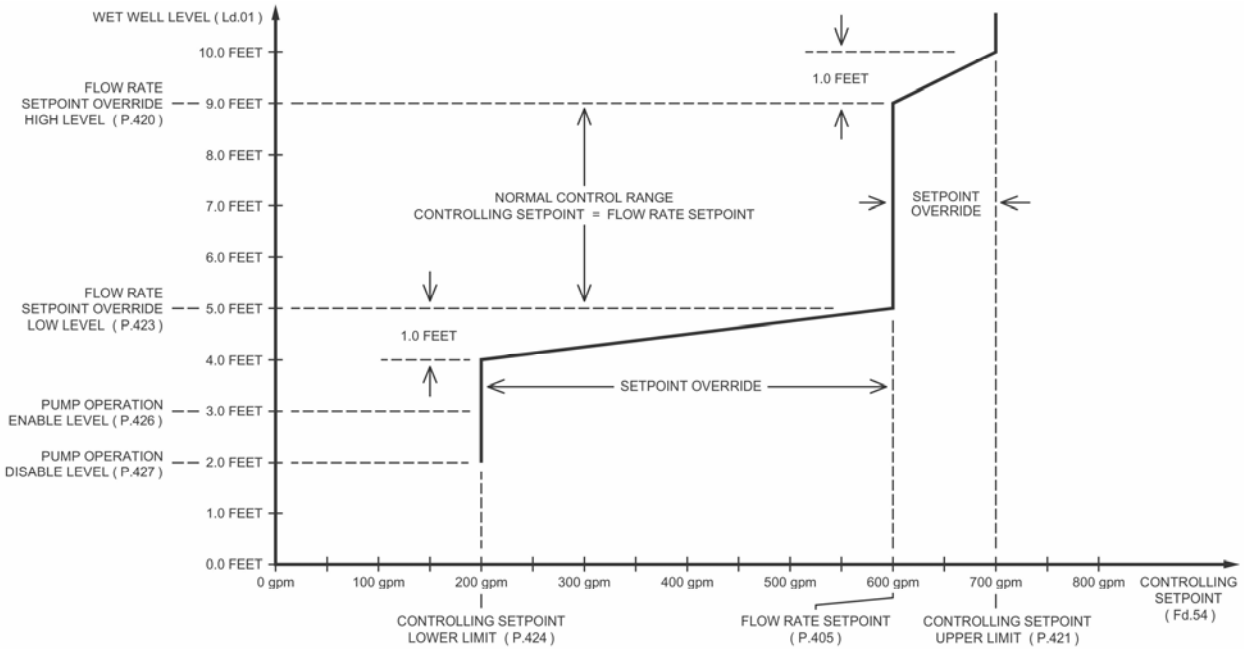


User / Operator Info.			SCADA	
Parameter	Default Value	Current Value	Register Address	Description of Parameters and SCADA Notes
Turning On of Pumps				
P.414	98.0 %		40414	Pump Speed Upper Threshold Range: 30.0% - 100.0% of Full Speed Note: When the Pump Speed Reference has increased to where it is greater than or equal to what is set on this parameter, the **Delay To Turn On One Pump** (Parameter P.415) is started. When the delay expires an additional pump will be turned on.
P.415	10 sec.		40415	Delay To Turn On One Pump Range: 1 - 600 seconds Note: This delay starts when the Pump Speed Reference has increased to where it is greater than or equal to the **Pump Speed Upper Threshold** (Parameter P.414). When the delay expires an additional pump will be turned on.
Turning Off of Pumps				
P.416	42.0 %		40416	Pump Speed Lower Threshold Range: 10.0% - 90.0% of Full Speed Note: When the Pump Speed Reference has decreased to where it is less than or equal to what is set on this parameter, the **Delay To Turn Off One Pump** (Parameter P.417) is started. When the delay expires one pump will be turned off. This parameter must be set higher than or equal to the **Minimum Pump Speed** (Parameter P.418).
P.417	10 sec.		40417	Delay To Turn Off One Pump Range: 1 - 600 seconds Note: This delay starts when the Pump Speed Reference has decreased to where it is less than or equal to the **Pump Speed Lower Threshold** (Parameter P.416). When the delay expires one pump will be turned off.
Minimum Pump Speed				
P.418	40%		40418	Minimum Pump Speed Range: 0% - 95% of full speed Note: For each application there is usually a minimum speed, below which pump operation is undesirable. This parameter sets the minimum pump speed allowed. With the **Minimum Pump Speed** set on Parameter P.418, care must be taken that there is not also a minimum speed set on the VFDs.

FLOW CONTROL

Controlling Setpoint Versus Wet Well Level

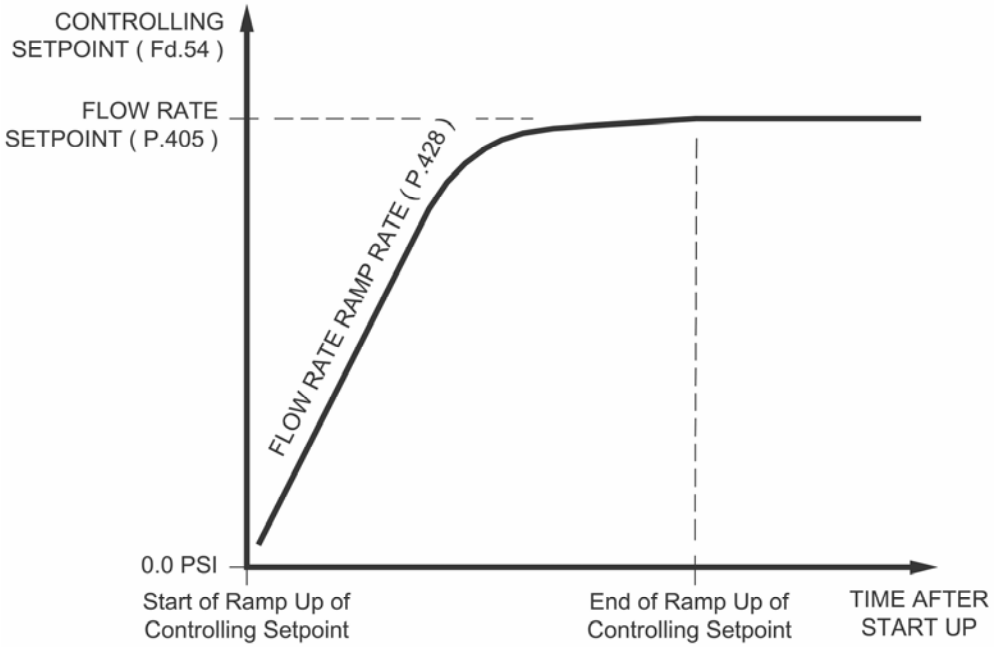
Pumping Application - Example Shown With All Setup Parameters Set On Their Default Values



User / Operator Info.			SCADA	
Parameter	Default Value	Current Value	Register Address	Description of Parameters and SCADA Notes
Flow Rate Setpoint Override - High Level				
P.420	9.0 feet		40420	Flow Rate Setpoint Override High Level — Range: 1.0 - 231.0 feet Note: This is the wet well level at which the **Controlling Setpoint** will be temporally increased above the **Flow Rate Setpoint** as needed to prevent the wet well level from continuing to rise. The logic is allowed to increase the Controlling Setpoint up to the Controlling Setpoint Upper Limit (Parameter P.421), but no higher.
P.421	700 gpm		40421	Controlling Setpoint Upper Limit — Range: 30 - 65,000 gpm Note: This sets the upper limit of what the setpoint override logic is allowed to increase the **Controlling Setpoint** to, when the wet well level rises above what is set on Parameter P.420.
Flow Rate Setpoint Override - Low Level				
P.423	5.0 feet		40423	Flow Rate Setpoint Override Low Level — Range: 1.0 - 231.0 feet Note: This is the wet well level at which the **Controlling Setpoint** will be temporally decreased below the **Flow Rate Setpoint** as needed to prevent the wet well level from continuing to lower. The logic is allowed to decrease the Controlling Setpoint down to the Controlling Setpoint Lower Limit (Parameter P.424), but no lower.
P.424	200 gpm		40424	Controlling Setpoint Lower Limit — Range: 30 - 65,000 gpm Note: This sets the lower limit of what the setpoint override logic is allowed to decrease the **Controlling Setpoint** to, when the wet well level drops below what is set on Parameter P.423.
The "PID Controller Setpoint Override Active" status bit may be read from Modbus Coil 257 (Register 40017 Bit 0).				
Pump Operation Enable / Disable				
P.426	3.0 feet		40426	Pump Operation Enable Level — Range: 0.1 - 231.0 feet Note: This is the supply liquid level, in the wet well, at which the operation of all available pumps will be enabled to run as needed to meet the **Controlling Setpoint**.
P.427	2.0 feet		40427	Pump Operation Disable Level — Range: 0.1 - 231.0 feet Note: This is the supply liquid level, in the wet well, at which all pump operation is disabled and all pumps turned off in order to prevent the supply level from continuing to lower.
The "Supply Level Too Low for Pump Operation" status bit may be read from Modbus Coil 258 (Register 40017 Bit 1).				

FLOW CONTROL

Flow Rate Controlling Setpoint - During Start Up



Start Up

During start up, the Flow Control logic slowly ramps up the Controlling Setpoint (Parameter Fd.54), following the curve shown above. The Flow Rate Ramp Rate (Parameter P.428) is provided to set the start up ramp rate.

During start up, with an adequate Supply Level, the Controlling Setpoint (Parameter Fd.54) that is sent to the PID Controller is slowly ramped up until it matches the Flow Rate Setpoint (Parameter P.405).

However, if the Supply Level is below what is set on the Flow Rate Setpoint Override Low Level (Parameter P.423), the control logic will limit the Controlling Setpoint (Fd.54) as shown in the graph on page 2-14.

Also, if the Supply Level is above what is set on the Flow Rate Setpoint Override High Level (Parameter P.420), the control logic will increase the Controlling Setpoint (Fd.54) as shown in the graph on page 2-14.

The decrease in the ramp rate at the end of the curve shown above, is to reduce the overshooting of the Flow Rate Setpoint at start up.

At start up, if the Flow Rate is excessively overshooting the Flow Rate Setpoint, reduce the setting on the Flow Rate Ramp Rate (Parameter P.428), until the overshooting is within acceptable limits.

User / Operator Info.			SCADA	
Parameter	Default Value	Current Value	Register Address	Description of Parameters and SCADA Notes
Flow Rate Ramp Rate				
P.428	10.0 gpm / sec		40428	Flow Rate Ramp Rate — Range: 1.0 - 6500.0 gpm / sec Note: Parameter P.428 sets the initial rate at which the control logic is allowed to change the Flow Rate's Controlling Setpoint (Parameter Fd.54). Parameter P.428 must be set so that during start up the Flow Rate does not overshooting of the Flow Rate Setpoint beyond the acceptable limit.
At startup or at any time the Setpoint Override logic keeps the Controlling Setpoint from being equal to the Flow Rate Setpoint, the "PID Controller Setpoint Override Active" status bit will be set. Its status may be read from Modbus Coil 257 (Register 40017 Bit 0).				

