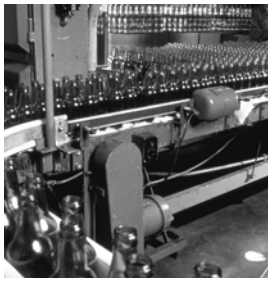
# Pump Control Connected Components Building Block



**Quick Start**

ALLEN-BRADLEY • ROCKWELL SOFTWARE

Rockwell Automation

# Important User Information

Solid state equipment has operational characteristics differing from those of electromechanical equipment. Safety Guidelines for the Application, Installation and Maintenance of Solid State Controls (publication SGI-1.1 available from your local Rockwell Automation sales office or online at http://literature.rockwellautomation.com) describes some important differences between solid state equipment and hard-wired electromechanical devices. Because of this difference, and also because of the wide variety of uses for solid state equipment, all persons responsible for applying this equipment must satisfy themselves that each intended application of this equipment is acceptable.

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The examples and diagrams in this manual are included solely for illustrative purposes. Because of the many variables and requirements associated with any particular installation, Rockwell Automation, Inc. cannot assume responsibility or liability for actual use based on the examples and diagrams.

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Throughout this manual, when necessary, we use notes to make you aware of safety considerations.

| | |
|---|---|
| **WARNING**  | Identifies information about practices or circumstances that can cause an explosion in a hazardous environment, which may lead to personal injury or death, property damage, or economic loss. |
| **IMPORTANT** | Identifies information that is critical for successful application and understanding of the product. |
| **ATTENTION**  | Identifies information about practices or circumstances that can lead to personal injury or death, property damage, or economic loss. Attentions help you identify a hazard, avoid a hazard, and recognize the consequence. |
| **SHOCK HAZARD**  | Labels may be on or inside the equipment, for example, a drive or motor, to alert people that dangerous voltage may be present. |
| **BURN HAZARD**  | Labels may be on or inside the equipment, for example, a drive or motor, to alert people that surfaces may reach dangerous temperatures. |

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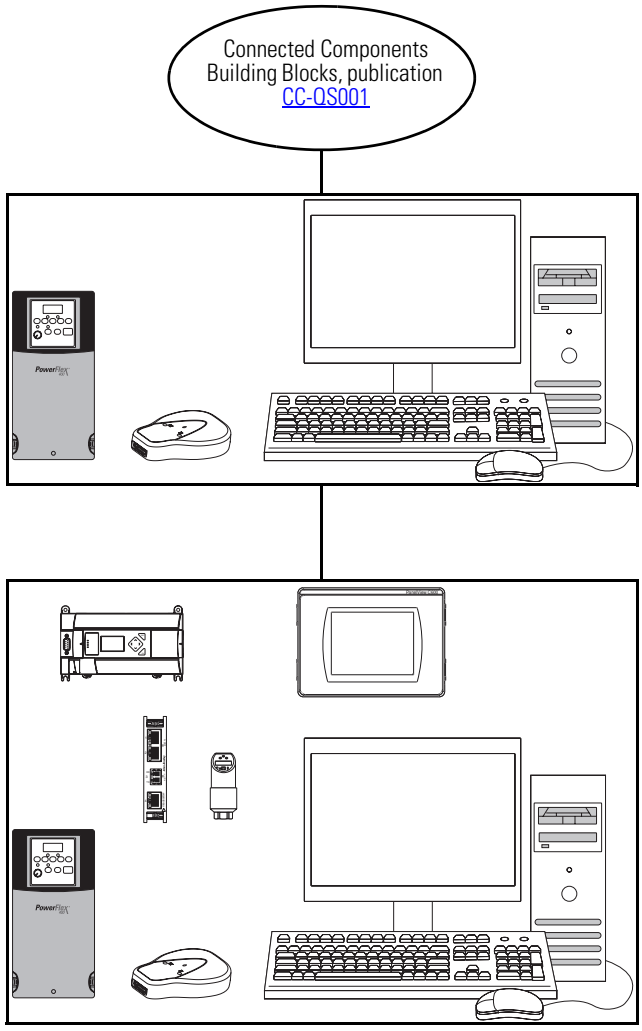
Follow the path below to complete your Pump Control application.

Chapter 1 PowerFlex 400 Drive Integration

Chapter 2 System Validation and Application Tips



## Notes:

## Introduction

This connected component building block quick start was created to aid in the design and implementation of a pump control system with advanced features.

**IMPORTANT**

Use this Connected Components Building Block Quick Start in conjunction with the Connected Components Building Blocks Quick Start, publication CC-QS001.

Refer to Additional Resources on page 8 for a listing of Quick Start documents.

To assist in the design and installation of your system, application files and other information are provided on the Connected Component Building Blocks Overview DVD, publication CC-QR001. The DVD provides bills of materials (BOM), CAD drawings for panel layout and wiring, control programs, Human Machine Interface (HMI) screens, and more. With these tools and the built-in best-practices design, the system designer is free to focus on the design of their machine control and not on design overhead tasks.

The beginning of each chapter contains the following information. Read these sections carefully before beginning work in each chapter:

- **Before You Begin** - This section lists the steps that must be completed and decisions that must be made before starting that chapter. The chapters in this quick start do not have to be completed in the order in which they appear, but this section defines the minimum amount of preparation required before completing the current chapter.
- **What You Need** - This section lists the tools that are required to complete the steps in the current chapter. This includes, but is not limited to, hardware and software.
- **Follow These Steps** - This illustrates the steps in the current chapter and identifies which steps are required to complete the examples.

## Conventions Used in This Manual

This manual uses the following conventions.

| Convention | Meaning | Example |
|---|---|---|
| Click | Click the left mouse button once. | Click Edit. |
| Type | What you type on the keyboard. | Type the IP address. |
| Right-click | Click the right mouse button once while the cursor is positioned on object or selection. | Right-click the 1768 Bus icon. |
| Select | Using the mouse to highlight a specific option. | Select the application name. |
| Press | Pressing a specific key on the keyboard or the PowerFlex 400 keypad. | Press Enter. |
| Touch | Touching a specific button on the PanelView Component (PVc) terminal. | Touch the Start button. |

## Additional Resources

| Resource | Description |
|---|---|
| Connected Components Building Blocks Quick Start, publication CC-QS001 | Provides information on how to select products and gain access to panel and wiring information. |
| Connected Component Building Blocks Overview DVD, publication CC-QR001 | Provides files for the Connected Component Building Blocks. |
| MicroLogix 1400 User Manual, publication 1766-UM001 | Provides information on using the MicroLogix 1400 Programmable Controller. |
| PanelView Component Quick Start Manual, publication 2711C-QS001A | Provides information on using the PanelView component. |
| PanelView Component Operator Terminals User Manual, publication 2711C-UM001 | Provides information on using the PanelView Component HMI Terminals. |
| PowerFlex 400 User Manual, publication 22C-UM001 | Provides information on installing the PowerFlex 400 Adjustable Frequency AC Drive including wiring and parameter setup. |
| 1203-USB USB Converter User Manual, publication DRIVES-UM001 | Provides information on using the 1203-USB converter. |
| http://www.ab.com | Provides access to the Allen-Bradley website. |
| http://rockwellautomation.com/knowledgebase | Provides access to self-service support. |
| http://www.rockwellautomation.com/components/connected | Provides access to the Connected Components website. |

# PowerFlex 400 Drive Integration

## Introduction

This chapter provides instructions on how to plan for and connect multiple PowerFlex 400 drives to a Modbus RTU network and to connect a PowerFlex 400 drive to a personal computer and load, via DriveExplorer™ software, the pre-configured parameter file that is necessary for communication with the MicroLogix controller. The pre-configured parameter file also includes the proper drive configuration for the pump control features. The parameter setup file can be modified to fit the specific application needs. You will need to consult the drive documentation for information on all the other drive parameters.

## Before You Begin

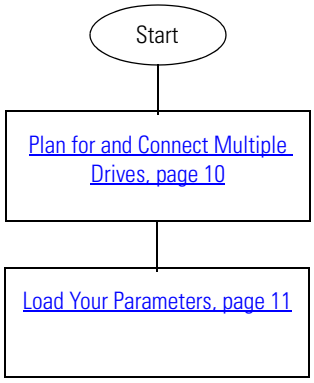
- Review the Connected Components Building Blocks Quick Start, publication CC-QS001, verifying that you have completed the hardware design and installation as well as the software installation.
- Review and/or record all pump motor nameplate parameters.

## What You Need

- PowerFlex 400 drive(s)
- RJ45 cable and AK-U0-RJ45-TB2 connector
- Personal computer with DriveExplorer (full version) software installed
- 1203-USB converter
- 22-HIM-H10 Cable
- USB Cable
- Connected Components Building Blocks Overview DVD, publication CC-QR001
- Pump Control Default Parameters Cx_xx.csf file (available on the Connected Components Building Blocks Overview DVD)

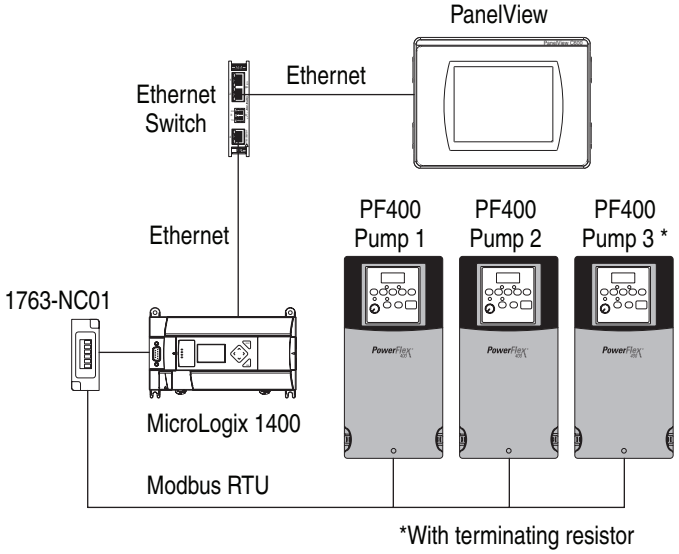
# Follow These Steps

Follow this step to adjust your drive parameters.




# Plan for and Connect Multiple Drives

The MicroLogix Pump Communication routine example supports Modbus communication with 1…8 PowerFlex 400 drives without any modifications. Since a Modbus network supports communication with only one device at a time, the more drives on the network, the longer it takes to communicate with all of the drives. With the default communication settings, the MicroLogix controller takes approximately 225 ms to get a status update from each enabled drive because two separate read requests are required. Therefore, you must first confirm that the slower response time for multiple drives is acceptable (8 PowerFlex 400 drives would have a maximum response time of 1800 ms).



Follow these steps to connect multiple PowerFlex 400 drives to your Modbus network.

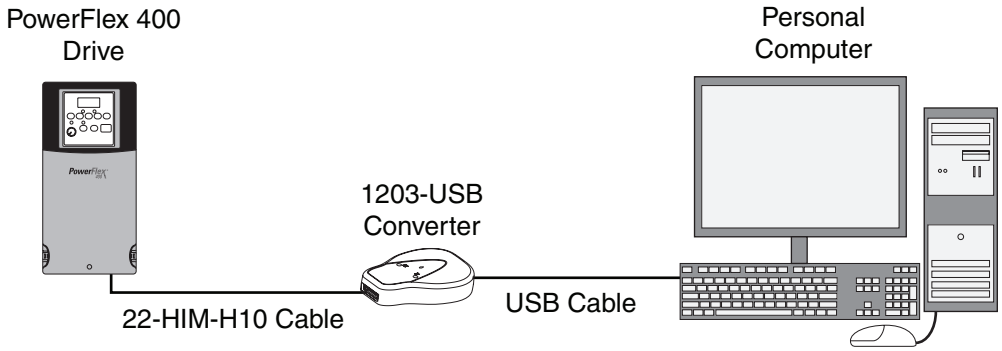
1. Verify that all power is removed.
2. Install each drive.
3. Connect an RJ45 cable and AK-U0-RJ45-TB2 connector from drive to drive, in a daisy-chain configuration (as illustrated above). The termination resistor must be installed on the last drive.
4. Follow the steps below to download the default parameter set from the file provided on the Connected Components Building Blocks Overview DVD, publication CC-QR001, and set the application specific parameters.

## Load Your Parameters

Follow these steps to load your drive parameters. These steps must be performed for each drive in the network.

1. Apply power to the drive.
2. Disconnect the RJ45 cable with the AK-U0-RJ45-TB2 connector from the PowerFlex 400 drive.
3. Connect a personal computer, with DriveExplorer software installed, to the drive using the 1203-USB converter module and cables as shown below.

**PowerFlex Drive to Personal Computer Connections**



4. Launch the DriveExplorer software, click OK and configure the communications connection:

   **a.** From the Explore menu, choose Configure Communications.

   **b.** Choose Serial.

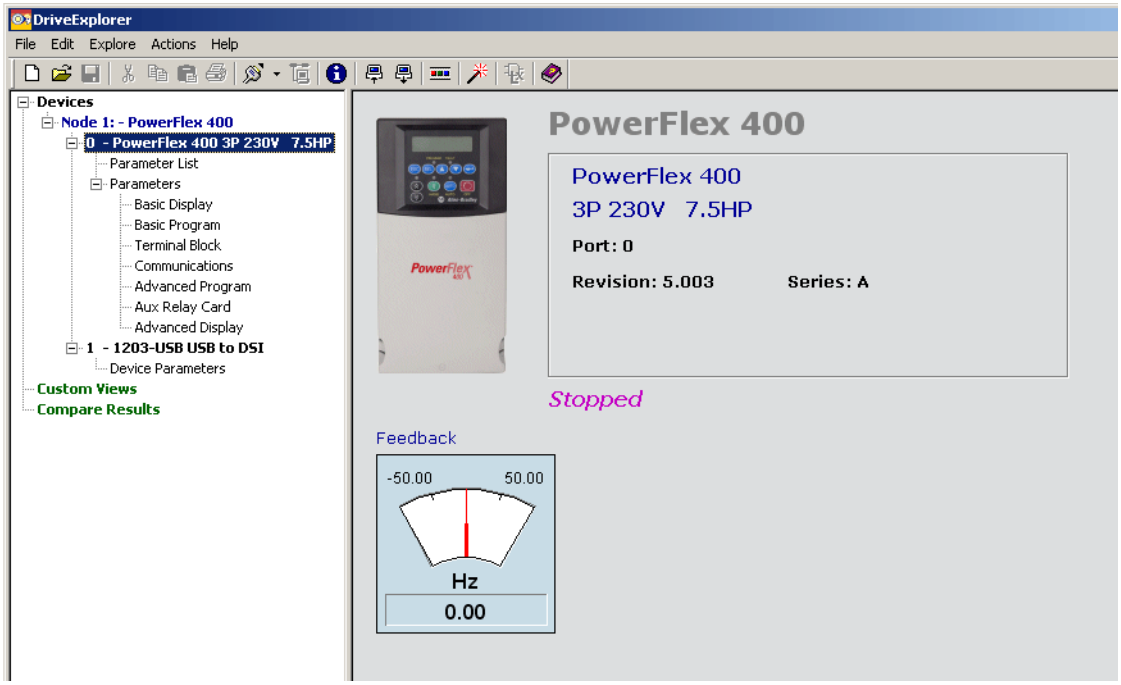
   **c.** Choose Port: COM *x* (The *x* represents the name of your USB Communications port.)

   **d.** Choose Baud: 115200

   **e.** Click OK. If you are changing from a previously selected communication method other than serial, a message displays confirming your choice. Click Yes.

