

DESIGN  GROUP

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## FERMENTATION SKID

## OPERATIONS & MAINTENANCE MANUAL

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**Danone White Wave**

**Louisville, CO**

July 26<sup>th</sup>, 2019

Revision 0

**Fermentation Skid User Manual**  
**Revision Form**

Document Description	Sub-Part
This document describes the operation of the process equipment associated with the fermentation skid at the Danone facility in Louisville, CO. It provides a detailed user guideline for the operation, maintenance and controls required for operation of the new process	
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## CONTENTS

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1.	GENERAL DESCRIPTION OF PROJECT SCOPE .....	- 4 -
2.	HMI Basics.....	- 5 -
2.1	HMI Header.....	- 5 -
2.2	HMI Footer & Navigation.....	- 5 -
2.3	HMI Navigation Arrows.....	- 7 -
2.4	Mode Indicators.....	- 7 -
2.5	Control Module Faceplates.....	- 8 -
2.5.1	P_Din Faceplate .....	- 9 -
2.5.2	P_AlnAdv Faceplate.....	- 11 -
2.5.3	P_ValveSO Faceplate.....	- 15 -
2.5.4	P_ValveMP Faceplate.....	- 17 -
2.5.5	P_Motor Faceplate.....	- 19 -
2.5.6	P_VSD Faceplate .....	- 21 -
2.5.7	P_PIDE Faceplate .....	- 23 -
2.8	Sequence Faceplate.....	- 25 -
2.9	Alarms and Failures .....	- 27 -
2.10	User Security .....	- 28 -
2.11	PlantPAx Alarms.....	- 28 -
3.	Sequences – Functional description.....	- 29 -
5.	CONTROL MODULES .....	- 29 -
6.	ETHERNET NETWORK SETUP .....	- 31 -
6.1	Level 3 Communications.....	- 31 -
6.2	Level 2 Communications.....	- 32 -
6.3	Level 1 Communications.....	- 33 -
	Appendix A: Work Instruction Procedure Documents .....	- 34 -
	Appendix B: Equipment BOM.....	- 35 -
	Appendix C: Drawings .....	- 35 -
	Appendix E: Troubleshooting Guide.....	- 35 -

## 1. GENERAL DESCRIPTION OF PROJECT SCOPE

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The fermentation skid is designed to run two batches of product at any given time. The skid consists of two (2) fermentation vessels, a fruit addition tank, and a manifold of valves & pumps to transfer and blend product.

The fermentation skid has a one primary control panel that is mounted on the skid. The panel is dedicated low voltage (24VDC or less) and is powered by the high voltage (480/120 VAC) cabinet, thus eliminating the need for Arc Flash P.P.E. during low voltage work. The fermentation skid also has a remote I/O cabinet mounted within the skid frame for local I/O.

The primary control panel has a ControlLogix PLC chassis. The processor is 1756-L72 series ControlLogix Controller v21.03. There is one (1) PanelView HMIs (FactoryTalk ME V8.1) included in the system. The HMI is mounted on the control panel door for the fermentation skid.

## 2. HMI BASICS

### 2.1 HMI HEADER



The header appears on every HMI screen. Description of display elements from left to right:

- Blue column: Name of the currently active sequence, i.e. T101 Fermentation, T201 SIP, T401 CIP, etc. and this is blank if there is no active sequence
- 1<sup>st</sup> Black column: State of the active sequence, i.e. Running, Held, Aborting, Restarting, Resetting and blank if there is no active sequence
- 2<sup>nd</sup> Black column: Displays the current step number of the active sequence, this is 1-99 or blank if there is no active sequence
- 3<sup>rd</sup> Black column: Displays the current step description of the active sequence or blank if there is no active sequence
- Alarm Event: This displays any currently active alarms
- Current User: Currently logged on user. The default user, with no security privileges is 'DEFAULT'
- Current Date/Time

### 2.2 HMI FOOTER & NAVIGATION



The footer appears on every HMI screen. Description of display elements from left to right:

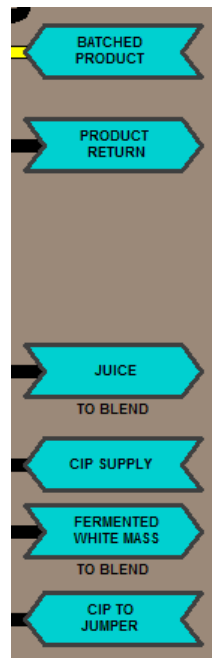
- Home Button: This navigates to the fermentation skid overview screen
- Back Button: This navigates to the previous screen that the operator was on
- Forward Button: If an operator was using the Back Button this will return the operator to the screen that displayed before the operator hit the Back Button
- Fruit Hopper Button: Navigates the operator to the Fruit Hopper screen
- Fermenter TK-201 Button: Navigates the operator to the fermentation tank TK-201
- Fermenter TK-101 Button: Navigates the operator to the fermentation tank TK-101
- Filling Emptying Button: Navigates the operator to the Filling Emptying and FP-101 screen
- Transfer IN\_OUT Button: Navigates the operator to the Transferring in and out of the fermentation skid and FP-201 screen
- Blending Button: Navigates the operator to the blending screen
- Utilities Button: Raises more navigation buttons to get to the Jacket Heat/Cool, CIP Supply, CIP Return and Steam/Air screens



