

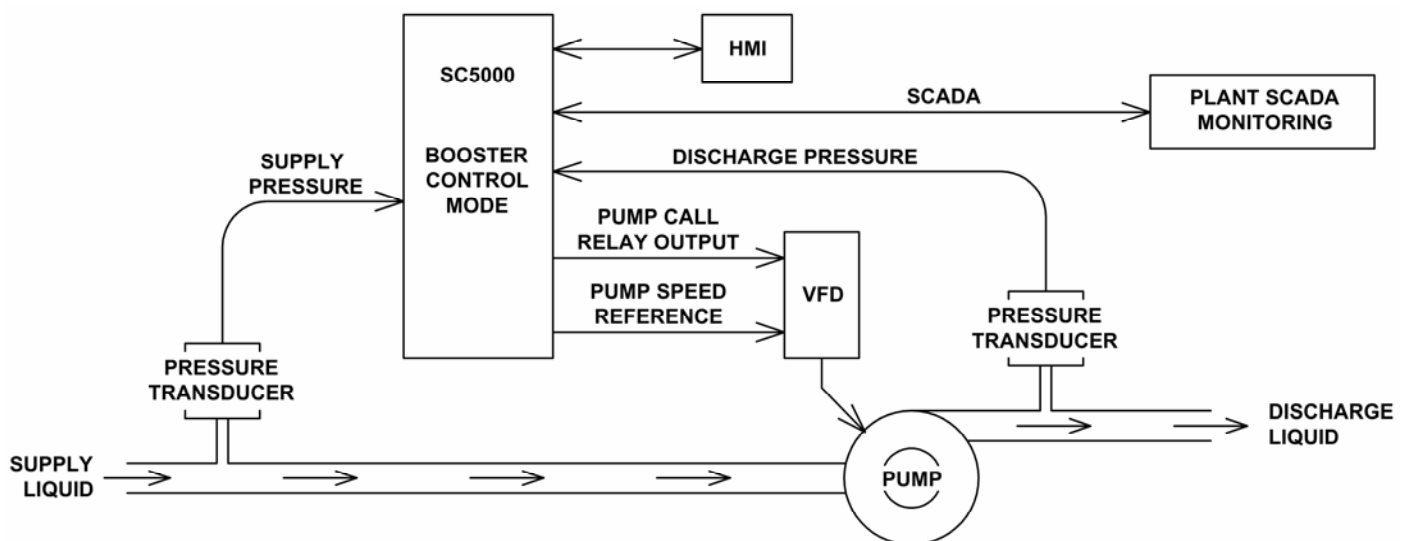
# SC5000

## INSTRUCTION MANUAL

### SECTION 4

#### BOOSTER DISCHARGE PRESSURE CONTROL

Booster Control that Maintains the Discharge Pressure at a Discharge Pressure Setpoint



# MOTOR PROTECTION ELECTRONICS, LLC

2464 Vulcan Road  
Apopka, Florida 32703

Phone: (407) 299-3825  
Website: [www.mpelectronics.com](http://www.mpelectronics.com)

# SECTION 4

## BOOSTER DISCHARGE PRESSURE CONTROL

<b>TABLE OF CONTENTS</b>	<b>Page Number</b>
<b>DESCRIPTION OF FEATURES</b>	
Description of Features Available in the Booster Discharge Pressure Control Mode .....	4-3
<b>CONTROL SETUP &amp; DATA DISPLAY</b>	
Master Control Mode .....	4-10
Pump Setup .....	4-10
Supply Pressure Input Setup and Status .....	4-11
Discharge Pressure Input Setup and Status .....	4-12
Pump Alternation Setup and Status .....	4-13
Discharge Pressure Setpoint .....	4-14
Controlling Setpoint Ramp Rate .....	4-14
PID Controller Tuning .....	4-14
Discharge Pressure Setpoint Override - Upon Low Supply Pressure .....	4-15
Starting Pumps .....	4-16
Stopping Pumps .....	4-17
Start Up Delay .....	4-18
Lag Pump Delay .....	4-18
Minimum & Maximum Pump Speed Limits .....	4-18
Pump Speed Acceleration / Deceleration Rate .....	4-19
Supply Pressure Alarms .....	4-19
Discharge Pressure Alarms .....	4-19
Number of Pumps Required at Startup .....	4-20
Pump Speed Reference Status .....	4-20
Starting & Stopping Pump Delays Status .....	4-21
Analog Pressure Meters APM1 and APM2 .....	N-1
<b>CONNECTION DIAGRAMS</b>	
Booster Control Example .....	4-22
Analog Pressure Input Examples .....	N-3
<b>HMI</b>	
SC5000-CTS-HMI Screens used for Booster Discharge Pressure Control .....	4-23

# BOOSTER DISCHARGE PRESSURE CONTROL

## DESCRIPTION OF FEATURES

### General Description

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

In the Booster Discharge Pressure Control Mode, a PID Controller (Proportional, Integral, Derivative) regulates the pump speed in order to maintain the Discharge Pressure at the Discharge Pressure Setpoint.

The Booster Discharge Pressure Control logic also determines the number of pumps required to run in order to maintain the Discharge Pressure at the Discharge Pressure Setpoint.

The Booster Discharge Pressure Control logic also alternates the pumps and provides Pump Start/Stop Parameters and Pump Start/Stop Delay Parameters for each pump call, Lag Pump Delay, Number of Pumps Required at Startup, Low Supply Pressure Alarm, High Supply Pressure Alarm, Low Discharge Pressure Alarm, and High Discharge Pressure Alarm. 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 Booster Discharge Pressure Control Mode requires that each pump have its own VFD.

The Booster Discharge Pressure 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 **Color Touch Screen** HMI programmed with screens that show the Supply Pressure, Discharge Pressure, Pump Speed Reference, Pump Run Status, Pump Available for Service indication, High Supply Pressure and Low Supply Pressure alarms, High Discharge Pressure and Low Discharge Pressure alarms, Discharge Pressure Setpoint Override Active indication, Supply Pressure Too Low For Pump Operation 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 reset the Elapsed Run Time meters, and reset any Fault Codes.

### Supply Pressure Input Select

The Booster Discharge Pressure Control mode requires that an analog Supply Pressure Input be provided to the Controller to monitor the Supply Pressure. The Supply Pressure Input Select (Parameter P.701) is provided to allow for the selection of either Analog Pressure Meter APM1, or APM2. See Section N.

### Discharge Pressure Input Select

The Booster Discharge Pressure Control mode requires that an analog Discharge Pressure Input be provided to the Controller to monitor the Discharge Pressure. The Discharge Pressure Input Select (Parameter P.703) is provided to allow for the selection of either Analog Pressure Meter APM1, or APM2. See Section N.

### Supply Pressure Too Low for Pump Operation Alarm Status

When Supply Pressure is too low for pump operation, based on Parameters P.731 and P.743, the “Supply Pressure Too Low for Pump Operation” alarm status bit will be set and may be read from Modbus Coil 259 (Register 40017 Bit 2).

# BOOSTER DISCHARGE PRESSURE CONTROL

## Standard Pump Alternation

When standard “First On First Off” alternation is required, the Alternation Sequence Mode should be set for Standard Alternation (Parameter P.122 = 1).

The following describes the features that are available with Standard Pump Alternation:

### Time Based Alternation

Time Based Alternation is available to automatically alternate the pumps. The Time Based Alternation logic may be triggered by an Internal Time Clock or from an External Time Clock.

If the Internal Time Clock is used to trigger alternation of the pumps, then the alternation period must be set on Parameter P.131.

If an External Time Clock is used to trigger alternation of the pump, then an External Time Clock must be connected to a Discrete Input on the Controller (assigned to Function 21), or it may be initiated remotely by setting Modbus Coil 95 (Register 40006 Bit 14).

### Force Lead Pump Position

When manual control over the pump call sequence is required, the operator can use the Forced Lead Pump Position feature to set the Lead Pump Position. This is done by setting the lead pump’s number into Parameter P.129. This sets the order that 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.

### Pump Disable Discrete Inputs

Discrete Inputs assigned the Function of “Pump Disable” (Functions 11 - 16) inputs may be used to disable one or more pumps so that they will not be called to run and will be skipped in the pump call sequence.

### Fixed Order Sequence

When total control over the pump call sequence is desired, then the Alternation Sequence Mode should be set for the Fixed Order Sequence (Parameter P.122 = 2). In this mode each pump has its own parameter to fix its position in the pump call sequence.

The following Parameters are used to establish the Fixed Order Sequence:

- Parameter P.711 - Pump 1 Fixed Order Position
- Parameter P.712 - Pump 2 Fixed Order Position
- Parameter P.713 - Pump 3 Fixed Order Position
- Parameter P.714 - Pump 4 Fixed Order Position
- Parameter P.715 - Pump 5 Fixed Order Position
- Parameter P.716 - Pump 6 Fixed Order Position

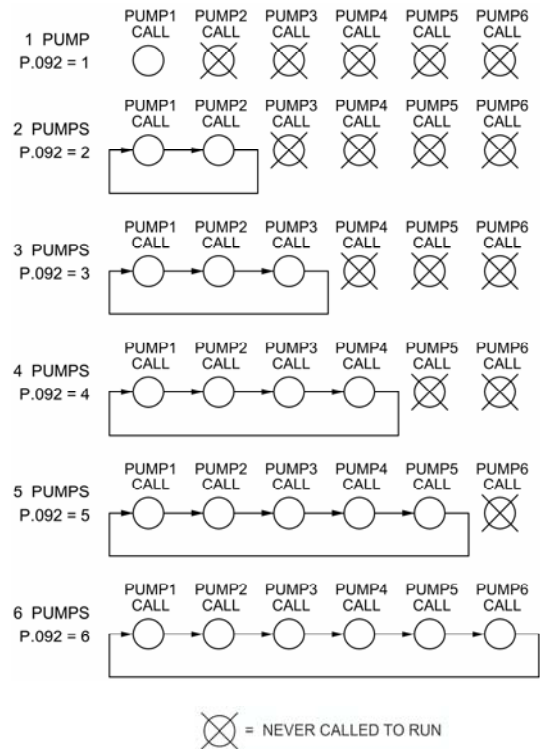
### ETM Based Alternation

When it is required that the pump call sequence be established based on each of the pump’s run times, then the Alternation Sequence Mode should be set for Elapsed Time Meter Based Alternation (Parameter P.122 = 3).