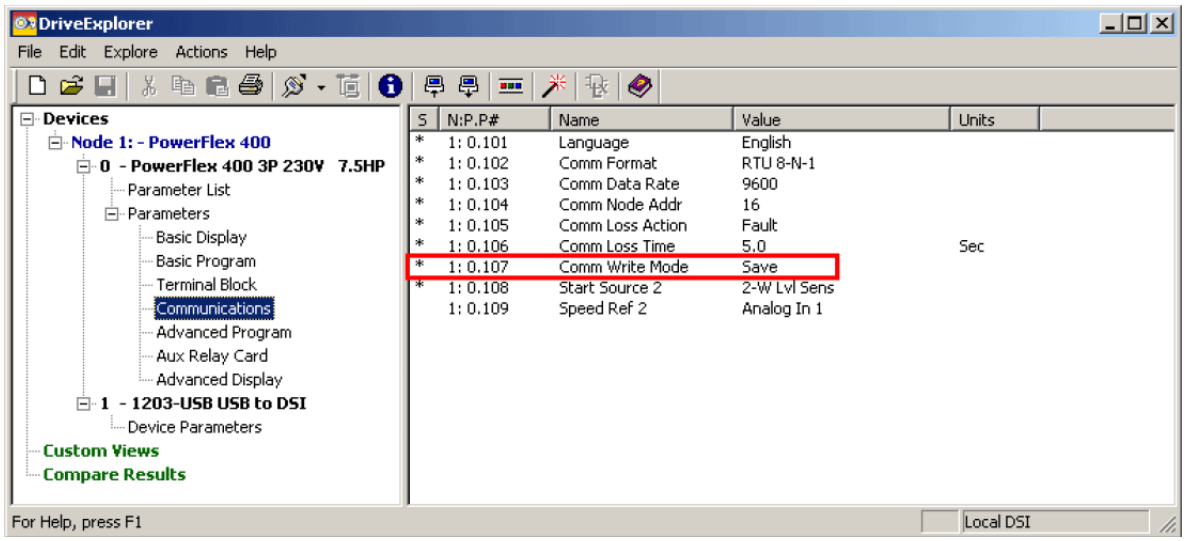
   **f.** Choose Explore > Connect > Serial Point-to-Point.

   Once you are connected, the drive displays in the right-hand pane of the window.



5. In the Device pane on the left, click the plus (+) next to Parameters and select Communications.

6. Verify that parameter C107 [Comm Write Mode] is set to 0-Save prior to downloading the saved offline file.




7. Download the default parameters set from the file provided on the Connected Components Building Blocks Overview DVD, publication CC-QR001 to the drive.

   a. From the Actions menu, choose Download Saved File…

   b. Click Yes in the message box that displays.

   c. In the Open dialog box, browse to and select the Pump Control Default Parameters Cx_xx.csf file on your DVD ROM drive and click Open.

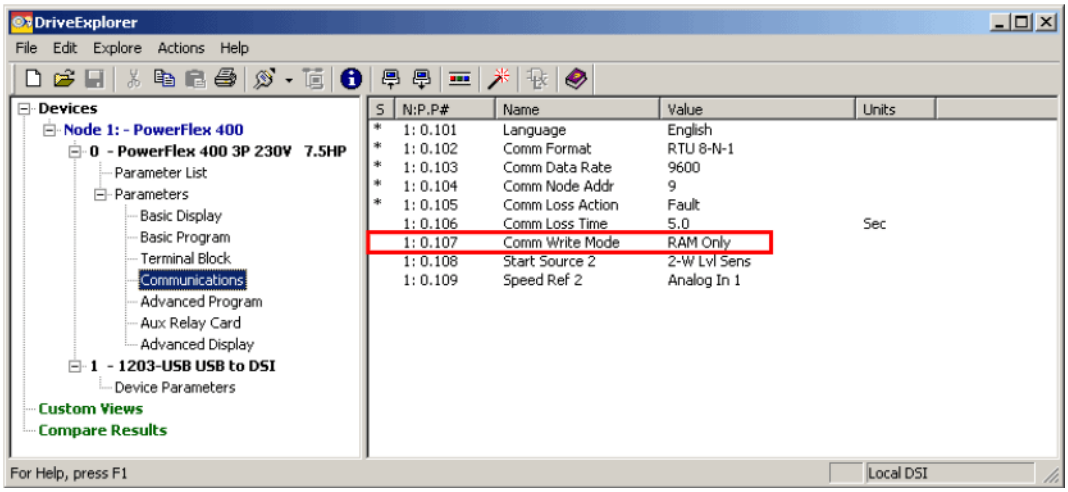
      The following dialog box displays.


- Refer to Chapter A for a list of the default parameter settings required for correct operation of the pump control features.

8. Set the following application specific drive parameters:

| Parameter | Description | Value | Notes |
|---|---|---|---|
| P31 | Motor NP Volts | | Set based on the pump motor nameplate data. |
| P32 | Motor NP Hertz | | |
| P33 | Motor OL Current | | |
| T69 | Analog In 1 Sel | | Select the analog input signal mode (0-20mA, 4-20mA, or 0-10V) according to the pressure switch. Refer to the manufacturer's user manual.<br><br>**Important:** You must set DIP switch AI1 on the drive main control board to match the selected input signal mode. Refer to Chapter 1 Installation/ Wiring in the *PowerFlex 400 AC Drive for Fan & Pump Applications User Manual*, publication 22C-UM001, for more information. |

9. Set parameter C107 [Comm Write Mode] to 1-RAM Only to prevent damage to the Non-Volatile Storage and avoid possible drive malfunction.




10. Save the configuration changes to your personal computer for future reference by selecting File > Save > Parameters and following the prompts.

11. Disconnect the 1203-USB device from the PowerFlex 400 drive.

12. Connect the RJ45 cable with the AK-U0-RJ45-TB2 connector to the PowerFlex 400 drive.

13. Repeat steps 1…12 for each drive (up to 8 drives), incrementing parameter A104 [Comm Mode Addr] by 1 for each drive.

14. Cycle power or reset the drive(s).

# Additional Resources

Refer to page 8 for a listing of product and information resources.

# System Validation and Application Tips

## Introduction

In this chapter, you validate that communication is occurring as intended between the MicroLogix controller and the PowerFlex 400 drive(s), as well as between the MicroLogix controller and the PanelView terminal.

The operation of the Pump Control and Pump Configuration sample screens will be described as well as the steps for merging in the drive Parameter Backup and Restore (PB&R) routine.

## Before You Begin

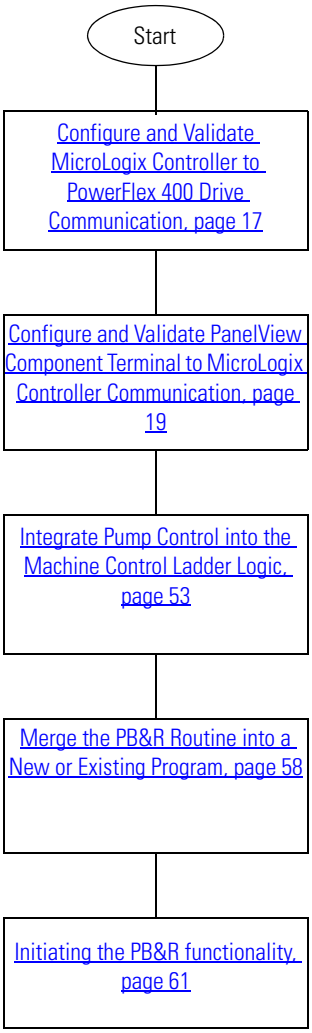
- Review the Connected Components Building Blocks Quick Start, publication CC-QS001, in its entirety, verifying that you have completed all of the steps in Chapter 3 of that document.
- Verify that you have completed all of the steps in Chapter 1 of this document.
- Verify that all of the devices are connected according to the Pump Control CAD wiring diagram.
- Verify that power is applied to the MicroLogix controller, PowerFlex drive, and PanelView terminal.
- For closed loop centrifugal pump systems:
  - Verify that the pressure switch is wired correctly and providing the appropriate feedback.
  - Determine the correct motor/pump rotation direction per the manufacturer.

## What You Need

- Connected Component Building Blocks Overview DVD, publication CC-QR001.
- PowerFlex 400 drive(s).
- MicroLogix 1400 controller.
- Pressure Switch.
- Personal computer with the previously loaded software.
- PanelView Component TC600 terminal.
- Standalone Ethernet switch so that you can connect your personal computer to both the MicroLogix controller and PanelView terminal over an isolated Ethernet network.

# Follow These Steps

Follow these steps to verify that communication is occurring between your devices and to test the system.



# Configure and Validate MicroLogix Controller to PowerFlex 400 Drive Communication

By default, the MicroLogix Pump Communication routine example is configured for communicating with 1 drive, set to node address 9. It is recommended that communication be verified with one drive at a time. Therefore, the step-by-step procedures in this section are listed for the first drive only. You should perform the same steps for each subsequent drive.

Data table bits B240/9…B240/16 (may also be represented as bits B240:0/9…B240:0/16) are the drive-communication enable bits for node addresses 9…16. If a bit is turned on, then the MicroLogix controller attempts to communicate with the drive at the node address represented by that bit during each communication scan.

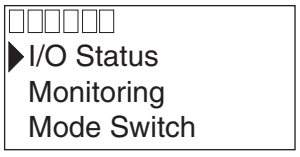
**IMPORTANT** For every drive that does not respond at an enabled node address, a 2 second delay is added into the overall communication scan. Therefore, for best system communication performance, it is important to enable only node addresses for drives that can successfully respond.

By default, only bit B240/9 (drive #9 enabled) is set. Bits B240/1…8 and B240/10…16 are cleared. You can change and verify these settings by either using the programming software or the built-in Bit Monitoring function of the MicroLogix LCD Display.

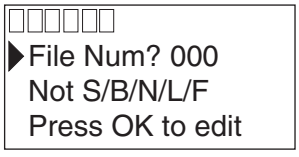
## Verify or Change Settings

Follow these steps to verify or change the settings:

1. Press ESC on the MicroLogix front panel until the LCD screen displays the Main menu.




2. Press the down arrow on the LCD screen keypad so that the cursor (▶) is pointing at Monitoring and press OK. The LCD screen displays the following:



3. Use the arrow keys on the keypad to enter file number 240 and then press OK. B240:0/0=OFF displays, where 0/0 is flashing.

4. Press the up arrow key to display B240:0/9 (with 0/9 flashing) and verify that the value is '=ON'. If not, you can change it from OFF to ON by pressing OK so that 'OFF' starts flashing. Press the up arrow key to change OFF to ON and then press OK to accept the change (the 0/9 in B240:0/9 will begin flashing again and '=ON' is constantly displayed).

5. Verify that bits B240:0/1…8 and B240:0/10…16 are all OFF by pressing the up key to display the state of each bit.

## Verify Communications

Now you are ready to verify that communication is working between the MicroLogix controller and the drive at node address 9.

1. Confirm that the MicroLogix controller is in RUN mode by verifying that the RUN status indicator next to the LCD screen is ON (solid green). If not, you can change the controller to RUN mode by using either the programming software or through the Mode Switch function of the MicroLogix LCD display. The Pump Control routine should now be constantly communicating with the drive via communication channel 0.

2. Inspect the COMM0 status indicator in the top left corner of the MicroLogix LCD display and verify that it is flashing rapidly.

   If the COMM0 status indicator is flashing rapidly, then you are ready to test any additional drives by repeating the steps previously completed in Verify or Change Settings and Verify Communications above, enabling one additional drive at a time.

   If the COMM0 status indicator is flashing only once every 2 to 3 seconds, then the drive is not responding to the MicroLogix communication attempts. If this is the case, verify the wiring connections and the drive communication parameter settings completed in Chapter 1.

   If the COMM0 status indicator is always off, then either the MicroLogix controller is not in RUN mode or the Pump Control routine was not properly downloaded to the controller.

# Configure and Validate PanelView Component Terminal to MicroLogix Controller Communication

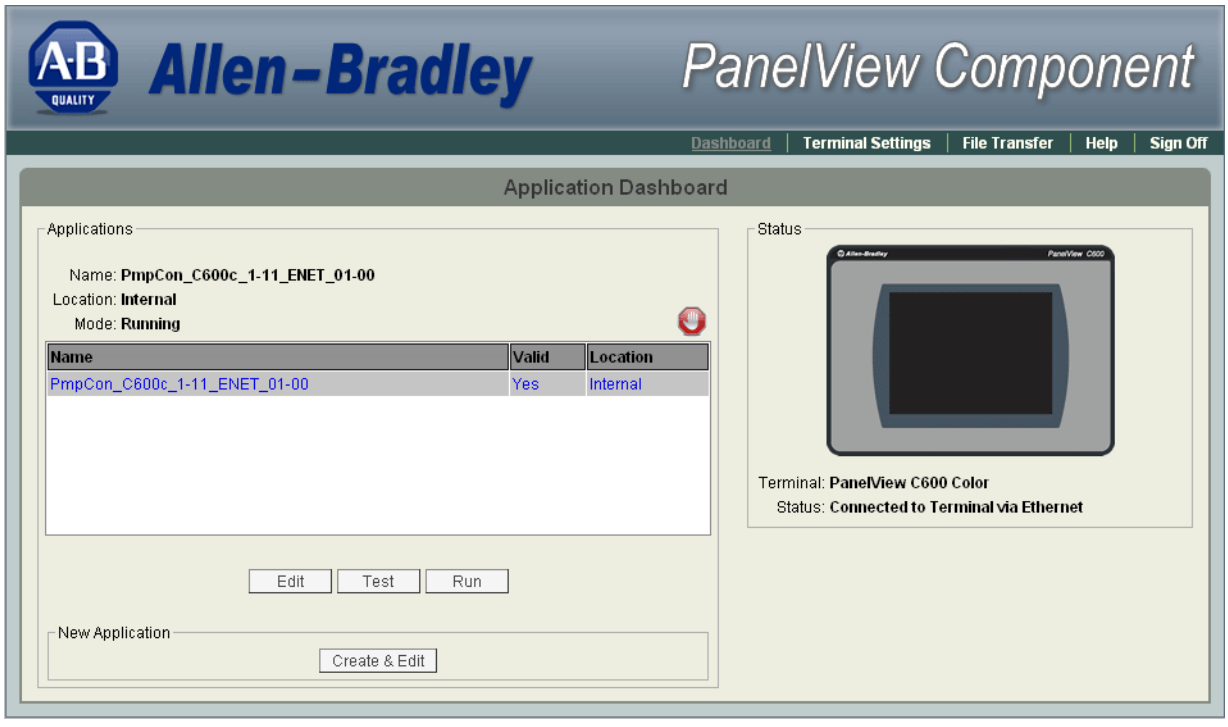
The 6-inch color touchscreen PanelView Component (PVc) terminal communicates with the MicroLogix controller over the Ethernet network. The PVc application reads from and writes to the data table of the MicroLogix controller. When the PVc application writes to the MicroLogix controller, the controller program detects the value change and writes that new value to the appropriate drive via the Modbus network. Since the controller program is continually updating status data from all of the enabled drives into its data table via Modbus reads, the PVc application is monitoring the latest drive status data.

The sample CCBB Pump Control programs for the controller and PVc terminal assumes the static IP address for the MicroLogix controller is 192.168.1.2. If you are using a different IP address for the controller, then the first thing that you must do is modify the MicroLogix 1400 IP address in the PVc application.

