OptiPump HPS

Making Complex Applications Simple

Operation and Configuration Manual

Firmware Version 2.01

Revision 1.00

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Table of Contents

! CAUTION !

Always verify that the power has been disconnected from both the panel and the Fuji MEGA variable frequency drive before making changes to the wiring.

Failure to do so may result in severe injury or death!

High DC voltages may still be present for a period of time after main power has been removed from the variable frequency drive. Take note of the red **Charge** LED, labeled CRG, located on the drive. Depending on the size of the drive, the LED may be visible through the front cover. The LED will go dark when the DC bus has been discharged. Until then, potentially dangerous voltages may still be present for several minutes after disconnecting power.

Always verify that terminals are no longer powered by using a properly working and tested multimeter.

Technical Specifications	
Display	12.1” 64K color touchscreen QVGA (800x600) TFT
Digital Inputs	16 (with I/O modules)
Digital Outputs	16 (with I/O modules)
Analog Inputs	23 (with I/O modules) 14 4-20 mA 1 J-type thermocouple 8 100 Ohm RTD
Analog Outputs	2 (with I/O modules) 2 4-20 mA
Data Storage	Micro SD card
Battery-Backed Memory	7 years typical at 25°C Replaceable without opening controller
Date, Time, and Supervisor	Battery-Backed Real-Time Clock and Watchdog
Power Supply Voltage	24 VDC 20.4 VDC to 28.8 VDC with less than 10% ripple
Power Supply Current	500 mA maximum at 24 VDC
Power Consumption	12 Watts
Temperature	Operation: 0 °C to +50 °C (32 °F to 122 °F) Storage:-20 °C to +60 °C (-4 °F to 140 °F)
Humidity	5 % to 95 % (non-condensing)
Physical	12.32” x 9.62” x 2.32” (313.1 mm x 244.6 mm x 59.1 mm) 60 oz (1.7 kg)
Mounting	IP 66/IP65/NEMA 4X for front panel

Please note that all wiring to and from the controller should be shielded in order to reduce any potential for electrical interference. Using unshielded wiring may result in erratic and unpredictable behavior.

The OptiPump HPS controller follows a defined sequence of steps during startup, running, and stopping of the system. The steps help to ensure proper and safe operation of the system, and attempt to prevent damage in the event of equipment or device failure. Some steps may be optional depending on features included with the system. Use extreme caution when altering any configuration options that were set during the initial commissioning of the system, as an improperly configured system could result in equipment damage or injury to personnel. Always refer to the most recent revision of the Operation and Configuration Manual and consult qualified technical support or engineering staff if any question regarding physical modification or changes in configuration parameters arises.

Pre-Run Sequence

The Pre-Run sequence begins when the HOA switch is in the Hand or Auto position, and the configured start conditions have been met. If the Pre-Run sequence is aborted for any reason (including by the operator or an event), the Pre-Run sequence equipments states are set back to their waiting/idle positions. The Post-Run sequence will not run if the Pre-Run sequence is aborted prior to successful completion.

1. If enabled, start the thrust chamber oil pump, wait to confirm the thrust chamber oil pump is running, and then wait for the thrust chamber oil pump pre-run timer to elapse. Set a fault event if the thrust chamber oil pump does not confirm running within 5 seconds.

2. If the block valve control mode for sequence operation is enabled, command the block valve to open and wait for the block valve to confirm the full-open position. Set a fault event if the block valve does not confirm the full-open position within the travel time.

3. Command the pressure control valve to the start position.

4. If the pressure control valve feedback is configured for analog or both feedback, wait for the pressure control valve position to be within ±5% of the commanded position. Set a fault event if the pressure control valve position fails to move to ±5% of the commanded position within the travel time.

5. If the pressure control valve feedback is configured for digital or both feedback, wait for the pressure control valve to confirm not closed. Set a fault event if the pressure control valve fails to confirm not closed within the travel time.

6. If enabled, start the charge pump, confirm the charge pump is running, and wait for the charge pump pre-run timer to elapse. Set a fault event if the charge pump does not confirm running within 5 seconds.

7. Pre-Run sequence complete.

Run Sequence

The Run sequence begins after the Pre-Run sequence successfully completes, and comprises the main control loop for the system. The controller will continually run this process until a stop condition has been met.

1. Command the variable frequency drive to run and control the speed based on configured parameter values.

2. Hold the pressure control valve at the start position, start the stabilization timer, and wait for the stabilization timer to elapse.

3. Release the pressure control valve from the start position and allow the pump curve to automatically control the commanded position.

4. Continue running the normal process control until a stop condition has been met.

Post-Run Sequence

The Post-Run sequence begins when a stop condition has been met while running. If a shutdown or fault event occurs while running, the Post-Run sequence will be followed. The Post-Run sequence will not run if the Pre-Run sequence is aborted prior to successful completion.

1. Wait for the variable frequency drive to decelerate and come to a stop.

2. If the block valve control mode for sequence operation is enabled, command the block valve to close.

3. Command the pressure control valve to the fully closed position.

4. If the thrust chamber oil pump is enabled, start the thrust chamber oil pump post-run timer and wait for the timer to elapse.

5. If the charge pump is enabled, start the charge pump post-run timer (simultaneously with the thrust chamber oil pump post-run timer) and wait for the timer to elapse.

6. Post-Run sequence complete.

The OptiPump HPS controller uses a color touchscreen interface to display information and interact with the local operator. The touchscreen uses a resistive touchscreen, which works well for operators with bare fingers, or when the operator is wearing gloves or using a stylus. To select an option on the screen, the operator need only lightly touch the button or area indicated.

Note:

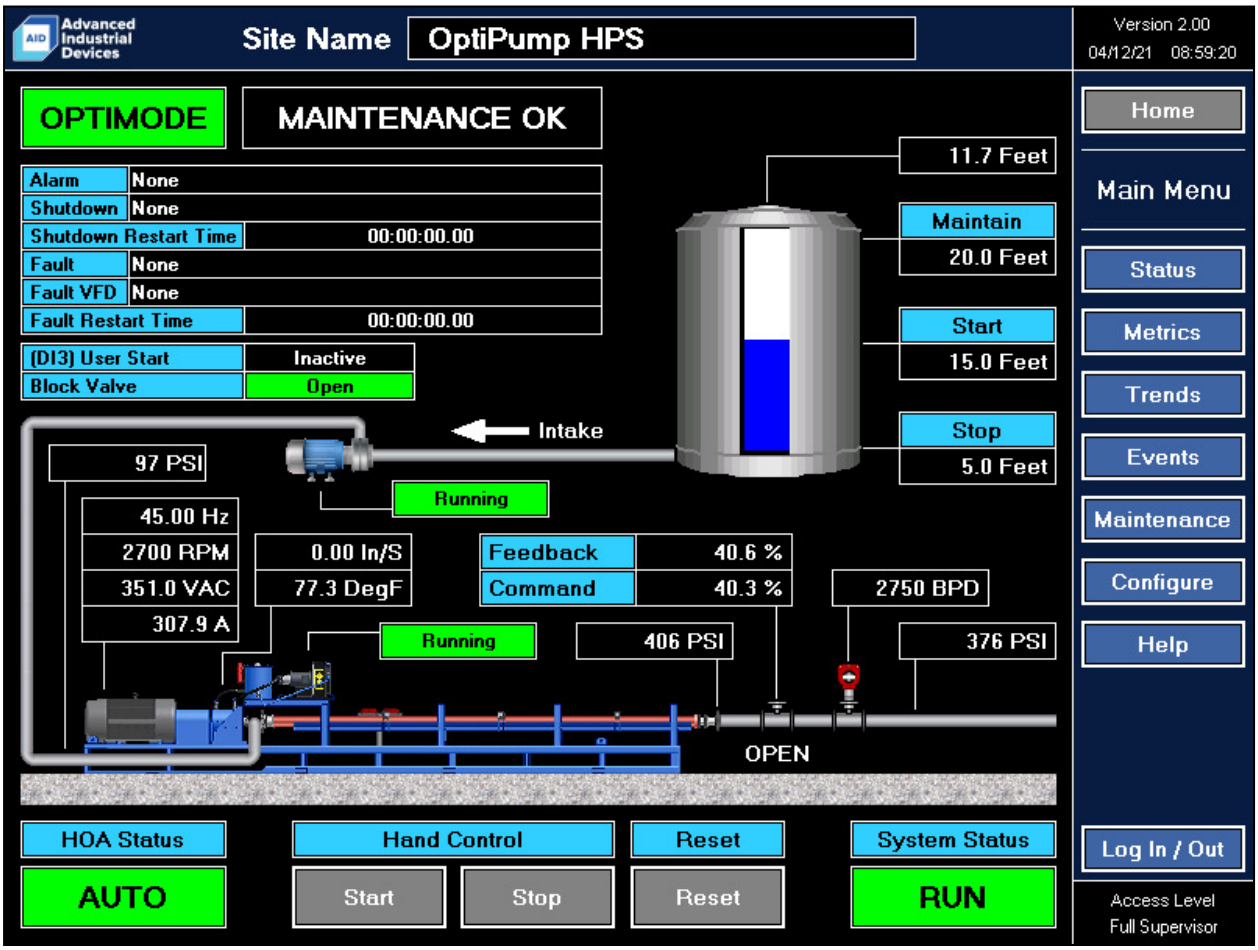
During periods of operator inactivity, the OptiPump HPS controller may turn off the display, very similar to a blank screensaver on a desktop or laptop computer. If power is available to the controller, simply touch anywhere on the screen to enable/wake the local display. The time for this feature can be adjusted, or disabled, in the System configuration settings.