- Sequence Selection: Navigates to the sequence Start/Hold/Restart/Abort screen for each sequence
- Prompt Alert: Alerts the operator that a Prompt needs to be acknowledged
- Trending Button: Navigates to the trends screen
- Network Status Button: Navigates tot the Network Status screen
- Factory Viewer Button: Opens a Factory Talk Viewer program
- Global Alarm Reset Button: Acknowledges all active alarms in the system
- Login Button: Select this button to log in
- Logout Button: Select this button to log out

### 2.3 HMI NAVIGATION ARROWS

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- Navigation arrows appear on every screen and by clicking them you can quick navigate to the display of the button that was clicked











### 2.4 MODE INDICATORS

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The PLC programming follows the S88 Batch programming methodology. This is a hierarchal control strategy starting with Control Modules at the bottom layer, and Sequences as the overarching control. The project utilizes PlantPAx , which is a Rockwell product offering Control Module AOI's and HMI graphic objects.

Control Modules and Equipment Modules are always in either Operator, Program, or Maintenance mode. In operator mode, the operator has control over the device. In program mode, the program has control over the device. In maintenance mode, maintenance has the ability to bypass interlocks and permissives. The graphic below, provided by Rockwell, shows the how a device's mode is indicated on the HMI.

**Table 7 - Command Source Indicators**

Graphic Symbol	Description
No Symbol	Device is in normal command source operation
	Device is out of service
	Device is not in normal command source operation
	Device is in program command source operation
	Device is in program locked command source
	Device is in maintenance command source operation
	Device is in operator command source operation
	Device is in external command source operation
	Device is in operator locked command source operation
	Device is in override command source operation
	Device is in hand command source operation

## 2.5 CONTROL MODULE FACEPLATES

This project utilizes PlantPax HMI objects for control modules. Screenshots of each control module utilized is categorized below. A complete documentation set, produced by Rockwell, should be referenced for more insight into the faceplates. The control modules used in this project are:

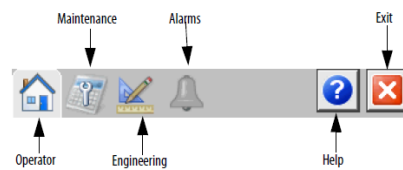
- P\_Din, Digital Input



## Fermentation Skid Operations & Maintenance Manual

- P\_AInAdV, Analog Input
- P\_ValveSO, Solenoid Valve
- P\_Motor, Single Speed Motor
- P\_VSD, Variable Speed Drive
- P\_PIDE, PID Loop

The faceplates for all the different objects generally have the same header, complete with navigation tabs and a help button, as shown below.



TYPICAL CONTROL MODULE FACEPLATE HEADER, SHOWING THE VARIOUS TABS

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### 2.5.1 P\_DIN FACEPLATE

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This object is used for digital inputs, such as proximity switches to access the faceplate, click on the digital input's name.

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#### 2.5.1.1 OPERATOR TAB

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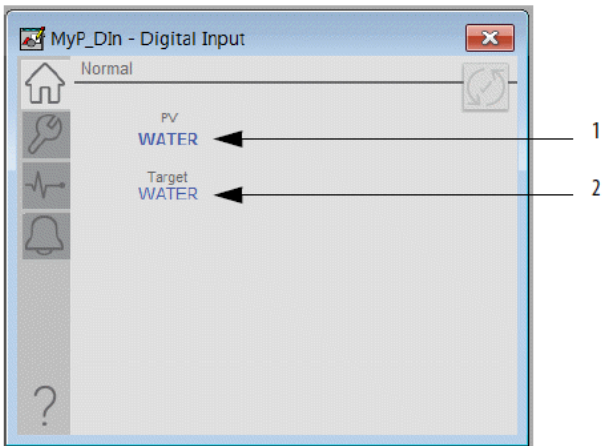
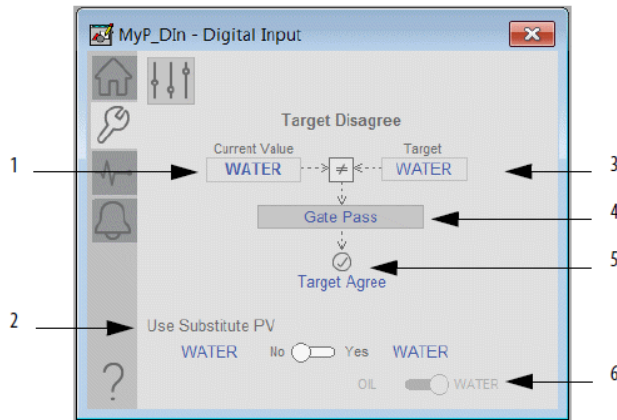


Table 80 - Operator Tab Description

Item	Description
1	Current Process Variable
2	Target Process Variable

2.5.1.2 MAINTENANCE TAB



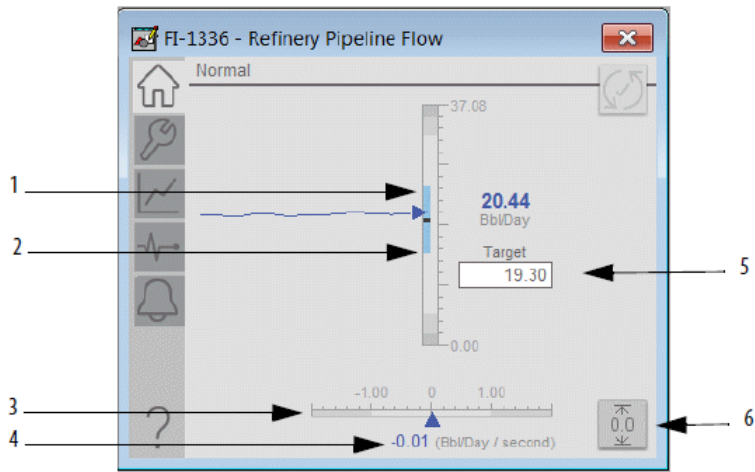
**Table 81 - Maintenance Tab Description**