FLOW CONTROL

User / Operator Info.			SCADA	
Parameter	Default Value	Current Value	Register Address	Description of Parameters and SCADA Notes
First Pump Start Delay				
P.429	10 sec.		40429	First Pump Start Delay — Range: 1 - 180 seconds Notes: The First Pump Start Delay period starts when all the following conditions are met: 1. Power is applied to Controller. 2. The Wet Well Level is at or above the Pump Operation Enable Level (Parameter P.426). 3. The "All Pump Disable" discrete input (Discrete Input Function 17) is open. 4. The "Pump Cutoff Low-Low Level" discrete input (Discrete Input Function 59) is open and the delay set on the pump Re-enable Delay (Parameter P.153) has expired. 5. At least one Pump is available for service and has its "Pump Disable" discrete input (Discrete Input Functions 11 - 16) open.
Lag Pump Delay				
P.430	5 sec.		40430	Lag Pump Delay — Range: 1 - 100 seconds Note: This is the minimum time period between the calling of pumps to run at startup. It is also used to delay the turning on of the replacement pump when an operating pump is suddenly disabled, or when a time based alternation of the pumps is performed.
Number of Pumps Required at Startup				
P.431	1		40431	Number of Pumps Required at Startup — Range: 1 - 6 Note: This is the minimum number of pumps that are initially turned on in order to meet the Flow Rate Setpoint. When the First Pump Start Delay (Parameter P.429) expires, the first required pump will be turned on and each additional required pump will wait for the Lag Pump Delay (Parameter P.430) to expire.
Re-enable Delay - Pump Cutoff Low-Low Level				
P.153	10 sec.		40153	Re-enable Delay - Pump Cutoff Low-Low Level — Range: 1 - 600 seconds Notes: 1. While the Low-Low Level Float Switch is closed no pump operation will be allowed. 2. A Low-Low Level Float Switch must be connected to a Discrete Input assigned to Function 59. 3. The Delay starts timing out when the Discrete Input opens. When the Re-enable Delay expires the Pump Cutoff Low-Low Level feature will no longer prevent pump operation. 4. While the Pump Cutoff Low-Low Level input is closed the Low Level Alarm will be active. The contacts of a relay assigned to the Low Level Alarm (Function 7) will also be closed. Also, Fault Code 1041 will be generated.
The "Pump Cutoff Active Low-Low Level" status is available from Modbus Coil 131 (Register 40009 Bit 2). The "Low Level Alarm" status is available from Modbus Coil 47 (Register 40003 Bit 14).				

FLOW CONTROL

User / Operator Info.			SCADA	
Parameter	Default Value	Current Value	Register Address	Description of Parameters and SCADA Notes
Pump Speed Acceleration / Deceleration Rate				
P.166	30 sec.		40166	Pump Speed Acceleration Rate Range: 1 - 100 seconds / 100% speed Notes: 1. When a pump is turned on, this is the rate at which the pump's Speed Reference will be increased until it matches the Pump Speed Reference produced by the PID Controller (Parameter Pd.41). This is also the rate at which a pump's Speed Reference will follow increases of the Pump Speed Reference produced by the PID Controller. 2. The setting on Parameter P.166 is the time required for a pump's Speed Reference to go from 0% - 100%. 3. The Controller performs the Acceleration of the pump speed of the individual pumps. Therefore, the Accel Parameter on the VFDs should be set to a value less than or equal to what is set on Parameter P.166.
P.167	30 sec.		40167	Pump Speed Deceleration Rate Range: 1 - 100 seconds / 100% speed Notes: 1. When a pump is turned off, this is the rate at which the pump's Speed Reference will be decreased to 0% speed. This is also the rate at which a pump's Speed Reference will follow decreases of the Pump Speed Reference produced by the PID Controller. 2. The setting on Parameter P.167 is the time required for a pump's Speed Reference to go from 100% - 0%. 3. When a pump is turned off, the pump's Control Relay contact will be kept closed during the Deceleration of the pump to 0% speed, then the contact will be opened. 4. The Controller performs the Deceleration of the pump speed of the individual pumps. Therefore, the Decel Parameter on the VFDs should be set to a value less than or equal to what is set on Parameter P.167.
Level Alarms				
P.101	2.0 feet		40101	Low Level Alarm Range: 0.0 - 231.0 feet Notes: 1. This sets the level at which the Low Level Alarm will be activated. 2. The Low Level Alarm operation is delayed for 90 seconds after power is applied. 3. The Low Level Alarm does not act as a redundant pump off. 4. A Float Switch connected to a Discrete Input assigned to either Function 59 or 61 will also activate the Low Level Alarm. 5. Upon a Low Level Alarm, the contacts of a relay assigned to Function 7 will close.
The "Low Level Alarm" status is available from Modbus Coil 47 (Register 40003 Bit 14).				
P.102	10.0 feet		40102	High Level Alarm Range: 0.1 - 231.0 feet Notes: 1. This sets the level at which the High Level Alarm will be activated. 2. The High Level Alarm operation is delayed for 10 seconds after power is applied. 3. A Float Switch connected to a Discrete Input assigned to Function 62 will also activate the High Level Alarm. 4. Upon a High Level Alarm, the contacts of a relay assigned to Function 8 will close.
The "High Level Alarm" status is available from Modbus Coil 48 (Register 40003 Bit 15).				
Flow Rate Alarms				
P.437	100 gallons / minute		40437	Low Flow Rate Alarm Range: 10 - 65,535 gallons / minute Notes: 1. This sets the Flow Rate at which the Low Flow Rate Alarm will be activated. 2. Upon a Low Flow Rate Alarm, the contacts of a relay assigned to Function 9 will close.
The "Low Flow Rate Alarm" status is available from Modbus Coil 269 (Register 40017 Bit 12).				
P.439	900 gallons / minute		40439	High Flow Rate Alarm Range: 10 - 65,535 gallons / minute Notes: 1. This sets the Flow Rate at which the High Flow Rate Alarm will be activated. 2. Upon a High Flow Rate Alarm, the contacts of a relay assigned to Function 10 will close.
The "High Flow Rate Alarm" status is available from Modbus Coil 270 (Register 40017 Bit 13).				

PUMP ALTERNATION SEQUENCE

STANDARD ALTERNATION

Parameter P.122 = 1

With the Master Control Mode set on Flow Control the Alternation Sequence Mode will be fixed on Standard Alternation (Parameter P.122 = 1).

The pumps will be Alternated “First On First Off”.

Discrete Inputs assigned the Function of “Pump Disable” (Functions 11 - 16) inputs may be used to disable pumps so that they will not be called to run.

Discrete Inputs assigned the Function of “Call Pump Last” (Functions 41 - 46) may be used to assign pumps to standby status, where they will only be called to run if no other pumps are available.

Discrete Inputs assigned the Function of “Sequence Input” (Functions 31 - 36) may be used to set the lead pump.

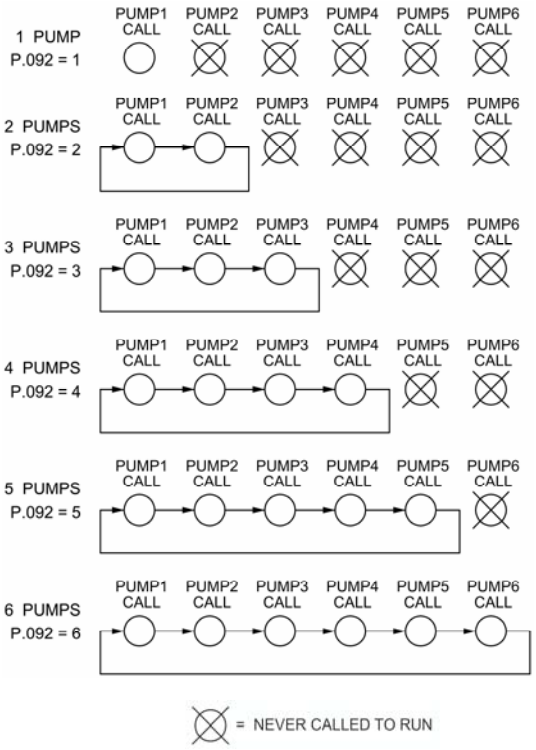
The “Forced Lead Pump Position” (Parameter P.129) may be used to set the lead pump.

“Time Based Alternation” (Parameter P.131) may be setup to force an alternation using an Internal Time Clock.

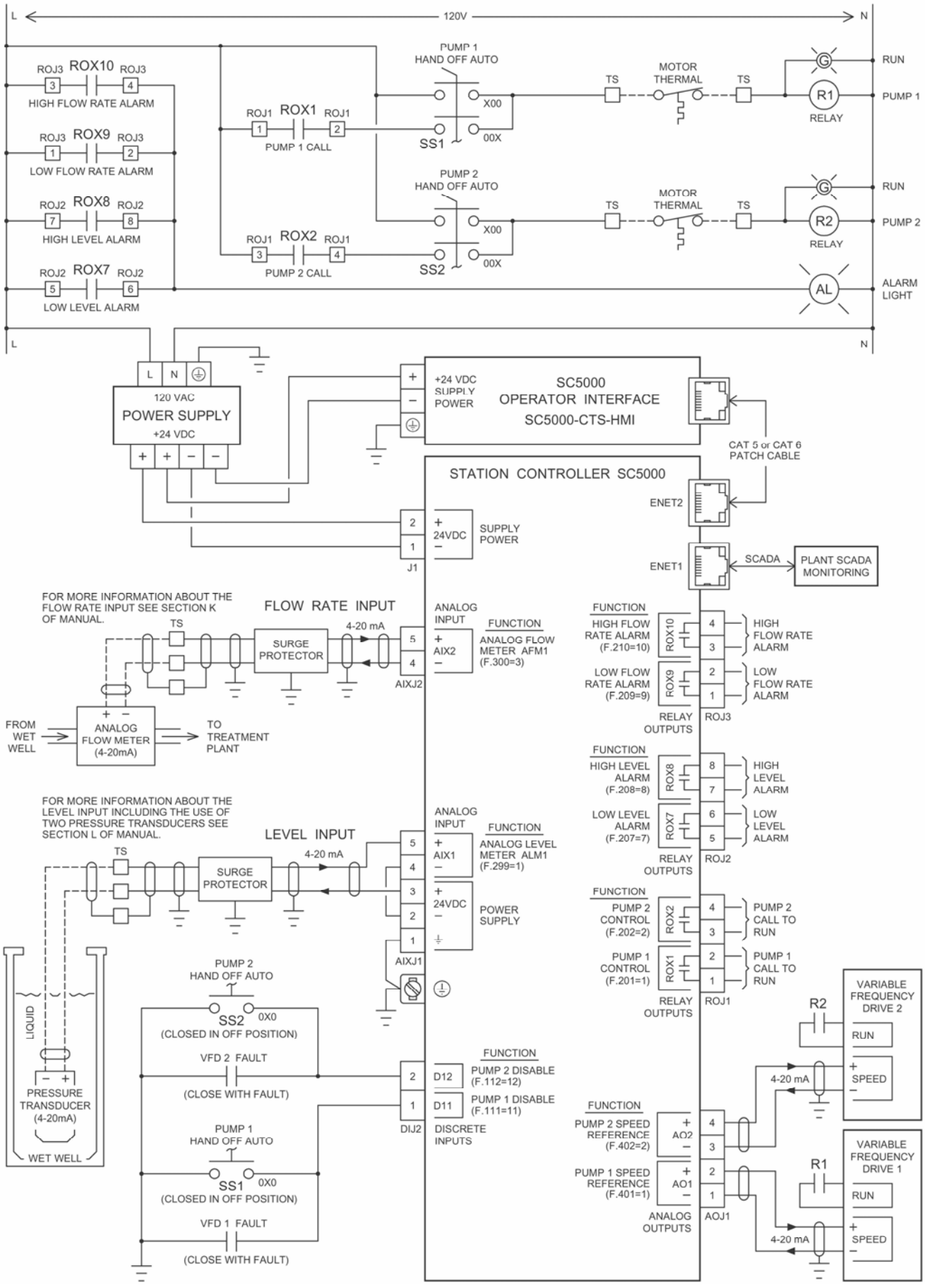
A Discrete Input assigned the Function of “External Alternation” (Function 21) may be connected to an External Time Clock and used to force an alternation.

A SCADA system may initiate an alternation by momentarily setting Modbus Coil 95 (Register 40006, Bit 14).