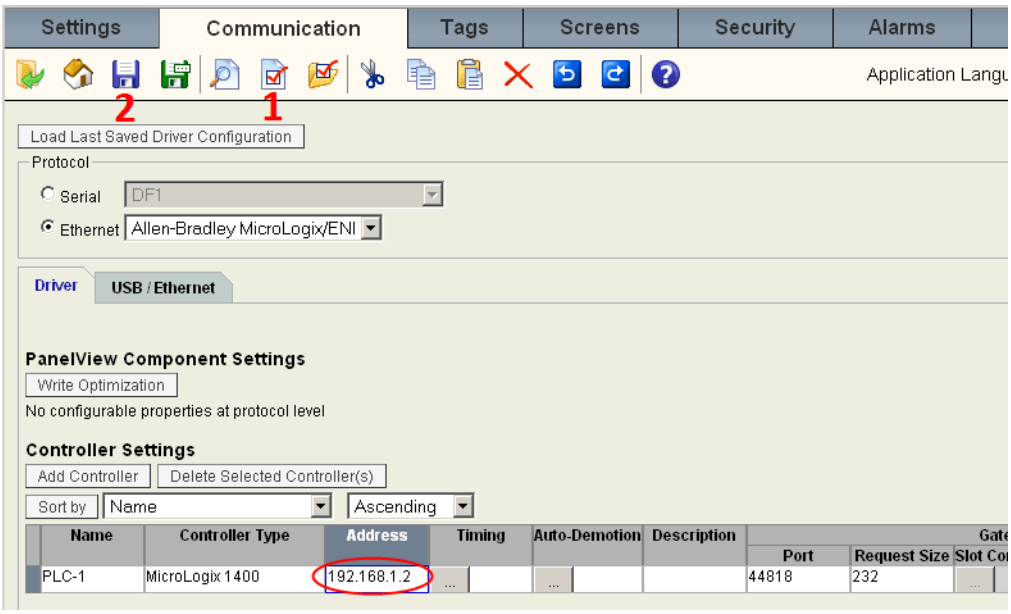
Follow this procedure to modify the MicroLogix IP address in the PVc application.

1. Connect to the PVc terminal with your Internet Explorer or Firefox web browser by entering the terminal IP address in the web browser location bar and pressing Enter.

2. In the PVc Application Dashboard dialog, select the application name and click Edit.



3. In the Edit dialog box, click the Communication tab. The following dialog box displays.




4. Enter the IP address you are using for the MicroLogix controller (refer to the PanelView Component HMI Terminals User Manual, publication 2711C-UM001 for details).

5. Click  to validate the PVc application.

6. Click  to save the PVc application.

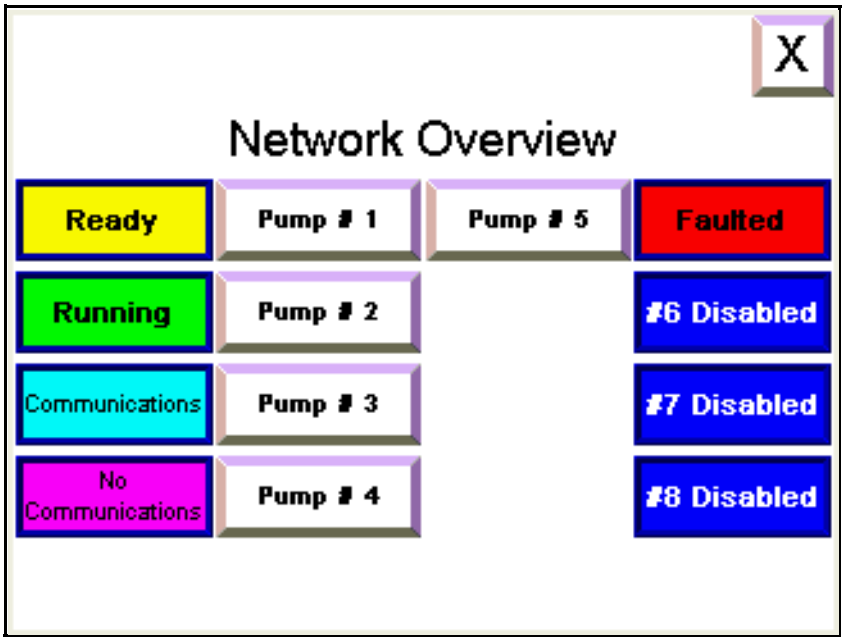
7. In the Application Dashboard dialog box, click Run to run the PVc Pump Control application.

   The Network Overview screen (described below) displays on the PVc HMI.

## Network Overview

The Network Overview screen has been preconfigured to support up to 8 drives (node addresses 9…16). When the application is running, a 'Pump #x' push button displays for each enabled drive along with a status button to the left or right. If a pump node address is disabled, its 'Pump # x' push button is invisible.

**Drives Enabled**

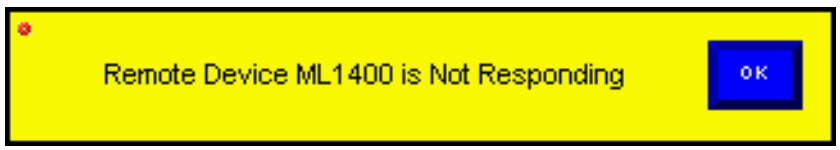



Since you have already verified that communication between the MicroLogix controller and the PowerFlex 400 drive(s) is working, once the PVc application is running, any drives that are enabled should be displayed as being 'Ready' on the Network Overview screen.

Ready - indicates that the drive is responding when the MicroLogix controller attempts to communicate with it and that the drive is ready to be started.

If a yellow banner message like the one shown below displays instead, then the PVc application is still not able to communicate with the MicroLogix controller over the Ethernet network at the configured IP address.

**Banner Message**




Use RSLogix programming software and your web browser to verify that the MicroLogix controller's IP address configured for channel 1 matches the one in the PVc application. If your personal computer can communicate with both devices over the Ethernet network, then the PVc terminal should be able to communicate with the MicroLogix controller over the Ethernet network.

### Drive Node Address Status

Once the PVc terminal is successfully communicating with the MicroLogix controller, you may observe a drive status other than Disabled or Ready. Other statuses include:

- Running - indicates that the drive has been started and is currently running.
- Communications - indicates that the drive is responding to communication and is only seen momentarily before being ready.
- No Communications - indicates that the drive is not responding to communication attempts from the MicroLogix controller.
- Faulted - indicates that the drive is currently faulted.

### Enable/Disable Drive Node Addresses

You can now enable or disable a drive node address from the Network Overview screen. To disable a drive node address, press the status button next to the 'Pump #x' for the desired drive - the status changes to '#x Disabled'. Press '#x Disabled' for a drive to enable that node address - the button description changes to one of the statuses listed above.

The  button in the top-right corner of the screen lets you exit the application to the PVc Terminal Configuration dialog box.

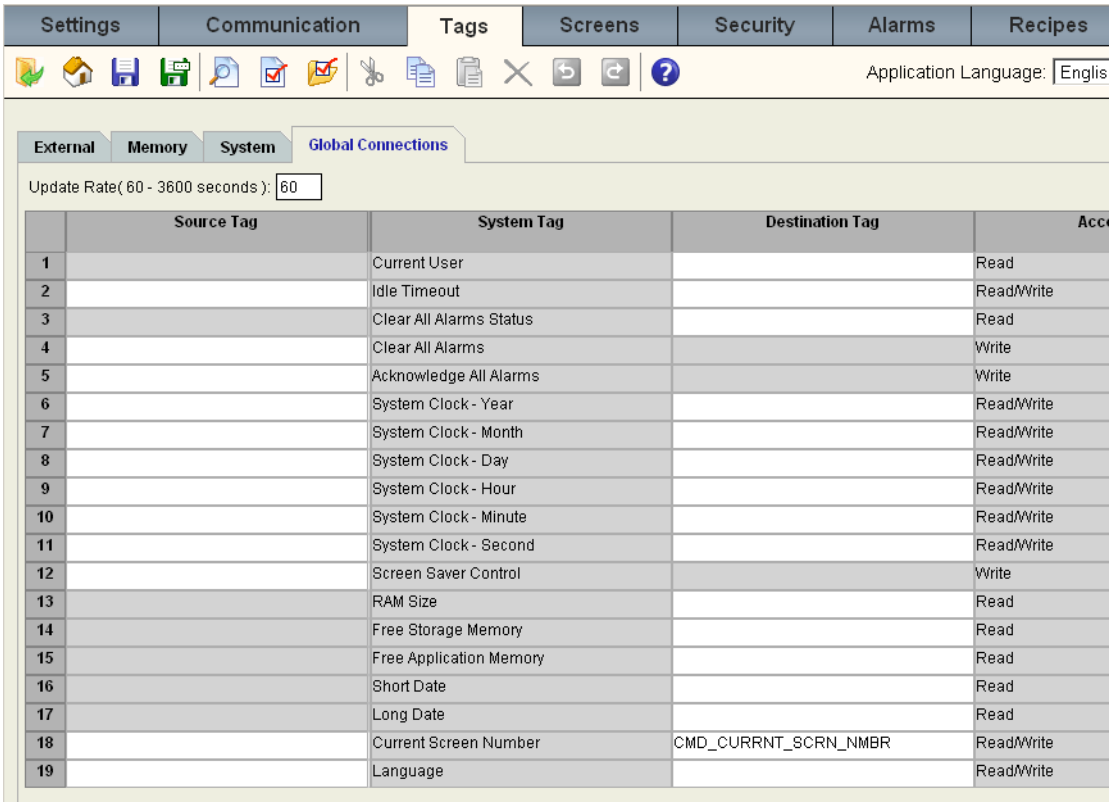
**IMPORTANT** Before proceeding, make sure that all of the configured drives are enabled and communicating successfully and that all of the drive node addresses that are not being used (no drive installed) are disabled on the Network Overview screen.

**TIP** At this point, you can edit the Network Overview screen and delete the buttons and status displays that are associated with unused drive node addresses. You can also edit the drive descriptions (such as Pump #1) to something more meaningful in the application (such as Main Discharge Pump).

**IMPORTANT** The Pump Control screen numbers defined in the PVc application program are set up to match the drive node address (9…16). With every change initiated on a screen, the PVc terminal writes the screen number to the MicroLogix controller by entering a destination tag for the Current Screen Number under the Tags > Global Connections. CMD_CURRENT_SCRN_NMBR is a write-only tag defined for the MicroLogix controller.

## Tag Definitions

Because all of the Pump Control screens use the same tag definitions, the MicroLogix controller copies the data for the appropriate drive based on the current screen number.




| | Source Tag | System Tag | Destination Tag | Acc |
|---|---|---|---|---|
| 1 | | Current User | | Read |
| 2 | | Idle Timeout | | Read/Write |
| 3 | | Clear All Alarms Status | | Read |
| 4 | | Clear All Alarms | | Write |
| 5 | | Acknowledge All Alarms | | Write |
| 6 | | System Clock - Year | | Read/Write |
| 7 | | System Clock - Month | | Read/Write |
| 8 | | System Clock - Day | | Read/Write |
| 9 | | System Clock - Hour | | Read/Write |
| 10 | | System Clock - Minute | | Read/Write |
| 11 | | System Clock - Second | | Read/Write |
| 12 | | Screen Saver Control | | Write |
| 13 | | RAM Size | | Read |
| 14 | | Free Storage Memory | | Read |
| 15 | | Free Application Memory | | Read |
| 16 | | Short Date | | Read |
| 17 | | Long Date | | Read |
| 18 | | Current Screen Number | CMD_CURRNT_SCRN_NMBR | Read/Write |
| 19 | | Language | | Read/Write |

## Accessing the Pump Control Screen

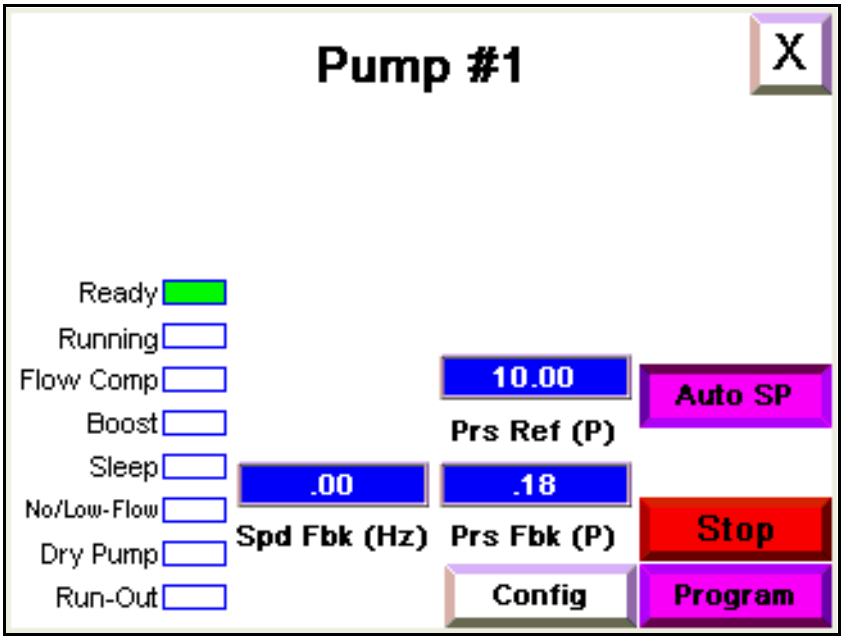
Now that the PVc terminal is successfully communicating with the MicroLogix controller, you are ready to configure and test the Pump Control functionality. You will begin by first examining the Pump Control screen.

**IMPORTANT** It is strongly recommended that the pump configuration setup procedure is completed prior to operating the drive to avoid damage to the pump and/or system.

Pressing the Pump #x button on the Network Overview screen for a drive that is enabled displays the Pump Control screen.

**Pump Control > Program Mode > Auto Setpoint**

Note: The Pump #x button is invisible for a drive until it is enabled by pressing Disabled #x. The screen that displays will be similar to the screen shown if it is in Program mode and Auto SP is selected.




The indicators on the left-hand side indicate whether the drive is: Ready to run, Running, utilizing Flow Compensation, in Boost mode, in Sleep Mode, has detected a Low/No-Flow condition, has detected a Dry Pump condition, and/or has detected a Run-Out/Leakage condition. Numeric displays located in the middle of the screen change depending on the selected pump mode.

On this screen, 'Pump #1' is a text object that you can change to reflect the name and description of drive #1.

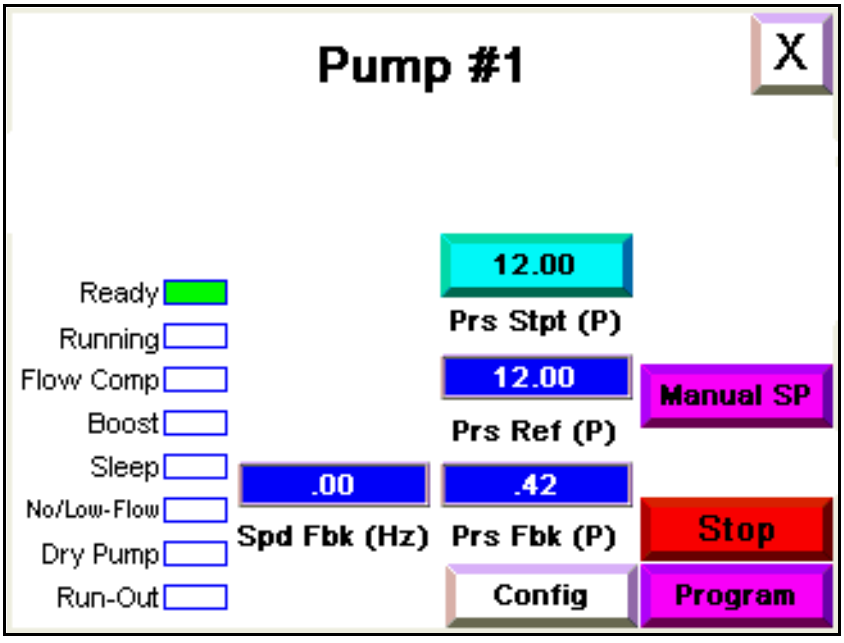
**IMPORTANT** All of the pressure inputs and display values are in generic units called 'P' or pressure units. The 'P' units text objects can be changed to reflect the actual pressure units (such as PSI). The MicroLogix controller will accept any pressure units as long as they are consistent. Do NOT mix units or unit prefix values.

Notice that the button in the lower right-hand corner displays as **Program**. This indicates that the screen is in Program mode and is currently used for monitoring only. Whenever **Program** is selected, the MicroLogix program controls the drive. When in **Auto SP** mode, the MicroLogix controller program determines the pressure setpoint. The only action that you can initiate from this screen while in Program mode, with Auto Setpoint selected, is to stop the drive by pressing **Stop**.