Configuration and operation of controller is performed primarily via the menu located on the right side of the screen. This menu is context-sensitive – that is, the content will change depending on which screen is currently displayed. The text located just below the Home button near the top of the menu indicates which menu is currently displayed. The Home button located at the top of the menu is present on all menus, regardless of context. This button will always return the operator immediately to the Home screen. The AID logo in the upper left corner of the screen functions as a Home button as well.

Generally, if an item on the screen is blue, the item is touch-sensitive, and will react when pressed. If an item is Gray, the item is touch-sensitive, but currently disabled for some reason. This reason could be that the function is not active or that the operator is not logged-in. An example of the Home and Main Menu is shown below.

Button Examples

	**Menu Button Disabled**
	**Menu Button Active**
	**Operation Button Disabled**
	**Operation Button Active**



The Home screen provides an overview of the operational values of the HPS system, and is used as the launching point for navigating to more advanced features of the controller, such as configuration and diagnostic information. The Home screen will automatically change the displayed flow diagram based on the options that are enabled. For example, the charge pump and block valve will automatically appear when enabled in the Support Pumps and Block Valve configuration settings.

Operational controls are also available at the bottom of the Home screen. When the Hand-Off-Auto (HOA) switch is in the Hand position, the Hand Control Start and Stop buttons become active – as indicated by their transition from gray to blue. If a fault or shutdown is currently active, the Reset button will become active in order for the operator to manually reset the fault or shutdown.

HOA Status

OFF	**HOA switch is in the Off position.**
HAND	**HOA switch is in the Hand position.** The system can now be started and stopped using the buttons on the Home screen under the Hand Control heading.
AUTO	**HOA switch is in the Auto position.** The system will automatically start and stop based on the Start/Stop Source parameter in the Main Pump configuration settings.

System Status

OFF	**System is off.** Pre-Run, Run, and Post-Run are complete. No Alarm, Shutdown, or Fault is present. The system is not currently in Timed Restart.
READY	**System is ready and waiting for a start condition to be met.** The HOA switch is in the Hand position, but the system is currently stopped. The HOA switch is in the Auto position, but the system start condition has not been met.
PRE-RUN	**Pre-Run sequence for start-up of the main pump is currently active.** Start conditions have been met, and the system is performing steps needed to prepare the main pump to run (either in Hand or Auto). This includes items such as starting of the charge and oil pumps, initial positioning of the process control and block valves, etc.
RUN	**System is running.** The main pump and supporting equipment is performing as expected.
POST-RUN	**Post-Run sequence for stopping the main pump is currently active.** Stop conditions have been met, and the system is performing steps needed to safely stop the main pump and supporting equipment. This includes items such as continuing to run the thrust chamber oil pump and charge pump for a period of time, etc.

	**Alarm event is active.** One or more alarm conditions have been met. When an alarm is active, the system will continue to run as normal, but the operator should investigate the alarm and take the necessary action to address the condition, if the condition is unexpected.
	**Shutdown event is active, and is configured for manual restart.** A shutdown condition has been met. When a shutdown occurs, the system stops after completing the Post-Run sequence. A shutdown condition should generally not occur during normal operation. However, setpoints have been configured to handle the occurrence by stopping the system if the condition does occur.
	**Fault event is active, and is configured for manual restart.** A fault condition has been met. When a fault occurs, the system stops after completing the Post-Run sequence. A fault condition should never occur during normal operation, and indicates a failure of hardware. If a fault event is active or appears in the event history, the operator should thoroughly investigate the fault code and/or description and snapshot data, then take steps necessary to address and correct the source of the fault before resuming normal operation.
	**Shutdown or fault event is active, and a configured for timed restart.** A shutdown or fault condition has been met, and is configured to automatically reset the shutdown or fault and restart the system automatically after a period of time. Automatic/Timed restart of the system is intended to address intermittent nuisance trips of conditions like low voltage, etc. Ideally, these conditions should be addressed in order to prevent them from occurring without the need for automatic/timed restart.

Access to the configuration parameters of the system is restricted by a user/password system. Local operators must log-in with the password of the desired access level. When logged-out, the local operator can view all of the configuration parameter values, but cannot change the values. This feature can be useful when on-site personnel need to verify operational parameters without the need to provide the personnel with the ability to change the parameters.

The current access level is shown in the lower right corner of the screen, just below the Log In/Out button.

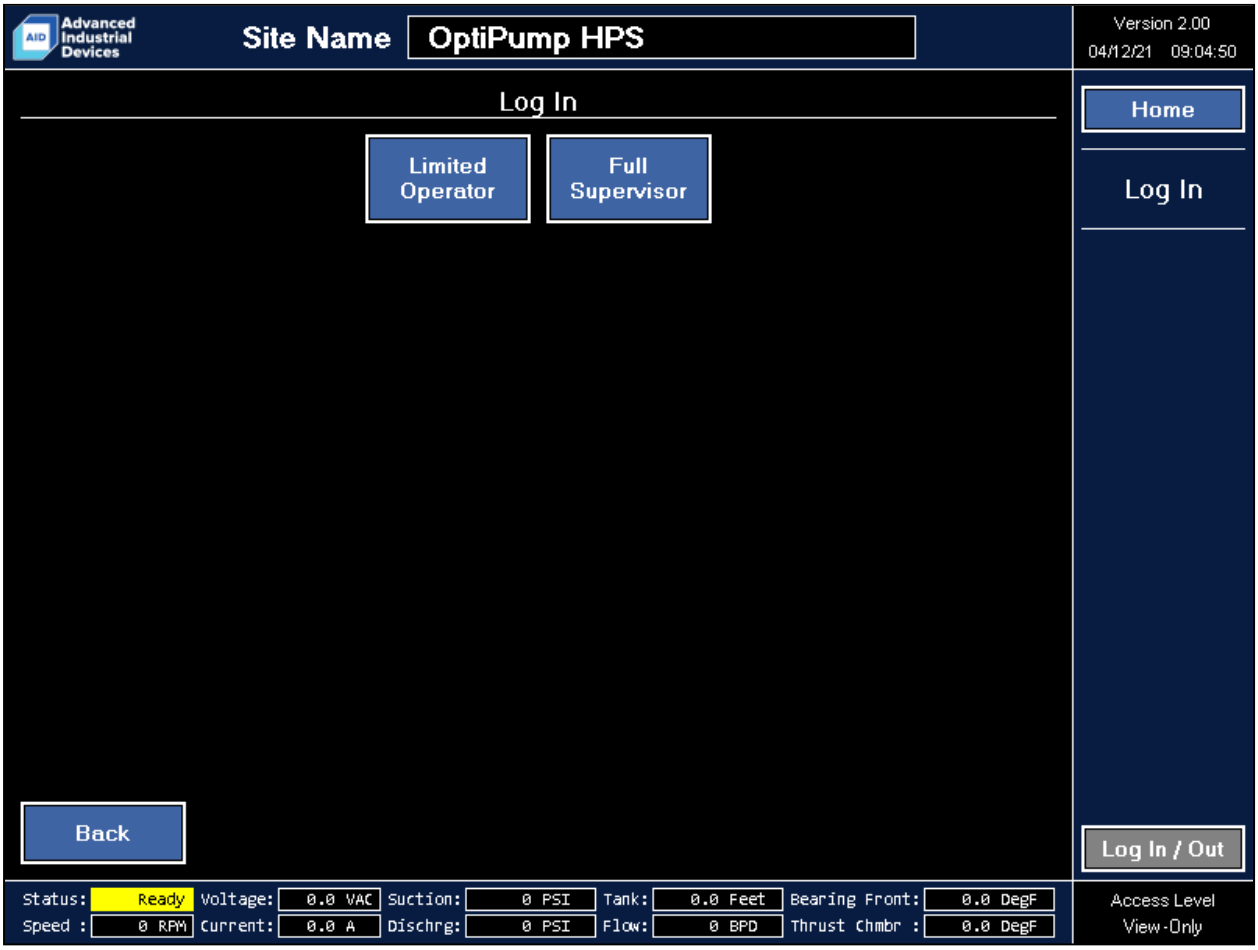
The OptiPump HPS controller supports several types of operator access levels:

Access Level

Access Level View-Only	**View-Only** All configuration parameters are viewable, but cannot be changed. This is the default, logged-out, access level.
Access Level Limited Operator	**Limited Operator** Access to operational setpoints needed for day-to-day operation of the system. Access to all other configuration parameters is restricted.
Access Level Full Supervisor	**Full Supervisor** Access to all configuration parameters is available. No restrictions.
Access Level Factory	**Factory** Special access for factory technical personnel is available. This access level is only available by speaking with the technical or engineering support department.