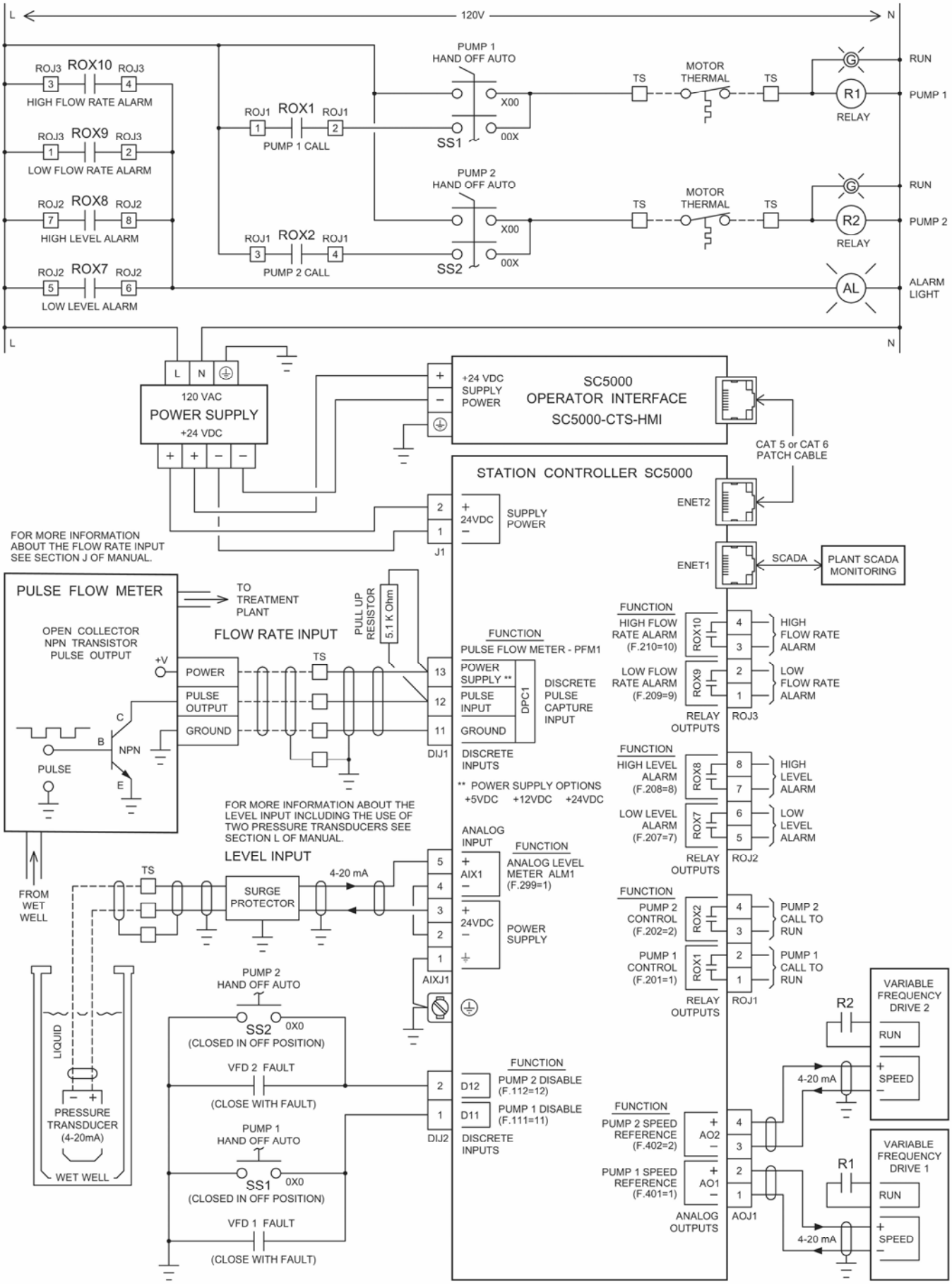
Movement of Lead Pump Upon Alternation



FLOW CONTROL EXAMPLE - ANALOG FLOW RATE INPUT

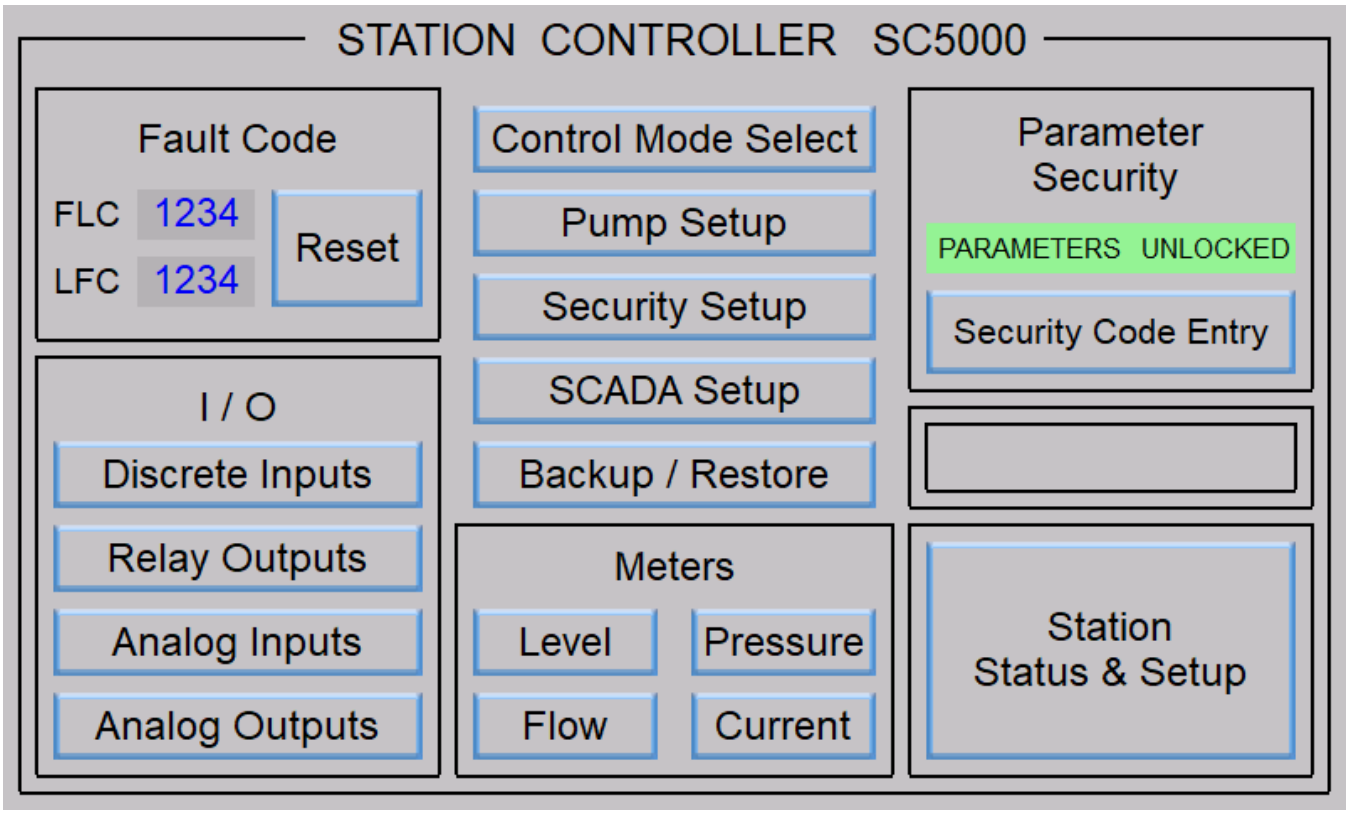


FLOW CONTROL EXAMPLE - PULSE FLOW RATE INPUT

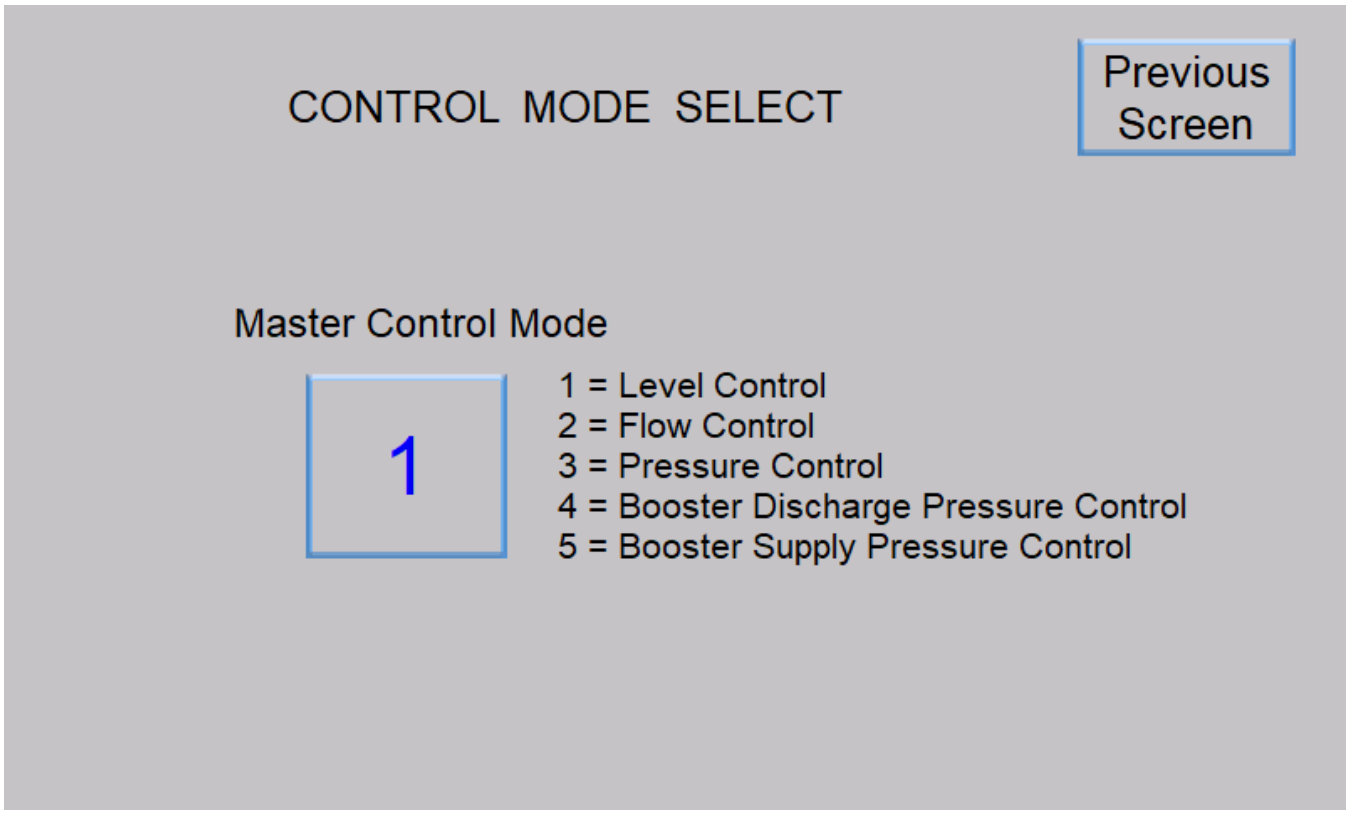


FLOW CONTROL - Touchscreen HMI SCREENS