In this mode the Alternator logic selects the next pump to turn on based on which pump has the least time on its ETM among the pumps that are currently off.

Also, in this mode the Alternator logic selects the next pump to turn off based which pump has the most time on its ETM among the pumps that are currently on.

### Movement of Lead Pump Upon Alternation



## BOOSTER DISCHARGE PRESSURE CONTROL

### Discharge Pressure Setpoint

The Discharge Pressure Setpoint (Parameter P.719) must be set by the operator for the desired Discharge Pressure that must be maintained by the pumping station.

At startup, if there is adequate Supply Pressure, the Booster Control logic will start one pump. If the one pump called at startup is unable to bring the Discharge Pressure Up to the Discharge Pressure 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 Discharge Pressure Setpoint is met. Additionally, the logic will turn off any unneeded pumps. If only one pump is left on and the Supply Pressure is too low then the control logic will turn off the last remaining pump.

Provided that the liquid flowing into the Booster Station has adequate pressure, the PID Controller will control the VFD speed reference to maintain the Discharge Pressure at the Discharge Pressure Setpoint.

### Controlling Setpoint

The PID Controller is the part of the SC5000's control program that regulates the pump speed. In order to operate, the PID Controller requires two pieces of information, the value of the Discharge Pressure Setpoint to follow and the value of the Discharge Pressure which it uses as feedback.

To ensure the smooth stable control of the Discharge Pressure while starting the first pump, the PID Controller is not initially fed the Discharge Pressure Setpoint (Parameter P.719), but rather it is fed the Controlling Setpoint (Parameter Pd.31) which is carefully controlled.

Before the 1st pump is turned on a snap shot of the Discharge Pressure is captured and then used as the initial Controlling Setpoint (Parameter Pd.31). After the 1st pump is turned on the value of the Controlling Setpoint is slowly increased until it equals the Discharge Pressure Setpoint (Parameter P.719).

After start up the Controlling Setpoint will be kept equal to the Discharge Pressure Setpoint.

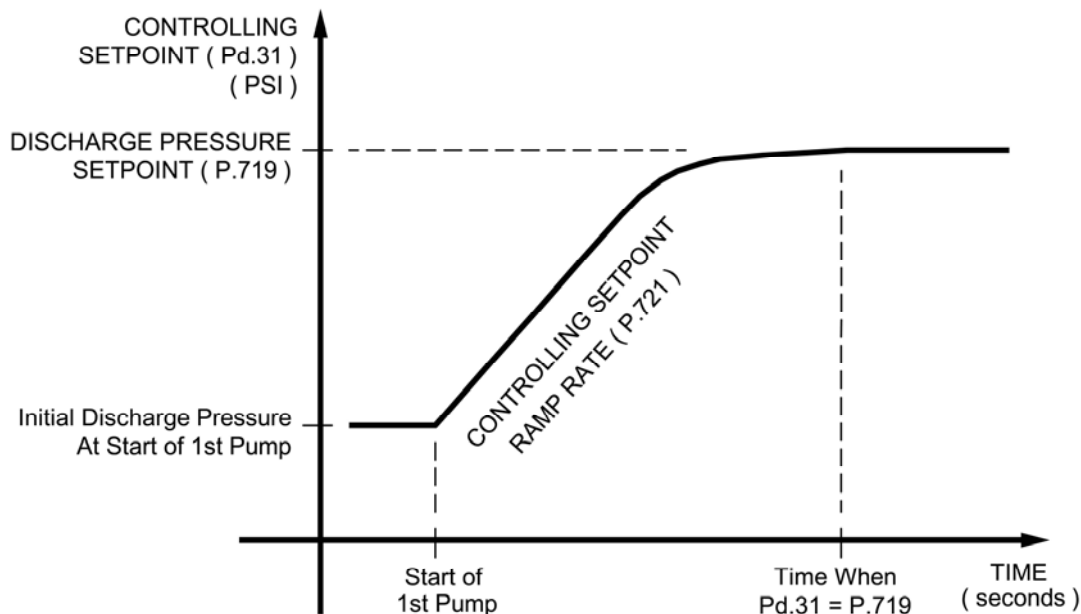
If the Discharge Pressure Setpoint is changed by an operator, while the pumps are operating, then the Controlling Setpoint will be slowly ramped up or down to the new value of the Discharge Pressure Setpoint.

While the Controlling Setpoint is being ramped up or down toward being equal to the Discharge Pressure Setpoint, the "PID Controller Setpoint Override Active" status bit will be set and may be read from Modbus Coil 257 (Register 40017 Bit 0).

### Controlling Setpoint Ramp Rate

The Controlling Setpoint Ramp Rate (Parameter P.721) is what sets the rate of change of the Controlling Setpoint (Parameter Pd.31) toward being equal to the Discharge Pressure Setpoint (Parameter P.719).

### Controlling Setpoint versus Time at Start Up of 1st Pump



# BOOSTER DISCHARGE PRESSURE CONTROL

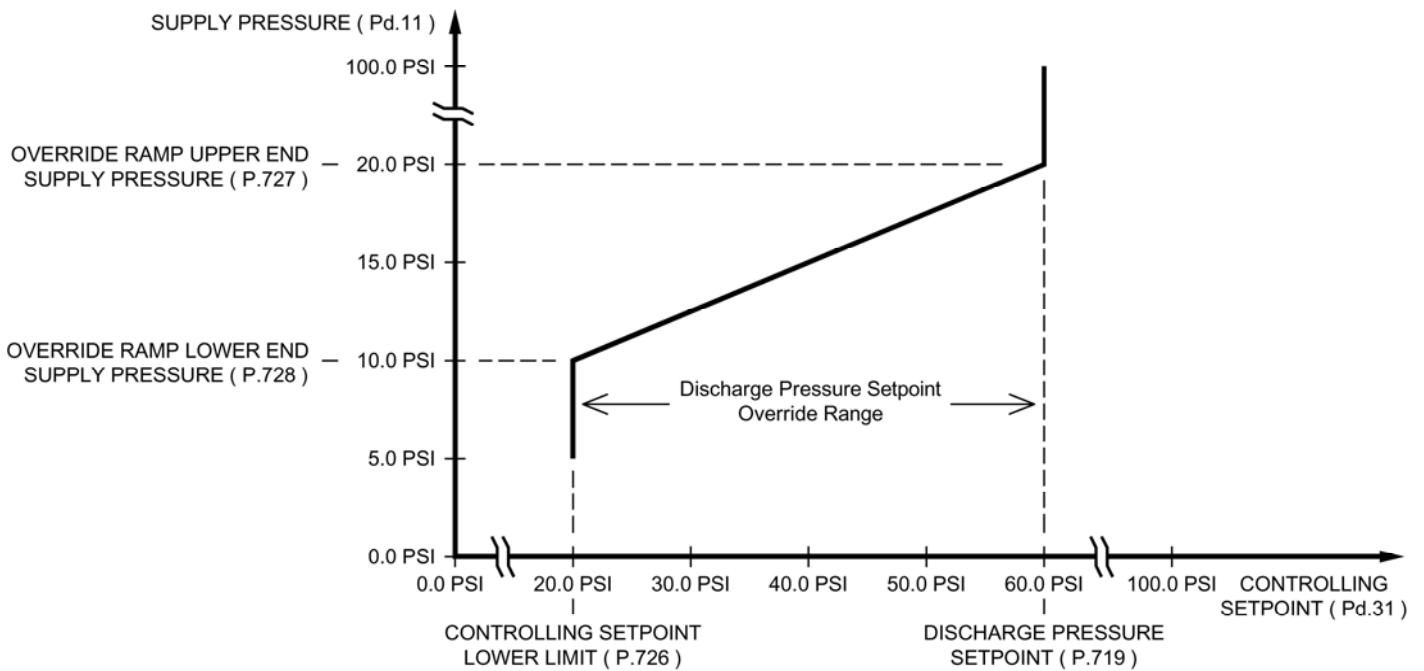
## Discharge Pressure Setpoint Override - Upon a Low Supply Pressure

Upon a low Supply Pressure condition, where the Supply Pressure is lower than what is set on Parameter P.727, the Setpoint Override logic will ramp down the Controlling Setpoint as shown in the graph below. This must be done to prevent the Supply Pressure from becoming too low, risking cavitation of the pumps.

Upon a low Supply Pressure condition the Discharge Pressure Setpoint Override logic makes the Controlling Setpoint (Pd.31) lower (or much lower) than the Discharge Pressure Setpoint (P.719). Then the PID Controller responds by ramping down the Pump Speed Reference (Pd.41). The reduced pump speed would then allow the Supply Pressure to either rise or to not go any lower.

If the low Supply Pressure condition requires that the Pump Speed Reference (Pd.41) be decreased to the point where it is less than or equal to the next relevant Stop Pump Speed Parameter (P.745, P.747, P.749, P.751, or P.753) for the time set on the next relevant Stop Pump Delay Parameter (P.746, P.748, P.750, P.752 or P.754), then the control logic will turn off one or more of the pumps.

## Discharge Pressure Setpoint Override - Upon Low Supply Pressure



## **BOOSTER DISCHARGE PRESSURE CONTROL**

### **Starting Pumps**

#### **Start 1st Pump**

To allow the 1st pump to start, the Supply Pressure (Parameter Pd.11) must first rise up to or be above what is set on the Start 1st Pump Pressure (Parameter P.729), and the Start 1st Pump Delay (Parameter P.731) must have counted down to zero.

#### **Starting Additional Pumps**

If at some point conditions in the system require that the pump speed be increased in order to maintain the Discharge Pressure at the Discharge Pressure Setpoint, then the pump speed reference will be increased as needed. If the pump speed reference is increased to the point where it is equal to or greater than the next relevant Start Pump Speed parameter, then its corresponding Start Pump Delay parameter will start counting down and when it reaches zero one additional pump will be started. This may be repeated again and again until all the available pumps have been started. The next Start Pump Delay can not begin counting down until the speed of the previously called pump matches the Pump Speed Reference.