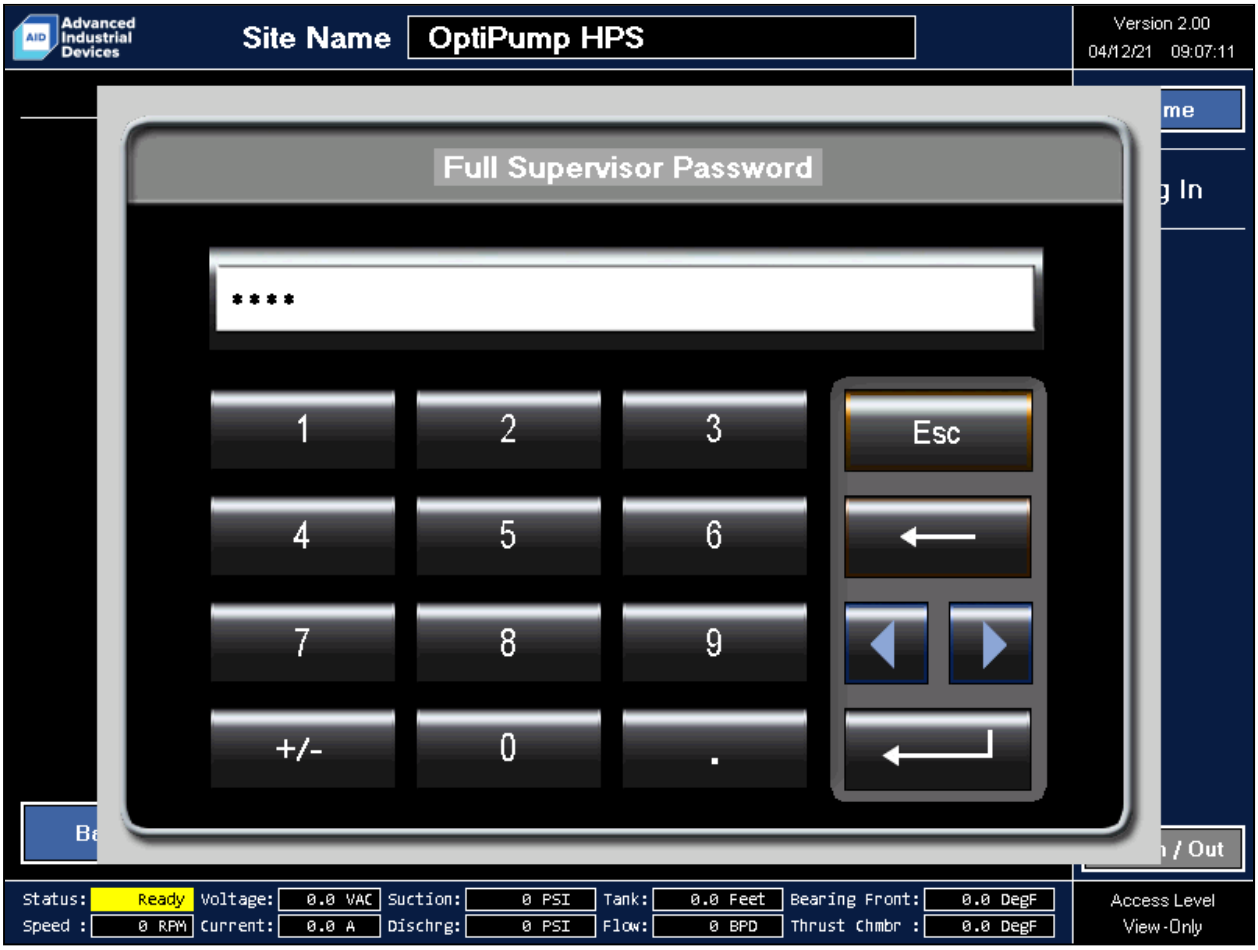
In order to modify configuration parameters, the local operator must first log-in by pressing the Log In/Out button. The Log In/Out button is located at the bottom of the menu located on the right side of the screen, and is available on all menus regardless of context. After the button is pressed, the Log In screen will be displayed, with the option to select between the Limited Operator and Full Supervisor access levels.

Log In



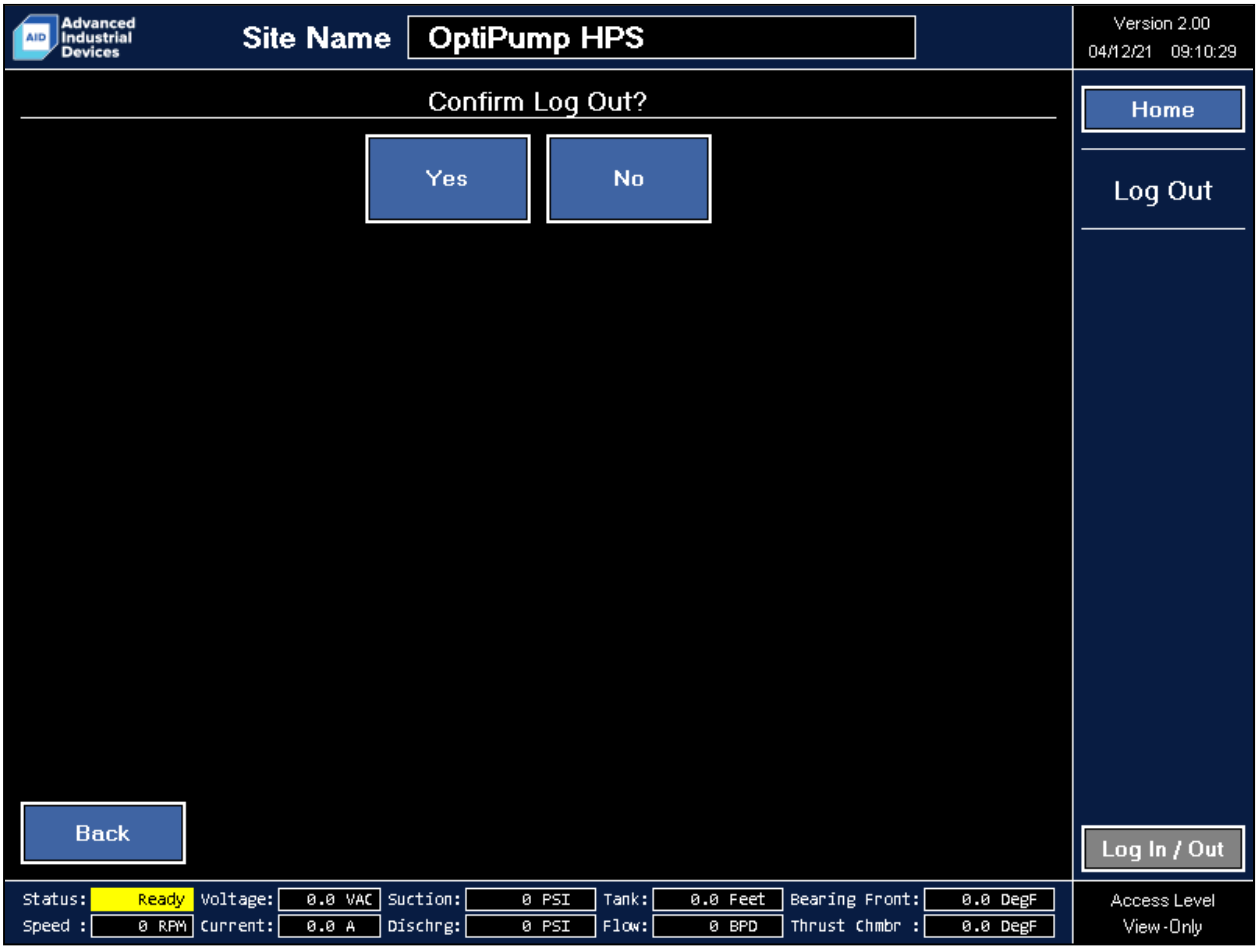
After pressing either of the access level buttons, the operator will be prompted for the password for the selected access level.

Password Entry



Entering the correct password will result in the display returning to the screen from which the Log In/Out button was pressed. Pressing the Esc button will return to the Log In screen, and pressing the Back button from the Log In screen will also result in the display returning to the screen from which the Log In/Out button was initially pressed.