Main Screen

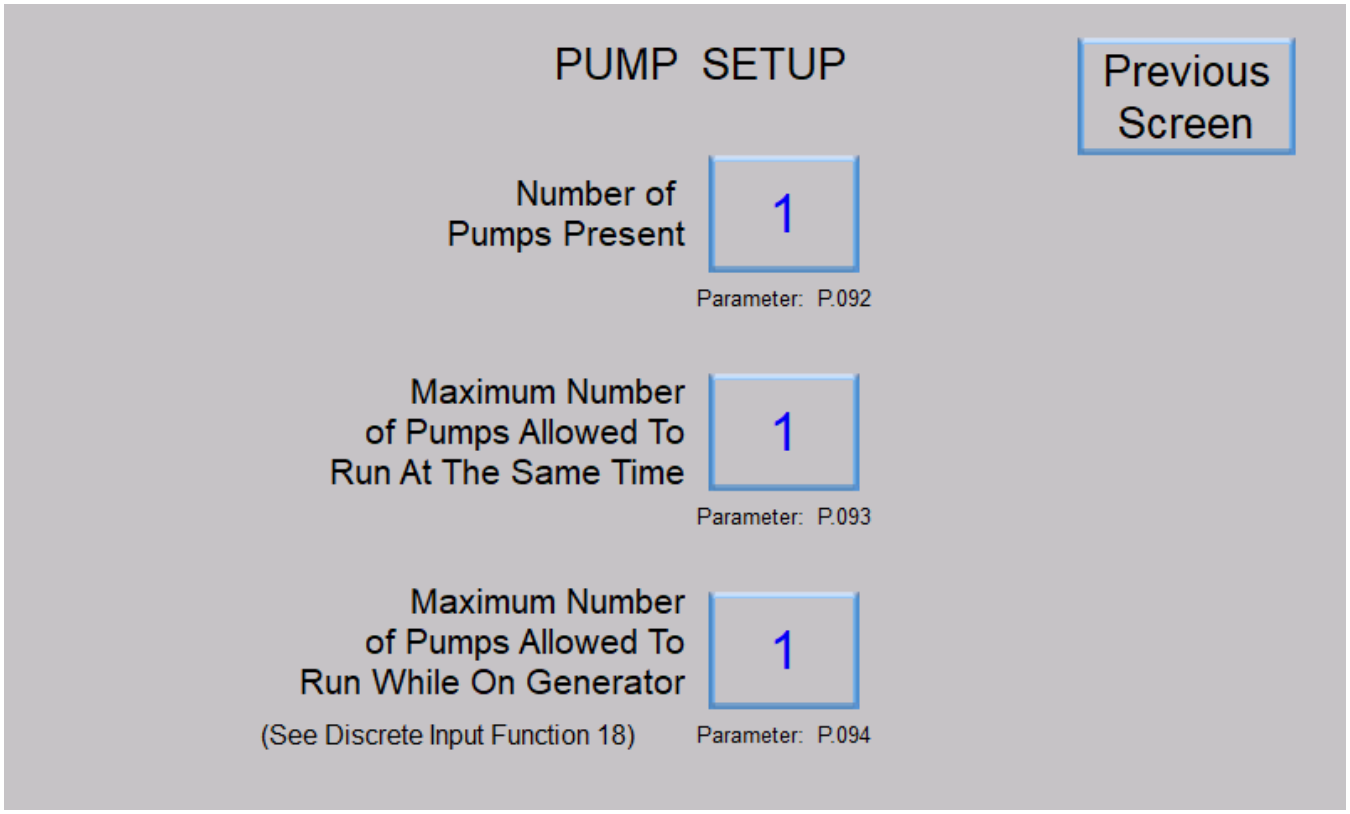


Control Mode Select

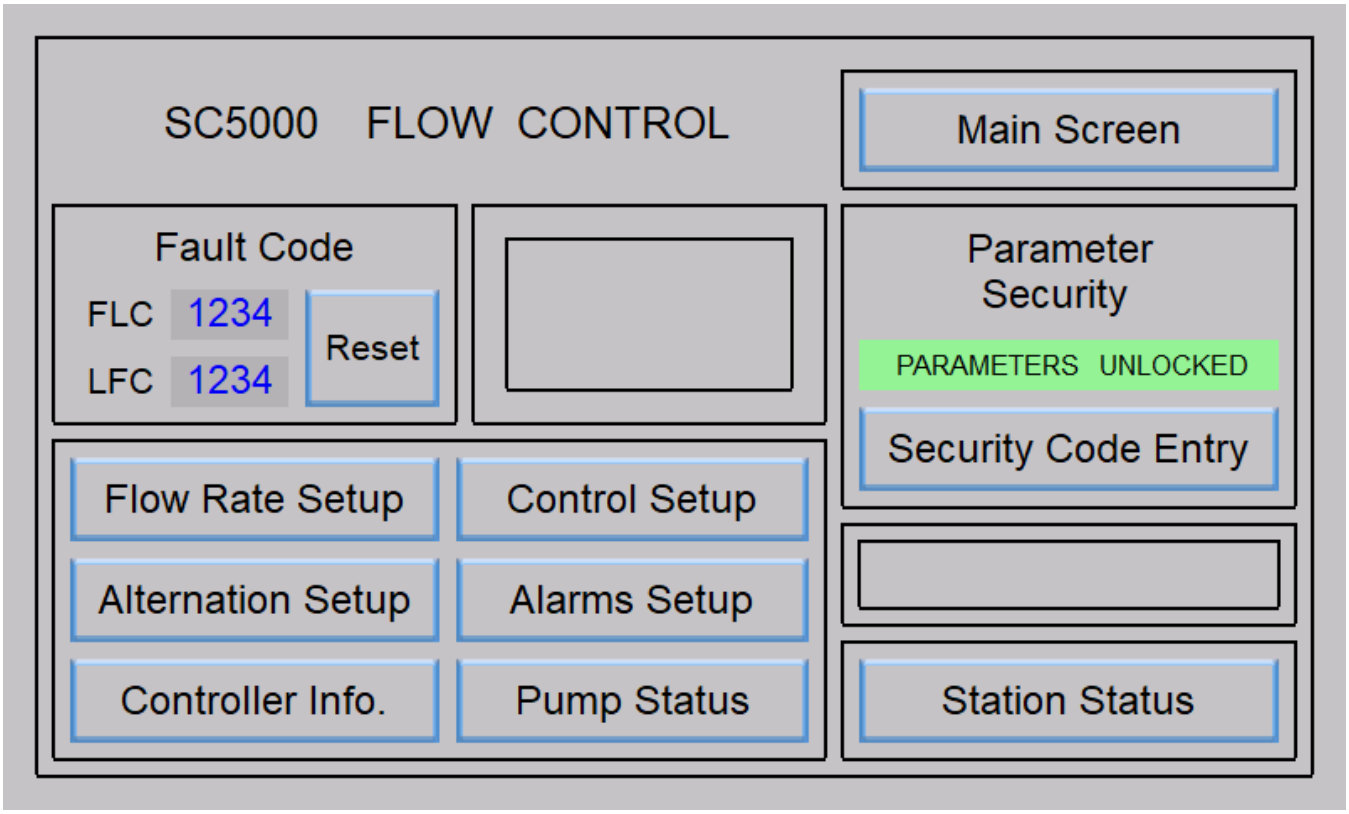


FLOW CONTROL - Touchscreen HMI SCREENS

Pump Setup

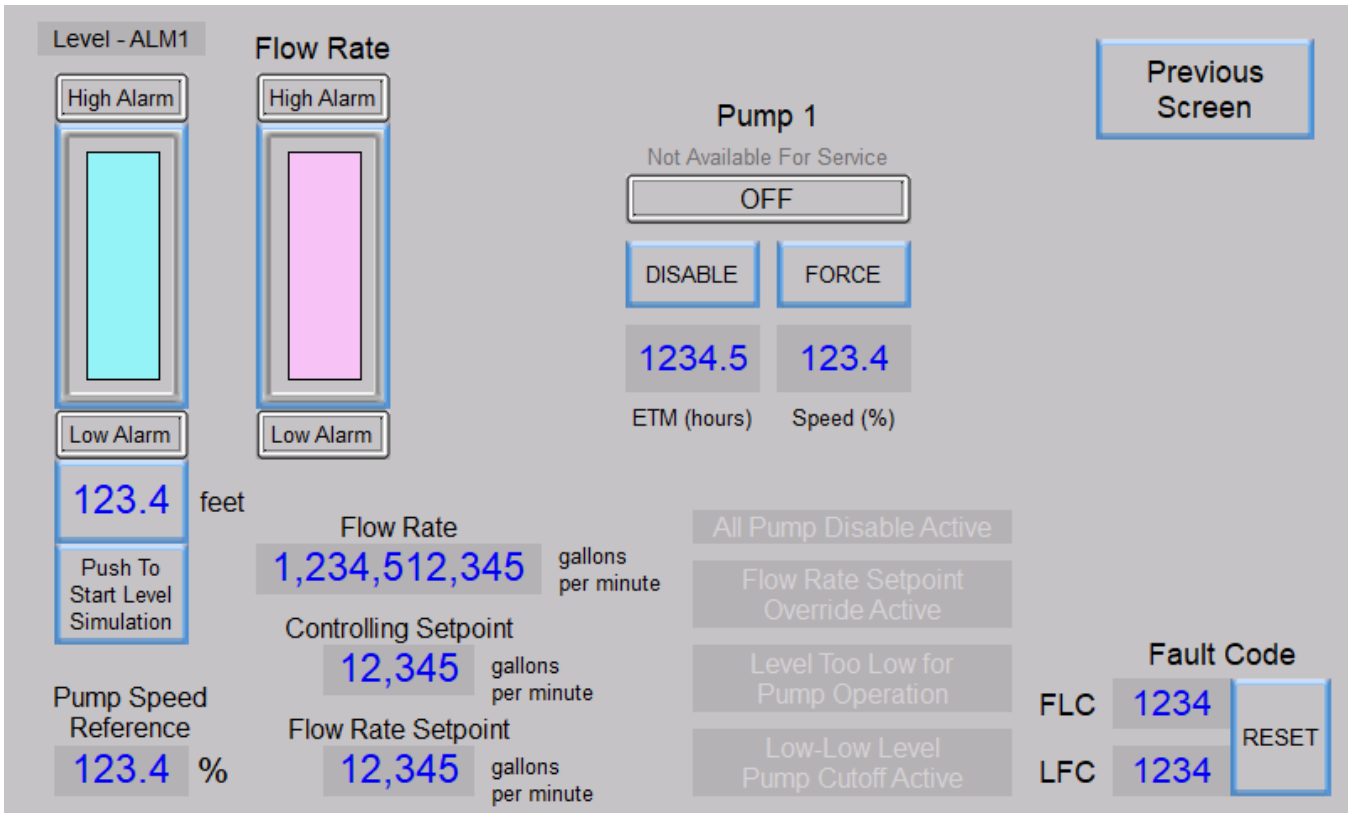


Flow Control Main Screen

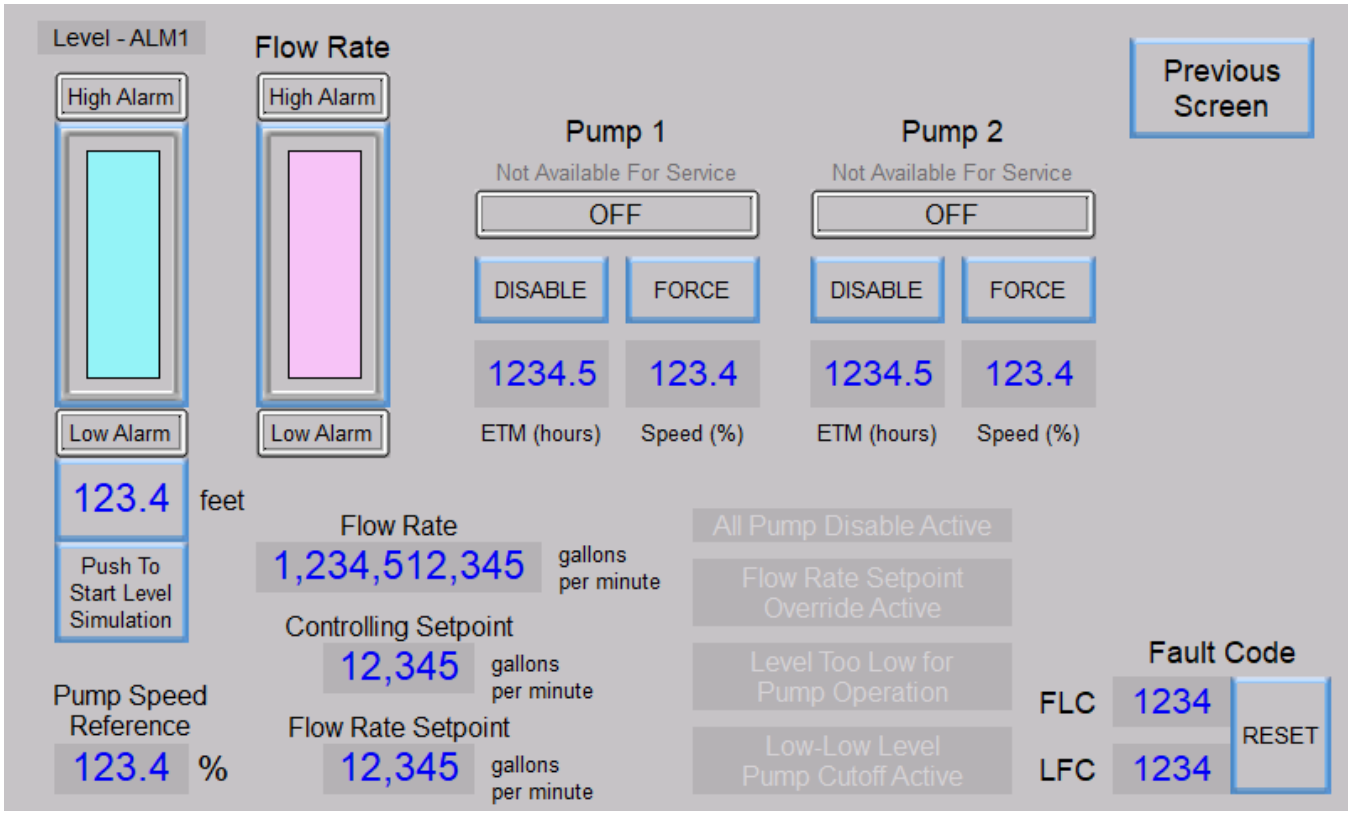