The following Parameters are used to determine when to start pumps:

- Parameter P.729 - Start 1st Pump Pressure (Supply Pressure)
- Parameter P.731 - Start 1st Pump Delay
- Parameter P.732 - Start 2nd Pump Speed
- Parameter P.733 - Start 2nd Pump Delay
- Parameter P.734 - Start 3rd Pump Speed
- Parameter P.735 - Start 3rd Pump Delay
- Parameter P.736 - Start 4th Pump Speed
- Parameter P.737 - Start 4th Pump Delay
- Parameter P.738 - Start 5th Pump Speed
- Parameter P.739 - Start 5th Pump Delay
- Parameter P.740 - Start 6th Pump Speed
- Parameter P.741 - Start 6th Pump Delay

### **Stopping Pumps**

#### **Stopping Unneeded Pumps**

If at some point conditions in the system require that the pump speed be decreased in order to maintain the Discharge Pressure at the Discharge Pressure Setpoint, then the pump speed reference will be decreased as needed. If the pump speed reference is decreased to the point where it is equal to or less than the next relevant Stop Pump Speed parameter, then its corresponding Stop Pump Delay parameter will start counting down and when the delay reaches zero one unneeded pump will be turned off. This may be repeated again and again until only one pump is left running. The next Stop Pump Delay can not begin counting down until the speed of the previously stopped pump reaches zero.

#### **Stop All Pumps**

If the Supply Pressure (Parameter Pd.11) falls below what is set on the Stop All Pumps Pressure (Parameter P.742), and the Stop All Pumps Delay (Parameter P.744) has counted down to zero, then all pumps will be stopped immediately.

The following Parameters are used to determine when to stop pumps:

- Parameter P.742 - Stop All Pumps Pressure (Supply Pressure)
- Parameter P.744 - Stop All Pumps Delay
- Parameter P.745 - Stop 2nd Pump Speed
- Parameter P.746 - Stop 2nd Pump Delay
- Parameter P.747 - Stop 3rd Pump Speed
- Parameter P.748 - Stop 3rd Pump Delay
- Parameter P.749 - Stop 4th Pump Speed
- Parameter P.750 - Stop 4th Pump Delay
- Parameter P.751 - Stop 5th Pump Speed
- Parameter P.752 - Stop 5th Pump Delay
- Parameter P.753 - Stop 6th Pump Speed
- Parameter P.754 - Stop 6th Pump Delay

## **BOOSTER DISCHARGE PRESSURE CONTROL**

### **Start Up Delay**

The Start Up Delay (Parameter P.755) is provided to delay pump operation after a power outage.

The Start Up Delay period starts when all the following conditions are met:

1. Power is applied to the Controller and it has completed its start up routine.
2. The “All Pump Disable” discrete input (Discrete Input Function 17) is open.

When the Start Up Delay expires the Controller will then verify that the Supply Pressure is at or above the Start 1st Pump Pressure (Parameter P.729) and if it is, the Controller will begin the count down delay set on the Start 1st Pump Delay (Parameter P.731).

If at any time the “All Pump Disable” Discrete Input (Discrete Input Function 17) closes the Start Up Delay will be reset and all pump operation will be suspended.

### **Lag Pump Delay**

The Lag Pump Delay (Parameter P.756) establishes the minimum time period between the calling of pumps to run. It is used to delay the turning on of a replacement pump when an operating pump is suddenly disabled, or when a time based alternation of the pumps is performed.

The Lag Pump Delay should be set shorter than all of the Start Pump Delays, so that at start up the Lag Pump Delay will have already expired before each of the respective Start Pump Delays expire.

### **Number of Pumps Required at Startup**

The Number of Pumps Required at Startup (Parameter P.769) sets the minimum number of pumps that are initially started in order to meet the Discharge Pressure Setpoint. The default setting of Parameter P.769 is set to start only one pump at startup. By setting Parameter P.769 to start more than one pump, faster startup times will be achieved.

When Parameter P.769 is set to start more than one pump at startup, after the first pump is started each additional pump will only need to wait for the Lag Pump Delay (Parameter P.756) to expire. It will not need to wait for the Pump Speed Reference (Parameter Pd.41) to match or exceed the next relevant Start Pump Speed Parameter (P.732, P.734, P.736, P.738 or P.740) and for the next relevant Start Pump Delay Parameter (P.733, P.735, P.737, P.739 or P.741) to expire.

### **Pump Speed Limits**

For each pumping application there is usually a minimum pump speed, below which pump operation is undesirable. Also, some pumping applications may require a maximum pump speed limit. Where there are mismatched pumps, the required minimum and maximum speed limits may not be the same for all of the pumps.

The following Parameters are used to set pump speed limits of each individual pump:

- Parameter P.757 - Pump 1 Maximum Speed Limit
- Parameter P.758 - Pump 1 Minimum Speed Limit
- Parameter P.759 - Pump 2 Maximum Speed Limit
- Parameter P.760 - Pump 2 Minimum Speed Limit
- Parameter P.761 - Pump 3 Maximum Speed Limit
- Parameter P.762 - Pump 3 Minimum Speed Limit
- Parameter P.763 - Pump 4 Maximum Speed Limit
- Parameter P.764 - Pump 4 Minimum Speed Limit
- Parameter P.765 - Pump 5 Maximum Speed Limit
- Parameter P.766 - Pump 5 Minimum Speed Limit
- Parameter P.767 - Pump 6 Maximum Speed Limit
- Parameter P.768 - Pump 6 Minimum Speed Limit

# BOOSTER DISCHARGE PRESSURE 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
- External Alternation - External Time Clock Input
- Sequence Inputs - Lead Pump Selector Switch Inputs
- Call Pump Last 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 Supply Pressure Alarm Outputs
- High or Low Discharge Pressure 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 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)

## 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

## BOOSTER DISCHARGE PRESSURE CONTROL

User / Operator Info.			SCADA	Description of Parameters and SCADA Notes
Parameter	Default Value	Current Value	Register Address	
<b>Master Control Mode</b>				
P.091	1		40091	Master Control Mode 1 = Level Control 2 = Flow Control 3 = Pressure Control 4 = Booster Discharge Pressure Control 5 = Booster Supply Pressure Control <span style="color: red; font-weight: bold;">Must Be Set On "4" for Booster Discharge Pressure Control</span>
<b>Pump Setup</b>				
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.

## BOOSTER DISCHARGE PRESSURE CONTROL

User / Operator Info.			SCADA	Description of Parameters and SCADA Notes
Parameter	Default Value	Current Value	Register Address	
<b>Supply Pressure Input Setup</b>				
P.701	1		40701	<p>Supply Pressure Input Select</p> <p>1 = Analog Pressure Meter APM1 2 = Analog Pressure Meter APM2 3 = Demo Mode (APM1 - APM2 / 4)</p> <p>Note: This parameter establishes which Analog Pressure Meter's status data will be used as the Supply Pressure. The Supply Pressure status data selected here is available to be read from Parameters Pd.11 and Pd.12. See Section N.</p> <p>The Demo Mode is for table top demonstrations of the Controller's features while it is not connected to an actual pumping station. With APM1 as the Supply Pressure Input and APM2 as the Discharge Pressure Input, this mode makes the simulated Supply Pressure equal to the Supply Pressure Input minus one fourth of the Discharge Pressure Input. A simulated Supply Pressure Input (a 4-20mA Signal Generator) must be connected to the Supply Pressure Input APM1. To simulate the Discharge Pressure the VFD speed reference Analog Outputs of all pumps must be summed together and connected to the Discharge Pressure Input APM2. Also, for the Demo Mode to operate Parameters P.701 and P.703 must both be set on the Demo Mode.</p>
P.702	100.0 psi		40702	<p>Supply Pressure Bar Graph Span</p> <p>Note: This parameter sets the span of the Supply Pressure Bar Graph for Parameter Pd.12.</p>
<b>Supply Pressure Status</b>				
Pd.11	-	-	42229	<p>Supply Pressure Status - For Numerical Display of Supply Pressure</p> <p>Note: This is the value of the Supply Pressure status data selected on Parameter P.701 scaled into psi for numerical display.</p>
Pd.12	-	-	42230	<p>Supply Pressure Status - For Bar Graph Display of Supply Pressure</p> <p>Note: This is the value of the Supply Pressure status data selected on Parameter P.701 scaled for display on a bar graph. It is scaled to a range of 0 - 4095 by using the "Supply Pressure Bar Graph Span" (Parameter P.702). The Bar Graph Display scaling setup on the HMI device must be set for 0 - 4095.</p>

## BOOSTER DISCHARGE PRESSURE CONTROL

User / Operator Info.		SCADA		Description of Parameters and SCADA Notes
Parameter	Default Value	Current Value	Register Address	
<b>Discharge Pressure Input Setup</b>				
<b>P.703</b>	2		40703	<p>Discharge Pressure Input Select</p> <p>1 = Analog Pressure Meter APM1 2 = Analog Pressure Meter APM2 3 = Demo Mode (APM1 + APM2 / 4)</p> <p>Note: This parameter establishes which Analog Pressure Meter's status data will be used as the Discharge Pressure. The Discharge Pressure status data selected here is available to be read from Parameters Pd.21 and Pd.22. See Section N.</p> <p>The Demo Mode is for table top demonstrations of the Controller's features while it is not connected to an actual pumping station. With APM1 as the Supply Pressure Input and APM2 as the Discharge Pressure Input, this mode makes the simulated Discharge Pressure equal to the Supply Pressure Input plus one fourth of the Discharge Pressure Input. A simulated Supply Pressure Input (a 4-20mA Signal Generator) must be connected to the Supply Pressure Input APM1. To simulate the Discharge Pressure the VFD speed reference Analog Outputs of all pumps must be summed together and connected to the Discharge Pressure Input APM2. Also, for the Demo Mode to operate Parameters P.701 and P.703 must both be set on the Demo Mode.</p>
<b>P.704</b>	100.0 psi		40704	<p>Discharge Pressure Bar Graph Span</p> <p>Note: This parameter sets the span of the Discharge Pressure Bar Graph for Parameter Pd.22.</p>
<b>Discharge Pressure Input Status</b>				
<b>Pd.21</b>	-	-	42231	<p>Discharge Pressure Status - For Numerical Display of Discharge Pressure</p> <p>Note: This is the value of the Discharge Pressure status data selected on Parameter P.703 scaled into psi for numerical display.</p>
<b>Pd.22</b>	-	-	42232	<p>Discharge Pressure Status - For Bar Graph Display of Discharge Pressure</p> <p>Note: This is the value of the Discharge Pressure status data selected on Parameter P.703 scaled for display on a bar graph. It is scaled to a range of 0 - 4095 by using the "Discharge Pressure Bar Graph Span" (Parameter P.704). The Bar Graph Display scaling setup on the HMI device must be set for 0 - 4095.</p>