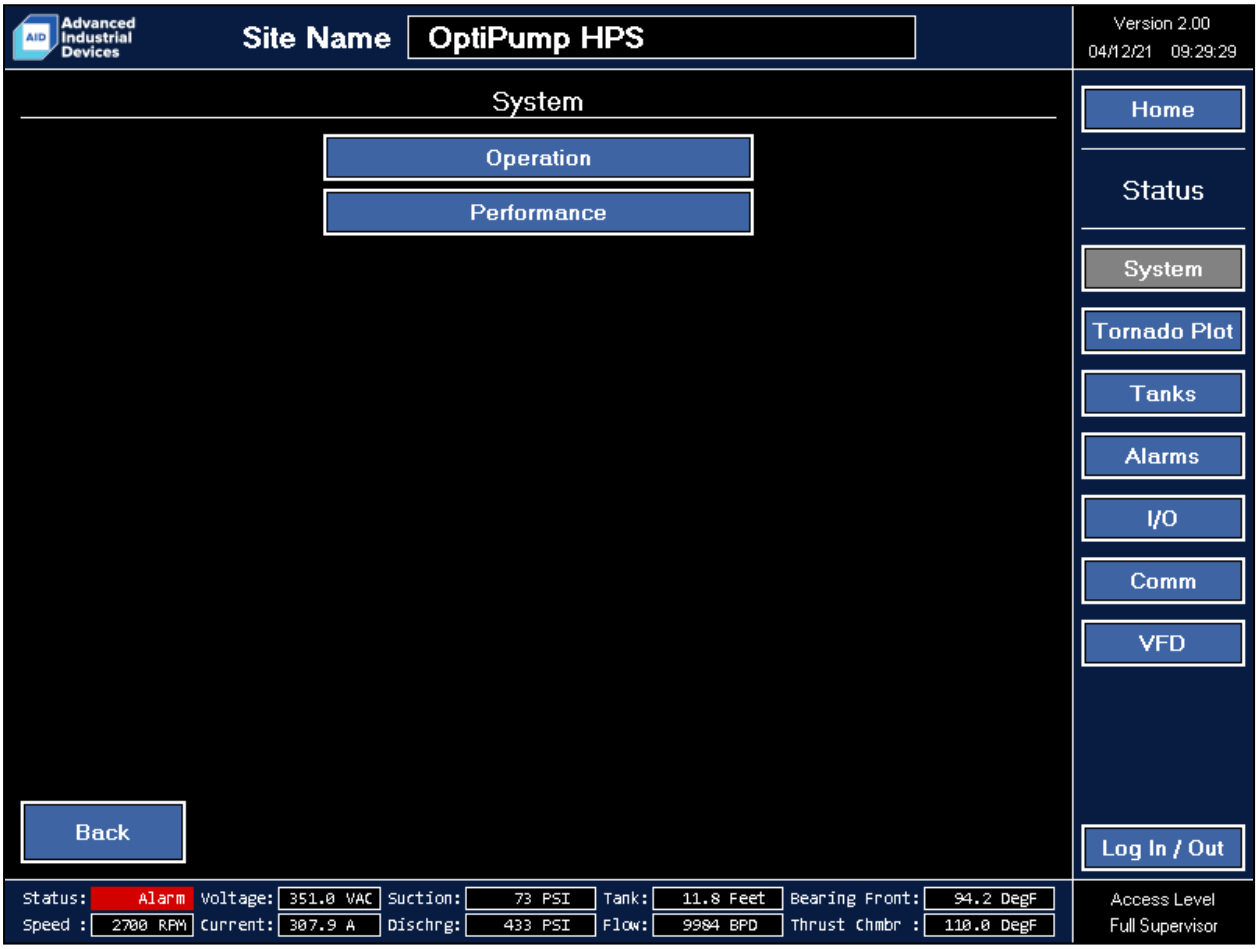
Log Out



Once the local operator has completed making changes to the configuration parameters, the operator, as a good practice, should log-out before walking away from the controller. This prevents others from accidentally making changes to the configuration. After pressing the Log In/Out button, the Log Out screen will be displayed, with the option to Confirm Log Out – Yes or No. Pressing the Yes button will result in the operator access level being returned to View-Only and the display returning to the screen from which the Log In/Out button was pressed. Pressing the No button (or the Back button) will result in the display immediately returning to the screen from which the Log In/Out button was pressed, and the operator access level being unchanged.

The OptiPump HPS controller provides extensive operational status information that can be used as a powerful tool for commissioning, troubleshooting, and optimization of the pump system. This information is available by pressing the Status button on the Main Menu. The status information is available using the View-Only access level, and does not require a password to view.

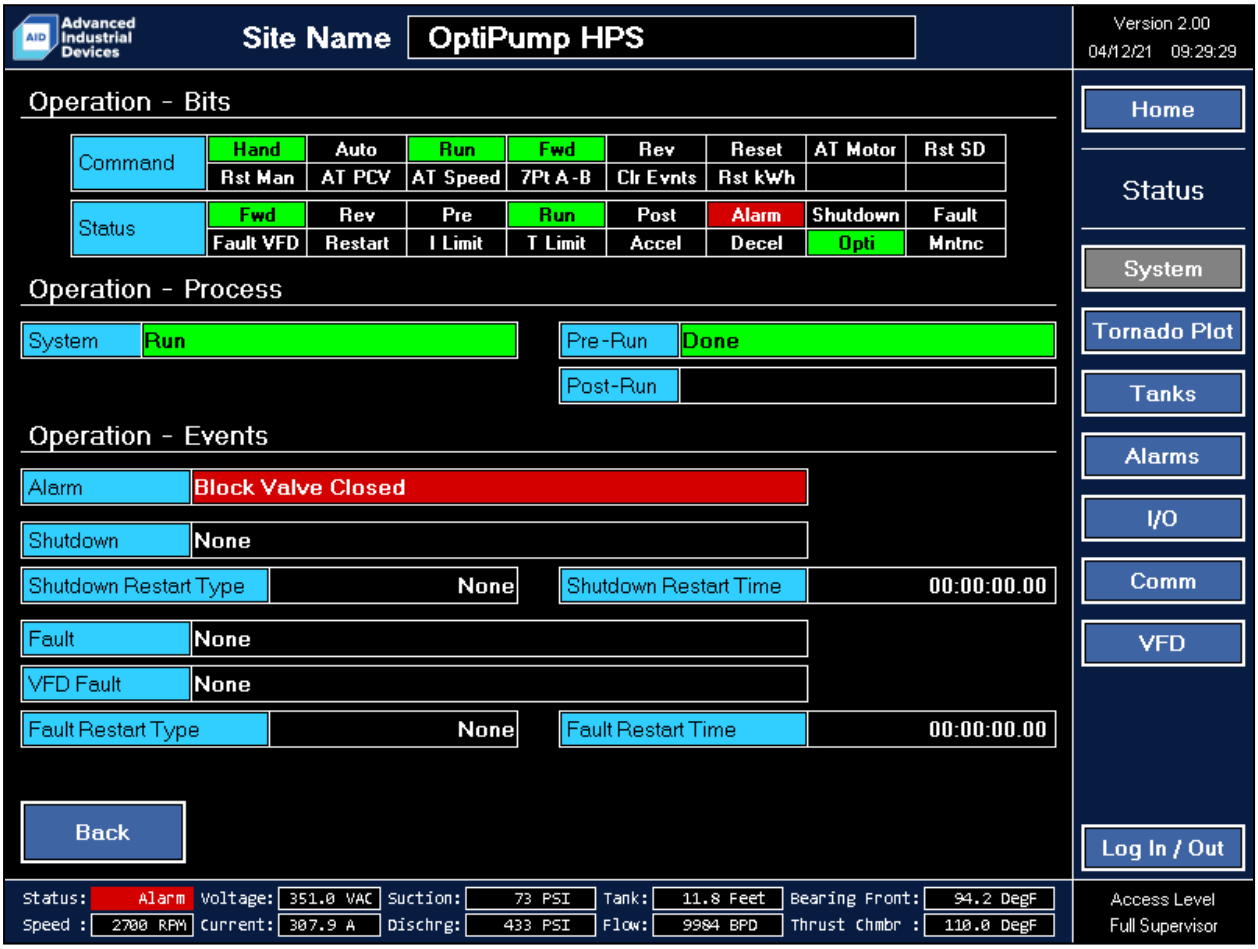
For convenience, the status information is presented in groups, which are selectable using the menu. If a status group contains subgroups, a selection menu will appear in the content area on the screen.



The System status information provides a quick overview of the current operating conditions of the controller, and is presented in two groups:

- Operation
  Status Bits, Process State, and Events

- Performance
  Status Bits, Variable Frequency Drive Performance, and Motor Performance



Command and Status bits are duplicated on both the System Operation and System Performance status screens in order to provide a quick reference for the local operator, without the need to flip back and forth between screens for the needed information.

Command and Status bits are displayed in white text over a black background when in the reset/inactive (logic 0) state. During normal operation, Command and Status bits are displayed in black text over a green background when in the set/active (logic 1) state, or when in need of immediate attention, in white text over a red background.