FLOW CONTROL - Touchscreen HMI SCREENS

Station Status - 1 Pump

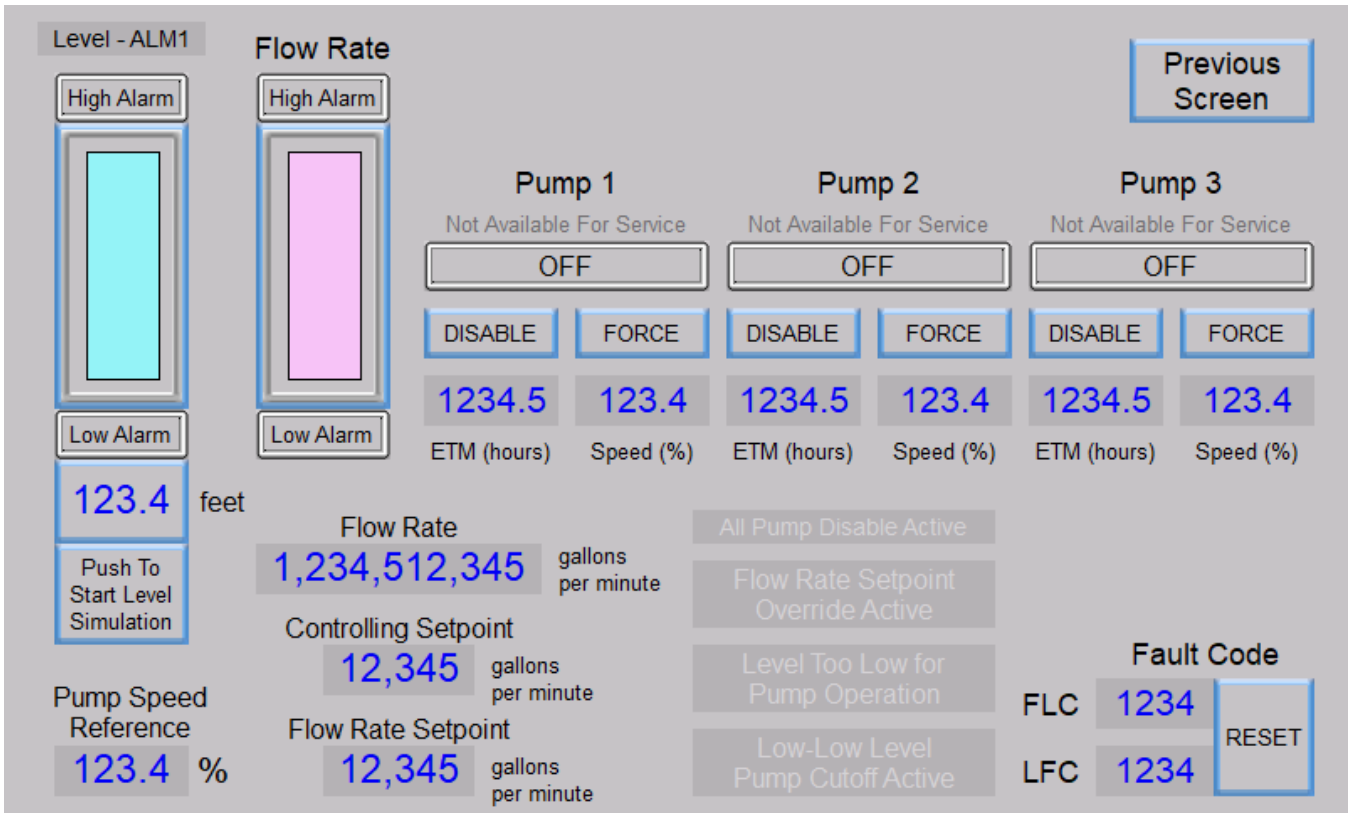


Station Status - 2 Pumps

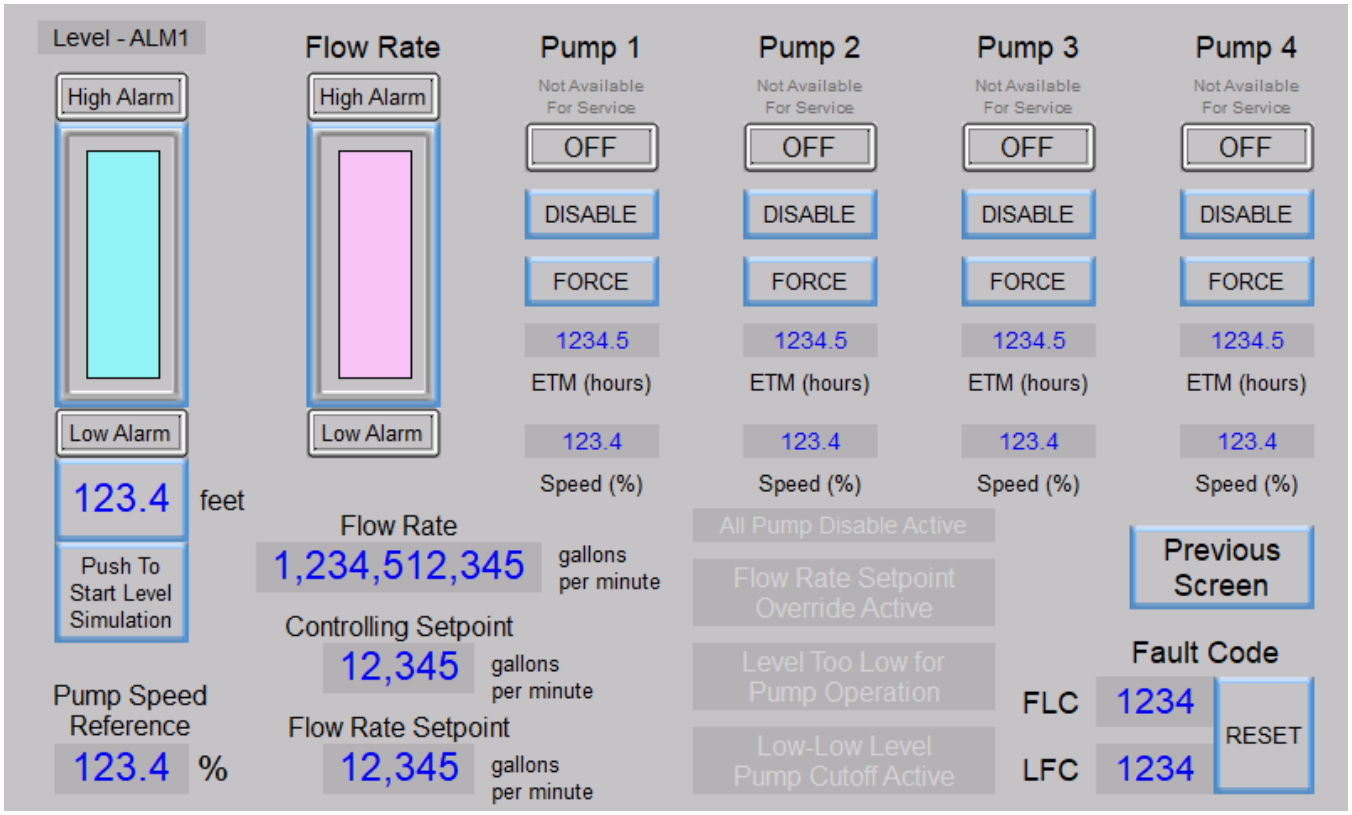


FLOW CONTROL - Touchscreen HMI SCREENS

Station Status - 3 Pumps

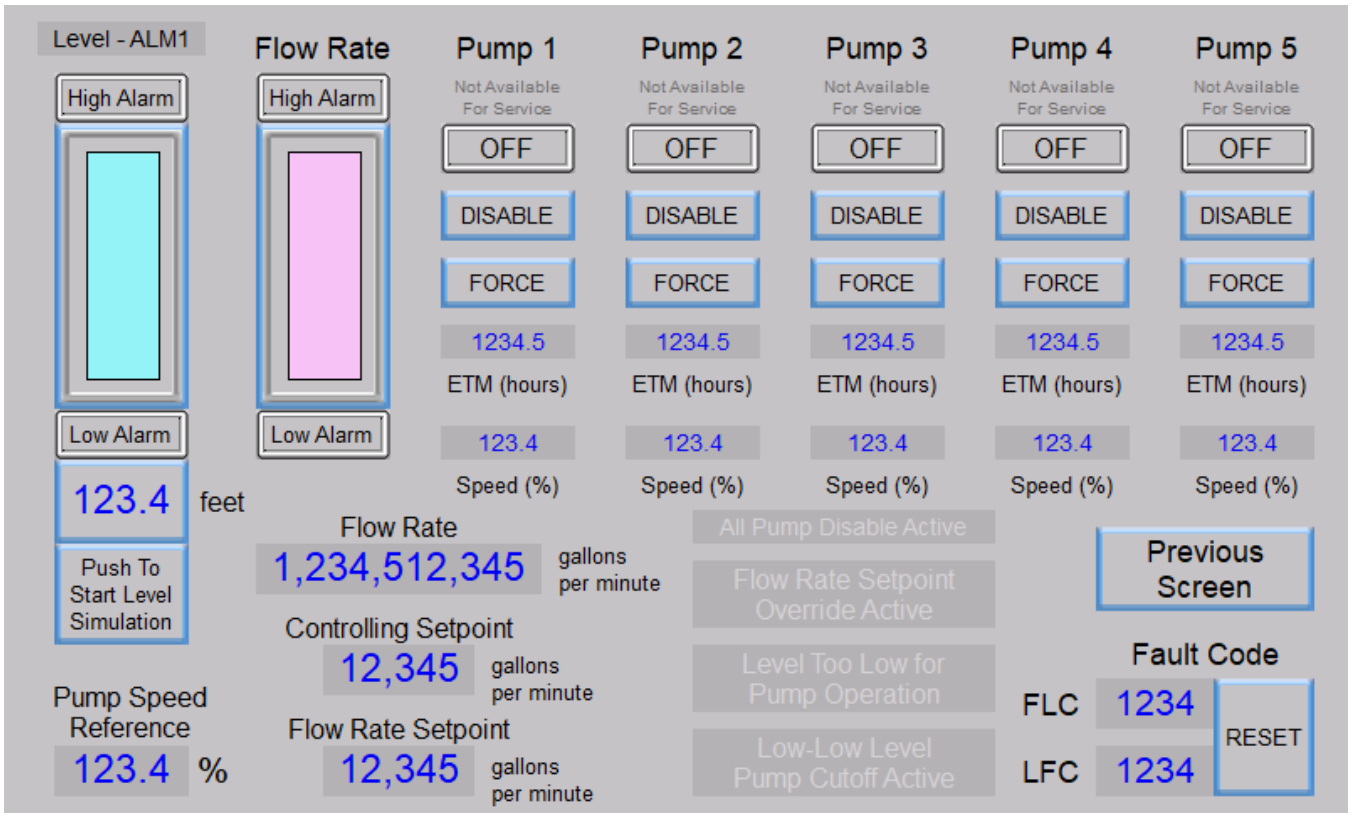


Station Status - 4 Pumps