## BOOSTER DISCHARGE PRESSURE CONTROL

User / Operator Info.			SCADA	Description of Parameters and SCADA Notes
Parameter	Default Value	Current Value	Register Address	
<b>Alternation Sequence Mode</b>				
<b>P.122</b>	1	1	40122	Alternation Sequence Mode 1 = Standard Alternation 2 = Fixed Order Sequence 3 = Elapsed Time Meter Based Alternation
<b>Parameters Available with Standard Alternation (Parameter P.122 = 1)</b>				
<b>P.129</b>	0		40129	Forced Lead Pump Position 0 = Normal Alternation    X = Pump X as Lead
<b>P.131</b>	0		40131	Time Based Alternation <span style="float: right;">Range: 0 - 65535 minutes</span> 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.
<b>Ad.01</b>	-	-	41888	Current Lead Pump    Shows the number of the current Lead Pump.
<b>Parameters Available with Fixed Order Sequence (Parameter P.122 = 2)</b>				
<b>P.711</b>	1		40711	Pump 1 Fixed Order Position
<b>P.712</b>	2		40712	Pump 2 Fixed Order Position
<b>P.713</b>	3		40713	Pump 3 Fixed Order Position
<b>P.714</b>	4		40714	Pump 4 Fixed Order Position
<b>P.715</b>	5		40715	Pump 5 Fixed Order Position
<b>P.716</b>	6		40716	Pump 6 Fixed Order Position

## BOOSTER DISCHARGE PRESSURE CONTROL

User / Operator Info.		SCADA		Description of Parameters and SCADA Notes
Parameter	Default Value	Current Value	Register Address	
<b>Discharge Pressure Setpoint</b>				
<b>P.719</b>	60.0 psi		40719	<b>Discharge Pressure Setpoint (SP)</b> <span style="float: right;">Range: 3.0 - 300.0 psi</span> Note: This is the parameter that sets the desired Discharge Pressure of the liquid being pumped.
<b>Pd.31</b>	-		42233	<b>Controlling Setpoint</b> Note: To ensure the smooth stable control of the Discharge Pressure while starting the first pump the PID Controller is not initially fed the Discharge Pressure Setpoint (Parameter P.719), but rather it is fed the Controlling Setpoint (Parameter Pd.31). Before the 1st pump is started, a snap shot of the Discharge Pressure is captured and then used as the initial Controlling Setpoint (Parameter Pd.31). After the 1st pump is started the value of the Controlling Setpoint is slowly changed until it equals the Discharge Pressure Setpoint (Parameter P.719). The rate of change is set by the operator on the Controlling Setpoint Ramp Rate (Parameter P.721).
<b>Controlling Setpoint Ramp Rate</b>				
<b>P.721</b>	3.00 psi /sec		40721	<b>Controlling Setpoint Ramp Rate</b> <span style="float: right;">Range: 0.10 - 10.00 psi / sec</span> Note: This parameter sets the rate at which the control logic is allowed to change the Controlling Setpoint (Parameter Pd.31) toward being equal to the Discharge Pressure Setpoint (Parameter P.719).
At startup or at any time the Controlling Setpoint is not equal to the Discharge Pressure 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).				
<b>PID Controller Tuning</b>				
<b>P.723</b>	1.60		40723	<b>Controller Gain (Kc)</b> <span style="float: right;">Range: 0.01 - 30.00</span> Note: This parameter is used to tune the proportional component of the PID Controller's Pump Speed Reference output.
<b>P.724</b>	0.02 minutes / repeat		40724	<b>Integral Time (Ti)</b> <span style="float: right;">Range: 0.01 - 60.00 minutes / repeat</span> 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.
<b>P.725</b>	0.00 minutes		40725	<b>Derivative Time (Td)</b> <span style="float: right;">Range: 0.00 - 2.00 minutes</span> Note: This parameter is used to tune the derivative component of the PID Controller's Pump Speed Reference output.

## BOOSTER DISCHARGE PRESSURE CONTROL

User / Operator Info.		SCADA		Description of Parameters and SCADA Notes
Parameter	Default Value	Current Value	Register Address	
<b>Controlling Setpoint Lower Limit</b>				
<b>P.726</b>	20.0 psi		40726	Controlling Setpoint Lower Limit      Range: 3.0 - 300.0 psi Note: Parameter P.726 sets the lowest value that the Setpoint Override logic is allowed to make the Controlling Setpoint.
<b>Override Ramp Upper End Supply Pressure</b>				
<b>P.727</b>	20.0 psi		40727	Override Ramp Upper End Supply Pressure      Range: 3.0 - 300.0 psi Note: Parameter P.727 sets the Supply Pressure that corresponds to where the Setpoint Override logic makes the Controlling Setpoint equal to the Discharge Pressure Setpoint (Parameter P.719).
<b>Override Ramp Lower End Supply Pressure</b>				
<b>P.728</b>	10.0 psi		40728	Override Ramp Lower End Supply Pressure      Range: 3.0 - 300.0 psi Note: Parameter P.728 sets the Supply Pressure that corresponds to where the Setpoint Override logic makes the Controlling Setpoint equal to the Controlling Setpoint Lower Limit (Parameter P.719).
<p>At startup or at any time the Setpoint Override logic keeps the Controlling Setpoint from being equal to the Discharge Pressure 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).</p>				

## BOOSTER DISCHARGE PRESSURE CONTROL

User / Operator Info.			SCADA	Description of Parameters and SCADA Notes
Parameter	Default Value	Current Value	Register Address	
<b>Starting Pumps</b>				
<b>P.729</b>	12.5 psi		40729	Start 1st Pump Pressure (Supply Pressure)      Range: 3.0 - 300.0 psi Note: For the 1st pump to start, the Supply Pressure must be equal to or higher than the <b>Start 1st Pump Pressure</b> for the delay set on the <b>Start 1st Pump Delay</b> .
<b>P.731</b>	10 sec.		40731	Start 1st Pump Delay      Range: 1 - 600 seconds Note: The <b>Start 1st Pump Delay</b> starts to count down to zero when the Supply Pressure becomes equal to or higher than the <b>Start 1st Pump Pressure</b> .
<b>P.732</b>	98.0 %		40732	Start 2nd Pump Speed      Range: 30.0% - 100.0% of Full Speed Note: For the 2nd pump to start, the Pump Speed Reference must be equal to or higher than the <b>Start 2nd Pump Speed</b> for the delay set on the <b>Start 2nd Pump Delay</b> .
<b>P.733</b>	10 sec.		40733	Start 2nd Pump Delay      Range: 1 - 600 seconds Note: The <b>Start 2nd Pump Delay</b> starts to count down to zero when the Pump Speed Reference becomes equal to or higher than the <b>Start 2nd Pump Speed</b> .
<b>P.734</b>	98.0 %		40734	Start 3rd Pump Speed      Range: 30.0% - 100.0% of Full Speed Note: For the 3rd pump to start, the Pump Speed Reference must be equal to or higher than the <b>Start 3rd Pump Speed</b> for the delay set on the <b>Start 3rd Pump Delay</b> .
<b>P.735</b>	10 sec.		40735	Start 3rd Pump Delay      Range: 1 - 600 seconds Note: The <b>Start 3rd Pump Delay</b> starts to count down to zero when the Pump Speed Reference becomes equal to or higher than the <b>Start 3rd Pump Speed</b> .
<b>P.736</b>	98.0 %		40736	Start 4th Pump Speed      Range: 30.0% - 100.0% of Full Speed Note: For the 4th pump to start, the Pump Speed Reference must be equal to or higher than the <b>Start 4th Pump Speed</b> for the delay set on the <b>Start 4th Pump Delay</b> .
<b>P.737</b>	10 sec.		40737	Start 4th Pump Delay      Range: 1 - 600 seconds Note: The <b>Start 4th Pump Delay</b> starts to count down to zero when the Pump Speed Reference becomes equal to or higher than the <b>Start 4th Pump Speed</b> .
<b>P.738</b>	98.0 %		40738	Start 5th Pump Speed      Range: 30.0% - 100.0% of Full Speed Note: For the 5th pump to start, the Pump Speed Reference must be equal to or higher than the <b>Start 5th Pump Speed</b> for the delay set on the <b>Start 5th Pump Delay</b> .
<b>P.739</b>	10 sec.		40739	Start 5th Pump Delay      Range: 1 - 600 seconds Note: The <b>Start 5th Pump Delay</b> starts to count down to zero when the Pump Speed Reference becomes equal to or higher than the <b>Start 5th Pump Speed</b> .
<b>P.740</b>	98.0 %		40740	Start 6th Pump Speed      Range: 30.0% - 100.0% of Full Speed Note: For the 6th pump to start, the Pump Speed Reference must be equal to or higher than the <b>Start 6th Pump Speed</b> for the delay set on the <b>Start 6th Pump Delay</b> .
<b>P.741</b>	10 sec.		40741	Start 6th Pump Delay      Range: 1 - 600 seconds Note: The <b>Start 6th Pump Delay</b> starts to count down to zero when the Pump Speed Reference becomes equal to or higher than the <b>Start 6th Pump Speed</b> .