To take control of the pressure setpoint, while in Program mode, press Auto SP. **Manual SP** displays.

**Pump Control > Program Mode > Manual Setpoint**

The Pressure Setpoint (Prs Stpt (P)) button is now visible; this will allow manual control of the pressure setpoint.

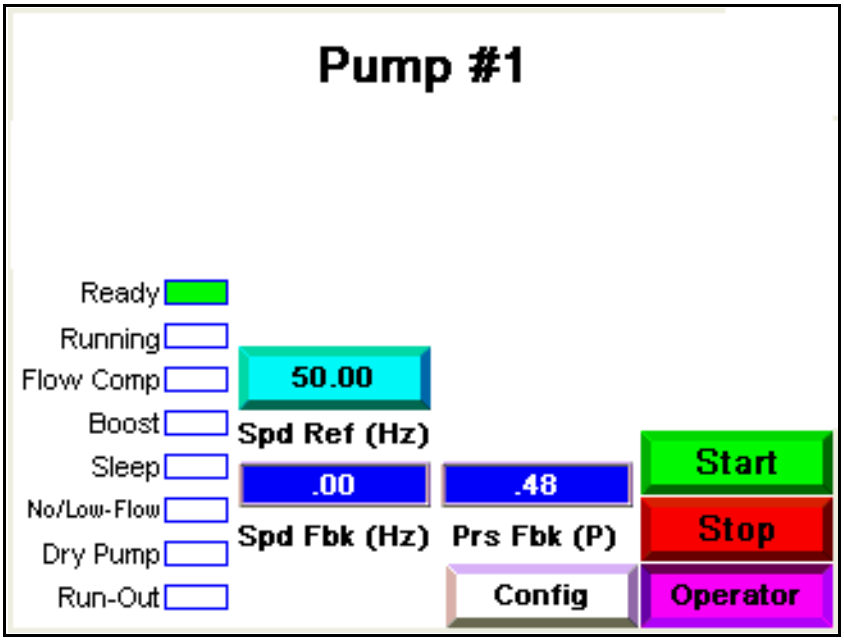


If you want to take complete control of the drive away from the MicroLogix controller, press Program to change the screen to Operator mode.

Note: Whenever the pump is changed from Program to Operator mode, or vice versa, a stop command is initiated.

**Pump Control > Operator Mode**

The Speed Reference (Spd Ref (Hz)) and Start buttons are visible; this will allow manual (speed) control of the drive.

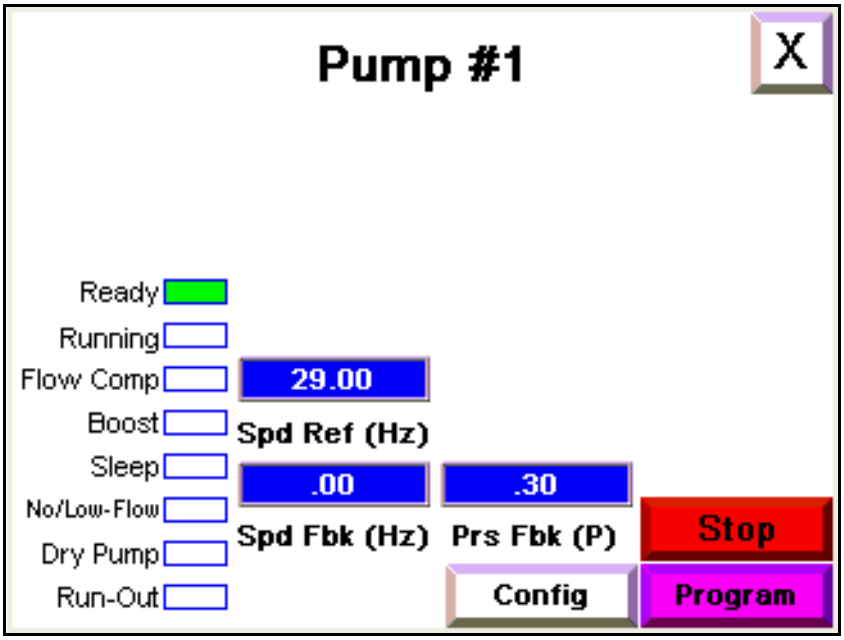


When in Program mode, the following display indicates that the pump is in Program Speed Reference mode. This mode is enabled by the MicroLogix controller whenever the Program Speed Reference Enable bit (n#_CMD_PCCFG_PROG, where n# = 9…16) is set to 1.

For more information on the Program Speed Reference Enable bit, please refer to the Integrate Pump Control into the Machine Control Ladder Logic section on page 53.

**Pump Control > Program > Program Speed Reference**

Notice that the Pressure Setpoint button and Pressure Reference are not visible. The drive will operate in speed control mode; the speed reference is set by the MicroLogix controller.




The numeric displays in the middle of the screen display the Speed Reference in Hz (Spd Ref (Hz), Speed Feedback in Hz (Spd Fbk (Hz)), and Pressure Feedback in 'P' units (Prs Fbk (P)).

Press the X button in the top-right corner to return the Network Overview screen. This button is only visible in Program mode.

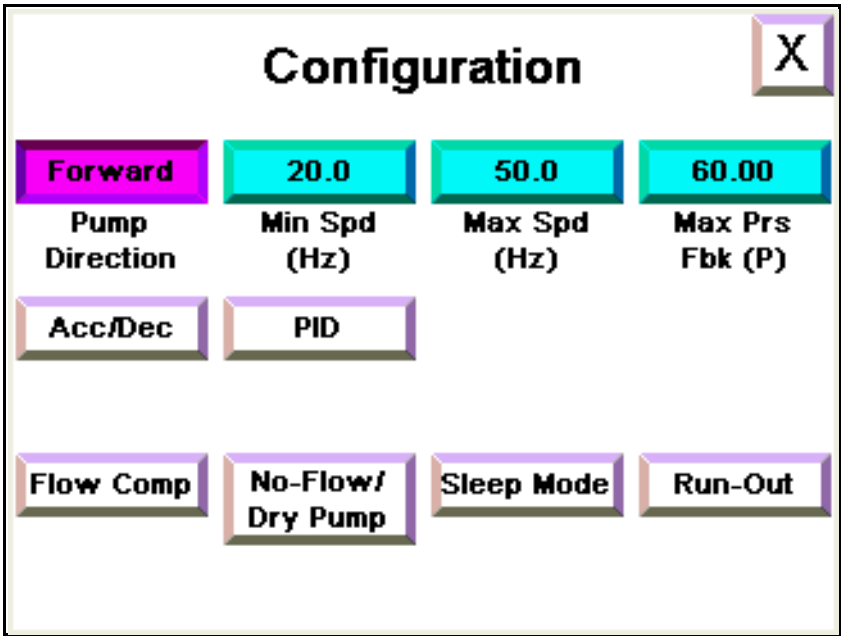
## Accessing the Main Configuration Screen

To access the Main Configuration screen, from the Pump Control screen, press Config.

**Main Configuration**

The configuration screen displays the setup for the pump from which this screen was accessed.

You can access additional sub-configuration screens from this screen.




You can press the X button in the top-right corner to return to the Pump Control screen.

Note: During the configuration setup, if any of the pump control features are inadvertently enabled, the pump may not operate as expected. By default, all of the pump control features have been Disabled or set to Off.

At this time, it is recommended that the following pump control features available via the Configuration screen remain disabled:

- Flow Compensation (accessed via the Flow Comp button)
- Low Power Detect (accessed via the No-Flow/Dry Pump button)
- Low Speed Detect (accessed via the No-Flow/Dry Pump button)

At this time, is recommended that the following pump control features available via the Configuration screen remain off:

- Low/No-Flow Action (accessed via the No-Flow/Dry Pump button)
- Dry Pump Action (accessed via the No-Flow/Dry Pump button)
- Run-Out Action (accessed via the Run Out button)

## *Set Min / Max Speed Limits & Max Pressure Feedback*

Follow this procedure to adjust each of the setpoints listed in the table.

| Setpoint Name | Units | Notes |
|---|---|---|
| Min Spd | Hz | Minimum or lowest speed that the pump will operate at.<br><br>Suggested default value: 0.0 Hz. |
| Max Spd | Hz | Maximum or highest speed that the pump will operate at.<br><br>Suggested default value: 60.0 Hz. |
| Max Prs Fbk | 'P' units | Maximum pressure feedback at the maximum analog input. This parameter needs to be set correctly to avoid scaling errors.<br><br>Example: If the analog input range is set to 4…20 mA, the Max Prs Fbk is set to the pressure value at 20 mA. |

1. Navigate to the Main Configuration screen.

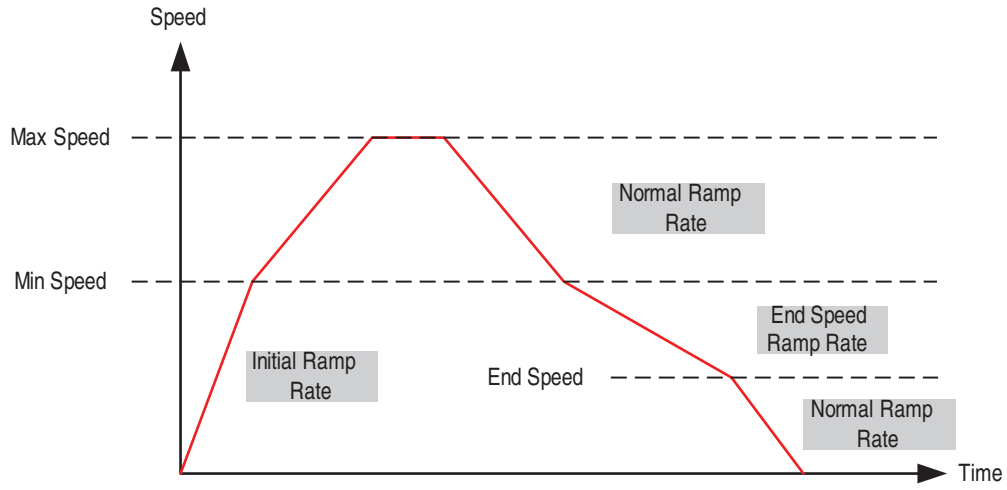
2. Press  above the desired setpoint. The following keypad displays.


3. Enter the desired value using the numeric keypad and press Enter (  ). For fields with a decimal value, you must enter the desired value for the field including the decimal value. For example, for a value of 10.0, press 1, 0, 0.

4. Repeat steps 2 and 3 for each setpoint listed in the table.

## *Set Accel/Decel Rates*

The acceleration/deceleration rates, or ramp rates, for the drive are calculated based on ramp times and end speed. These ramp rates are summarized below.

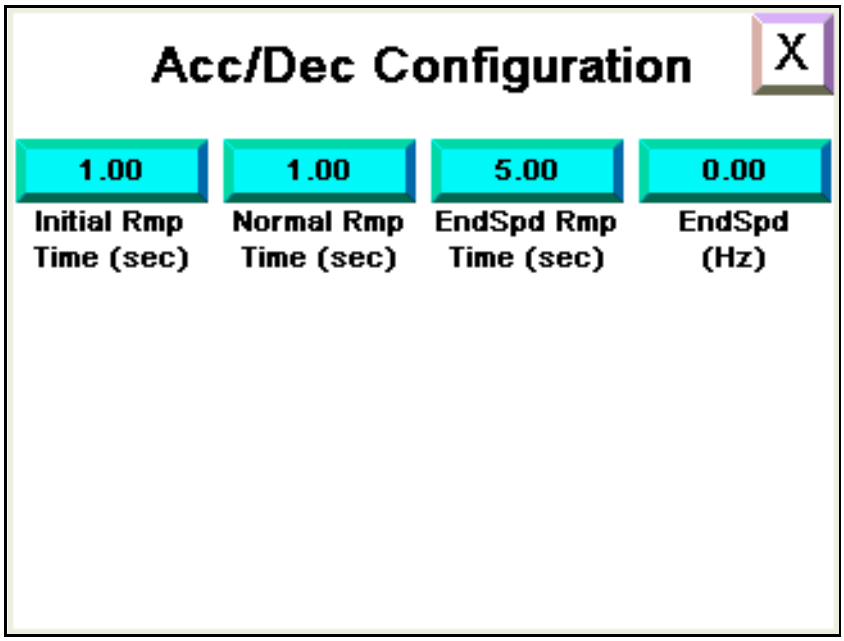



Follow this procedure to adjust each of the setpoints listed in the table.

| Setpoint Name | Units | Notes |
|---|---|---|
| Initial Rmp Time | sec | The time to accelerate the pump from "0 speed" to the minimum speed (Min Spd). |
| Normal Rmp Time | sec | The time to accelerate / decelerate the pump from the minimum speed (Min Spd) to the maximum speed (Max Spd) or vice versa. |
| EndSpd Rmp Time | sec | The time to decelerate the pump from the minimum speed (Min Spd) to the end speed (End Spd). |
| EndSpd | Hz | Typically used in applications with a check valve, to allow for a "soft" close. This is the speed where the check valve is expected to be closed.<br><br>Suggested default value: 0.0 Hz in applications without a check valve |

1. Navigate to the Main Configuration screen.

2. Press Acc/Dec to access the Acc/Dec Configuration screen.




3. To adjust the setpoint, press . The keypad displays.


4. Enter the desired value. For fields with a decimal value, you must enter the desired value for the field including the decimal value. For example, for a value of 10.0, press 1, 0, 0.

5. Repeat steps 3 and 4 for each setpoint listed in the table.

6. Press the X button in the top-right corner to return to the Main Configuration screen.

## *Set Pump Direction*

Follow this procedure to set the pump direction:

Note: To avoid damage to the pump and/or system that may result from operating the pump in the wrong direction, you may need to uncouple the motor from the pump before proceeding.

1. Determine the direction the pump should rotate; CW or CCW.

2. Navigate to the desired Pump Control screen. If necessary, press 

until the Pump Control screen displays.

3. If necessary, press 

to change the Pump Control screen to Operator mode.

4. Press Spd Ref. The keypad displays.

5. Enter a suitable speed value, such that the motor and/or pump rotation can be determined.

6. Press 

to Start the drive.

7. Verify the direction in which the motor and/or pump is turning.

8. Press 

, to stop the drive.

9. If the direction was correct, continue with Flow Compensation Configuration on page 33.

10. If the direction was incorrect, change the pump direction by pressing 

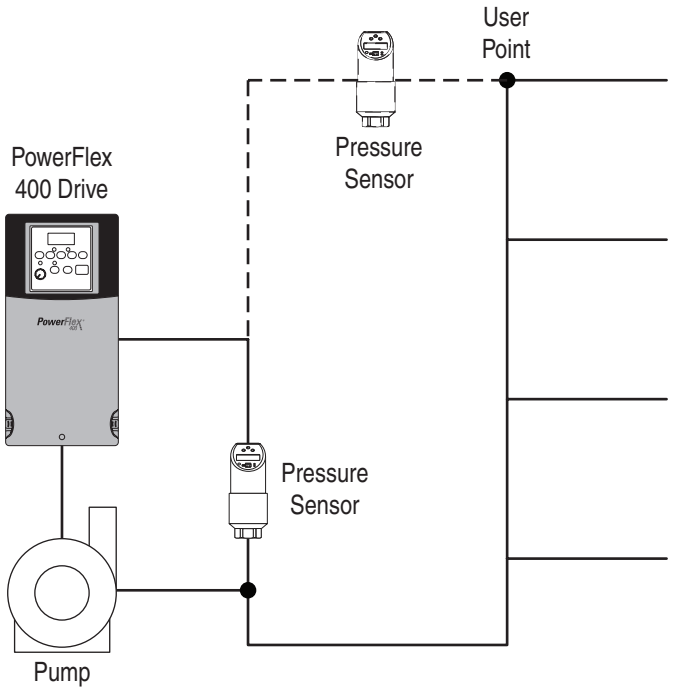
to display 

. This will cause the PowerFlex 400 drive to change the pump rotation direction.