Command Bits

Hand	**Hand** Active when the HOA is in the Hand position and the local operator has started the system using the Start button on the Home screen.

	**Auto** Active when the HOA is in the Auto position and the start condition has been met (digital input, analog input, etc.).
	**Run** Active when the Hand and/or Auto Command Bit(s) is/are active.
	**Forward** Active when the Run Command Bit and the Run Status Bit are active.
	**Reverse** Future firmware release. Currently not used. Always inactive.
	**Reset** Active when a reset of a shutdown or fault is requested, either manually by the operator (locally or via SCADA) or automatically by the controller if the shutdown or fault is configured for a timed reset.
	**Auto-Tune Motor** Future firmware release. Currently not used. Always inactive.
	**Reset SD Card Logging** Active when a reset of the SD card logging system is requested by the local operator (factory use only).
	**Reset Manual** Active when a manual reset of a shutdown or fault is requested locally by the operator.
	**Auto-Tune Pressure Control Valve** Active when the pressure control valve PID auto-tune process is requested by the local operator, and remains active until the PID auto-tune process completes.
	**Auto-Tune Speed** Active when the main pump speed PID auto-tune process is requested by the local operator, and remains active until the PID auto-tune process completes.
	**7-Point Generate Auto-Bounds** Active when the 7-point pump curve auto-bounds generation to calculate the bounds values is requested by the local operator.
	**Clear Events** Active when a clearing of the event history is requested by the local operator (factory use only).

	**Reset kWh** Future firmware release. Currently not used. Always inactive.

Status Bits

	**Forward** Active when the variable frequency drive is confirmed running in the forward direction.
	**Reverse** Active when the variable frequency drive is confirmed running in the reverse direction.
	**Pre-Run** Active when the controller is processing the Pre-Run sequence.
	**Run** Active when the controller has completed the Pre-Run sequence, and the main pump is running.
	**Post-Run** Active when the controller is processing the Post-Run sequence.
	**Alarm** Active when any alarm event is currently present.
	**Shutdown** Active when any shutdown event is currently present.
	**Fault** Active when any fault event is currently present.
	**Fault Variable Frequency Drive** Active when a variable frequency drive fault is currently present.
	**Restart** Active when a shutdown or fault is currently present, and is configured for a timed/automatic restart.
	**I (Current) Limit** Active when the variable frequency drive is current limiting.

	**T (Torque) Limit** Active when the variable frequency drive is torque limiting.
	**Accelerating** Active when the variable frequency drive is accelerating.
	**Decelerating** Active when the variable frequency drive is decelerating.
	**Opti Mode** Active when Opti Mode is enabled.
	**Maintenance Required** Active when any Maintenance Reminder is in need of attention.

Process - System

Off	The HOA switch is in the Off position, and the system will not run.
Ready	The HOA switch is in the Hand or Auto position, and the system is waiting for run conditions to be met.
Pre-Run	The Pre-Run sequence is currently running.
Run	The main pump is running.
Post-Run	The Post-Run sequence is currently running.
Alarm	One or more alarm conditions is/are currently present.
Shutdown	A shutdown event is currently present.
Fault	A fault event is currently present (system or variable frequency drive).
Restart	A shutdown or fault event is currently present, and is configured for a timed/automatic restart.

Process - Pre-Run

Pre-Run	Waiting
Waiting	The system is waiting for start conditions to be met (the HOA could also be in the Off position).
Thrust Chamber Oil Pump Run	The thrust chamber oil pump is currently running.
Block Valve Open	The block valve is opening.
Pressure Control Valve Position	The pressure control valve is moving to the start position.
Charge Pump Run	The charge pump is running.
Done	The Pre-Run sequence has completed successfully.

Process - Post-Run

Post-Run	
----------	Future firmware release. Currently not used. Always blank.

Events - Alarm

Alarm	None
Displays a text description of any alarm event (single or multiple) that is currently present. Refer to the Events chapter for a list of alarm events and descriptions.	

Displays a text description of a shutdown event that is currently present.
Refer to the Events chapter for a list of shutdown events and descriptions.

Displays the restart type of a shutdown event that is currently present.

- None
  No shutdown event is currently present.
- Manual
  The shutdown event requires a manual reset.
- Timed
  The shutdown event will automatically reset when the Shutdown Restart Time elapses. The shutdown event can also be manually reset before the Shutdown Restart Time elapses.

Displays the amount of time remaining before the shutdown event is automatically reset, if the Shutdown Restart Type is Timed.

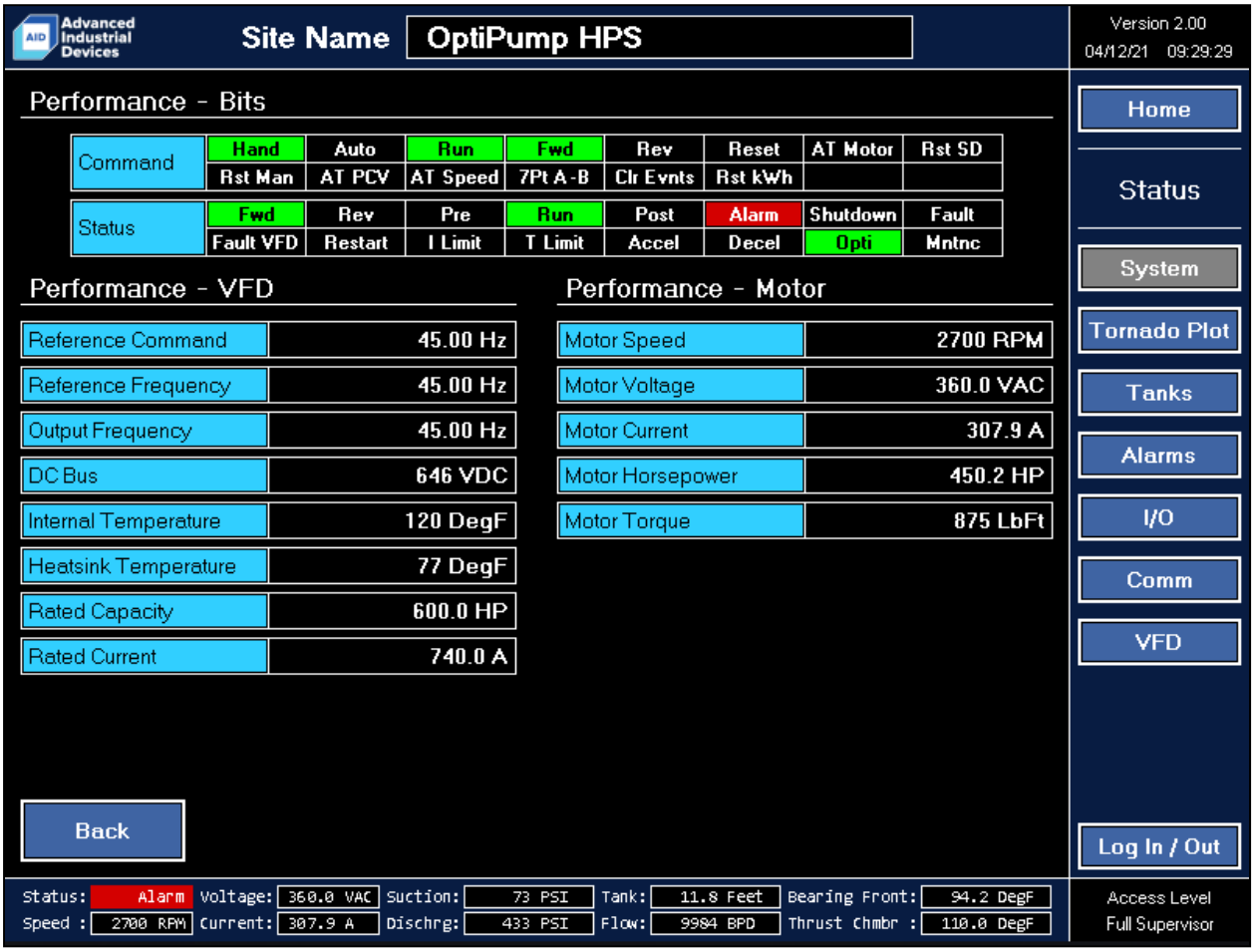
Displays a text description of a fault event that is currently present.
Refer to the Events chapter for a list of fault events and descriptions.

Displays a text description of a variable frequency drive specific fault event.
Refer to the Events chapter for a list of variable frequency drive fault events and descriptions.

Displays the restart type of a fault event that is currently present.

- None
  No fault event is currently present.
- Manual
  The fault event requires a manual reset.
- Timed
  The fault event will automatically reset when the Fault Restart Time elapses. The fault event can also be manually reset before the Fault Restart Time elapses.

Displays the amount of time remaining before the fault event is automatically reset, if the Fault Restart Type is Timed.



Command and Status bits are duplicated on both the System Operation and System Performance status screens in order to provide a quick reference for the local operator, without the need to flip back and forth between screens for the needed information.