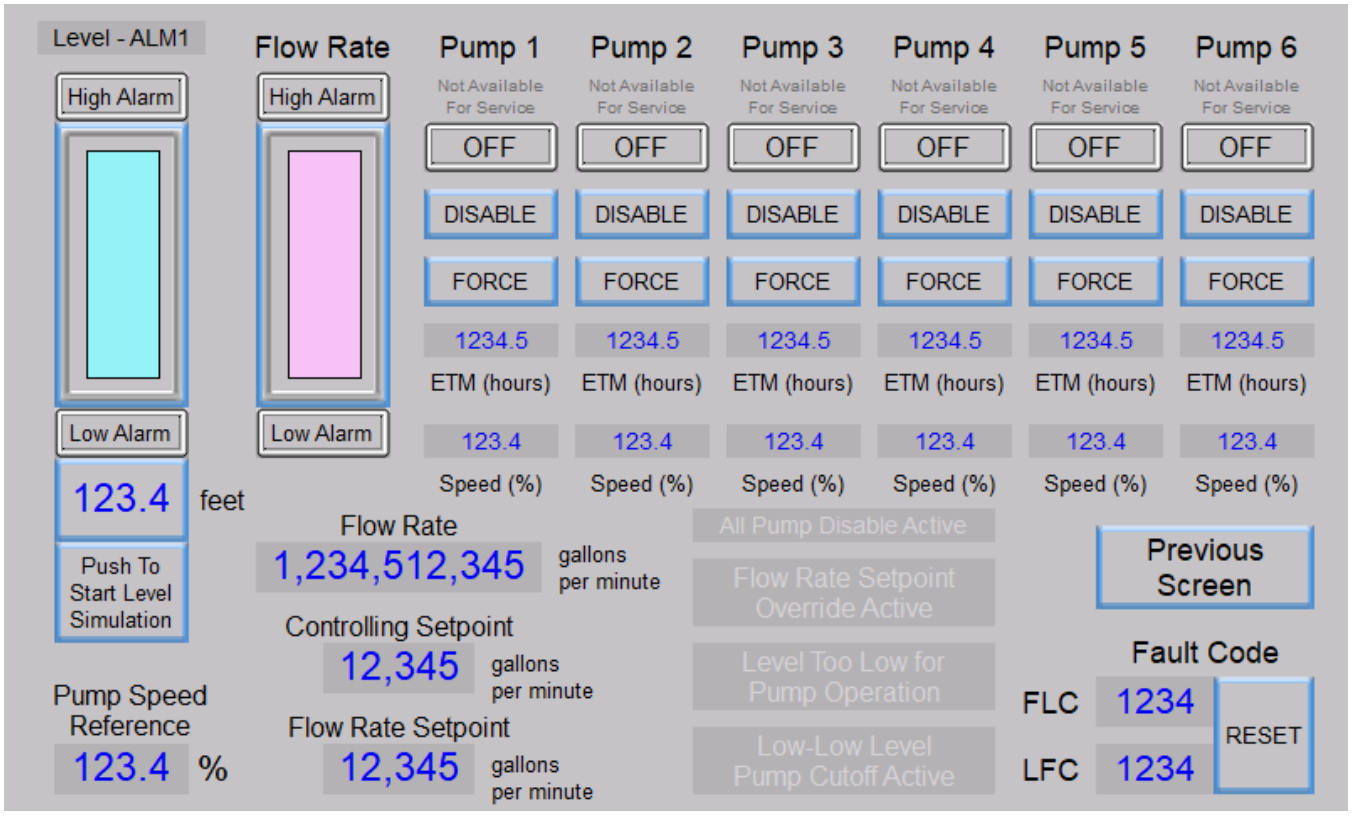


FLOW CONTROL - Touchscreen HMI SCREENS

Station Status - 5 Pumps

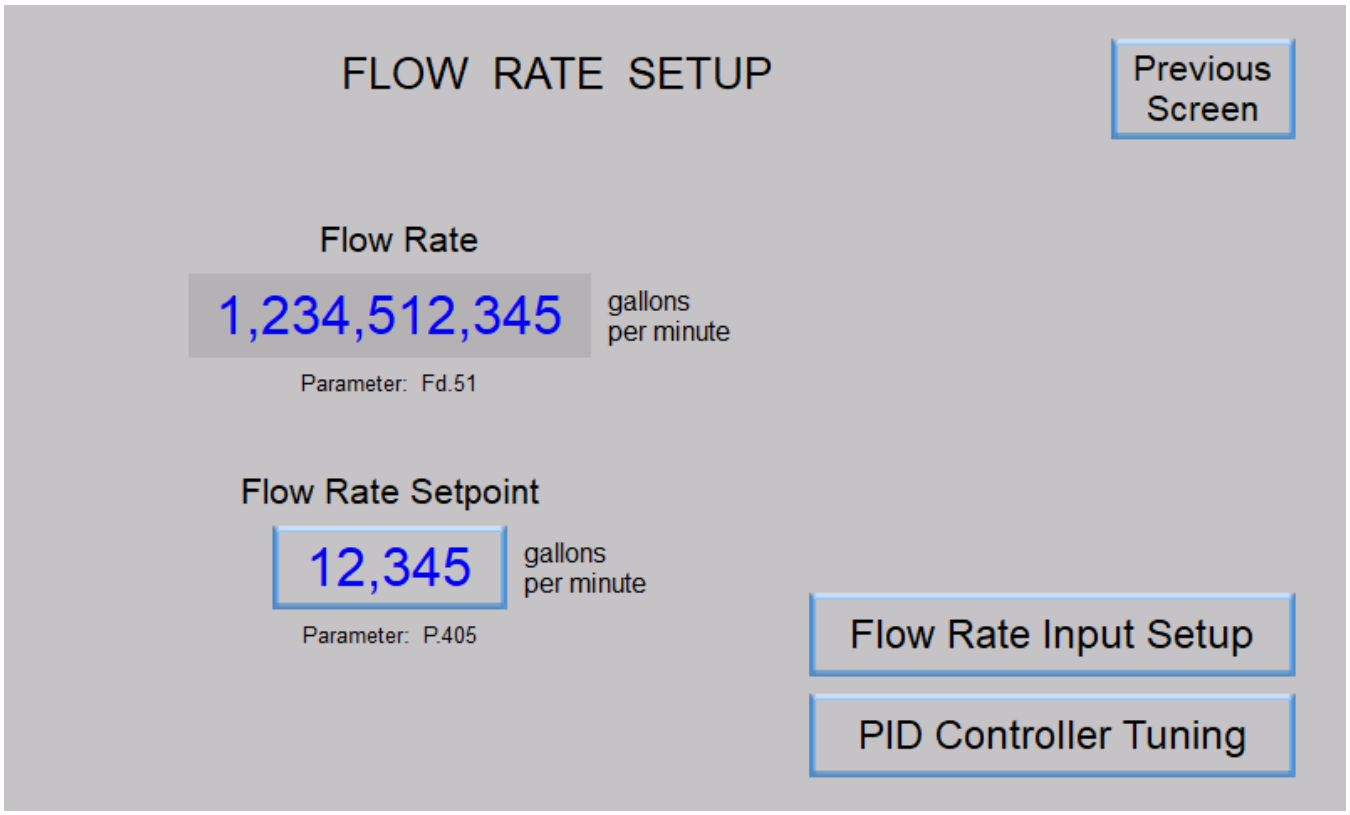


Station Status - 6 Pumps

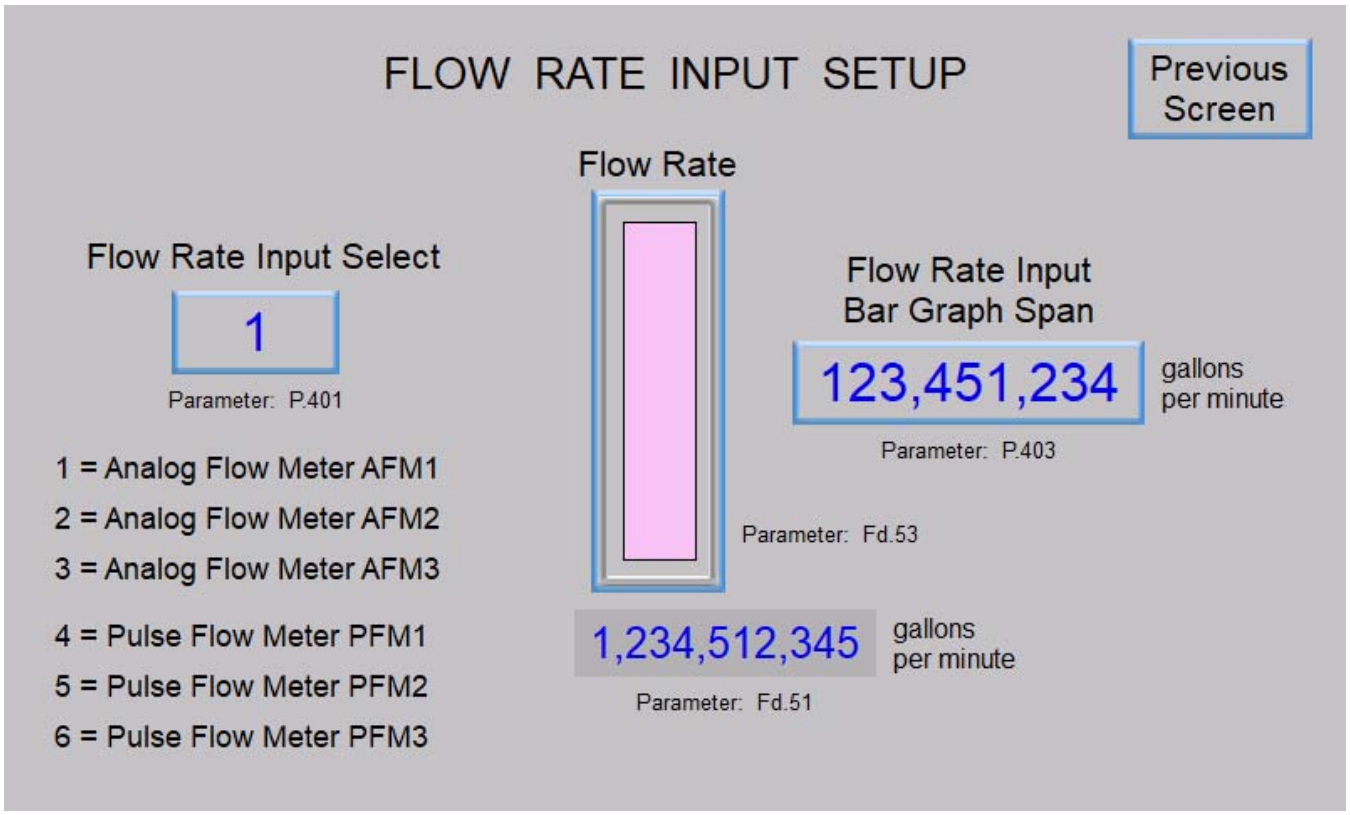


FLOW CONTROL - Touchscreen HMI SCREENS

Flow Rate Setup

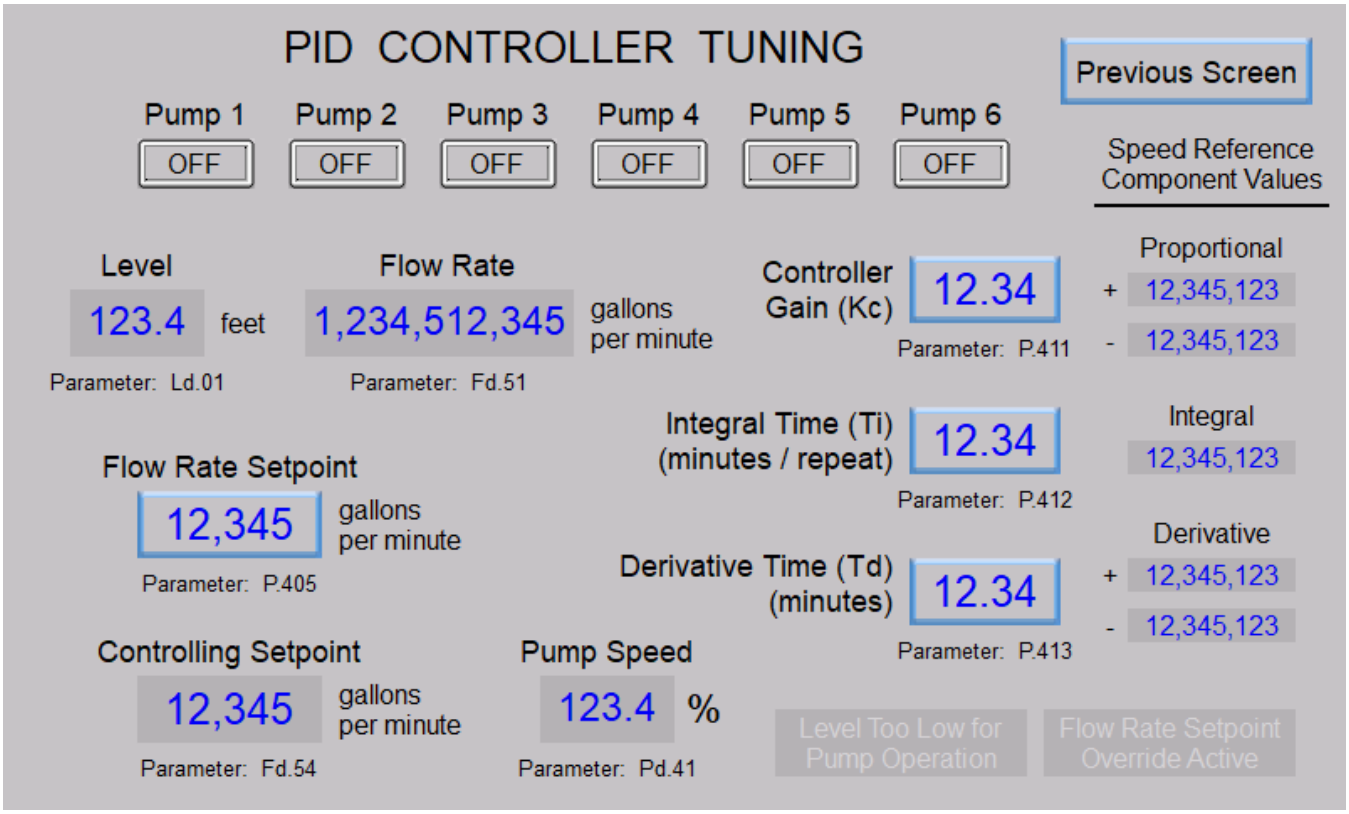