## *Flow Compensation Configuration*

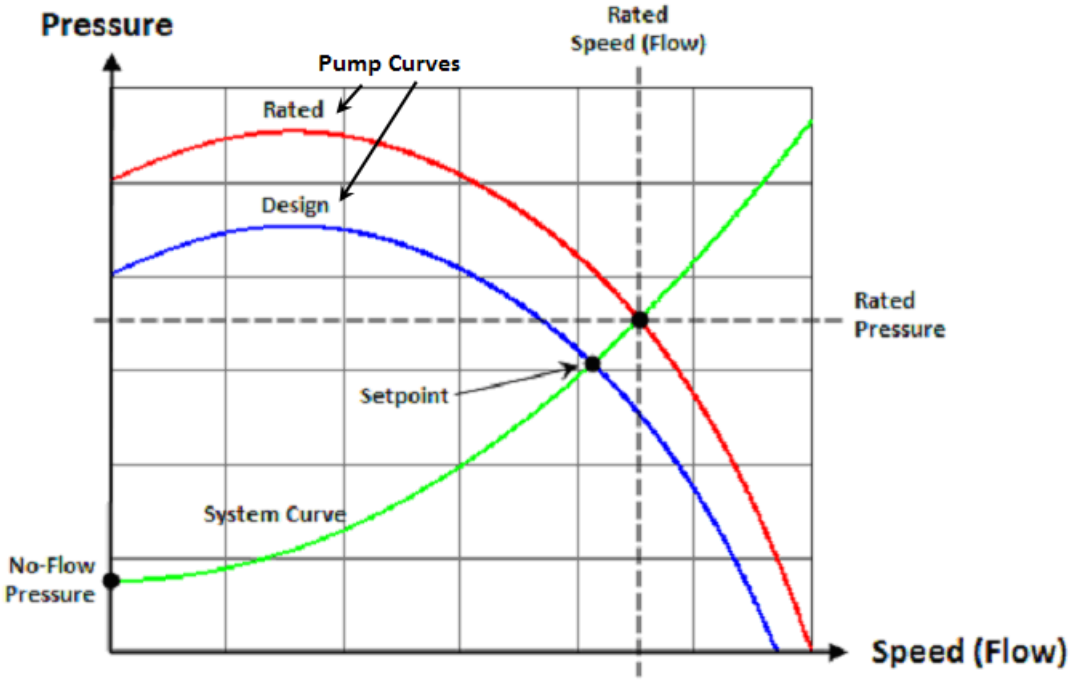
In some constant pressure closed loop applications, the pressure sensor cannot be located at the desired user point. Instead the pressure sensor must be mounted in close proximity to the pump.

As a result, when a reduced or low flow condition occurs, the pump will continue to operate at higher speeds in order to produce the desired pressure setpoint. However, at the user point, there is much less pressure drop in the system due to the reduced flow, causing an over pressure condition.

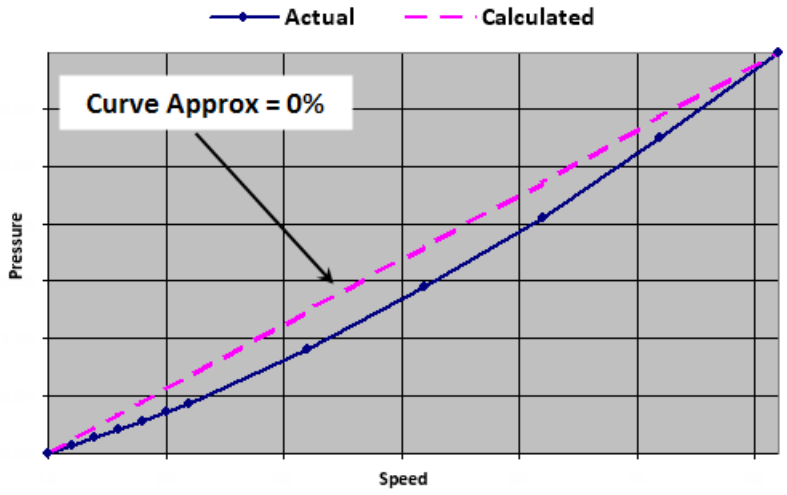



To counteract this over pressure condition, flow compensation reduces the pressure setpoint according to pump speed (which is approximately proportional to flow) to help maintain a constant pressure at the user point.

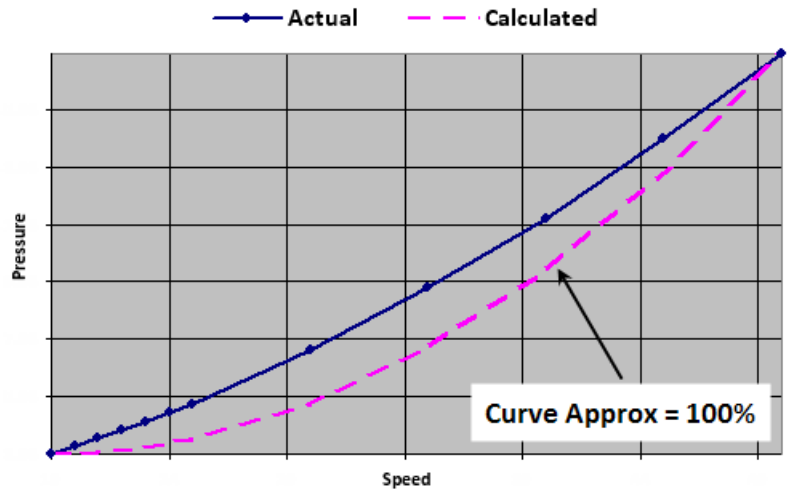
To compensate based on flow or speed, the system curve is calculated by the MicroLogix controller based on the no-flow and rated pressure points.



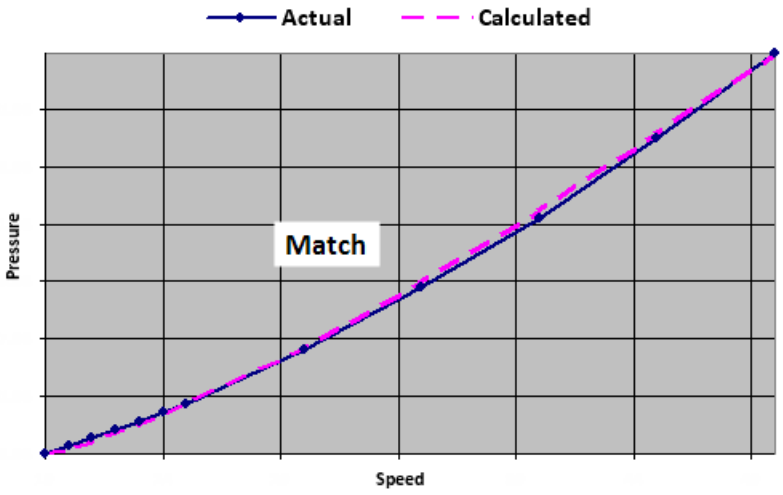

To achieve the best results, the calculated system curve needs to precisely match the actual system curve. This can be accomplished by adjusting the curve approximation. A curve approximation of 0%, will produce a linear result and may reside above the actual curve.



A curve approximation of 100%, will produce a more “ideal” result and may reside below the actual system curve.




Determining the best curve approximation may require quantitative knowledge of the actual system curve. Please reference the Flow Compensation System Curve Calculator.xls (located on the Connected Components Building Blocks Overview DVD, CC-QR001) for a suggested procedure and tool to help determine the optimum curve approximation.




The Flow Comp indicator on the Pump Control screen indicates that flow compensation is enabled and actively reducing the pressure setpoint.


The Prs Ref (P) field displays the pressure setpoint (or pressure reference) following the adjustment by flow compensation.

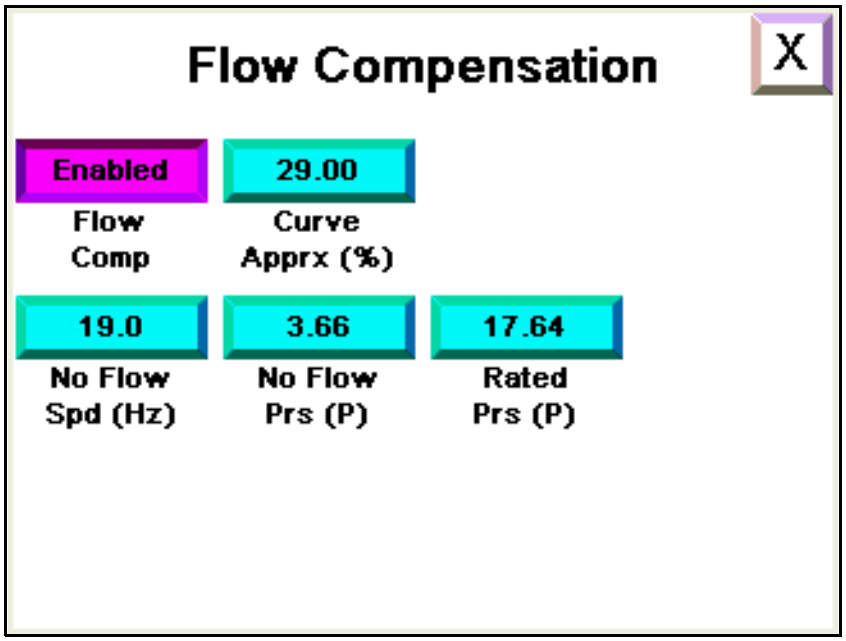
### Setting Up Flow Compensation

Note: If flow compensation is not going to be implemented, leave it set to the default setting of disabled, and see Low/No-Flow and Dry Pump Detection Configuration on page 38.

Follow this procedure to adjust each of the setpoints listed in the table.

| Setpoint Name | Units | Notes |
|---|---|---|
| No Flow Spd | Hz | The speed of the motor at which flow has effectively stopped and minimum or no-flow pressure (No Flow Prs) is achieved. |
| No Flow Prs | 'P' units | The minimum or no-flow pressure corresponding to no flow speed (No Flow Spd). |
| Rated Prs | 'P' units | The pressure produced at the maximum speed (Max Spd) of the pump. |
| Curve Apprx | % | Adjusts the shape of the calculated system curve.<br><br>This parameter needs be adjusted such that the calculated system curve matches or overlays the actual system curve.<br><br>0% = Linear<br><br>100% = Ideal (or $x^2$)<br><br>Suggested default value: 50% |

1. Navigate to the Main Configuration screen.
2. Press Flow Comp to access the Flow Compensation configuration screen.




3. Verify that Flow Comp is initially set to Disabled.
4. Press X until you have returned to the Pump Control screen.
5. If necessary, press Program to change the Pump Control screen to Operator mode.
6. Enter the highest speed reference (Spd Ref) that results in no-flow.
7. Start the drive.
8. Verify that no-flow exists. If at steady state, no-flow has been achieved, record the corresponding speed reference and pressure feedback (Prs Fbk).
9. Stop the drive.
10. If a no-flow condition was not achieved or if a higher speed reference could result in a no-flow condition, repeat steps 6…9. Otherwise continue with the next step.
11. Enter the maximum speed (Max Spd) into the speed reference (Spd Ref).
12. Start the drive.

13. Allow the pump to reach maximum speed and the pressure feedback to reach a steady state. Record the corresponding pressure feedback (Prs Fbk).

14. Stop the drive

15. Determine the Curve Approximation (Curve Apprx) by following the procedure outlined in the Flow Compensation System Curve Calculator.xls (located on the Connected Components Building Blocks Overview DVD, CC-QR001). This procedure will quantitatively determine the actual system curve by using your the recorded pressure feedback values at various speed setpoints between no-flow speed (No Flow Spd) and maximum speed (Max Spd).

16. Return to the Flow Compensation configuration screen.

17. Enter each of the flow compensations setpoints that were previously recorded:
    - No Flow Spd
    - No Flow Prs
    - Rated Prs
    - Curve Apprx

18. Flow Comp can now be enabled.

Note : You may choose to leave flow compensation disabled until after the configuration setup has been completed.

### *Low/No-Flow and Dry Pump Detection Configuration*

The following pump protection features have been built into the Pump Control.

Low/No-Flow Detection: Indicates that a low or no-flow condition exists in the system. This condition is detected when the pump is operated at low power (and NOT at maximum speed) or at low speed. The low power detect and/or low speed detect features must be enabled for low/no-flow detection.

Dry Pump Detection: Indicates a lack of water or liquid in the pump. This condition is detected when the pump is operated at low power and maximum speed. The low power detect feature must be enabled for dry pump detection.

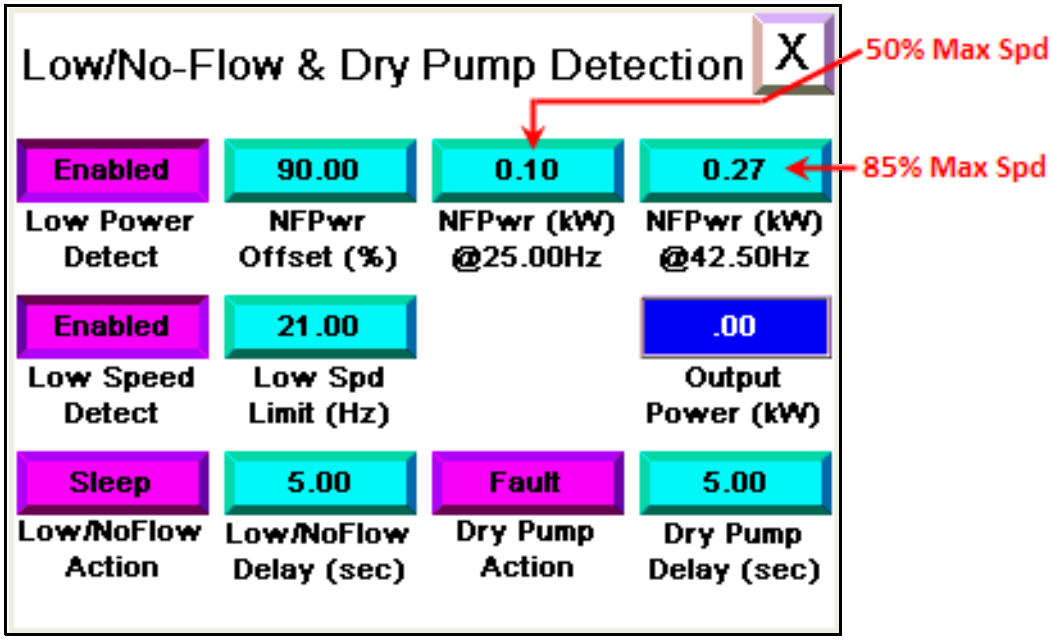
Note: If the low/no-flow and dry pump detection features are not going to be implemented, leave the detect selections set to the default settings of disabled and action selections set to the default settings of off and see Sleep Mode Configuration on page 43.