Command and Status bits are displayed in white text over a black background when in the reset/inactive (logic 0) state. During normal operation, Command and Status bits are displayed in black text over a green background when in the set/active (logic 1) state, or when in need of immediate attention, in white text over a red background.

Command Bits

Hand	**Hand** Active when the HOA is in the Hand position and the local operator has started the system using the Start button on the Home screen.

	**Auto** Active when the HOA is in the Auto position and the start condition has been met (digital input, analog input, etc.).
	**Run** Active when the Hand and/or Auto Command Bit(s) is/are active.
	**Forward** Active when the Run Command Bit and the Run Status Bit are active.
	**Reverse** Future firmware release. Currently not used. Always inactive.
	**Reset** Active when a reset of a shutdown or fault is requested, either manually by the operator (locally or via SCADA) or automatically by the controller if the shutdown or fault is configured for a timed reset.
	**Auto-Tune Motor** Future firmware release. Currently not used. Always inactive.
	**Reset SD Card Logging** Active when a reset of the SD card logging system is requested by the local operator (factory use only).
	**Reset Manual** Active when a manual reset of a shutdown or fault is requested locally by the operator.
	**Auto-Tune Pressure Control Valve** Active when the pressure control valve PID auto-tune process is requested by the local operator, and remains active until the PID auto-tune process completes.
	**Auto-Tune Speed** Active when the main pump speed PID auto-tune process is requested by the local operator, and remains active until the PID auto-tune process completes.
	**7-Point Generate Auto-Bounds** Active when the 7-point pump curve auto-bounds generation to calculate the bounds values is requested by the local operator.
	**Clear Events** Active when a clearing of the event history is requested by the local operator (factory use only).

	**Reset kWh** Future firmware release. Currently not used. Always inactive.

Status Bits

	**Forward** Active when the variable frequency drive is confirmed running in the forward direction.
	**Reverse** Active when the variable frequency drive is confirmed running in the reverse direction.
	**Pre-Run** Active when the controller is processing the Pre-Run sequence.
	**Run** Active when the controller has completed the Pre-Run sequence, and the main pump is running.
	**Post-Run** Active when the controller is processing the Post-Run sequence.
	**Alarm** Active when any alarm condition is currently present.
	**Shutdown** Active when any shutdown condition is currently present.
	**Fault** Active when any fault condition is currently present.
	**Fault Variable Frequency Drive** Active when a variable frequency drive fault is currently present.
	**Restart** Active when a shutdown or fault is currently present, and is configured for a timed/automatic restart.
	**I (Current) Limit** Active when the variable frequency drive is current limiting.

T Limit	**T (Torque) Limit** Active when the variable frequency drive is torque limiting.
Accel	**Accelerating** Active when the variable frequency drive is accelerating.
Decel	**Decelerating** Active when the variable frequency drive is decelerating.
Opti	**Opti Mode** Active when Opti Mode is enabled.
Mntnc	**Maintenance Required** Active when any Maintenance Reminder is in need of attention.

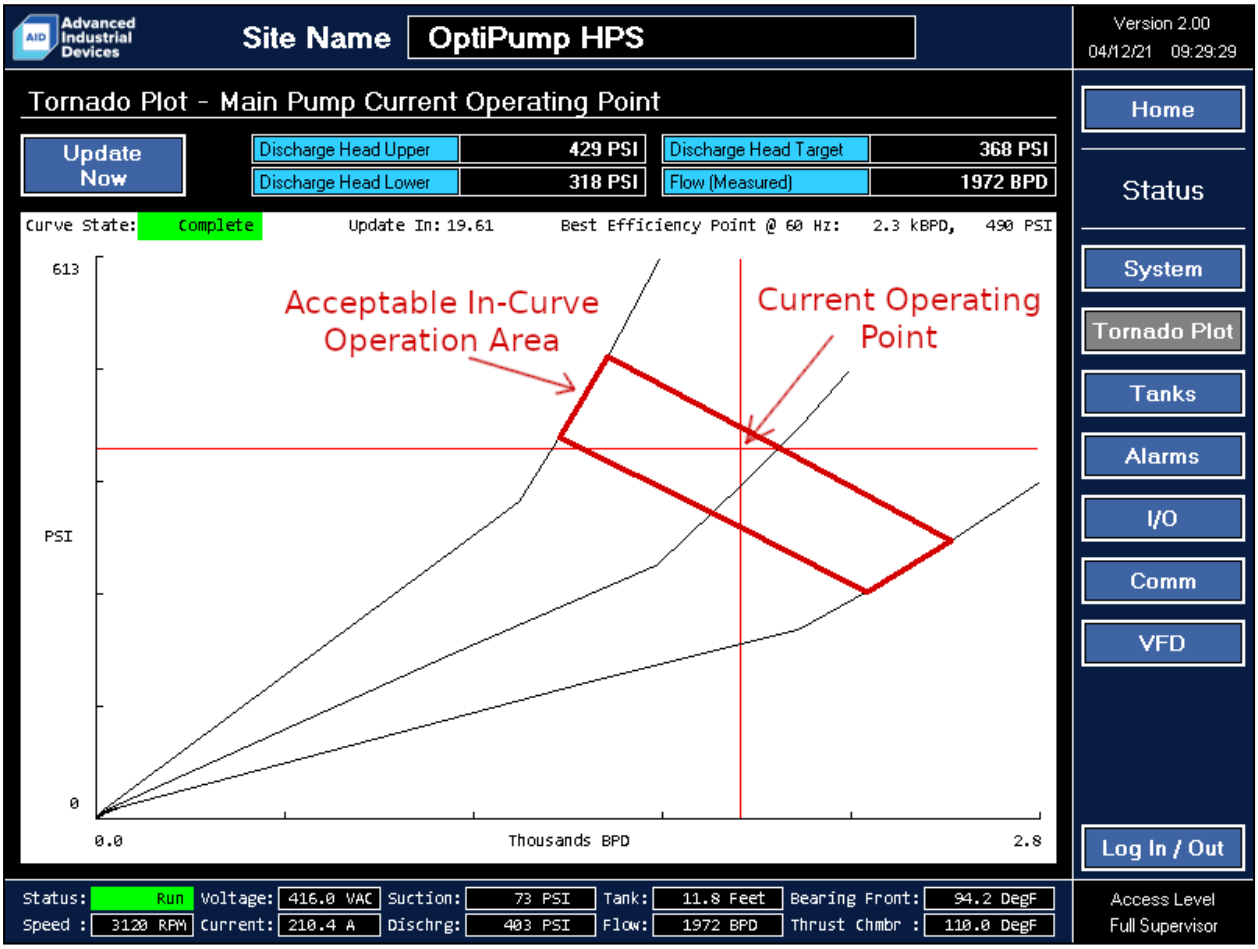
Variable Frequency Drive

Reference Command	The Reference Command is the reference frequency, in Hz, set by the controller and sent to the variable frequency drive.
Reference Frequency	The Reference Frequency is the reference frequency, in Hz, read back as a monitor from the variable frequency drive. Under normal operating conditions, the Reference Command and Reference Frequency should match, or be very close in value.
Output Frequency	The Output Frequency is the frequency output, in Hz, at the variable frequency drive motor terminals.
DC Bus	The DC Bus is the value of the internal DC bus, in volts DC, of the variable frequency drive. The DC voltage has a relationship of 1.141 times the incoming AC RMS voltage. For example, 480 VAC incoming, results in 480 VAC * 1.414 = 678 VDC (approximately). This monitor can be helpful when troubleshooting internal issues with the variable frequency drive or incoming power.
Internal Temperature	The Internal Temperature is the temperature of the control card, in degrees F, of the control card located inside the variable frequency drive.
Heatsink Temperature	The Heatsink Temperature is the temperature of the large aluminum heatsink, in degrees F, of the variable frequency drive.

Rated Capacity	The Rated Capacity identifies the rated capacity, in horsepower, of the variable frequency drive. The rated capacity horsepower should match the label located on the outside of the variable frequency drive if correctly identified by the controller firmware.
Rated Current	The Rated Current identifies the rated current, in amps, of the variable frequency drive. The rated current amperage should match the label located on the outside of the variable frequency drive if correctly identified by the controller firmware.

Motor

Motor Speed	The speed of the motor in RPM.
Motor Voltage	The output voltage at the motor terminals of the variable frequency drive in volts AC.
Motor Current	The output current of the variable frequency drive to the motor in amps AC.
Motor Horsepower	The electrical power input to the motor in horsepower.
Motor Torque	The shaft torque of the main pump motor in Lb-Ft.