## BOOSTER DISCHARGE PRESSURE CONTROL

User / Operator Info.			SCADA	Description of Parameters and SCADA Notes
Parameter	Default Value	Current Value	Register Address	
<b>Stopping Pumps</b>				
<b>P.742</b>	5.0 psi		40742	Stop All Pumps Pressure (Supply Pressure)      Range: 3.0 - 300.0 psi Note: For the 1st pump to stop, the Supply Pressure must be equal to or lower than the <b>Stop All Pumps Pressure</b> for the delay set on the <b>Stop All Pumps Delay</b> .
<b>P.744</b>	10 sec.		40744	Stop All Pumps Delay      Range: 1 - 600 seconds Note: The <b>Stop All Pumps Delay</b> starts to count down to zero when the Supply Pressure becomes equal to or lower than the <b>Stop All Pumps Pressure</b> .
<b>P.745</b>	42.0 %		40745	Stop 2nd Pump Speed      Range: 10.0% - 90.0% of Full Speed Note: For the 2nd pump to stop, the Pump Speed Reference must be equal to or lower than the <b>Stop 2nd Pump Speed</b> for the delay set on the <b>Stop 2nd Pump Delay</b> .
<b>P.746</b>	10 sec.		40746	Stop 2nd Pump Delay      Range: 1 - 600 seconds Note: The <b>Stop 2nd Pump Delay</b> starts to count down to zero when the Pump Speed Reference becomes equal to or lower than the <b>Stop 2nd Pump Speed</b> .
<b>P.747</b>	42.0 %		40747	Stop 3rd Pump Speed      Range: 10.0% - 90.0% of Full Speed Note: For the 3rd pump to stop, the Pump Speed Reference must be equal to or lower than the <b>Stop 3rd Pump Speed</b> for the delay set on the <b>Stop 3rd Pump Delay</b> .
<b>P.748</b>	10 sec.		40748	Stop 3rd Pump Delay      Range: 1 - 600 seconds Note: The <b>Stop 3rd Pump Delay</b> starts to count down to zero when the Pump Speed Reference becomes equal to or lower than the <b>Stop 3rd Pump Speed</b> .
<b>P.749</b>	42.0 %		40749	Stop 4th Pump Speed      Range: 10.0% - 90.0% of Full Speed Note: For the 4th pump to stop, the Pump Speed Reference must be equal to or lower than the <b>Stop 4th Pump Speed</b> for the delay set on the <b>Stop 4th Pump Delay</b> .
<b>P.750</b>	10 sec.		40750	Stop 4th Pump Delay      Range: 1 - 600 seconds Note: The <b>Stop 4th Pump Delay</b> starts to count down to zero when the Pump Speed Reference becomes equal to or lower than the <b>Stop 4th Pump Speed</b> .
<b>P.751</b>	42.0 %		40751	Stop 5th Pump Speed      Range: 10.0% - 90.0% of Full Speed Note: For the 5th pump to stop, the Pump Speed Reference must be equal to or lower than the <b>Stop 5th Pump Speed</b> for the delay set on the <b>Stop 5th Pump Delay</b> .
<b>P.752</b>	10 sec.		40752	Stop 5th Pump Delay      Range: 1 - 600 seconds Note: The <b>Stop 5th Pump Delay</b> starts to count down to zero when the Pump Speed Reference becomes equal to or lower than the <b>Stop 5th Pump Speed</b> .
<b>P.753</b>	42.0 %		40753	Stop 6th Pump Speed      Range: 10.0% - 90.0% of Full Speed Note: For the 6th pump to stop, the Pump Speed Reference must be equal to or lower than the <b>Stop 6th Pump Speed</b> for the delay set on the <b>Stop 6th Pump Delay</b> .
<b>P.754</b>	10 sec.		40754	Stop 6th Pump Delay      Range: 1 - 600 seconds Note: The <b>Stop 6th Pump Delay</b> starts to count down to zero when the Pump Speed Reference becomes equal to or lower than the <b>Stop 6th Pump Speed</b> .

## BOOSTER DISCHARGE PRESSURE CONTROL

User / Operator Info.			SCADA	Description of Parameters and SCADA Notes
Parameter	Default Value	Current Value	Register Address	
<b>Start Up Delay</b>				
<b>P.755</b>	10 sec.		40755	<p>Start Up Delay <span style="float: right;">Range: 1 - 180 seconds</span></p> <p>Notes: The Start Up Delay period starts when all the following conditions are met:</p> <ol style="list-style-type: none"> <li>1. Power is applied to the Controller and it has completed its start up routine.</li> <li>2. The "All Pump Disable" discrete input (Discrete Input Function 17) is open.</li> </ol>
<b>Lag Pump Delay</b>				
<b>P.756</b>	5 sec.		40756	<p>Lag Pump Delay <span style="float: right;">Range: 1 - 100 seconds</span></p> <p>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. It should be set shorter than all of the Start Pump Delays, so that at start up the Lag Pump Delay will have already expired before each of the respective Start Pump Delays expire.</p>
<b>Minimum &amp; Maximum Pump Speed Limits</b>				
<b>P.757</b>	100.0 %		40757	Pump 1 Maximum Speed Limit <span style="float: right;">Range: 70.0 - 100.0 %</span>
<b>P.758</b>	40.0 %		40758	Pump 1 Minimum Speed Limit <span style="float: right;">Range: 0.0 - 95.0 %</span>
<b>P.759</b>	100.0 %		40759	Pump 2 Maximum Speed Limit <span style="float: right;">Range: 70.0 - 100.0 %</span>
<b>P.760</b>	40.0 %		40760	Pump 2 Minimum Speed Limit <span style="float: right;">Range: 0.0 - 95.0 %</span>
<b>P.761</b>	100.0 %		40761	Pump 3 Maximum Speed Limit <span style="float: right;">Range: 70.0 - 100.0 %</span>
<b>P.762</b>	40.0 %		40762	Pump 3 Minimum Speed Limit <span style="float: right;">Range: 0.0 - 95.0 %</span>
<b>P.763</b>	100.0 %		40763	Pump 4 Maximum Speed Limit <span style="float: right;">Range: 70.0 - 100.0 %</span>
<b>P.764</b>	40.0 %		40764	Pump 4 Minimum Speed Limit <span style="float: right;">Range: 0.0 - 95.0 %</span>
<b>P.765</b>	100.0 %		40765	Pump 5 Maximum Speed Limit <span style="float: right;">Range: 70.0 - 100.0 %</span>
<b>P.766</b>	40.0 %		40766	Pump 5 Minimum Speed Limit <span style="float: right;">Range: 0.0 - 95.0 %</span>
<b>P.767</b>	100.0 %		40767	Pump 6 Maximum Speed Limit <span style="float: right;">Range: 70.0 - 100.0 %</span>
<b>P.768</b>	40.0 %		40768	Pump 6 Minimum Speed Limit <span style="float: right;">Range: 0.0 - 95.0 %</span>

## BOOSTER DISCHARGE PRESSURE CONTROL

User / Operator Info.		SCADA		Description of Parameters and SCADA Notes
Parameter	Default Value	Current Value	Register Address	
<b>Pump Speed Acceleration / Deceleration Rate</b>				
<b>P.166</b>	30 sec.		40166	<p><b>Pump Speed Acceleration Rate</b>      Range: 1 - 100 seconds / 100% speed</p> <p>Notes:</p> <ol style="list-style-type: none"> <li>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.</li> <li>The setting on Parameter P.166 is the time required for a pump's Speed Reference to go from 0% - 100%.</li> <li>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.</li> </ol>
<b>P.167</b>	30 sec.		40167	<p><b>Pump Speed Deceleration Rate</b>      Range: 1 - 100 seconds / 100% speed</p> <p>Notes:</p> <ol style="list-style-type: none"> <li>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.</li> <li>The setting on Parameter P.167 is the time required for a pump's Speed Reference to go from 100% - 0%.</li> <li>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.</li> <li>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.</li> </ol>
<b>Supply Pressure Alarms</b>				
<b>P.391</b>	5.0 psi		40391	<p><b>Low Supply Pressure Alarm</b>      Range: 0.0 - 300.0 psi</p> <p>Note: Upon a Low Supply Pressure Alarm, the contacts of a relay assigned to Function 11 will close.</p>
The "Low Supply Pressure Alarm" status is available from Modbus Coil 265 (Register 40017 Bit 8).				
<b>P.392</b>	50.0 psi		40392	<p><b>High Supply Pressure Alarm</b>      Range: 0.1 - 300.0 psi</p> <p>Note: Upon a High Supply Pressure Alarm, the contacts of a relay assigned to Function 12 will close.</p>
The "High Supply Pressure Alarm" status is available from Modbus Coil 266 (Register 40017 Bit 9).				
<b>Discharge Pressure Alarms</b>				
<b>P.393</b>	20.0 psi		40393	<p><b>Low Discharge Pressure Alarm</b>      Range: 0.0 - 300.0 psi</p> <p>Note: Upon a Low Discharge Pressure Alarm, the contacts of a relay assigned to Function 13 will close.</p>
The "Low Discharge Pressure Alarm" status is available from Modbus Coil 267 (Register 40017 Bit 10).				
<b>P.394</b>	70.0 psi		40394	<p><b>High Discharge Pressure Alarm</b>      Range: 0.1 - 300.0 psi</p> <p>Note: Upon a High Discharge Pressure Alarm, the contacts of a relay assigned to Function 14 will close.</p>
The "High Discharge Pressure Alarm" status is available from Modbus Coil 268 (Register 40017 Bit 11).				