Follow this procedure to adjust each of the setpoints listed in the table.

| Setpoint Name | Units | Notes |
|---|---|---|
| NFPwr Offset | % | Low/no-flow power offset makes corrections to the calculated output power.<br><br>If low/no-flow is incorrectly detected:<br><br>1. Detected when it should NOT be detected, then decrease below 100%.<br><br>2. NOT detected when it should be detected, then increase above 100%.<br><br>Suggested default value: 100%<br><br>This setpoint may require adjustment once the system has been fully commissioned as is operating under normal conditions. |
| NFPwr (@ 50% Max Speed) | kW | The output power at 50% of maximum speed (Max Spd) during a no-flow condition.<br><br>To configure this setpoint, the main system valve will need to be closed to stop flow. |
| NFPwr (@ 85% Max Speed) | kW | The output power at 85% of maximum speed (Max Spd) during a no-flow condition.<br><br>To configure this setpoint, the main system valve will need to be closed to stop flow. |
| Low Spd Limit | Hz | The speed limit for low/no-flow detection. A low speed condition exists if the speed feedback is less than or equal to this limit.<br><br>Suggested default value: Normally set to the minimum speed (Min Spd) of the pump. Set above this value if a higher low speed limit is required. |
| Low/NoFlow Action | NA | Sets the action that is taken when a low/no-flow condition has been detected.<br><br>Selections:<br><br>Off – Condition ignored.<br><br>Alarm – Indication only.<br><br>Fault – Pump is stopped, fault information displayed.<br><br>Sleep – Pump enters sleep mode. |
| Low/NoFlow Delay | sec | Sets the time that a low/no-flow condition must exist before action will occur. If the condition goes false before the time expires, the internal timer is reset. |
| Dry Pump Action | NA | Sets the action that is taken when a dry pump condition has been detected.<br><br>Selections:<br><br>Off – Condition ignored.<br><br>Alarm – Indication only.<br><br>Fault – Pump is stopped, fault information displayed. |
| Dry Pump Delay | sec | Sets the time that a dry pump condition must exist before action will occur. If the condition goes false before the time expires, the internal timer is reset. |

1. Navigate to the Main Configuration screen.

2. Press **No-Flow/ Dry Pump** to access the Low/No-Flow & Dry Pump Detection configuration screen.




3. Verify that all of the following are initially set to **Disabled**.

   - Low Power Detect
   - Low Speed Detect
   - Low/NoFlow Action
   - Dry Pump Action

4. Close the main pump control to stop system flow. System flow must be stopped in order measure the no-flow power output.

5. Press **X** until you are returned to the Pump Control screen.

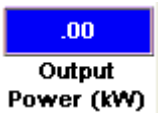
6. If necessary, press Program to change the Pump Control screen to Operator mode.

7. Enter a speed reference (Spd Ref) of 50% maximum speed (Max Spd).

8. Start the drive.

**9.** Return to the Low/No-Flow & Dry Pump Detection configuration screen.

**10.** Allow the pump to reach the speed reference.

**11.** Enter the output power displayed in 

into the 50% no-flow power setpoint (NFPwr (kW) @xx.xxHz) field (refer to screen example for location). The output power is displayed on the right-hand side of second row on the No-Flow / Dry Pump Configuration screen.

**12.** Return to the Pump Control screen.

**13.** Stop the drive.

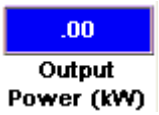
**14.** If necessary, press Program to change the Pump Control screen to Operator mode.

**15.** Enter a speed reference (Spd Ref) of 85% maximum speed (Max Spd).

**16.** Start the drive.

**17.** Return to the Low/No-Flow & Dry Pump Detection configuration screen.

**18.** Allow the pump to reach the speed reference.

**19.** Enter the output power displayed in 

into the 85% no-flow power setpoint (NFPwr (kW) @xx.xxHz) field (refer to screen example for location).

**20.** Return to the Pump Control screen.

**21.** Stop the drive.

**22.** Return to the Low/No-Flow & Dry Pump Detection configuration screen.

**23.** Set the No-Flow Power Offset (NFPwr Offset). Refer to the table above for details on how to properly set the No-Flow Power Offset.

Note: The No-Flow Power Offset (NFPwr Offset) may require adjustment once the system has been fully commissioned and is operating under normal conditions.

**24.** Enter the remaining setpoints:

- Low Spd Limit
- Low/NoFlow Delay
- Dry Pump Delay

**25.** Enable the Low Power Detect and Low Speed Detect.

**26.** Set the Low/NoFlow Action and Dry Pump Action accordingly.

Note: You may choose to leave low/no-flow and dry pump actions set to off until after the configuration setup has been completed.

**27.** You can now open the main pump control.

## *Sleep Mode Configuration*

If a low/no-flow condition has been detected, and the low/no-flow action has been set to sleep, the drive will enter into sleep mode. The following sequence occurs while the pump is in sleep mode:

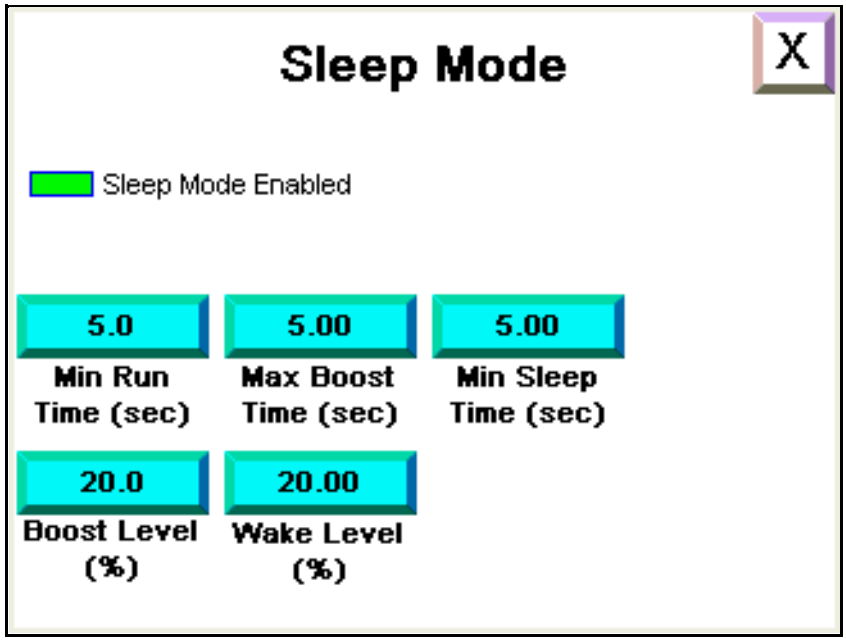
1. The system pressure setpoint is increased (boosted) to prevent short cycling.
2. Once the system pressure reaches the boost setpoint or the boost time has expired, the pump is stopped.
3. The pump will remained stopped until the system pressure falls below the wake level setpoint and the minimum sleep time has expired. When both conditions have been met, the pump will be re-started.
4. Before the pump can re-enter sleep mode, the pump must operate for a minimum run time.

Follow this procedure to adjust each of the setpoints listed in the table.

| Setpoint Name | Units | Notes |
|---|---|---|
| Min Run Time | sec | The minimum time the pump must operate before entering sleep mode. |
| Max Boost Time | sec | The maximum time the pump is allowed to boost the system pressure. If the time expires before the system pressure has reached the boost level, the pump will enter sleep mode. |
| Min Sleep Time | sec | The minimum time the pump will remain in sleep mode regardless of a drop in system pressure. |
| Boost Level | % | The amount the current pressure reference (Prs Ref) is increased or boosted to prevent short cycling of the pump.<br><br>Boost Reference ['P' units] = Boost Level [%] / 100 * Pressure Reference ['P' units] |
| Wake Level | % | The amount the pressure feedback (Prs Fbk) must drop below before the pump will be re-started.<br><br>Wake Reference ['P' units] = Wake Level [%] / 100 * Pressure Reference ['P' units] |

1. Navigate to the Main Configuration screen.

2. Press Sleep Mode, to access the Sleep Mode configuration screen.




3. Enter the following setpoints:

   - Min Run Time
   - Max Boost Time
   - Min Sleep Time
   - Boost Level
   - Wake Level

Note: Sleep Mode Enabled Indicates if the low/no-flow action on the No-Flow / Dry Pump Configuration screen has been set to sleep.

## *Run-Out/Leakage Detection Configuration*

The following pump protection feature has been built into the Pump Control.

Run-Out Detection: Indicates a leak in the system. This condition is detected when the pump is operated at maximum speed and pressure feedback is below the setpoint.

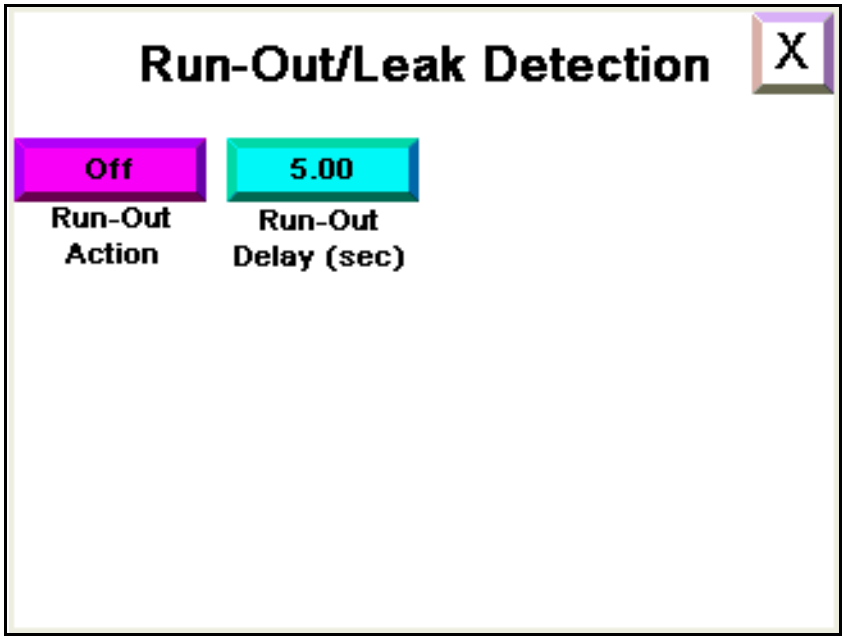
Note: If the run-out/leakage detection feature is not going to be implemented, leave the action selection set to Off and see PID Configuration on page 47.

Follow this procedure to adjust each of the setpoints listed in the table.

| Setpoint Name | Units | Notes |
|---|---|---|
| Run-Out Action | NA | Sets the action that is taken when a run-out/leakage condition has been detected.<br><br>Selections:<br><br>Off – Condition ignored.<br><br>Alarm – Indication only.<br><br>Fault – Pump is stopped, fault information displayed. |
| Run-Out Delay | sec | Sets the time that a run-out/leakage condition must exist before action will occur. If the condition goes false before the time expires, the internal timer is reset. |

1. Navigate to the Main Configuration screen.

2. Press Run-Out, to access the Run-Out/Leak Detection configuration screen.



**3.** Set the Run-Out Action to On.

Note: You may choose to leave the run-out action set to off until after the configuration setup has been completed.

**4.** Set the Run-Out Delay time.

## *PID Configuration*

Follow this procedure to adjust each of the setpoints listed in the table.

| Setpoint Name | Units | Notes |
|---|---|---|
| KP-Prop Gain | NA | The proportional gain (no units) affects how the regulator reacts to the magnitude of the error. The proportional component of the PID regulator outputs a speed command proportional to the PID error. For example, a proportional gain of 1 would output 100% of max frequency when the PID error is 100% of the analog input range. A larger value for proportional gain makes the proportional component more responsive, and a smaller value makes it less responsive. Setting proportional gain to 0.00 disables the proportional component of the PID loop. |
| KI-Intg Time | sec | The integral gain (units of seconds) affects how the regulator reacts to error over time and is used to get rid of steady state error. For example, with an integral gain of 2 seconds, the output of the integral gain component would integrate up to 100% of max frequency when the PID error is 100% for 2 seconds. A larger value for integral time makes the integral component less responsive, and a smaller value makes it more responsive. Setting integral gain to 0 disables the integral component of the PID loop. |
| KD-Diff Rate | $sec^{-1}$ | The differential gain (units of 1/seconds) affects the rate of change of the PID output. The differential gain is multiplied by the difference between the previous error and current error. Thus, with a large error the differential gain has a large effect and with a small error the differential gain has less of an effect. This parameter is scaled so that when it is set to 1.00, the process response is 0.1% of maximum speed when the process error is changing at 1% / second. A larger value for differential rate makes the differential term have more of an effect and a small value makes it have less of an effect. In many applications, the differential gain is not needed. Setting differential rate to 0.00 (factory default) disables the differential component of the PID loop. |
| Deadband | % | Deadband is used to set a range, in percent, of the PID Reference that the drive will ignore.<br><br>Example:<br><br>Deadband is set to 5.0. The PID Reference is 25.0%. The PID Regulator will not act on a PID Error that falls between 20.0…30.0% |

1. Navigate to the Pump Control screen.
2. If necessary, press Operator to change the Pump Control screen to Program mode.
3. If necessary, press Auto SP to select 

.

**4.** Tune the PID loop:

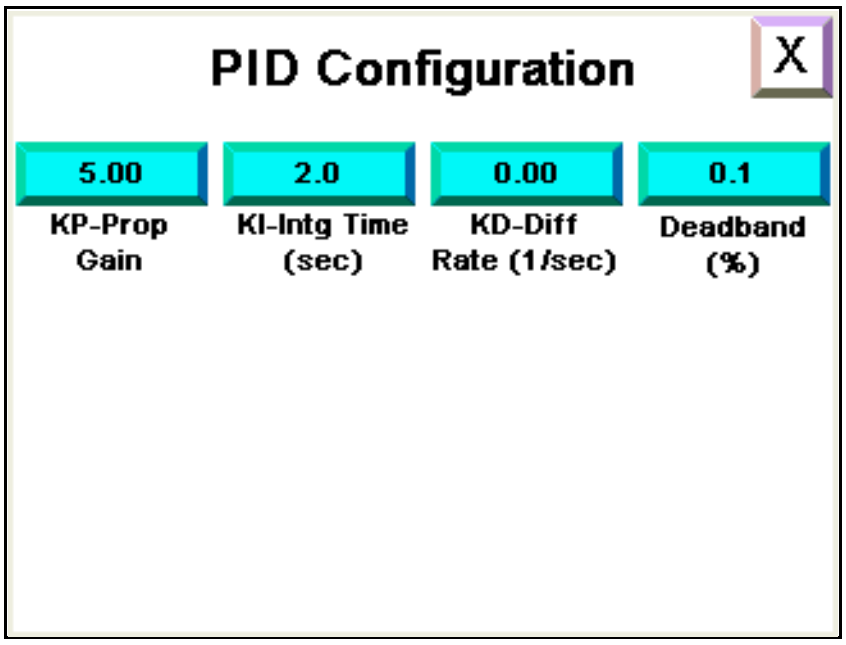
**a.** Using the MicroLogix Controller, manually initiate a start by setting the User Start Command bit (n#_CMD_PCCFG_START, where n# = 9…16).

For more information on the User Start Command bit, please refer the Integrate Pump Control into the Machine Control Ladder Logic on page 53.

**b.** On the Pump Control screen apply a step change in the pressure setpoint (Prs Stpt), typically 5…10%.

**c.** Press Config to access the Main Configuration screen.

**d.** Press PID , to access the PID Configuration screen.




Note: While adjusting the proportional gain (KP-Prop Gain), it may be desirable to disable the integral gain (KI-Intg Time) and differential gain (KD-Diff Rate) by setting their values to '0'.

**e.** Adjust the proportional gain accordingly:

- If the response is too slow increase the proportional gain.
- If the response it too quick and/or unstable, decrease proportional gain.
- Typically, proportional gain is set to some value below the point where the PID begins to go unstable.

**f.** Repeat steps b…e, until the desired response is achieved.

**g.** Return to the Pump Control screen and reset the pressure setpoint (Prs Stpt) to the original value.

**h.** Apply a step change in the pressure setpoint (leave the proportional gain set as in the previous step), typically 5…10%.

**i.** Adjust the integral gain accordingly:

- If the response is too slow, or the PID Feedback does not become equal to the PID Reference, decrease the integral time.
- If there is a lot of oscillation in the pressure feedback (Prs Fbk) before settling out, increase the integral time.

**j.** Repeat steps h and i, until the desired response is achieved.

**k.** At this point, the differential gain may not be needed. However, if after determining the values for proportional gain and integral time:

- The response is still slow after a step change - increase the differential rate.
- The response is still unstable - decrease the differential rate.