Flow Rate Input Setup

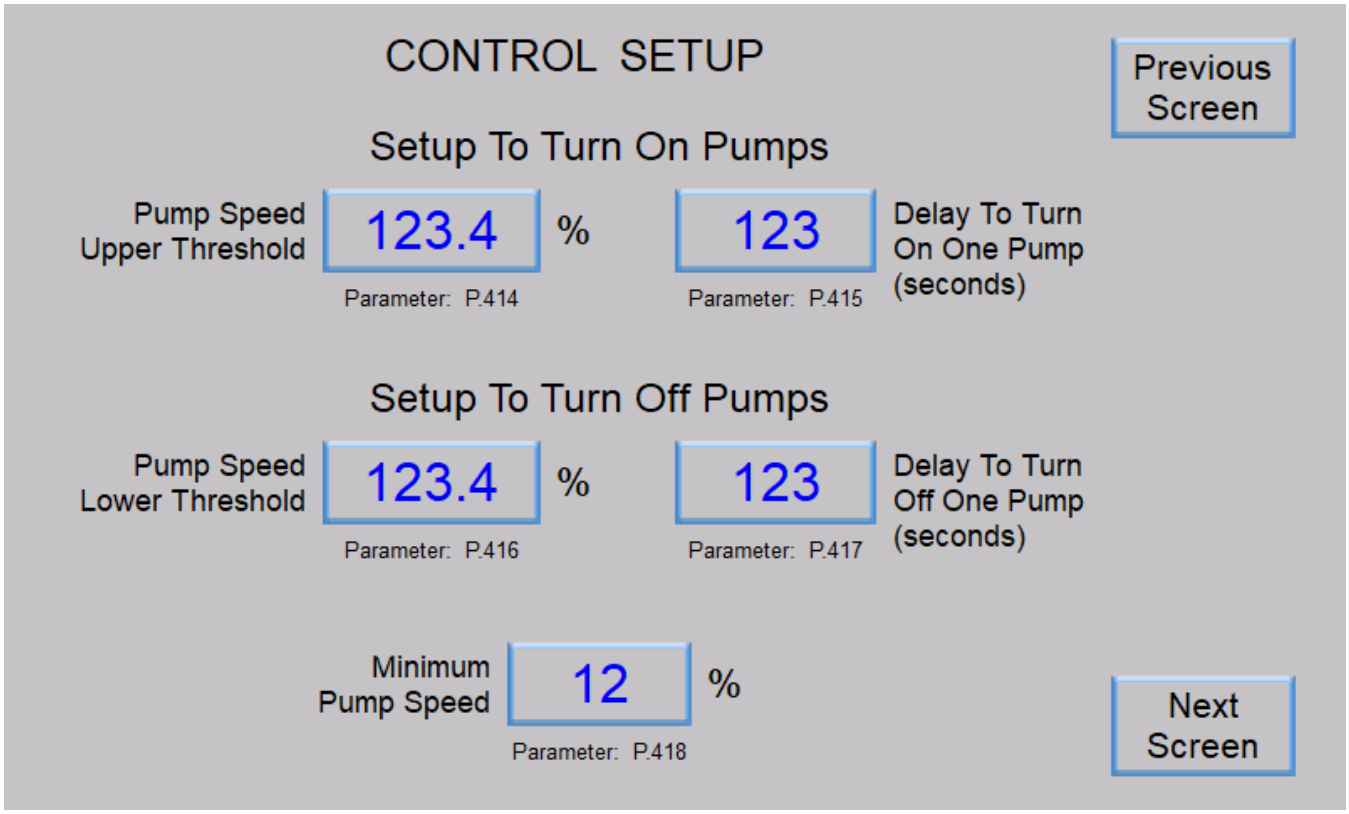


FLOW CONTROL - Touchscreen HMI SCREENS

PID Controller Tuning

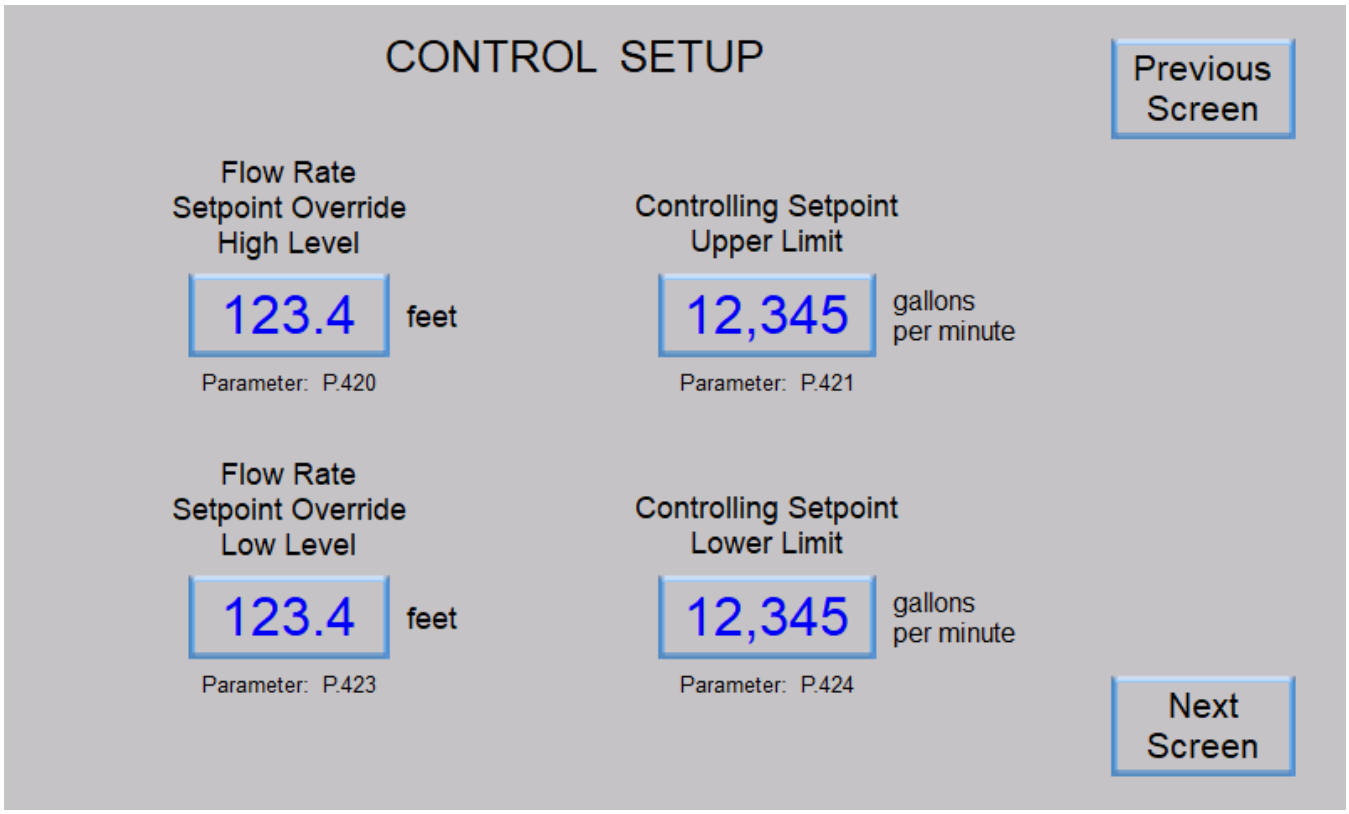


Control Setup

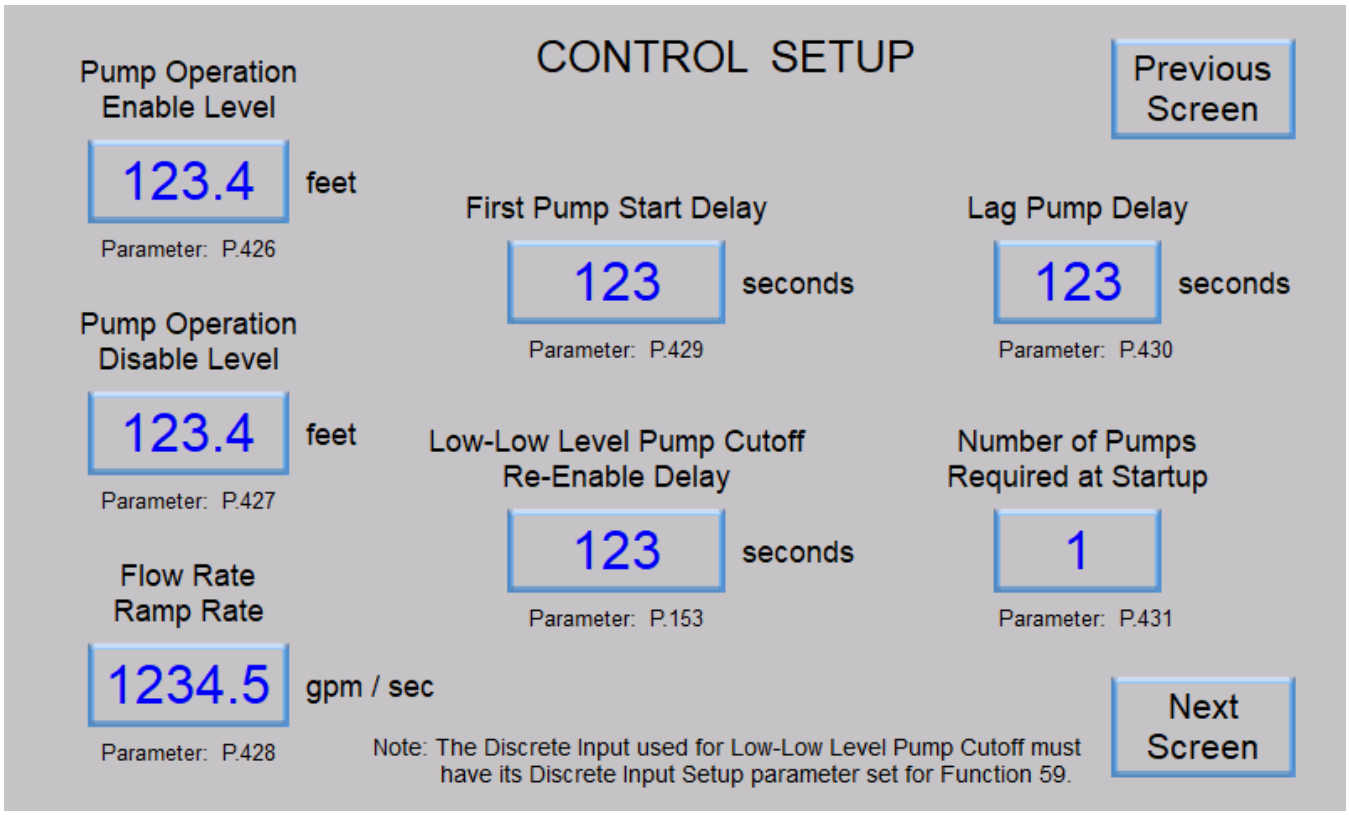


FLOW CONTROL - Touchscreen HMI SCREENS

Control Setup