Item	Description
1	Current Process Variable
2	Click to enable the use of the Substitute Process Variable.
3	Target Process Variable
4	Gate condition
5	Target status
6	Click to choose Process Variable to be used.

## 2.5.2 P\_AINADV FACEPLATE

This object is used for analog inputs, such as transmitters

### 2.5.2.1 OPERATOR TAB



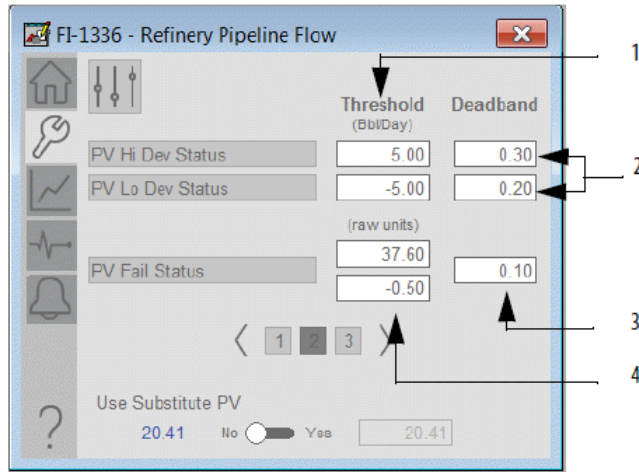
**Table 55 - P\_AlnAdv Home Tab Description**

Item	Description
1	High Deviation limit: the label background that changes color based on alarm severity when exceeded.
2	Low Deviation limit: the label background that changes color based on alarm severity when exceeded.
3	The rate of change bar graph (visible if Rate of Change calculations is enabled on the engineering tab).
4	The rate of change value (visible if Rate of Change calculations is enabled on the engineering tab).
5	Process Variable target.
6	Reset Rate of Change value to zero.

2.5.2.2 MAINTENANCE TAB

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**Table 56 - Maintenance Tab Page 2 Description**

Item	Description
1	Process variable high/low deviation threshold. Type the threshold (trip point) for analog input alarms.
2	Process variable high/low deviation deadband. Type the deadband (hysteresis) that is applied to each alarm limit. Deadband helps prevent a noisy signal from generating numerous spurious alarms. <b>Example:</b> If the High alarm limit is 90.0 and the High alarm deadband is 5, once the signal rises above 90.0 and generates a High alarm. The signal must fall below 85.0 (90.0 minus 5.0) for the alarm to clear.
3	Process variable fail deadband. Type the deadband (hysteresis) that is applied to each alarm limit. Deadband helps prevent a noisy signal from generating numerous spurious alarms. <b>Example:</b> If the High alarm limit is 90.0 and the High alarm deadband is 5, once the signal rises above 90.0 and generates a High alarm. The signal must fall below 85.0 (90.0 minus 5.0) for the alarm to clear.
4	Process variable fail threshold in raw units.

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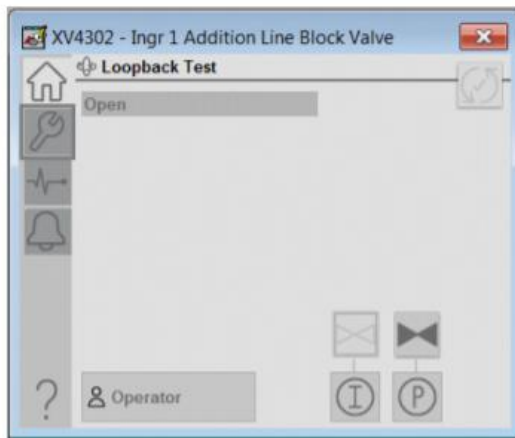
### 2.5.3 P\_VALVESO FACEPLATE

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This object is used for solenoid valves

#### 2.5.3.1 OPERATOR TAB

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#### 2.5.3.2 MAINTENANCE TAB

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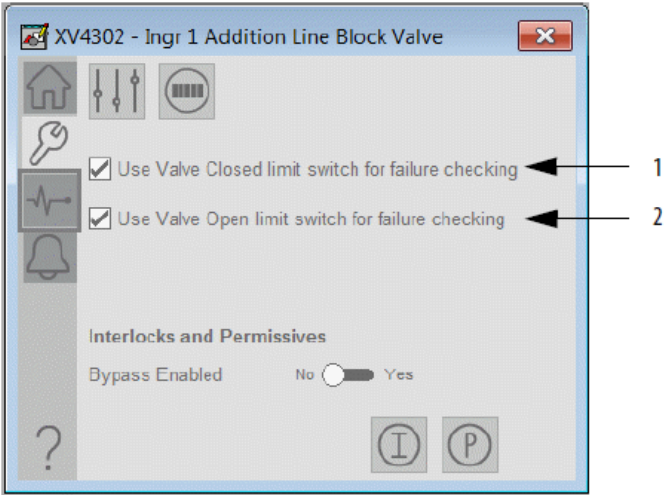


Table 300 - Maintenance Tab Description

Item	Description
1	Check if the instruction uses the closed limit switch feedback to check for valve full stall or transit stall.
2	Check if the instruction uses the open limit switch feedback to check for valve full stall or transit stall.