**l.** Adjust the deadband.

**5.** Stop the drive.

This concludes the configuration setup and the pump should be ready for normal operation. Several features, such as No-Flow Power Offset (NFPwr Offset), may require additional adjustment while the pump is in normal operation.

Note: During the configuration setup, the pump control features may have been disabled.

If necessary, the following pump control features should be Enabled:

- Flow Compensation
- Low Power Detect
- Low Speed Detect

If necessary, the following pump control features can be set appropriately:

- Low/No-Flow Action
- Dry Pump Action
- Run-Out Action

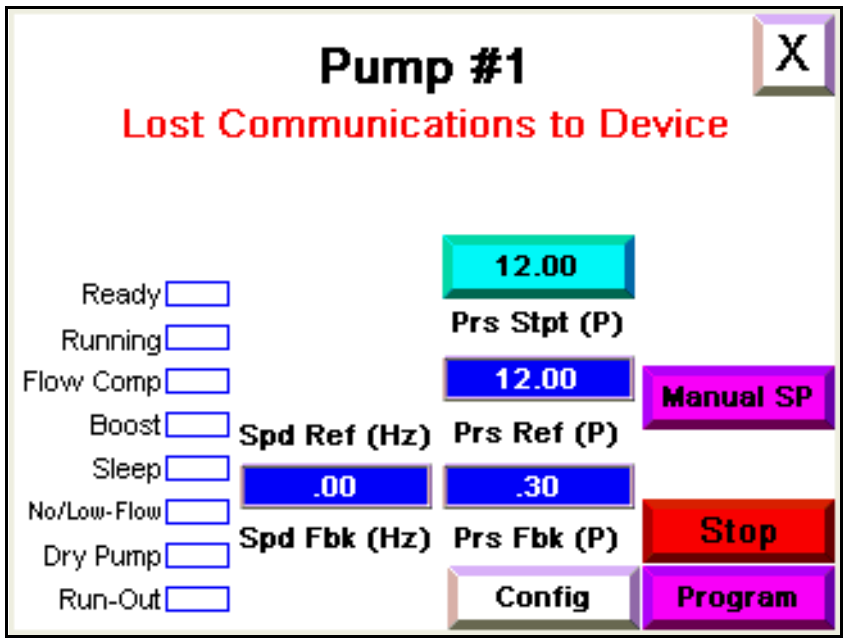
While in operation, if any of the pump control features do not appear to operate normally, it is strongly recommended that you revisit the corresponding configuration setup sections.

## Fault Look-up Display

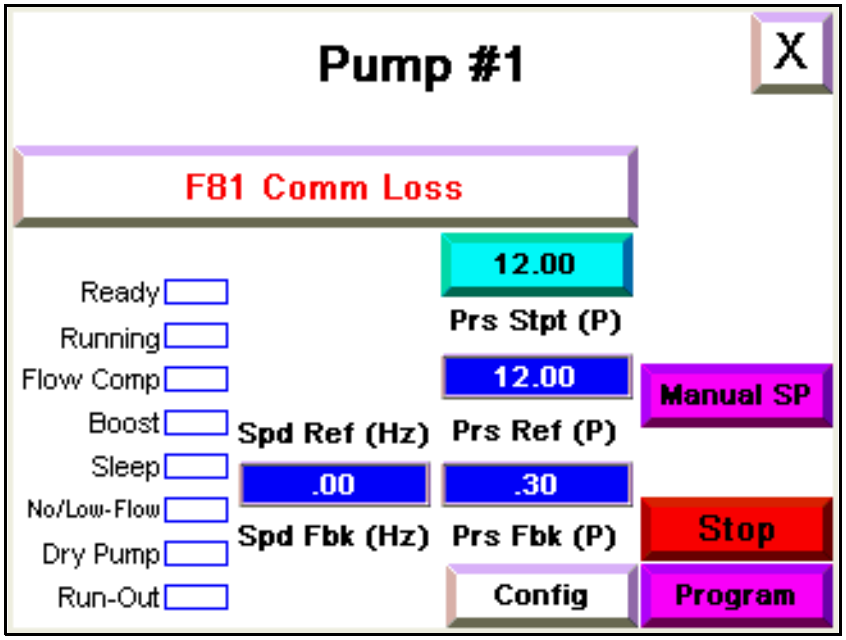
The final feature of the Operator screen to verify is the Fault Code display. The Fault Look-Up screen lets you cross reference a drive fault to a pump fault.

To test the Fault Code display, generate a drive fault condition:

1. Unplug the RJ45 connector from the drive and verify that the Lost Communications to Device message displays.



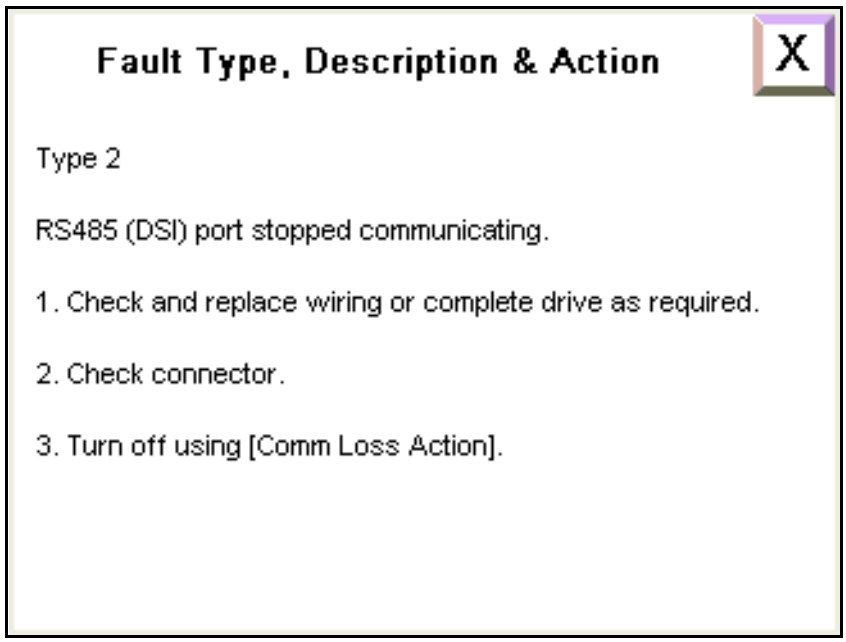
2. Plug the RJ45 connector back into the drive. The Lost Communications to Device message disappears and the F81 Comm Loss fault displays.




3. Press the drive fault banner ( 

) on the display.

The drive Fault Type, Description, & Action screen displays. This screen provides the same information and troubleshooting tips for the drive as is found in the drive User Manual.



Press  to return to the previous screen.

## *Pump Faults*

In addition to drive faults, the following pump specific faults may also display:

- Low/No-Flow Fault
- Dry Pump Fault
- Run-Out/Leakage Fault

To clear a drive or pump fault, the pump must be in Operator mode. Once in Operator mode, 

and 

will appear depending on the faults that currently exist.

To clear the drive fault, press 

. After doing so, the drive F81 Comm Loss fault clears, as indicated by the fault display. Once the drive fault has been cleared, the Clear Drive Fault button disappears. The Clear Pump Fault button will also disappear once all of the Pump faults have been cleared.

# Integrate Pump Control into the Machine Control Ladder Logic

The previous section demonstrated how the PVc HMI used the Pump Control (PUMP CTRL) and Pump Communication (PUMP COMM) routines to start, stop, set direction, clear faults, adjust the speed, and adjust the pressure setpoint of the drive while in Operator mode. When the HMI is in Program mode, it is your machine's control ladder logic that uses the Pump Control and Pump Communication routines to control one or more of the drives by adjusting specific bits and words in the data table.

An example of how to use the Pump Control and Pump Communication routines to start and stop one or more of the pumps is included in the USER PRGRM (ladder file 100) of the CCBB Pump Control program.

The following data table tags are used to control the pump while in Program mode:

| Symbol | Address | Notes |
|---|---|---|
| 9_CMD_PCCFG_PROG | B229:71/5 | |
| 10_CMD_PCCFG_PROG | B229:96/5 | |
| 11_CMD_PCCFG_PROG | B229:121/5 | Program speed reference enable bit.<br><br>When this bit is set and Program mode is selected, the pump will operate in speed mode and its reference will be set by program speed reference. |
| 12_CMD_PCCFG_PROG | B229:146/5 | |
| 13_CMD_PCCFG_PROG | B229:171/5 | |
| 14_CMD_PCCFG_PROG | B229:196/5 | |
| 15_CMD_PCCFG_PROG | B229:221/5 | |
| 16_CMD_PCCFG_PROG | B229:246/5 | |
| 9_CMD_PCCFG_STOP | B229:71/7 | |
| 10_CMD_PCCFG_STOP | B229:96/7 | |
| 11_CMD_PCCFG_STOP | B229:121/7 | |
| 12_CMD_PCCFG_STOP | B229:146/7 | User stop command bit.<br><br>Issues a Program stop command from the MicroLogix controller. |
| 13_CMD_PCCFG_STOP | B229:171/7 | |
| 14_CMD_PCCFG_STOP | B229:196/7 | |
| 15_CMD_PCCFG_STOP | B229:221/7 | |
| 16_CMD_PCCFG_STOP | B229:246/7 | |

| Symbol | Address | Notes |
|---|---|---|
| 9_CMD_PCCFG_START | B229:71/8 | |
| 10_CMD_PCCFG_START | B229:96/8 | |
| 11_CMD_PCCFG_START | B229:121/8 | |
| 12_CMD_PCCFG_START | B229:146/8 | User start command bit.<br><br>Issues a Program start command from the MicroLogix controller. |
| 13_CMD_PCCFG_START | B229:171/8 | |
| 14_CMD_PCCFG_START | B229:196/8 | |
| 15_CMD_PCCFG_START | B229:221/8 | |
| 16_CMD_PCCFG_START | B229:246/8 | |
| 9_CMD_PCPROG_SPDREF | F224:30 | |
| 10_CMD_PCPROG_SPDREF | F224:62 | |
| 11_CMD_PCPROG_SPDREF | F224:94 | Program speed reference.<br><br>When the program speed reference enable bit is set and Program mode is selected, the pump will operate in speed mode following this speed reference. |
| 12_CMD_PCPROG_SPDREF | F224:126 | |
| 13_CMD_PCPROG_SPDREF | F224:158 | |
| 14_CMD_PCPROG_SPDREF | F224:190 | |
| 15_CMD_PCPROG_SPDREF | F224:222 | |
| 16_CMD_PCPROG_SPDREF | F224:254 | |
| 9_CMD_PCPRS_AUTSP | F224:31 | |
| 10_CMD_PCPRS_AUTSP | F224:63 | |
| 11_CMD_PCPRS_AUTSP | F224:95 | Auto pressure setpoint.<br><br>When Program mode and Auto Setpoint (Auto SP) are selected, the pump will control to this pressure setpoint. |
| 12_CMD_PCPRS_AUTSP | F224:127 | |
| 13_CMD_PCPRS_AUTSP | F224:159 | |
| 14_CMD_PCPRS_AUTSP | F224:191 | |
| 15_CMD_PCPRS_AUTSP | F224:223 | |
| 16_CMD_PCPRS_AUTSP | F224:255 | |

# MicroLogix Sample Code for PowerFlex 4-Class Drive Parameter Backup & Restore

PowerFlex 4-Class Drive Parameter Backup & Restore (PB&R) provides the capability of backing up all of the configured drive parameters for up to 16 PowerFlex 4-class (PF4-class) drives, connected together on a Modbus serial RS-485 network. The parameter sets are stored as recipes within the MicroLogix controller, which is the Modbus master on the network. Recipe memory is used to store the parameter settings for each drive, without consuming any MicroLogix user program or data table memory (except for that memory used by the subroutines themselves). As recipes, the parameter settings are saved as part of the MicroLogix RSLogix program, as well as part of the optional memory module back-up image.

Once a PF4-class drive's parameters have been backed up to the MicroLogix 1400 controller, if that drive fails and is replaced with a new drive, those parameters can be quickly restored to the new drive, without requiring any programming device and/or software.

This MicroLogix sample code consists of an SLC library routine that can be imported into a new or existing MicroLogix 1400 RSLogix project. If the LCD user-display is not being controlled by any existing routines in the MicroLogix controller, this PB&R functionality can be initiated through the MicroLogix keypad and LCD user-display. Alternatively, PB&R can be initiated via the MicroLogix web server by using Internet Explorer web browser, or directly from RSLogix 500 software while online with the MicroLogix controller.

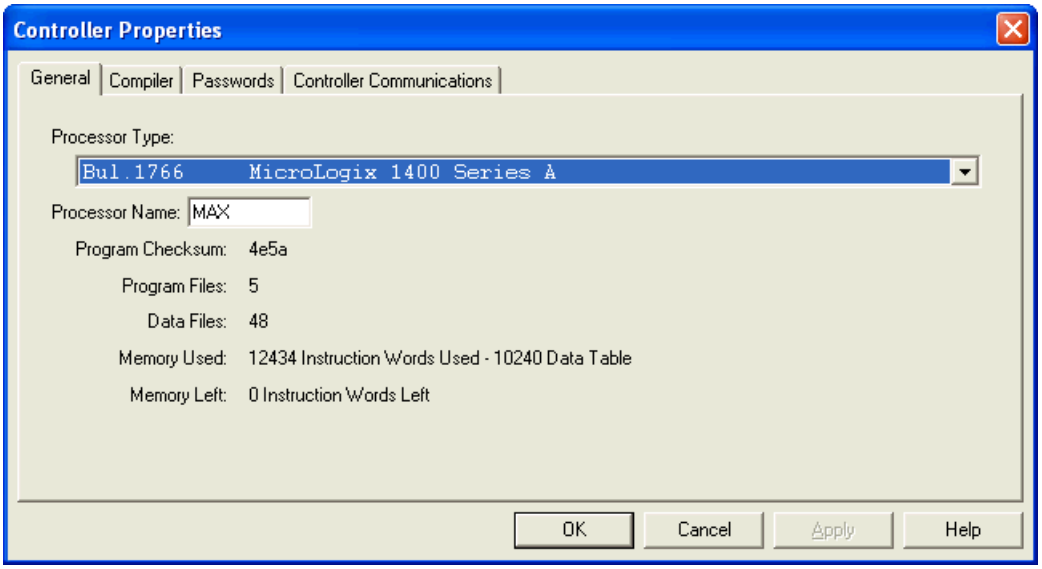
Before importing the PB&R routine, be sure to confirm all of the following:

- All drives are PowerFlex 4-class drives (PowerFlex 4M, 4, 40, 40P and/or 400).
- All drives are networked together with the MicroLogix 1400 controller by using RS-485 serial Modbus network.
- Channel 0 of the MicroLogix controller is configured for Modbus RTU Master. The MicroLogix controller must be the only master on the Modbus network.
- The Modbus communication parameters for all devices are set to 9600 baud, 8 data bits, no parity bit, and 1 stop bit, which is the factory default settings for PF4-class drives.
- All drive node addresses fall within the range of 1...16.
- No node address 100 exists on the network. This is reserved for the device restore functionality, since this is the factory-default node address for PF4-class drives.
- Recipe files 0...6 and recipe numbers 0...16 are available for use.
- Program files 242...255 and data table files 248...255 are available for use.
- Enough unused data table and program memory is available.

Although the drive parameters are stored in recipe memory, the various subroutines that make up the PB&R routine require program and data table memory, as well as specific program file numbers and data table file numbers. In order to minimize the amount of files and memory used, it is possible to delete some files, depending on which PF4-class drives are used. For instance, if you only need to support PowerFlex 400 drives, then you can delete the files that are specific to PowerFlex 4M, 4, 40, and 40P drives, to minimize the amount of memory used by the PB&R routine. The number of drives being supported does not matter, whether you have 1 or 16 drives, the same amount of program and data table memory is used for PB&R. Also, if you are not going to use the LCD user-display to initiate the back-up and restore functions, you can also delete the files specific to this functionality.