The Tornado Plot, aptly named for the funnel-like shape created by the acceptable in-curve operation boundaries, provides a visual representation of where the main pump is currently operating in relation to the defined main pump curve. The x-axis is flow, while the y-axis is discharge pressure. The acceptable in-curve operation area, highlighted in red, moves up and down the tornado diagram automatically, based on the speed of the main pump. The vertical and horizontal red lines create a crosshair that marks the current operating point of the main pump. If the current operating point is outside the red area, the pump is out-of-curve. Operating the main pump out-of-curve reduces efficiency and can damage the equipment. The pressure control valve will automatically attempt to keep the current operating point inside the acceptable in-curve operation area.

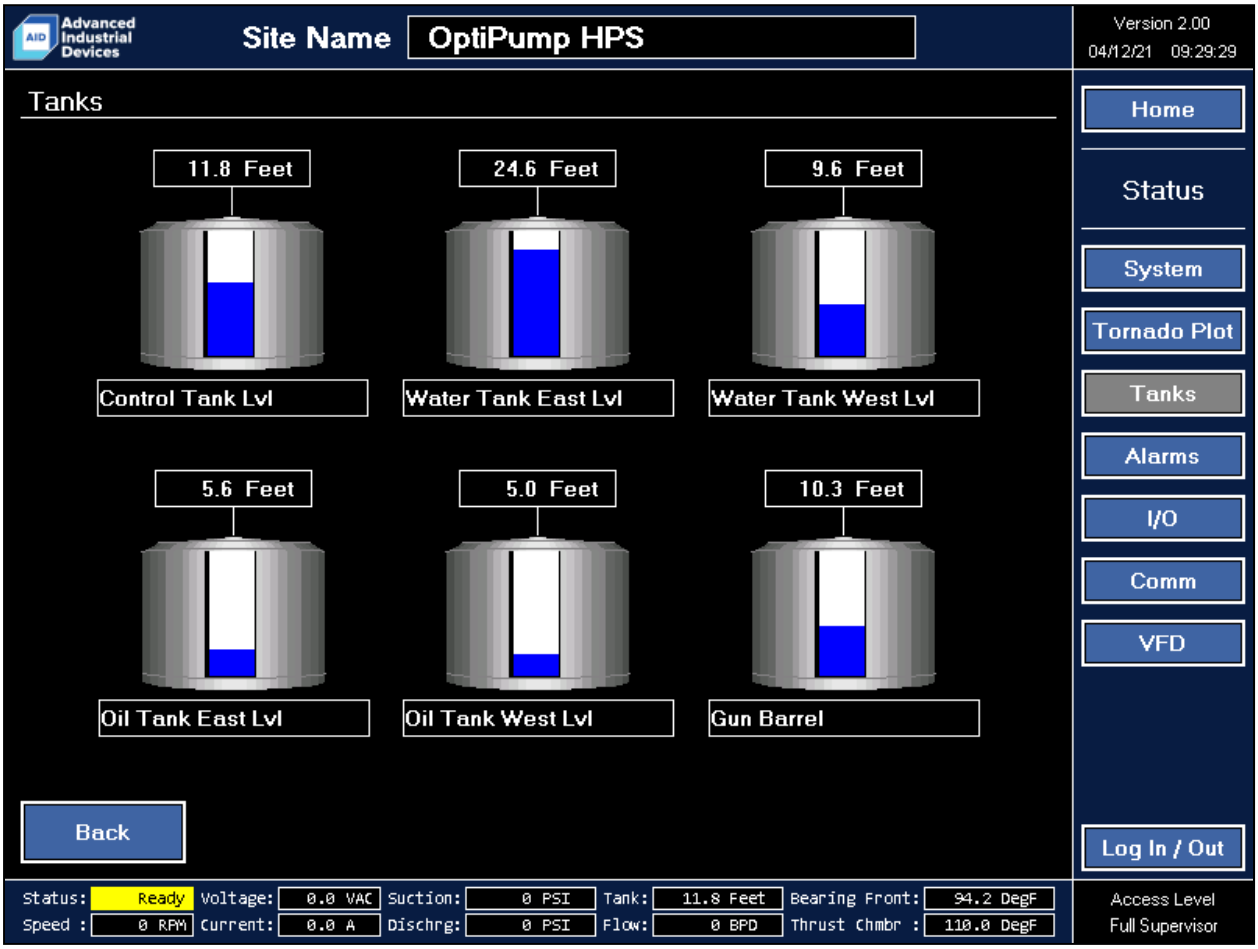
The Tornado Plot automatically refreshes once per minute. However, the operator can force the data to be refreshed immediately by pressing the Update Now button in the upper left corner of the screen.

The best efficiency point (BEP) at 60 Hz, based on the defined main pump curve, is displayed in the upper right corner of the plot.

For reference, several monitor values are included at the top of the screen.

Monitors

Discharge Head Target	The target discharge pressure the controller is attempting to maintain using the pressure control valve.
Flow (Calculated) Flow (Measured)	The flow rate on the discharge side of the main pump. A flow meter is required for optimal performance. However, if a flow meter is unavailable, the pump curve may be used to calculate the flow.
Discharge Head Upper	The upper acceptable limit of discharge pressure based on the pump curve, speed of the main pump, and current discharge flow rate.
Discharge Head Lower	The lower acceptable limit of discharge pressure based on the pump curve, speed of the main pump, and current discharge flow rate.



The Tanks status screen provides a visual overview of the tank levels. For installations with multiple tanks that require monitoring, the OptiPump HPS controller can be configured to support up to 6 tanks (including the main tank that may be used for start/stop and speed control of the main pump).

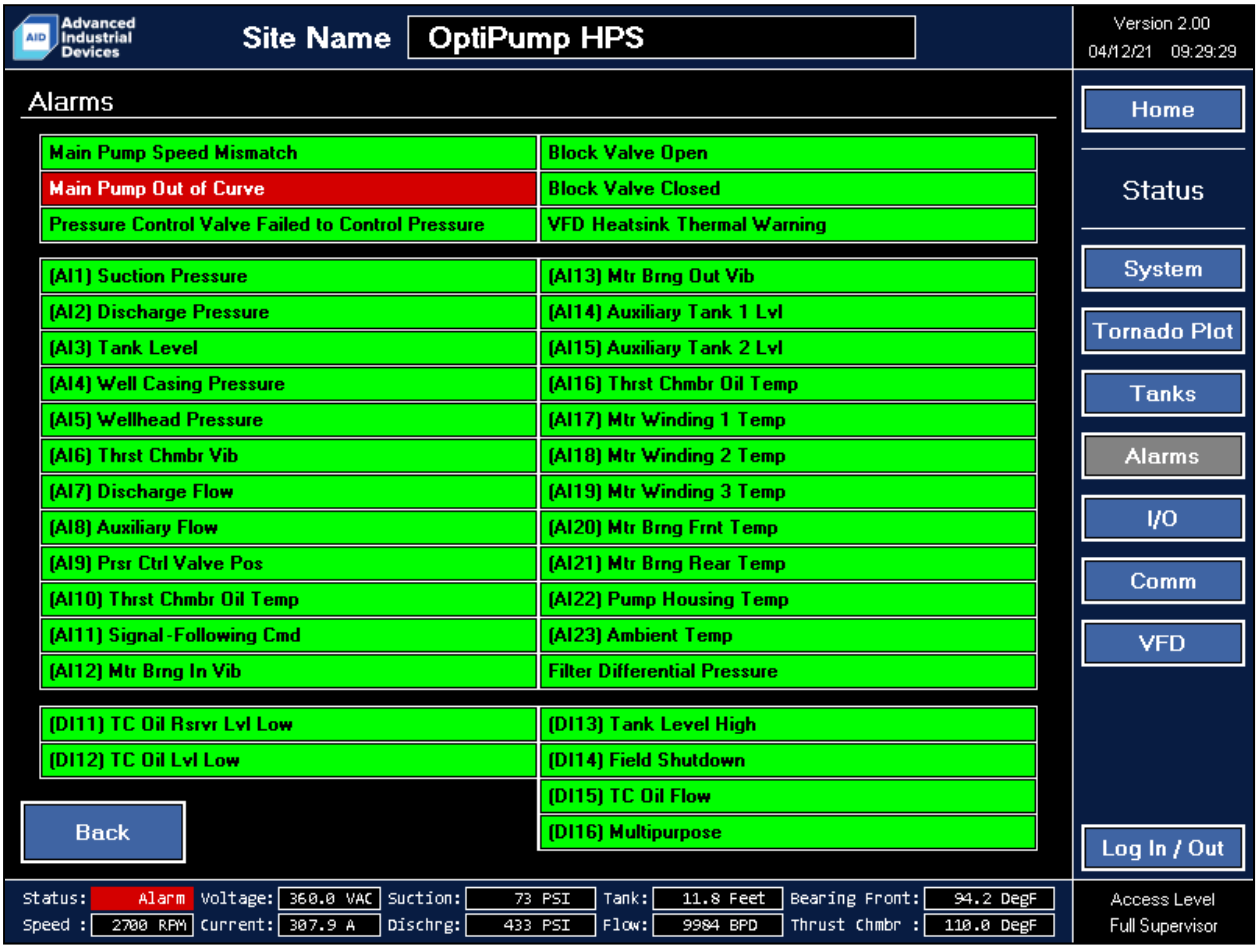
Several analog inputs can be configured for tank support. Enabling the tank support parameter on the associated analog input will allow the measured value to be shown as a tank on the Tanks status screen. Each of the 6 available tanks can be associated with one of these analog inputs, so the ordering of the tanks on this screen is determined by the operator. If a tank is not linked to an analog input, that tank will not be visible.