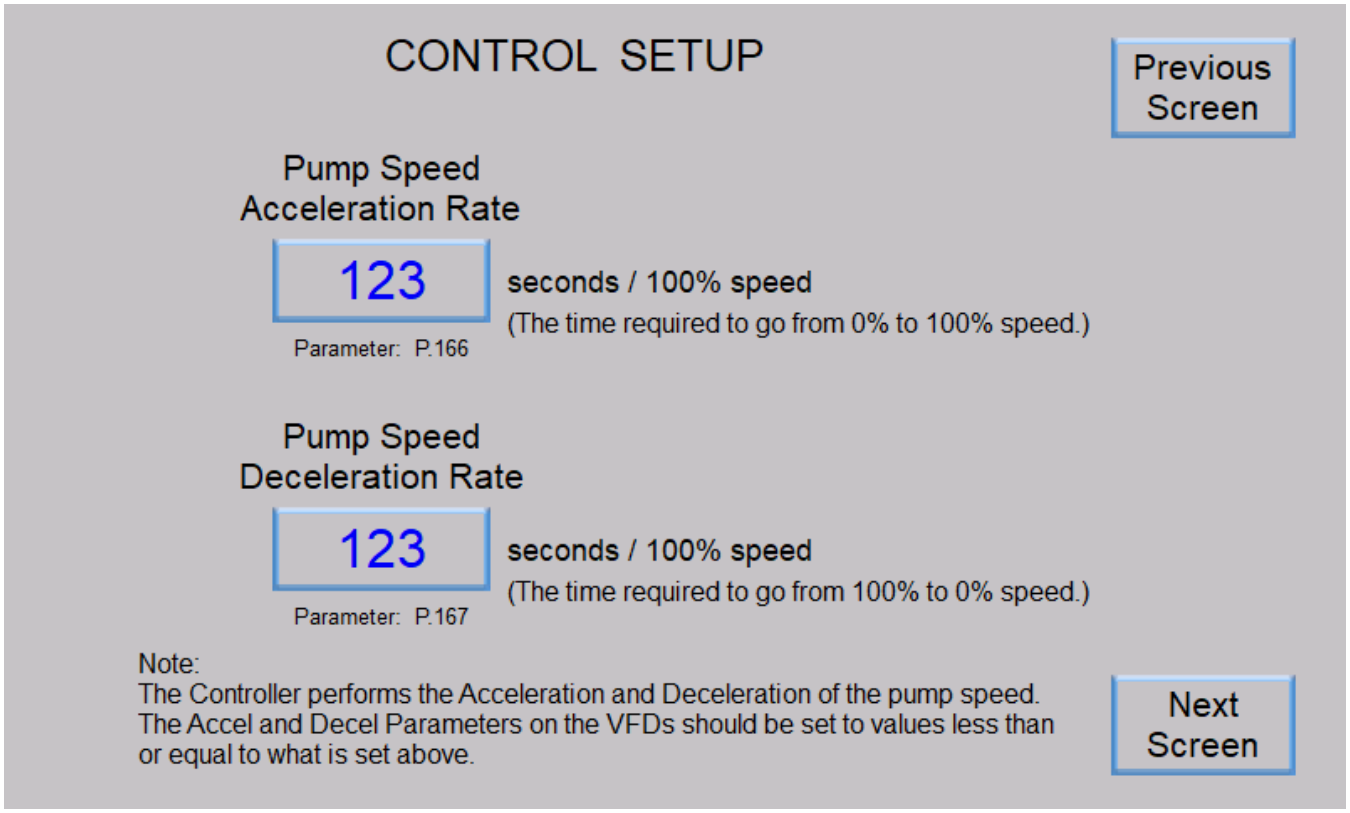


Control Setup

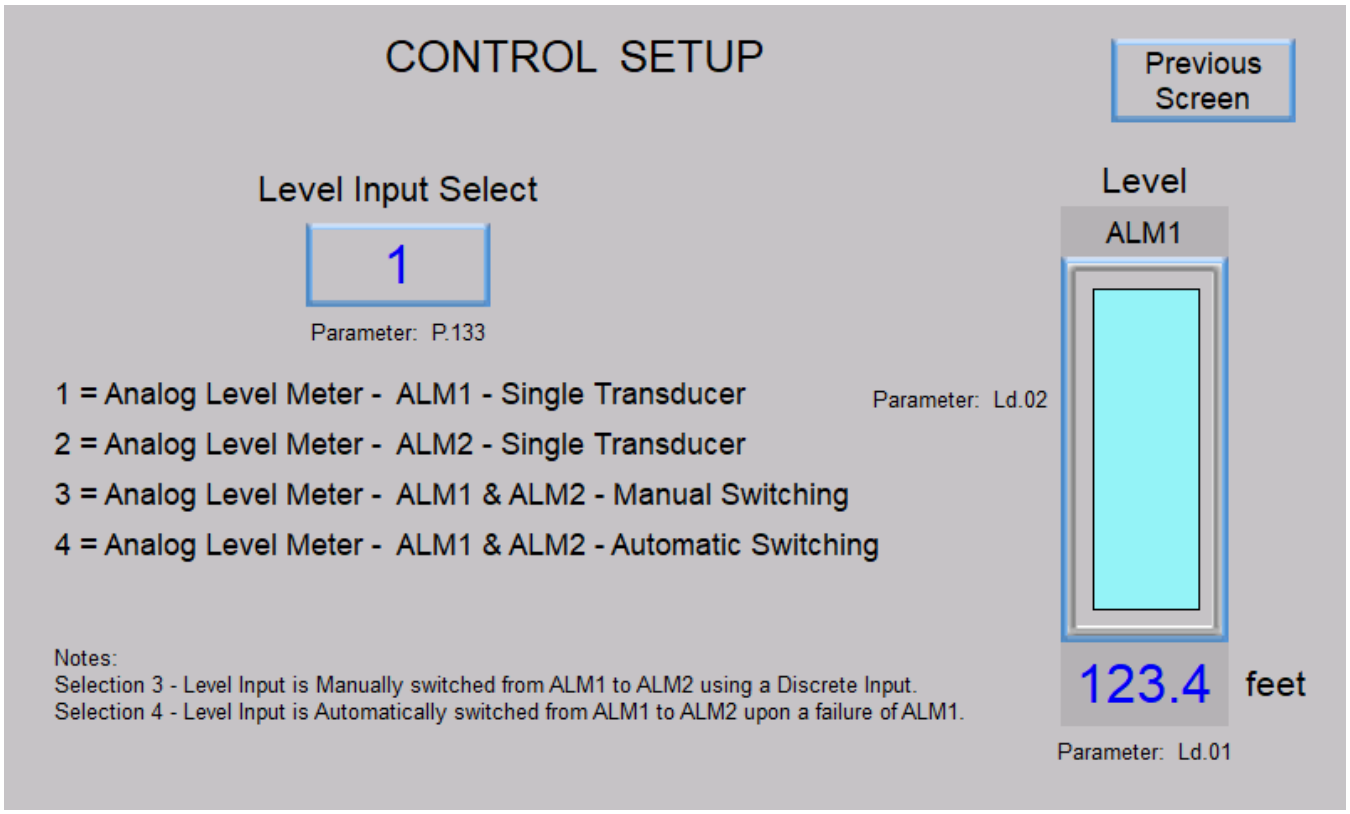


FLOW CONTROL - Touchscreen HMI SCREENS

Control Setup

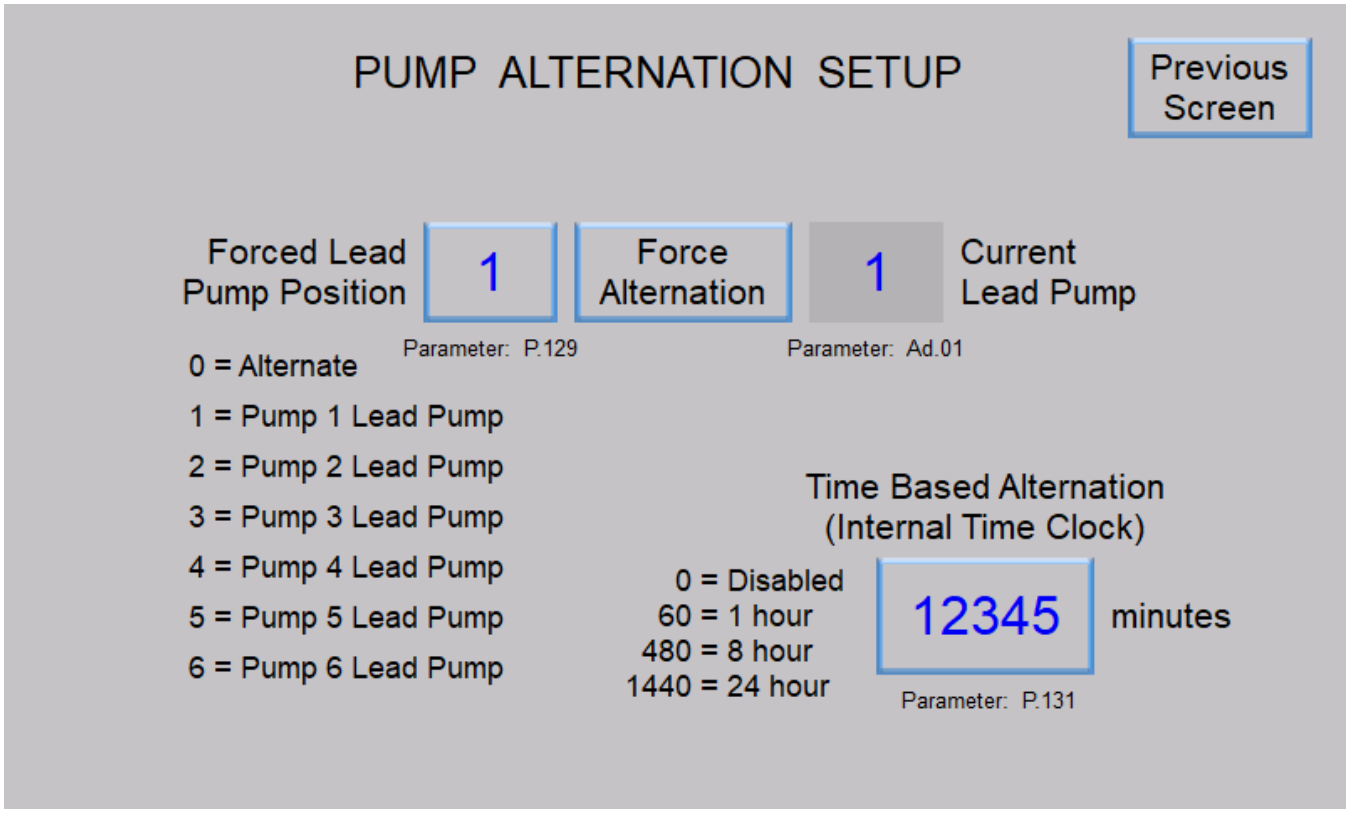


Control Setup



FLOW CONTROL - Touchscreen HMI SCREENS

Pump Alternation Setup



Alarm Setup