2.5.4 P\_VALVEMP FACEPLATE

This object is used for solenoid valves

2.5.4.1 OPERATOR TAB

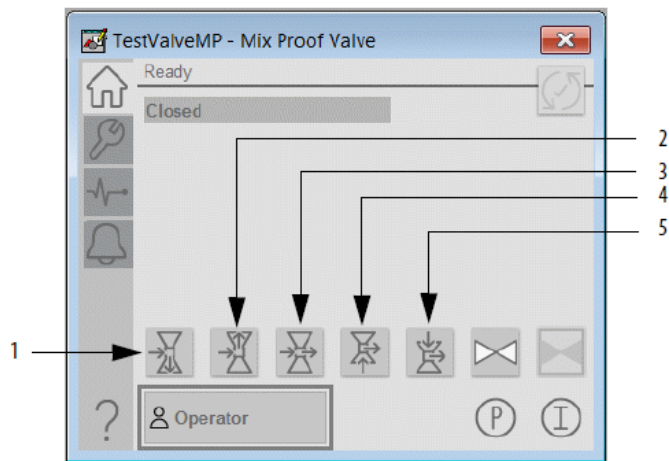
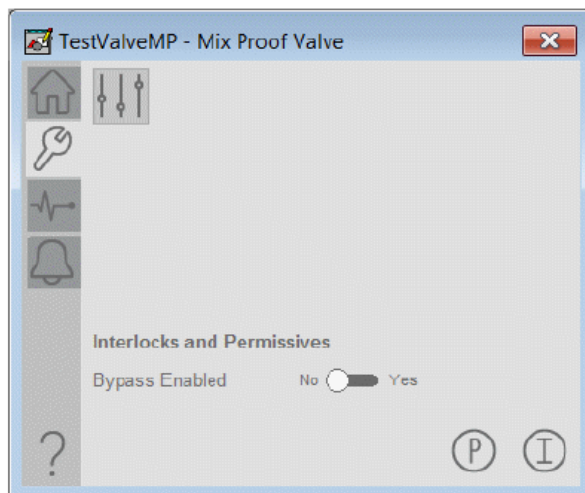


Table 292 - Operator Tab Description

Item	Description
1	Click to go to the CIP/SIP Valve Lower Seat state.
2	Click to go to the CIP/SIP Valve Upper Seat state.
3	Click to go to the CIP/SIP Valve Cavity state.
4	Click to go to the Lift Valve Lower Seat state.
5	Click to go to the Lift Valve Upper Seat state.

2.5.4.2 MAINTENANCE TAB



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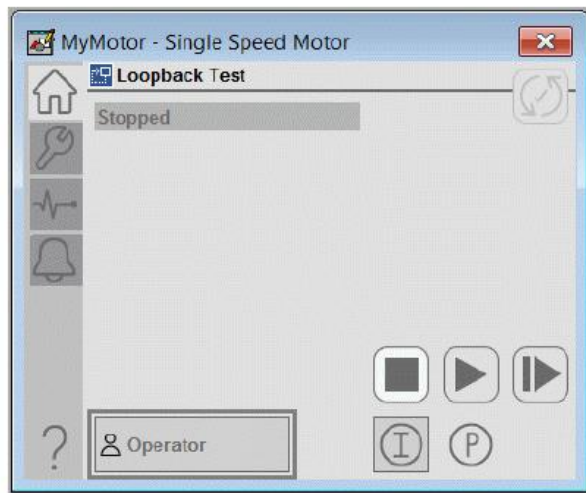
### 2.5.5 P\_MOTOR FACEPLATE

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This object is used for single speed motors

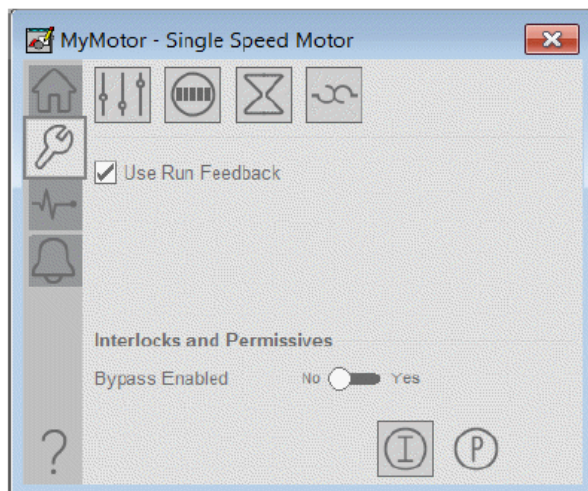
#### 2.5.5.1 OPERATOR TAB

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#### 2.5.5.2 MAINTENANCE TAB