The MicroLogix 1400 memory supports a maximum of 10240 Data Table words and a maximum of 12434 Instruction words.

**Controller Properties Dialog Box**




The 10240 Data Table words use up 2560 Instruction Words, so the maximum number of Instruction Words available for ladder logic is 9874.

These tables list the program files, data table files used, and memory usage.

**Ladder File Table**

| Ladder File Name | File No. | Required by | No. of Instruction Words |
|---|---|---|---|
| DRIVE PB&R | 255 | All | 20 |
| DRIVE BKUP | 254 | All | 62 |
| DRIVE RSTR | 253 | All | 68 |
| PB&R LCD | 252 | Optional | 600 |
| PF4M BKUP | 251 | PF4M only | 84 |
| PF4M RSTR | 250 | PF4M only | 252 |
| PF4 BCKUP | 249 | PF4 only | 56 |
| PF4 RESTR | 248 | PF4 only | 90 |
| PF40 BCKUP | 247 | PF40 only | 83 |
| PF40 RESTR | 246 | PF40 only | 121 |
| PF40P BKUP | 245 | PF40P only | 117 |
| PF40P RSTR | 244 | PF40P only | 157 |
| PF400 BKUP | 243 | PF400 only | 114 |
| PF400 RSTR | 242 | PF400 only | 103 |

**Data File Table**

| Data File Name | File No. | Required by | No. of Data Table Words |
|---|---|---|---|
| PB&R PARAM | 255 | All | 256 |
| PB&R MSG | 254 | All | 50 |
| PB&R LCD | 253 | Optional | 756 |
| PF4M MSG | 252 | PF4M only | 550 |
| PF4 MSG | 251 | PF4 only | 275 |
| PF40 MSG | 250 | PF40 only | 350 |
| PF40P MSG | 249 | PF40P only | 450 |
| PF400 MSG | 248 | PF400 only | 400 |

Therefore, the maximum amount of memory used by the PB&R routine, supporting all PF4-class drive types and including the LCD user-display capability, is 3087 Data Table words and 1927 Instruction words. The minimum amount of memory used by the PB&R routine, supporting only PowerFlex 4 drives with no LCD user-display capability, is 581 Data Table words and 296 Instruction words.

# Merge the PB&R Routine into a New or Existing Program

The PB&R routine library file names all start with:

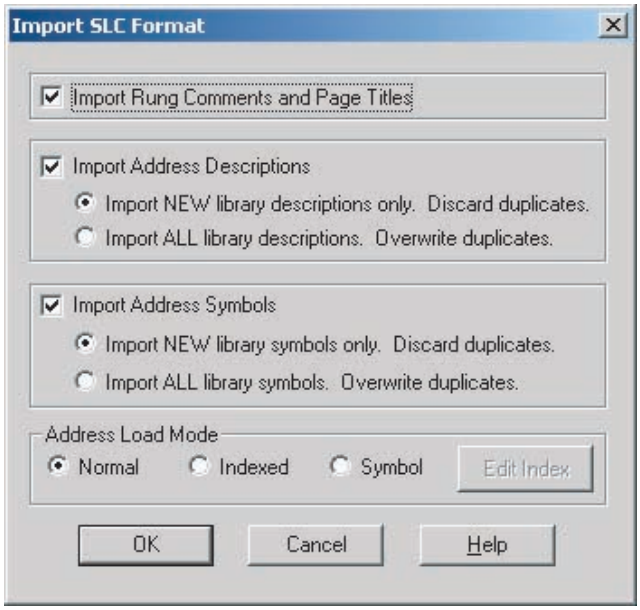
'ML1400 TO PF4-CLASS DRIVE PARAMETER BACKUP & RESTORE WITH USER DISPLAY'

Use RSLogix 500 software, version 7.20 or later, to open the MicroLogix 1400 series A file (new or existing) offline that you intend to copy the PB&R subroutines into. If you are merging into an existing file, make sure you have a back-up copy before proceeding.

1. Verify that Channel 0 in the existing file is configured for Modbus RTU Master.
2. Copy the PB&R routine files onto your computer, within RSLogix 500 software.
3. From the File menu, choose Open.
4. Browse to and select the following file:

   'ML1400 TO PF4-CLASS DRIVE PARAMETER BACKUP & RESTORE WITH USER DISPLAY.SLC'

   The following screen displays.

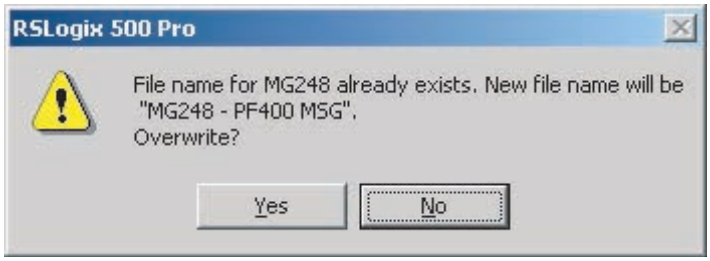


5. Match the default settings shown and click OK.

   The following warning message displays.


6. Click OK.

   You see a series of screens that are similar to this one.




7. Click Yes on all of these screens.

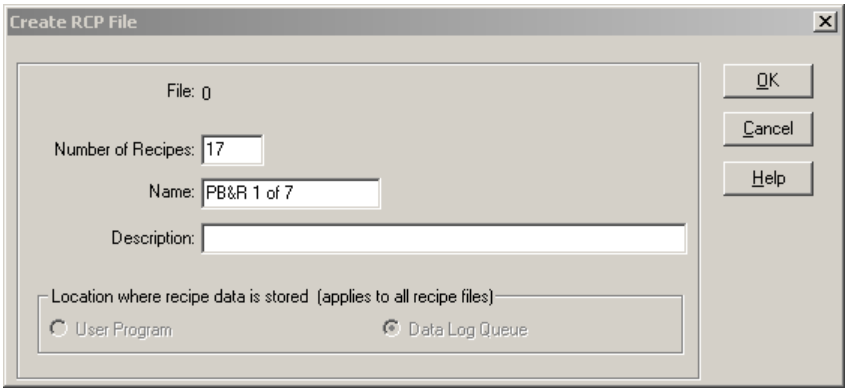
Next, if the Recipe (RCP) Configuration Files don't already exist in the ladder project, you must create the Recipe (RCP) Configuration Files for the project. Go to step 1 below to create the files.

If the files do exist, verify the project. See step 8 on page 60.

1. Right-click RCP Configuration Files and choose New.

2. In the Number of Recipes box, enter 17.

3. In the Name box, enter 'PB&R 1 of 7' for RCP File 0.

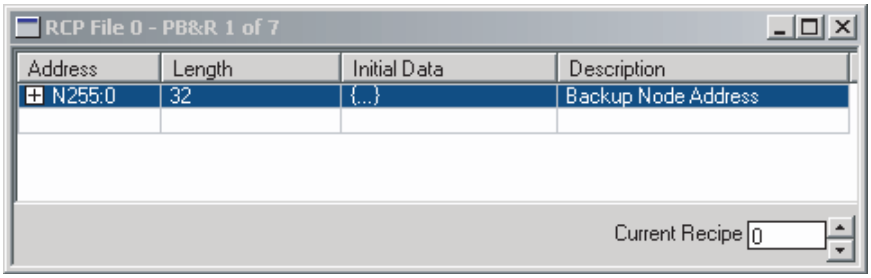


4. Click OK.

5. Click the Address box and enter N255:0

6. Click the Length box and enter 32.

   The Description will display automatically.




7. Close this screen and similarly create RCP Files 1...6 by using the following data.

| RCP File No. | No. of Recipes | Name | Address | Length |
|---|---|---|---|---|
| 0 | 17 | PB&R 1 of 7 | N255:0 | 32 |
| 1 | 17 | PB&R 2 of 7 | N255:32 | 32 |
| 2 | 17 | PB&R 3 of 7 | N255:64 | 32 |
| 3 | 17 | PB&R 4 of 7 | N255:96 | 32 |
| 4 | 17 | PB&R 5 of 7 | N255:128 | 32 |
| 5 | 17 | PB&R 6 of 7 | N255:160 | 32 |
| 6 | 17 | PB&R 7 of 7 | N255:192 | 32 |

8. Click Verify Project.

If you get verification errors, either attempt to fix them individually, or try merging from your original file again. If the project verified without any errors, then the merge was successful and you are ready to test the project or delete the files that you do not need.

Refer to the Ladder File Table and Data File Table to determine which files you can delete, based on the types of PF4-class drives you are using, in order to free up MicroLogix 1400 program and data table memory. If you delete a program file (subroutine), you also need to delete the rung that calls that subroutine in order for the project to successfully verify.

# Initiating the PB&R functionality

Every PF4-class drive on the Modbus network has a node address between 1...16. The Parameter Backup function is initiated by writing the node number to be backed up into data table word N255:0. Therefore, the backup can be initiated from any device that can write to N255:0, including the MicroLogix 1400 LCD user-display, the MicroLogix 1400 Web Server, and RSLogix 500 software. Similarly, the Parameter Restore function is initiated by writing the node number of the drive that was replaced into data table word N255:255. (The drive to be restored must be using its factory-default communication settings of node 100, 9600 baud, 8 data bits, no parity, and 1 stop bit.)

## *From the MicroLogix 1400 LCD User-display*

Follow this procedure to use the LCD user-display on the front of the MicroLogix 1400 controller to initiate the PB&R function.

1. Make sure that the MicroLogix 1400 controller is in Run or Remote Run mode.
2. Use the arrow to move the cursor down from the LCD top menu to the 'User Disp' selection and press OK.
3. Use the arrow to increase the displayed value from +00000 to +00001 for 'Backup' and to +00002 for 'Restore' and press OK.
4. On the second screen, use the arrow to increase the displayed value up to the node number of the drive (1...16) to be backed up or restored and press OK.

   Within several seconds, a status screen indicates whether the operation was successful.
5. Press ESC to return to the main PB&R screen.

   Note that immediately after the Restore function, you must cycle power to the drive for the restored node address to take effect.
6. To exit out of the PB&R main screen, press and hold ESC for several seconds.

## *From the MicroLogix 1400 Web Server*

Follow this procedure to use the MicroLogix 1400 Web Server to initiate the PB&R function.

1. Go online with the MicroLogix 1400 controller by using a standard web browser.
2. Select Data Views, and enter your User Name and Password that has write privileges (default is administrator/ml1400 - 'ml' must be lower case).
3. Click File Name N255.
4. Decide if you want to back up or restore, referring to the appropriate procedure.

Follow this procedure for backup.

1. Double-click N255:0.
2. Enter the node number of the drive to be backed up.
3. Click OK to confirm the value that was entered.
4. Close the Data Change Success dialog box and then click Update.

   Upon completion of the backup, the value of N255:0 returns back to 0.

Follow this procedure for Restore.

1. Double-click N255:255.
2. Enter the node number of the drive to be restored.
3. Click OK to confirm the value that was entered.
4. Close the Data Change Success dialog box and then click Update.

   Upon completion of the restore, the value of N255:255 returns to 0.

   Note that immediately after the Restore function, you must cycle power to the drive for the restored node address to take effect.

### *From RSLogix 500 Software*

Follow this procedure to initiate the PB&R function via RSLogix 500 software.

1. Go online with the MicroLogix 1400 controller and verify that the MicroLogix 1400 controller is in Run or Remote Run mode.
2. Double-click Data File N255.
3. Decide if you want to back up or restore, referring to the appropriate procedure.

Follow this procedure for Backup.

1. Double-click N255:0.
2. Enter the node number of the drive to be backed up.

   Upon completion of the backup, the value of N255:0 returns back to 0.

Follow this procedure for Restore.

1. Double-click N255:255.
2. Enter the node number of the drive to be restored.

   Upon completion of the restore, the value of N255:255 returns back to 0.

   Note that immediately after the Restore function, you must cycle power to the drive for the restored node address to take effect.

## Additional Resources

Refer to page 8 for a listing of product and information resources.

# Notes:

# Default Parameters

## Introduction

This appendix provides information on the default parameter settings required for the pump control features to operate correctly. Making changes to the non-application specific parameter default values could impact the MicroLogix control and, as a result, the drive and/or pump may not function as expected.

| Parameter | Description | Value | Notes |
|---|---|---|---|
| P31[1] | Motor NP Volts | | Set based on the pump motor nameplate data. |
| P32[1] | Motor NP Hertz | | |
| P33[1] | Motor OL Current | | |
| P36 | Start Source | 5-Comm Port | |
| P37 | Stop Mode | 0-Ramp, CF | Optional selection: 4-Ramp |
| P38 | Speed Reference | 5-Comm Port | |
| P42 | Auto Mode | 0-No Function | |
| P43 | Motor OL Ret | 1-Enabled | |
| T51 | Digital In1 Sel | 0-Not Used | Consult User Manual prior to changing the input selection options. Selections could impact the MicroLogix control and as a result the drive may not function as expected. |
| T52 | Digital In2 Sel | 0-Not Used | |
| T53 | Digital In3 Sel | 0-Not Used | |
| T54 | Digital In4 Sel | 0-Not Used | |
| T69[1] | Analog In 1 Sel | | Select the analog input signal mode (0-20mA, 4-20mA, or 0-10V) according to the pressure switch. Refer to the manufacturer's user manual.<br><br>**Important:** You must set DIP switch AI1 on the control board to match the selected input signal mode. Refer to Chapter 1 Installation/Wiring in the *PowerFlex 400 AC Drive for Fan & Pump Applications User Manual*, publication 22C-UM001, for more information. |
| T70 | Analog In 1 Lo | 0.0 | |
| T71 | Analog In 1 Hi | 100.0 | |
| T72 | Analog In 1 Loss | 1-Fault | |
| T77 | Sleep-Wake Sel | 0-Disabled | |
| C102 | Comm Format | 0-RTU 8-N-1 | |
| C103 | Comm Data Rate | 3-9600 | |
| C104 | Comm Node Addr | 9…16 | Increment based on number of connected drives. Default: 9 |
| C105 | Comm Loss Action | 0-Fault | |

| | | | |
|---|---|---|---|
| C106 | Comm Loss Time | 5.0 | |
| C107 | Comm Write Mode | 0-Save<br>(Initial Setup Only) | Initially set to 0-Save to save the default parameters to the drive. Then, set to 1-RAM Only to prevent damage to the Non-Volatile Storage and possible drive malfunction. See Load Your Parameters, page 11 for details. |
| | | 1-RAM Only | |
| A153 | PID Feedback Sel | 0-Analog In 1 | |
| A166 | REV Enabled | 1-REV Enabled | |

(1)The parameter value is application specific, actual values will vary.

# Rockwell Automation Support

Rockwell Automation provides technical information on the Web to assist you in using its products. At http://support.rockwellautomation.com, you can find technical manuals, a knowledge base of FAQs, technical and application notes, sample code and links to software service packs, and a MySupport feature that you can customize to make the best use of these tools.

For an additional level of technical phone support for installation, configuration, and troubleshooting, we offer TechConnect Support programs. For more information, contact your local distributor or Rockwell Automation representative, or visit http://support.rockwellautomation.com.

## Installation Assistance

If you experience a problem with a hardware module within the first 24 hours of installation, please review the information that's contained in this manual. You can also contact a special Customer Support number for initial help in getting your module up and running.

| | |
|---|---|
| United States | 1.440.646.3434<br>Monday – Friday, 8 a.m. – 5 p.m. EST |
| Outside United States | Please contact your local Rockwell Automation representative for any technical support issues. |

## New Product Satisfaction Return

Rockwell tests all of its products to ensure that they are fully operational when shipped from the manufacturing facility. However, if your product is not functioning, it may need to be returned.

| | |
|---|---|
| United States | Contact your distributor. You must provide a Customer Support case number (see phone number above to obtain one) to your distributor in order to complete the return process. |
| Outside United States | Please contact your local Rockwell Automation representative for return procedure. |

**www.rockwellautomation.com**

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