## BOOSTER DISCHARGE PRESSURE CONTROL

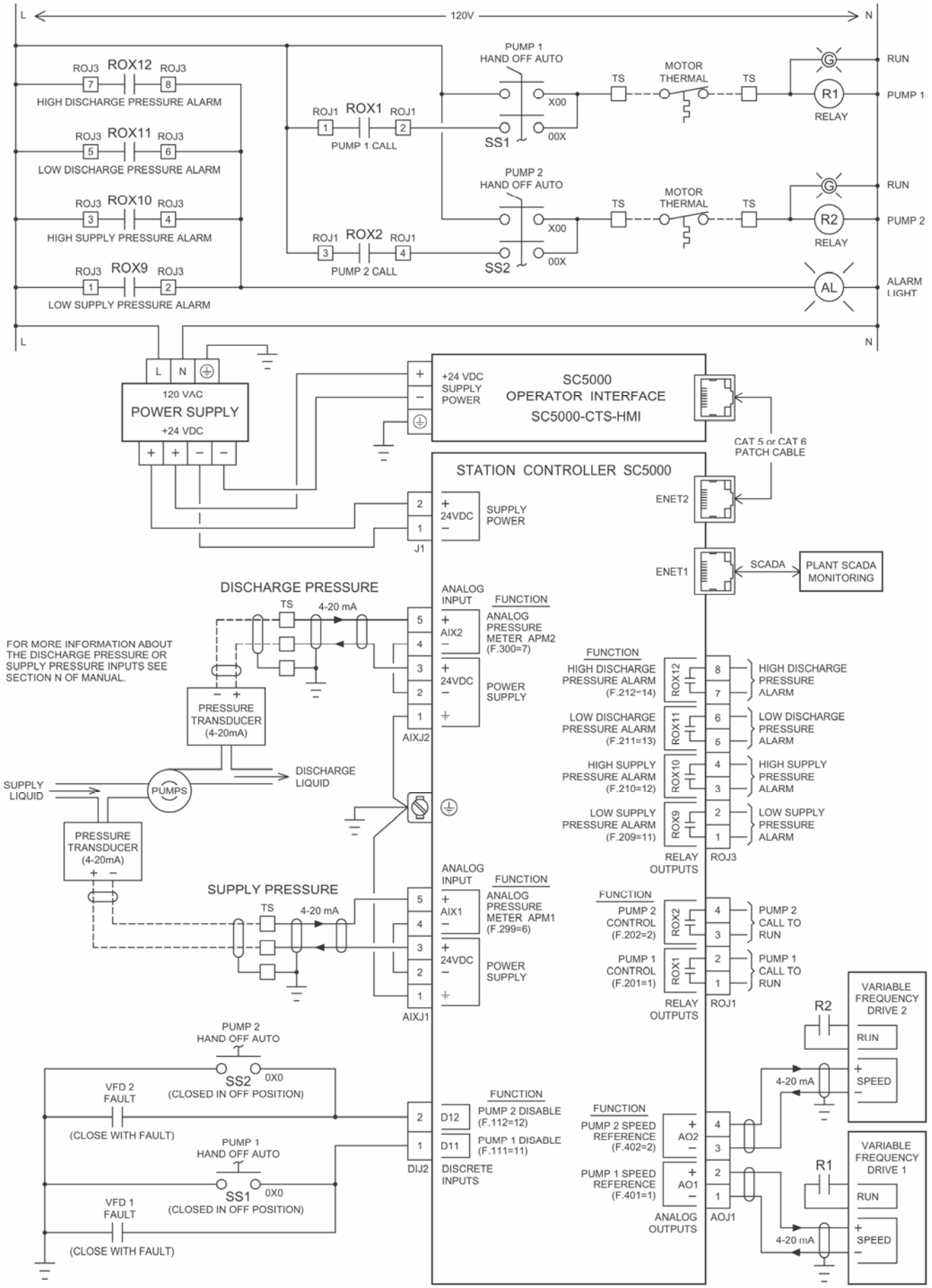
User / Operator Info.			SCADA	Description of Parameters and SCADA Notes
Parameter	Default Value	Current Value	Register Address	
<b>Number of Pumps Required at Startup</b>				
<b>P.769</b>	1		40769	<p>Number of Pumps Required at Startup <span style="float: right;">Range: 1 - 6</span></p> <p>Note: The Number of Pumps Required at Startup (Parameter P.769) sets the minimum number of pumps that are initially started in order to meet the Discharge Pressure Setpoint. The default setting of Parameter P.769 is set to start only one pump at startup. By setting Parameter P.769 to start more than one pump, faster startup times will be achieved.</p> <p>When Parameter P.769 is set to start more than one pump at startup, after the first pump is started each additional pump will only need to wait for the Lag Pump Delay (Parameter P.756) to expire. It will not need to wait for the Pump Speed Reference (Parameter Pd.41) to match or exceed the next relevant Start Pump Speed Parameter (P.732, P.734, P.736, P.738 or P.740) and for the next relevant Start Pump Delay Parameter (P.733, P.735, P.737, P.739 or P.741) to expire.</p>

Parameter	Register Address	Description of Data
<b>Pump Speed Reference Status</b>		
<b>Pd.41</b>	41877	<p>Pump Speed Reference Status <span style="float: right;">Range: 0.0 - 100.0 percent</span></p> <p>Notes:</p> <ol style="list-style-type: none"> <li>This is the Pump Speed Reference that is determined by the PID Controller. It is a percentage of full speed (60 Hz).</li> <li>This is the value of the Pump Speed Reference that is prepared to be sent to all of the VFDs, provided that the respective pump is turned on and that it is up to speed and its speed is not limited by either the Minimum or Maximum Pump Speed Limit settings (Parameters P.757 - P.768).</li> <li>The Pump Speed Reference sent to each individual pump is shown below.</li> </ol>
<b>Pump 1-6 Speed Reference Status</b>		
<b>Pd.61</b>	42301	Pump 1 Speed Reference Status <span style="float: right;">Range: 0.0 - 100.0 percent</span>
<b>Pd.62</b>	42302	Pump 2 Speed Reference Status <span style="float: right;">Range: 0.0 - 100.0 percent</span>
<b>Pd.63</b>	42303	Pump 3 Speed Reference Status <span style="float: right;">Range: 0.0 - 100.0 percent</span>
<b>Pd.64</b>	42304	Pump 4 Speed Reference Status <span style="float: right;">Range: 0.0 - 100.0 percent</span>
<b>Pd.65</b>	42305	Pump 5 Speed Reference Status <span style="float: right;">Range: 0.0 - 100.0 percent</span>
<b>Pd.66</b>	42306	Pump 6 Speed Reference Status <span style="float: right;">Range: 0.0 - 100.0 percent</span>

## BOOSTER DISCHARGE PRESSURE CONTROL

Parameter	Register Address	Description of Data
<b>Starting &amp; Stopping Pumps Delay Status</b>		
<b>Pd.71</b>	42307	Start 1st Pump Delay Status <span style="float: right;">seconds</span>
<b>Pd.72</b>	42308	Stop All Pumps Delay Status <span style="float: right;">seconds</span>
<b>Pd.73</b>	42309	Start 2nd Pump Delay Status <span style="float: right;">seconds</span>
<b>Pd.74</b>	42310	Stop 2nd Pump Delay Status <span style="float: right;">seconds</span>
<b>Pd.75</b>	42311	Start 3rd Pump Delay Status <span style="float: right;">seconds</span>
<b>Pd.76</b>	42312	Stop 3rd Pump Delay Status <span style="float: right;">seconds</span>
<b>Pd.77</b>	42313	Start 4th Pump Delay Status <span style="float: right;">seconds</span>
<b>Pd.78</b>	42314	Stop 4th Pump Delay Status <span style="float: right;">seconds</span>
<b>Pd.79</b>	42315	Start 5th Pump Delay Status <span style="float: right;">seconds</span>
<b>Pd.80</b>	42316	Stop 5th Pump Delay Status <span style="float: right;">seconds</span>
<b>Pd.81</b>	42317	Start 6th Pump Delay Status <span style="float: right;">seconds</span>
<b>Pd.82</b>	42318	Stop 6th Pump Delay Status <span style="float: right;">seconds</span>

# BOOSTER DISCHARGE PRESSURE CONTROL EXAMPLE



# BOOSTER DISCHARGE PRESSURE CONTROL - Touchscreen HMI

## Main Screen

STATION CONTROLLER SC5000

<p>Fault Code</p> <p>FLC 1234</p> <p>LFC 1234</p> <p>Reset</p>	<p>Control Mode Select</p> <p>Pump Setup</p> <p>Security Setup</p> <p>SCADA Setup</p> <p>Backup / Restore</p>	<p>Parameter Security</p> <p>PARAMETERS UNLOCKED</p> <p>Security Code Entry</p>
<p>I / O</p> <p>Discrete Inputs</p> <p>Relay Outputs</p> <p>Analog Inputs</p> <p>Analog Outputs</p>	<p>Meters</p> <p>Level</p> <p>Pressure</p> <p>Flow</p> <p>Current</p>	<p>Station Status &amp; Setup</p>

## Control Mode Select

CONTROL MODE SELECT

Previous Screen

Master Control Mode

1	<ul style="list-style-type: none"><li>1 = Level Control</li><li>2 = Flow Control</li><li>3 = Pressure Control</li><li>4 = Booster Discharge Pressure Control</li><li>5 = Booster Supply Pressure Control</li></ul>
---	--

# BOOSTER DISCHARGE PRESSURE CONTROL - Touchscreen HMI

## Pump Setup

**PUMP SETUP**

[Previous Screen](#)

Number of Pumps Present   
Parameter: P.092

Maximum Number of Pumps Allowed To Run At The Same Time   
Parameter: P.093

Maximum Number of Pumps Allowed To Run While On Generator   
(See Discrete Input Function 18) Parameter: P.094

## Booster Discharge Pressure Control Main Screen

SC5000 BOOSTER  
DISCHARGE PRESSURE CONTROL

[Main Screen](#)

<b>Fault Code</b> FLC <input type="text" value="1234"/> <input type="button" value="Reset"/> LFC <input type="text" value="1234"/>	<a href="#">Start / Stop Setup &amp; Status</a>	<b>Parameter Security</b> <span style="background-color: #90EE90;">PARAMETERS UNLOCKED</span> <a href="#">Security Code Entry</a>
<a href="#">Pressure Setup</a>	<a href="#">Speed Limits</a>	<input type="text"/>
<a href="#">Alternation Setup</a>	<a href="#">Control Setup</a>	<a href="#">Station Status</a>
<a href="#">Alarms Setup</a>	<a href="#">Controller Info.</a>	
<a href="#">Pump Status</a>		

# BOOSTER DISCHARGE PRESSURE CONTROL - Touchscreen HMI

## Station Status - 1 Pump

**Supply Pressure**  
High Alarm  
123.4 psi  
Low Alarm

**Discharge Pressure**  
High Alarm  
123.4 psi  
Low Alarm

**Pump 1**  
Not Available For Service  
OFF  
DISABLE FORCE  
1234.5 123.4  
ETM (hours) Speed (%)

Controlling Setpoint: 123.4 psi  
Discharge Pressure Setpoint: 123.4 psi  
Supply Pressure Too Low for Pump Operation  
All Pump Disable Active

Pump Speed Reference: 123.4 %  
Pressure Setpoint: 123.4 psi

Fault Code  
FLC 1234  
LFC 1234  
RESET

Previous Screen

## Station Status - 2 Pumps

**Supply Pressure**  
High Alarm  
123.4 psi  
Low Alarm

**Discharge Pressure**  
High Alarm  
123.4 psi  
Low Alarm

**Pump 1**  
Not Available For Service  
OFF  
DISABLE FORCE  
1234.5 123.4  
ETM (hours) Speed (%)

**Pump 2**  
Not Available For Service  
OFF  
DISABLE FORCE  
1234.5 123.4  
ETM (hours) Speed (%)

Controlling Setpoint: 123.4 psi  
Discharge Pressure Setpoint: 123.4 psi  
Supply Pressure Too Low for Pump Operation  
All Pump Disable Active