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2.5.6 P\_VSD FACEPLATE

This object is used for motors controlled by variable frequency drives

2.5.6.1 OPERATOR TAB

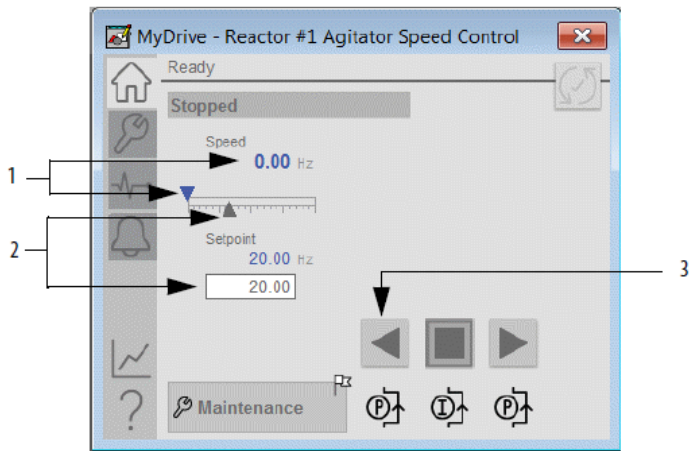


Table 187 - Operator Tab Description

Item	Description
1	Current speed of drive
2	Setpoint for the speed of the drive
3	Start motor in reverse

2.5.6.2 MAINTENANCE TAB

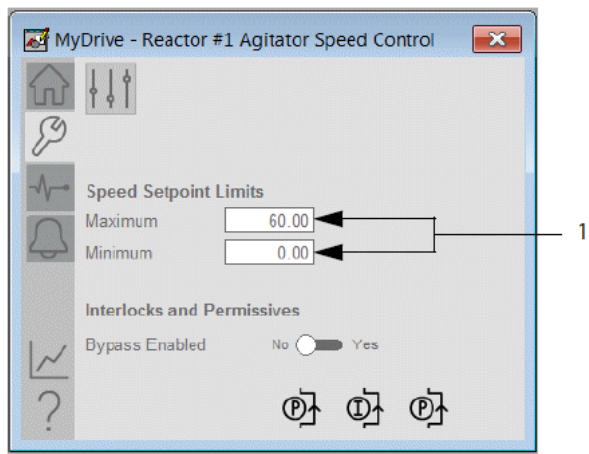


Table 188 - Maintenance Tab Description

Item	Description
1	Type the clamping limits for the speed setpoint. If a speed setpoint outside this range is entered, the speed is clamped at these limits and Sts_SpeedLimited is asserted.

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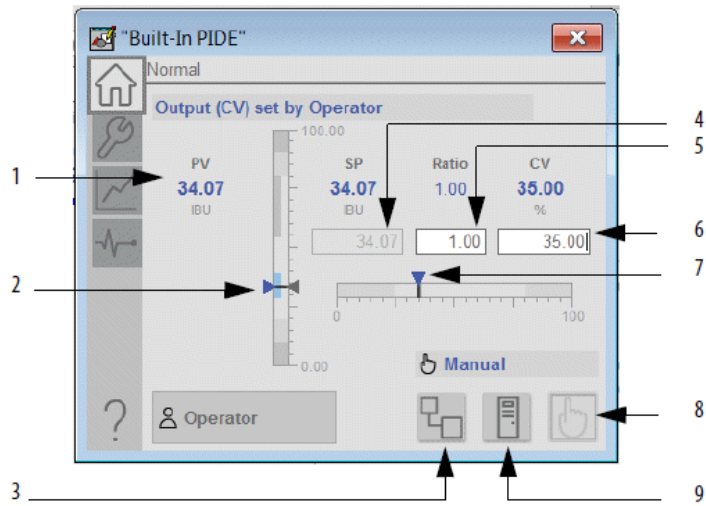
#### 2.5.7 P\_PIDE FACEPLATE

---

This object is used for PID control loops, such as a flow control loop

##### 2.5.7.1 OPERATOR TAB

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**Table 364 - Operator Tab Description**

Item	Description
1	Current PV value
2	PV Slider
3	Click to request Cascade Loop mode.
4	Type a value for the loop Setpoint.
5	Type a value for the ratio operator multiplier.
6	Type a value for CV.
7	Move this slider to adjust the loop CV output.
8	Click to go to request Manual loop mode.
9	Click to request Auto Loop mode.



2.5.7.2 MAINTENANCE TAB

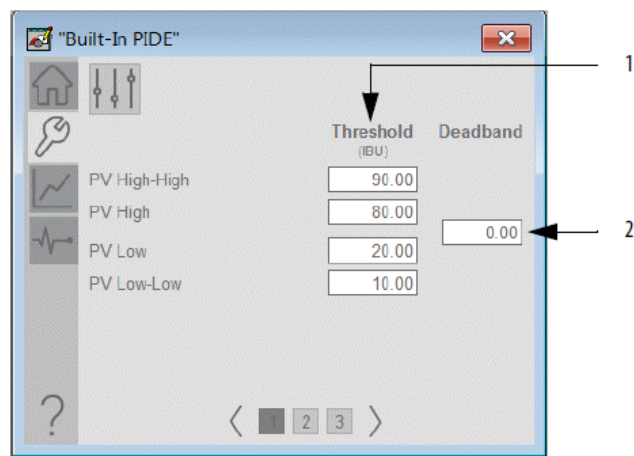


Table 365 - Maintenance Tab Page 1 Description

Item	Description
1	Type values for the PV high-high, high, low, and low-low alarm limits.
2	Type a value for the PV alarm limit deadband.

2.8 SEQUENCE FACEPLATE

Sequence faceplates are accessible by selecting one from the Sequence Selection Menu.

2.8.1 MAIN SEQUENCE SCREEN

The main Sequence screen for each sequence displays operator set points, selections, Sequence control buttons and Sequence start permissives.

FILL SEQUENCE

?

Fill Source

Tetrapak Processor

Fill Destination

T-101

T-201

T-101 & T-201

Agitator ON (min)

1

Agitator OFF (min)

1

Agitator Speed (%)

15

P

START SEQUENCE

HOLD SEQUENCE

RESTART SEQUENCE

ABORT SEQUENCE

2.8.2 PARAMETER SELECTION & SETPOINTS

Fill Source	<b>Tetrapak Processor</b>		
Fill Destination	T-101	<b>T-201</b>	T-101 & T-201
Agitator ON (min)	10		
Agitator OFF (min)	20		
Agitator Speed (%)	50		

Sequence parameters can be edited from this screen. Any edits on this screen change how the sequence operates each time it executes

### 2.8.3 SEQUENCE CONTROL

P

START SEQUENCE

HOLD SEQUENCE

RESTART SEQUENCE

ABORT SEQUENCE

The Sequence control buttons allow the operator to Start, Hold, Restart, or Abort and navigate to the permissives popup. Any of the Start, Hold, Restart, and Abort buttons will prompt the operator to make sure that the operator wants to execute the appropriate action. The permissives button will be a circle with a P in it if the permissives are okay. If the permissives are not okay the button has a black stop sign with a P in it.

### 2.9 ALARMS AND FAILURES

There are five tiers of user security in the system. A login is performed with the 'Login' button on the HMI header. Users will be automatically signed out after 15 minutes of inactivity.

## 2.10 USER SECURITY

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There are five tiers of user security in the system. A login is performed with the 'Login' button on the HMI header. Users will never be automatically signed out.

### DEFAULT:

**Username:** Guest\_User

**Password:** \*\*\*\*

-The Default security level provides access to device configuration parameters and ranges, options for device and I/O setup, and displayed text, for initial system commissioning or later system changes. The 'Engineer' security level has the following permissions:

- Normal operation of devices
- Manual device operation
- Equipment Maintenance
- Configuration and Tuning maintenance
- Engineering Configuration
- Acknowledge alarms
- Disable alarms, permissives, and interlocks
- Normal Production (phases)
- Override/ Force Sequences
- Shutdown Application

## 2.11 PLANTPAX ALARMS

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PlantPax objects come with embedded alarms. They are detailed below.

### 2.9.1 P\_VALVESO (SOLENOID VALVE) ALARMS

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- **Full Stall:** Valve position feedback indicates the valve did not move off its previous position at all during the configured time.
- **Transit Stall:** Valve position feedback indicates the valve moved from its original position but did not reach its target position within the configured time.
- **IO Fault:** IO Fault has been detected
- **Interlock Trip:** Raised if the Solenoid Valve is energized and an Interlock causes it to de-energize. If Interlocks are not bypassed, an interlock (that cannot be bypassed) not OK or an Interlock (that can be bypassed) not OK de-energizes the Solenoid Valve. If Interlocks are bypassed, only an interlock (that cannot be bypassed) not OK de-energizes the Solenoid Valve.

### 2.9.3 P\_D4SD (MULTI-STATE VALVE) ALARMS

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- **IO Fault:** Communication fault with device
- **Interlock Trip:** An interlocked condition caused the valve to change position
- **Fail:** Device failed to reach commanded position
- **Device Fault:** Device fault from device via an input

### 2.9.4 P\_AINADV (ANALOG INPUT) ALARMS

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- **Hihi:** PV above configured Hi-Hi Limit
- **Hi:** PV above configured Hi Limit
- **Lo:** PV below configured Lo Limit

- **LoLo:** PV below configured LoLo Limit
- **Input Failure:** PV is outside the configured Fail High and Fail Low limits. This could indicate the device has been disconnected

#### 2.9.5 P\_MOTOR (SINGLE SPEED MOTOR) ALARMS

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- **Fail to Start:** Raised if the motor has and is using run feedback, an attempt is made to start the motor, and the run feedback does not indicate the motor running within the configured time.
- **Fail to Stop:** Raised if the motor has and is using run feedback, an attempt is made to stop the motor, and the run feedback does not indicate the motor stopped within the configured time.
- **Interlock Trip:** Raised if the motor is running and an interlock causes it to stop.
- **IO Fault:** An IO fault has been detected.

#### 2.9.6 P\_VSD (VARIABLE SPEED DRIVE) ALARMS

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- **Fail to Start:** Raised if the motor has and is using run feedback, an attempt is made to start the motor, and the run feedback does not indicate the motor running within the configured time.
- **Fail to Stop:** Raised if the motor has and is using run feedback, an attempt is made to stop the motor, and the run feedback does not indicate the motor stopped within the configured time.
- **Interlock Trip:** Raised if the motor is running and an interlock causes it to stop.
- **IO Fault:** An IO fault has been detected.
- **Drive Fault:** A drive fault has been detected.

#### 2.9.7 P\_PIDE (PID) ALARMS

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- **HiHi Deviation:** PV exceeds SP by High-High threshold
- **Hi Deviation:** PV exceeds SP by High threshold
- **Lo Deviation:** PV falls below SP by Low threshold
- **Lolo Deviation:** PV falls below SP by Low-Low threshold
- **Interlock Trip:** An interlock condition has been tripped
- **Fail:** The internal PIDE has a fault

### 3. SEQUENCES – FUNCTIONAL DESCRIPTION

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The production and sanitation is run through the use of Sequences. A detailed account of each sequence is attached, ref Appendix A.