Pump Speed Reference: 123.4 %  
Pressure Setpoint: 123.4 psi

Fault Code  
FLC 1234  
LFC 1234  
RESET

Previous Screen

# BOOSTER DISCHARGE PRESSURE CONTROL - Touchscreen HMI

## Station Status - 3 Pumps

**Supply Pressure**  
High Alarm  
123.4 psi  
Low Alarm

**Discharge Pressure**  
High Alarm  
123.4 psi  
Low Alarm

**Pump 1**  
Not Available For Service  
OFF  
DISABLE FORCE  
1234.5 123.4  
ETM (hours) Speed (%)  
Controlling Setpoint 123.4 psi

**Pump 2**  
Not Available For Service  
OFF  
DISABLE FORCE  
1234.5 123.4  
ETM (hours) Speed (%)  
Discharge Pressure Setpoint Override Active  
Supply Pressure Too Low for Pump Operation  
All Pump Disable Active

**Pump 3**  
Not Available For Service  
OFF  
DISABLE FORCE  
1234.5 123.4  
ETM (hours) Speed (%)  
Fault Code  
FLC 1234  
LFC 1234  
RESET

Pump Speed Reference 123.4 %  
Pressure Setpoint 123.4 psi

Previous Screen

## Station Status - 4 Pumps

**Supply Pressure**  
High Alarm  
123.4 psi  
Low Alarm

**Discharge Pressure**  
High Alarm  
123.4 psi  
Low Alarm

**Pump 1**  
Not Available For Service  
OFF  
DISABLE FORCE  
1234.5 123.4  
ETM (hours) Speed (%)  
Controlling Setpoint 123.4 psi

**Pump 2**  
Not Available For Service  
OFF  
DISABLE FORCE  
1234.5 123.4  
ETM (hours) Speed (%)  
Discharge Pressure Setpoint Override Active  
Supply Pressure Too Low for Pump Operation  
All Pump Disable Active

**Pump 3**  
Not Available For Service  
OFF  
DISABLE FORCE  
1234.5 123.4  
ETM (hours) Speed (%)

**Pump 4**  
Not Available For Service  
OFF  
DISABLE FORCE  
1234.5 123.4  
ETM (hours) Speed (%)

Pump Speed Reference 123.4 %  
Pressure Setpoint 123.4 psi

Fault Code  
FLC 1234  
LFC 1234  
RESET

Previous Screen

# BOOSTER DISCHARGE PRESSURE CONTROL - Touchscreen HMI

## Station Status - 5 Pumps

Supply Pressure	Discharge Pressure	Pump 1	Pump 2	Pump 3	Pump 4	Pump 5
		Not Available For Service	Not Available For Service	Not Available For Service	Not Available For Service	Not Available For Service
High Alarm	High Alarm	OFF	OFF	OFF	OFF	OFF
Low Alarm	Low Alarm	DISABLE	DISABLE	DISABLE	DISABLE	DISABLE
123.4 psi	123.4 psi	FORCE	FORCE	FORCE	FORCE	FORCE
		1234.5	1234.5	1234.5	1234.5	1234.5
		ETM (hours)	ETM (hours)	ETM (hours)	ETM (hours)	ETM (hours)
		123.4	123.4	123.4	123.4	123.4
		Speed (%)	Speed (%)	Speed (%)	Speed (%)	Speed (%)
		Controlling Setpoint	Discharge Pressure Setpoint Override Active		Previous Screen	
		123.4 psi	Supply Pressure Too Low for Pump Operation		Fault Code	
	Pump Speed Reference	Pressure Setpoint	All Pump Disable Active		FLC 1234	RESET
	123.4 %	123.4 psi			LFC 1234	

## Station Status - 6 Pumps

Supply Pressure	Discharge Pressure	Pump 1	Pump 2	Pump 3	Pump 4	Pump 5	Pump 6
		Not Available For Service	Not Available For Service	Not Available For Service	Not Available For Service	Not Available For Service	Not Available For Service
High Alarm	High Alarm	OFF	OFF	OFF	OFF	OFF	OFF
Low Alarm	Low Alarm	DISABLE	DISABLE	DISABLE	DISABLE	DISABLE	DISABLE
123.4 psi	123.4 psi	FORCE	FORCE	FORCE	FORCE	FORCE	FORCE
		1234.5	1234.5	1234.5	1234.5	1234.5	1234.5
		ETM (hours)	ETM (hours)	ETM (hours)	ETM (hours)	ETM (hours)	ETM (hours)
		123.4	123.4	123.4	123.4	123.4	123.4
		Speed (%)	Speed (%)	Speed (%)	Speed (%)	Speed (%)	Speed (%)
		Controlling Setpoint	Discharge Pressure Setpoint Override Active		Previous Screen		
		123.4 psi	Supply Pressure Too Low for Pump Operation		Fault Code		
	Pump Speed Reference	Pressure Setpoint	All Pump Disable Active		FLC 1234	RESET	
	123.4 %	123.4 psi			LFC 1234		

# BOOSTER DISCHARGE PRESSURE CONTROL - Touchscreen HMI

## Pressure Setup

### PRESSURE SETUP

[Previous Screen](#)

Discharge Pressure

**123.4** psi  
Parameter: Pd.21

Discharge Pressure Setpoint

**123.4** psi  
Parameter: P.719

[Supply Pressure Input Setup](#)

[Discharge Pressure Input Setup](#)

[PID Controller Tuning](#)

## PID Controller Tuning

### PID CONTROLLER TUNING

[Previous Screen](#)

Pump 1  Pump 2  Pump 3  Pump 4  Pump 5  Pump 6

Supply Pressure **123.4** psi  
Parameter: Pd.11

Discharge Pressure **123.4** psi  
Parameter: Pd.21

Controller Gain (Kc) **12.34**  
Parameter: P.723

Discharge Pressure Setpoint **123.4** psi  
Parameter: P.719

Controlling Setpoint **123.4** psi  
Parameter: Pd.31

Integral Time (Ti) (minutes / repeat) **12.34**  
Parameter: P.724

Derivative Time (Td) (minutes) **12.34**  
Parameter: P.725

Pump Speed Reference **123.4** %  
Parameter: Pd.41

Speed Reference Component Values

Proportional + **12,345,123**  
- **12,345,123**

Integral **12,345,123**

Derivative + **12,345,123**  
- **12,345,123**

[Discharge Pressure Setpoint Override Active](#)

[Supply Pressure Too Low for Pump Operation](#)

# BOOSTER DISCHARGE PRESSURE CONTROL - Touchscreen HMI

## Supply Pressure Input Setup

**SUPPLY PRESSURE INPUT SETUP**

[Previous Screen](#)

**Supply Pressure Input Select**

1

Parameter: P.701

1 = Pressure Meter APM1  
2 = Pressure Meter APM2  
3 = Demo Mode (APM1 - APM2 / 4)

The selected Analog Pressure Meter APM1 or APM2 must be setup before using. To Setup go to the Main Screen and select "Pressure".

**Supply Pressure**

Parameter: Pd.12

**123.4** psi

Parameter: Pd.11

**Supply Pressure Input Bar Graph Span**

123.4

psi

Parameter: P.702

## Discharge Pressure Input Setup

**DISCHARGE PRESSURE INPUT SETUP**

[Previous Screen](#)

**Discharge Pressure Input Select**

1

Parameter: P.703

1 = Pressure Meter APM1  
2 = Pressure Meter APM2  
3 = Demo Mode (APM1 + APM2 / 4)

The selected Analog Pressure Meter APM1 or APM2 must be setup before using. To Setup go to the Main Screen and select "Pressure".

**Discharge Pressure**

Parameter: Pd.22

**123.4** psi

Parameter: Pd.21

**Discharge Pressure Input Bar Graph Span**

123.4

psi

Parameter: P.704

# BOOSTER DISCHARGE PRESSURE CONTROL - Touchscreen HMI

## Pump Start / Stop Setup & Status - 1 Pump

Supply Pressure 123.4 psi    Discharge Pressure 123.4 psi    Pump 1 OFF    Speed Reference 123.4 %    [Previous Screen](#)

PUMP START / STOP SETUP & STATUS

Start Pump Pressure (psi)	123.4
Parameter:	P.729
Delay Status →	123
Start Pump Delay (sec.)	123
Parameter:	P.731
Stop Pump Pressure (psi)	123.4
Parameter:	P.742
Delay Status →	123
Stop Pump Delay (sec.)	123
Parameter:	P.744

## Pump Start / Stop Setup & Status - 2 Pumps

Supply Pressure 123.4 psi    Discharge Pressure 123.4 psi    Pump 1 OFF    Pump 2 OFF    Speed Reference 123.4 %    [Previous Screen](#)

PUMP START / STOP SETUP & STATUS

	1st Pump	2nd Pump
Start Pump Pressure (psi)	123.4	Start Pump Speed (%) 123.4
Parameter:	P.729	Parameter: P.732
Delay Status →	123	Delay Status → 123
Start Pump Delay (sec.)	123	Start Pump Delay (sec.) 123
Parameter:	P.731	Parameter: P.733
Stop All Pumps Pressure (psi)	123.4	Stop Pump Speed (%) 123.4
Parameter:	P.742	Parameter: P.745
Delay Status →	123	Delay Status → 123
Stop All Pumps Delay (sec.)	123	Stop Pump Delay (sec.) 123
Parameter:	P.744	Parameter: P.746

# BOOSTER DISCHARGE PRESSURE CONTROL - Touchscreen HMI

## Pump Start / Stop Setup & Status - 3 Pumps

Supply Pressure **123.4** psi    Discharge Pressure **123.4** psi    Pump 1  OFF    Pump 2  OFF    Pump 3  OFF    Speed Reference **123.4** %    [Previous Screen](#)

**PUMP START / STOP SETUP & STATUS**

	2nd Pump	3rd Pump
Start 1st Pump Pressure (psi) Parameter: P.729	<b>123.4</b> Start Pump Speed (%) Parameter: P.732	<b>123.4</b> Start Pump Speed (%) Parameter: P.734
Delay Status → <b>123</b> Start 1st Pump Delay (sec.) Parameter: P.731	Delay Status → <b>123</b> Start Pump Delay (sec.) Parameter: P.733	<b>123</b> Start Pump Delay (sec.) Parameter: P.735
Stop All Pumps Pressure (psi) Parameter: P.742	<b>123.4</b> Stop Pump Speed (%) Parameter: P.745	<b>123.4</b> Stop Pump Speed (%) Parameter: P.747
Delay Status → <b>123</b> Stop All Pumps Delay (sec.) Parameter: P.744	Delay Status → <b>123</b> Stop Pump Delay (sec.) Parameter: P.746	<b>123</b> Stop Pump Delay (sec.) Parameter: P.748