### 5. CONTROL MODULES

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This section contains a listing of all CMs in the system and a brief description

- P\_AIn: CM used for reading Analog Inputs from devices on the skid
- P\_AOut: CM used to write Analog Outputs to devices on the skid

## Fermentation Skid Operations & Maintenance Manual

- P\_DIn: CM used for reading Discrete Inputs from devices on the skid
- P\_DOut: CM used to write Discrete Outputs to devices on the skid
- P\_PIDE: CM used to

Device Tag	Type	Device Tag	Type	Device Tag	Type
AT_502	P_Ain	ZS_144	P_Din	XV_141	P_ValveSO
FT_111	P_Ain	ZS_145	P_Din	XV_142	P_ValveSO
FT_111_Density	P_Ain	ZS_201	P_Din	XV_145	P_ValveSO
FT_311	P_Ain	ZS_202	P_Din	XV_152	P_ValveSO
FT_311_Density	P_Ain	ZS_203	P_Din	XV_160	P_ValveSO
FT_411	P_Ain	ZS_204	P_Din	XV_161	P_ValveSO
FT_411_Density	P_Ain	ZS_205	P_Din	XV_162	P_ValveSO
PT_101	P_Ain	ZS_206	P_Din	XV_202	P_ValveSO
PT_112	P_Ain	ZS_207	P_Din	XV_203	P_ValveSO
PT_141	P_Ain	ZS_208	P_Din	XV_205	P_ValveSO
PT_201	P_Ain	ZS_209	P_Din	XV_208	P_ValveSO
TT_105	P_Ain	ZS_244	P_Din	XV_231	P_ValveSO
TT_112	P_Ain	ZS_245	P_Din	XV_232	P_ValveSO
TT_113	P_Ain	_240MSR02	P_Din	XV_233	P_ValveSO
TT_141	P_Ain	P_111_Flow_Control	P_PIDE	XV_234	P_ValveSO
TT_142	P_Ain	P_311_Flow_Control	P_PIDE	XV_245	P_ValveSO
TT_161	P_Ain	P_411_Flow_Control	P_PIDE	XV_260	P_ValveSO
TT_205	P_Ain	TCV_112_Loop	P_PIDE	XV_309	P_ValveSO
TT_502	P_Ain	TCV_611_Loop	P_PIDE	XV_313	P_ValveSO
TT_602	P_Ain	MPV_101	P_ValveMP	XV_314	P_ValveSO
AT_106	P_Ain	MPV_104	P_ValveMP	XV_401	P_ValveSO
AT_206	P_Ain	MPV_107	P_ValveMP	XV_402	P_ValveSO
FT_501	P_Ain	MPV_115	P_ValveMP	XV_403	P_ValveSO
LT_102	P_Ain	MPV_201	P_ValveMP	XV_405	P_ValveSO
LT_202	P_Ain	MPV_204	P_ValveMP	XV_407	P_ValveSO
TCV_112	P_Aout	MPV_207	P_ValveMP	XV_408	P_ValveSO
TCV_611	P_Aout	MPV_312	P_ValveMP	XV_413	P_ValveSO
SV_112	P_Dout	MPV_404	P_ValveMP	XV_501	P_ValveSO
321XL04	P_Dout	MPV_412	P_ValveMP	XV_502	P_ValveSO
321XL05	P_Dout	M_101	P_VSD	XV_503	P_ValveSO
321XL06	P_Dout	M_111	P_VSD	XV_504	P_ValveSO
321XL07	P_Dout	M_112	P_VSD	XV_505	P_ValveSO
321XL08	P_Dout	M_201	P_VSD	XV_506	P_ValveSO
LSH_103	P_Din	M_311	P_VSD	XV_507	P_ValveSO
LSH_203	P_Din	M_411	P_VSD	XV_611	P_ValveSO
LSL_104	P_Din	M_501	P_VSD		
LSL_204	P_Din	P_121	P_VSD		
LSL_404	P_Din	P_601	P_VSD		
ZS_101	P_Din	PRV_111	P_ValveSO		
ZS_102	P_Din	PRV_311	P_ValveSO		
ZS_104	P_Din	PRV_411	P_ValveSO		
ZS_105	P_Din	XV_102	P_ValveSO		
ZS_106	P_Din	XV_105	P_ValveSO		

ZS_107	P_Din	XV_106	P_ValveSO		
ZS_108	P_Din	XV_108	P_ValveSO		
ZS_109	P_Din	XV_109	P_ValveSO		
ZS_110	P_Din	XV_116	P_ValveSO		
ZS_111	P_Din	XV_121	P_ValveSO		
ZS_112	P_Din	XV_131	P_ValveSO		
ZS_113	P_Din	XV_132	P_ValveSO		
ZS_114	P_Din	XV_133	P_ValveSO		
ZS_115	P_Din	XV_134	P_ValveSO		
ZS_116	P_Din	XV_140	P_ValveSO		

## 6. ETHERNET NETWORK SETUP

The Ferm1 system PLC communicates over three Ethernet communication networks as part of this project. The following is a description of those networks.

### 6.1 LEVEL 3 COMMUNICATIONS

This communication tier is meant for I/O local to the filter skid system. The module is a 1756-EN2T in slot 2 of the PLC chassis, with an IP address of 192.168.1.5. Fermentation Skid network architectures are shown below. A full table of Level 3 IP addresses follows.

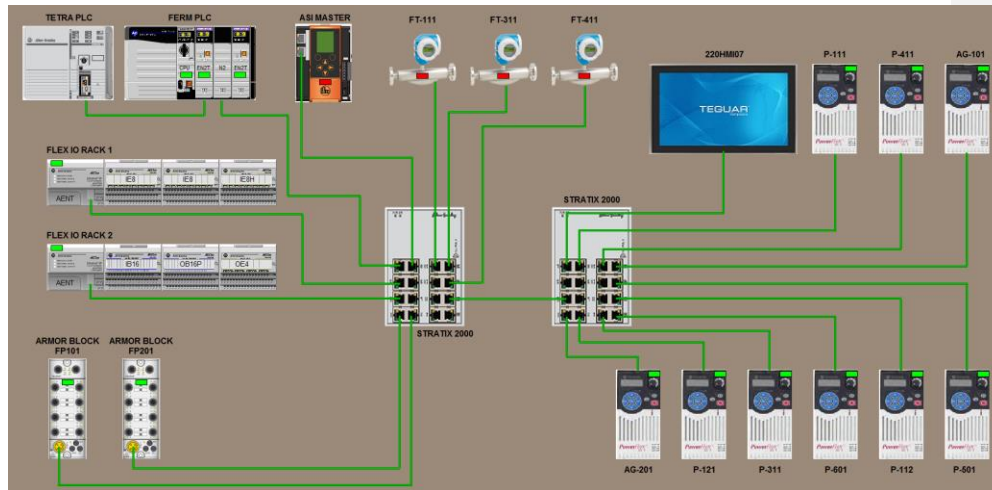


FIGURE 6.1.1: FILTER SKID #1 ETHERNET NETWORK

Device	IP Address	Subnet Mask	Installation Location
CONTROLLOGIX 1756-EN2T	192.168.1.1	255.255.255.0	CP-FSP1
Control Panel HMI	192.168.1.15	255.255.255.0	CP-FSP0
Flex I/O 1794-AENT Rack 1	192.168.1.20	255.255.255.0	CP-FSP1
Flex I/O 1794-AENT Rack 2	192.168.1.21	255.255.255.0	CP-FSP1
Armor Block Rack 3	192.168.1.22	255.255.255.0	Fermentation Skid
Armor Block Rack 4	192.168.1.23	255.255.255.0	Fermentation Skid
IFM ASI Master	192.168.1.40	255.255.255.0	CP-FSP1
EH FT-111	192.168.1.120	255.255.255.0	Fermentation Skid
EH FT-411	192.168.1.121	255.255.255.0	Fermentation Skid
EH FT-311	192.168.1.122	255.255.255.0	Fermentation Skid
VFD-P111	192.168.1.60	255.255.255.0	CP-FSP0
VFD-P411	192.168.1.61	255.255.255.0	CP-FSP0
VFD-AG101	192.168.1.62	255.255.255.0	CP-FSP0
VFD-AG201	192.168.1.63	255.255.255.0	CP-FSP0
VFD-P121	192.168.1.64	255.255.255.0	CP-FSP0
VFD-P311	192.168.1.65	255.255.255.0	CP-FSP0
VFD-P601	192.168.1.66	255.255.255.0	CP-FSP0
VFD-P112	192.168.1.67	255.255.255.0	CP-FSP0
VFD-P501	192.168.1.68	255.255.255.0	CP-FSP0

TABLE 6.1.1: FILTER SKID #1 LEVEL 3 IP ADDRESSING

## 6.2 LEVEL 2 COMMUNICATIONS

This communication tier is meant for PLC to PLC communications. The module is a 1756-EN2T in slot 1 of the PLC chassis. A table of Level 2 Ethernet addressing is below:

Device	Area	IP Address	Subnet Mask
TETRAPAK	Tetrapak	10.0.223.15	255.255.255.0

TABLE 7.2.1: LEVEL 2 IP ADDRESSING



### 6.3 LEVEL 1 COMMUNICATIONS

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This communication tier is meant for Plant-Level communications. There are no level 1 communications with the fermentation skid.

## APPENDIX A: WORK INSTRUCTION PROCEDURE DOCUMENTS

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This appendix details the different work instructions used, along with the affiliated document name.

- Fill Sequence SOP
- T101 Fermentation SOP
- T201 Fermentation SOP
- T101 Transfer Out SOP
- T201 Transfer Out SOP
- T101 CIP SOP
- T201 CIP SOP
- T101 SIP SOP
- T201 SIP SOP
- Air Header SOP
- White Mass Transfer Path CIP SOP
- Fruit & White Mass Transfer Path CIP SOP
- Juice & White Mass Transfer Path CIP SOP
- Fill Drain CIP SOP

**Commented [KJ(1)]:** this is not a deliverable for us do we want to include this section?

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## APPENDIX B: EQUIPMENT BOM

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- 1801824 – Bill of Materials

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## APPENDIX C: DRAWINGS

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- 1801824 – Fermentation Skid P&ID Rev.1

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## APPENDIX E: OTHER DOCUMENTS

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- Rockwell Process Objects