## Pump Start / Stop Setup & Status - 4 Pumps

Supply Pressure **123.4** psi    Discharge Pressure **123.4** psi    Pump 1  OFF    Pump 2  OFF    Pump 3  OFF    Pump 4  OFF    Speed Reference **123.4** %    [Previous Screen](#)

**PUMP START / STOP SETUP & STATUS**

	2nd Pump	3rd Pump	4th Pump
Start 1st Pump Pressure (psi) Parameter: P.729	<b>123.4</b> Start Pump Speed (%) Parameter: P.732	<b>123.4</b> Start Pump Speed (%) Parameter: P.734	<b>123.4</b> Start Pump Speed (%) Parameter: P.736
Delay Status → <b>123</b> Start 1st Pump Delay (sec.) Parameter: P.731	Delay Status → <b>123</b> Start Pump Delay (sec.) Parameter: P.733	<b>123</b> Start Pump Delay (sec.) Parameter: P.735	<b>123</b> Start Pump Delay (sec.) Parameter: P.737
Stop All Pumps Pressure (psi) Parameter: P.742	<b>123.4</b> Stop Pump Speed (%) Parameter: P.745	<b>123.4</b> Stop Pump Speed (%) Parameter: P.747	<b>123.4</b> Stop Pump Speed (%) Parameter: P.749
Delay Status → <b>123</b> Stop All Pumps Delay (sec.) Parameter: P.744	Delay Status → <b>123</b> Stop Pump Delay (sec.) Parameter: P.746	<b>123</b> Stop Pump Delay (sec.) Parameter: P.748	<b>123</b> Stop Pump Delay (sec.) Parameter: P.750

## BOOSTER DISCHARGE PRESSURE CONTROL - Touchscreen HMI

### Pump Start / Stop Setup & Status - 5 Pumps

Supply Press.	Discharge Press.	Pump 1	Pump 2	Pump 3	Pump 4	Pump 5	Speed Ref.	Previous Screen
123.4 psi	123.4 psi	OFF	OFF	OFF	OFF	OFF	123.4 %	
PUMP START / STOP SETUP & STATUS		2nd Pump		3rd Pump		4th Pump		5th Pump
Start 1st Pump Pressure (psi)	123.4	Start Pump Speed (%)	123.4	123.4	123.4	123.4	123.4	123.4
Parameter:	P.729	Parameter:	P.732	P.734	P.736	P.738		
Delay Status →	123	Delay Status →	123	123	123	123	123	123
Start 1st Pump Delay (sec.)	123	Start Pump Delay (sec.)	123	123	123	123	123	123
Parameter:	P.731	Parameter:	P.733	P.735	P.737	P.739		
Stop All Pumps Pressure (psi)	123.4	Stop Pump Speed (%)	123.4	123.4	123.4	123.4	123.4	123.4
Parameter:	P.742	Parameter:	P.745	P.747	P.749	P.751		
Delay Status →	123	Delay Status →	123	123	123	123	123	123
Stop All Pumps Delay (sec.)	123	Stop Pump Delay (sec.)	123	123	123	123	123	123
Parameter:	P.744	Parameter:	P.746	P.748	P.750	P.752		

### Pump Start / Stop Setup & Status - 6 Pumps

Supply Pressure	Pump 1	Pump 2	Pump 3	Pump 4	Pump 5	Pump 6	Speed Reference	Previous Screen	
123.4 psi	OFF	OFF	OFF	OFF	OFF	OFF	123.4 %		
PUMP START / STOP SETUP & STATUS		2nd Pump		3rd Pump		4th Pump		5th Pump	6th Pump
Start 1st Pump Pressure (psi)	123.4	Start Pump Speed (%)	123.4	123.4	123.4	123.4	123.4	123.4	123.4
Parameter:	P.729	Parameter:	P.732	P.734	P.736	P.738	P.740		
Delay Status →	123	Delay Status →	123	123	123	123	123	123	123
Start 1st Pump Delay (sec.)	123	Start Pump Delay (sec.)	123	123	123	123	123	123	123
Parameter:	P.731	Parameter:	P.733	P.735	P.737	P.739	P.741		
Stop All Pumps Pressure (psi)	123.4	Stop Pump Speed (%)	123.4	123.4	123.4	123.4	123.4	123.4	123.4
Parameter:	P.742	Parameter:	P.745	P.747	P.749	P.751	P.753		
Delay Status →	123	Delay Status →	123	123	123	123	123	123	123
Stop All Pumps Delay (sec.)	123	Stop Pump Delay (sec.)	123	123	123	123	123	123	123
Parameter:	P.744	Parameter:	P.746	P.748	P.750	P.752	P.754		

# BOOSTER DISCHARGE PRESSURE CONTROL - Touchscreen HMI

## Control Setup

### CONTROL SETUP

[Previous Screen](#)

<p>Override Ramp Upper End Supply Pressure</p> <div style="border: 1px solid blue; padding: 5px; display: inline-block; font-size: 24px; color: blue;">123.4</div> psi Parameter: P.727	<p>Controlling Setpoint Lower Limit</p> <div style="border: 1px solid blue; padding: 5px; display: inline-block; font-size: 24px; color: blue;">123.4</div> psi Parameter: P.726
<p>Override Ramp Lower End Supply Pressure</p> <div style="border: 1px solid blue; padding: 5px; display: inline-block; font-size: 24px; color: blue;">123.4</div> psi Parameter: P.728	<p>Discharge Pressure Ramp Rate</p> <div style="border: 1px solid blue; padding: 5px; display: inline-block; font-size: 24px; color: blue;">12.34</div> psi / sec Parameter: P.721

[Next Screen](#)

## Control Setup

### CONTROL SETUP

[Previous Screen](#)

<p>Pump Speed Acceleration Rate</p> <div style="border: 1px solid blue; padding: 5px; display: inline-block; font-size: 24px; color: blue;">123</div> seconds / 100% speed (The time required to go from 0% to 100% speed.) Parameter: P.166	<p>Start Up Delay</p> <div style="border: 1px solid blue; padding: 5px; display: inline-block; font-size: 24px; color: blue;">123</div> seconds Parameter: P.755
<p>Pump Speed Deceleration Rate</p> <div style="border: 1px solid blue; padding: 5px; display: inline-block; font-size: 24px; color: blue;">123</div> seconds / 100% speed (The time required to go from 100% to 0% speed.) Parameter: P.167	<p>Lag Pump Delay</p> <div style="border: 1px solid blue; padding: 5px; display: inline-block; font-size: 24px; color: blue;">123</div> seconds Parameter: P.756

Note:  
The Controller performs the Acceleration and Deceleration of the pump speed.

The Accel and Decel Parameters on the VFDs should be set to values less than or equal to what is set above.

Number of Pumps  
Required at Startup

1

  
Parameter: P.769

# BOOSTER DISCHARGE PRESSURE CONTROL - Touchscreen HMI

## Pump Speed Limit Setup

[Previous Screen](#)

### PUMP SPEED LIMIT SETUP

	Pump 1	Pump 2	Pump 3	Pump 4	Pump 5	Pump 6
Maximum Speed Limit (percent)	123.4	123.4	123.4	123.4	123.4	123.4
Parameter:	P.757	P.759	P.761	P.763	P.765	P.767
Minimum Speed Limit (percent)	123.4	123.4	123.4	123.4	123.4	123.4
Parameter:	P.758	P.760	P.762	P.764	P.766	P.768

## Alternation Setup

[Previous Screen](#)

### PUMP ALTERNATION SETUP

**1** Alternation Sequence Mode  
Parameter: P.122

1 = Standard Alternation  
2 = Fixed Order Sequence  
3 = Elapsed Time Meter Based Alternation

[Next Screen](#)

# BOOSTER DISCHARGE PRESSURE CONTROL - Touchscreen HMI

Screen Available with Standard Alternation (Parameter P.122 = 1)

Previous Screen

## PUMP ALTERNATION SETUP

Forced Lead Pump Position

Parameter: P.129

Force Alternation

Parameter: Ad.01

Current Lead Pump

- 0 = Alternate
- 1 = Pump 1 Lead Pump
- 2 = Pump 2 Lead Pump
- 3 = Pump 3 Lead Pump
- 4 = Pump 4 Lead Pump
- 5 = Pump 5 Lead Pump
- 6 = Pump 6 Lead Pump

Time Based Alternation  
(Internal Time Clock)

0 = Disabled  
60 = 1 hour  
480 = 8 hour  
1440 = 24 hour

minutes

Parameter: P.131

Screen Available with Fixed Order Sequence (Parameter P.122 = 2)

Previous Screen

## FIXED ORDER SEQUENCE SETUP

Fixed Order Position Setup

Pump 1	Pump 2	Pump 3	Pump 4	Pump 5	Pump 6
<span style="font-size: 1.5em;">1</span>	<span style="font-size: 1.5em;">1</span>	<span style="font-size: 1.5em;">1</span>	<span style="font-size: 1.5em;">1</span>	<span style="font-size: 1.5em;">1</span>	<span style="font-size: 1.5em;">1</span>
Parameter: P.711	P.712	P.713	P.714	P.715	P.716

# BOOSTER DISCHARGE PRESSURE CONTROL - Touchscreen HMI

## Alarms Setup

The image shows a touchscreen HMI interface for 'ALARMS SETUP'. The title 'ALARMS SETUP' is centered at the top. In the top right corner, there is a button labeled 'Previous Screen'. Below the title, there are four alarm configuration sections arranged in a 2x2 grid:

- High Supply Pressure Alarm:** The value '123.4' is displayed in a blue box, followed by 'psi' and 'Parameter: P.392'.
- High Discharge Pressure Alarm:** The value '123.4' is displayed in a blue box, followed by 'psi' and 'Parameter: P.394'.
- Low Supply Pressure Alarm:** The value '123.4' is displayed in a blue box, followed by 'psi' and 'Parameter: P.391'.
- Low Discharge Pressure Alarm:** The value '123.4' is displayed in a blue box, followed by 'psi' and 'Parameter: P.393'.