The tanks are numbered 1 through 6, starting in the upper left corner, then moving to the right. Tank 1 is located in the upper left corner. Tank 2 is located in the top row, middle. Tank 3 is located in the upper right corner. Tanks 4 through 6 follow a similar layout for the second row.

The operator defined name of the analog input is shown underneath the associated tank.

Analog inputs that can be assigned to tanks:

- (AI3) Tank Level
- (AI11) Signal-Following Cmd
- (AI12) Mtr Brng In Vib
- (AI13) Mtr Brng Out Vib
- (AI14) Auxiliary Tank 1 Lvl
- (AI15) Auxiliary Tank 2 Lvl

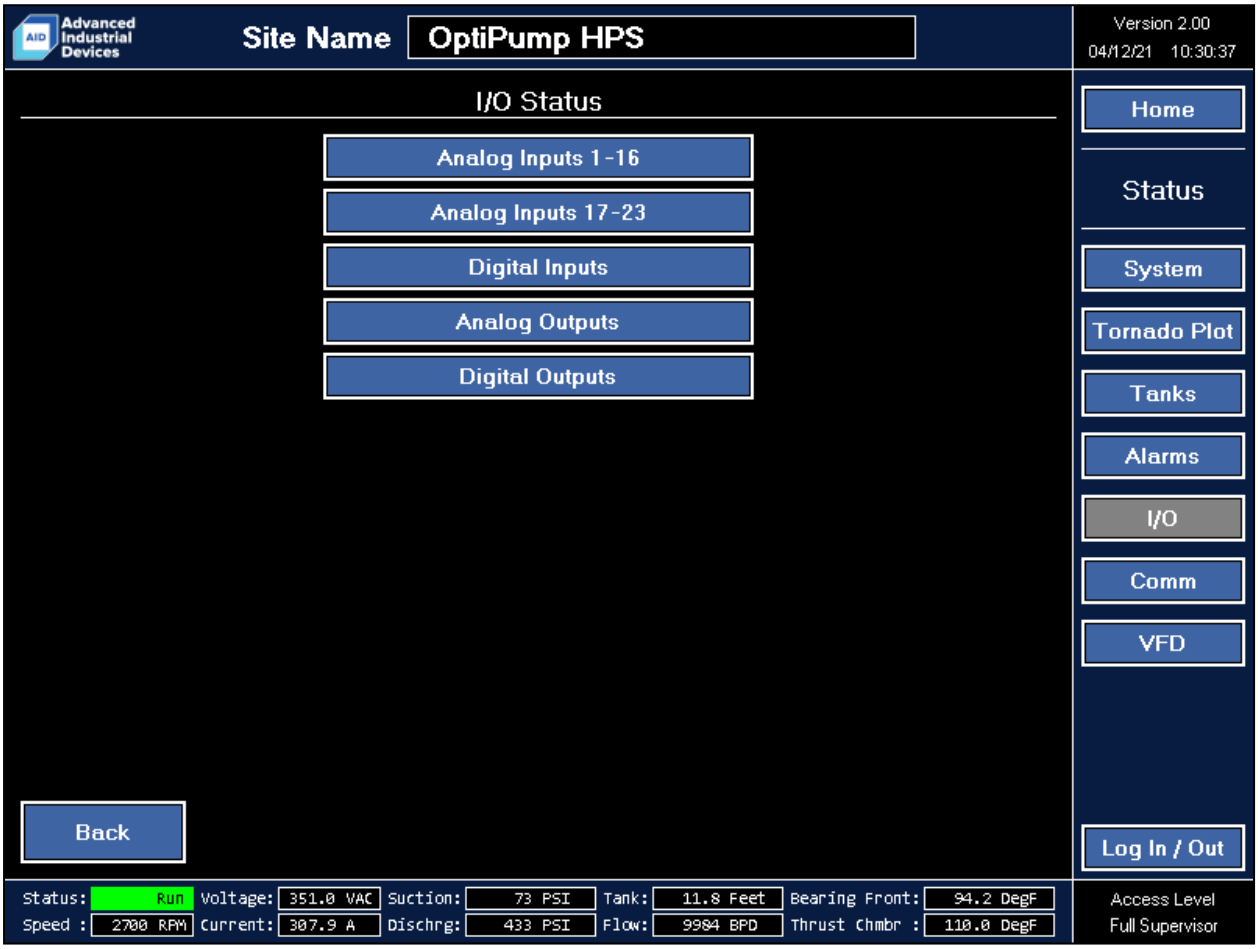


Alarm events serve to notify the operator or external equipment of a condition that warrants attention, but does not yet need to stop the process. Since the system continues to run when alarm events occur, multiple alarms can be present simultaneously.

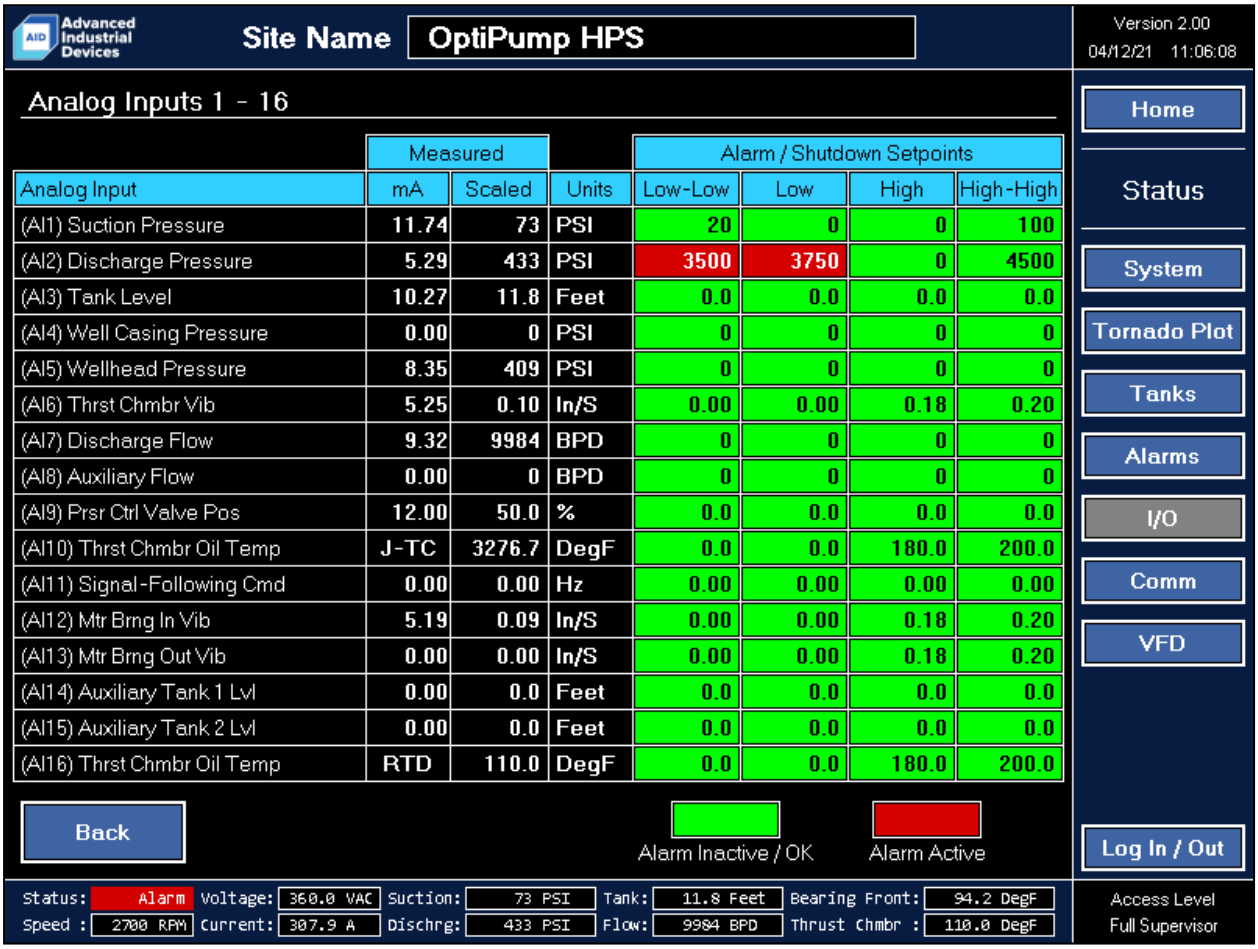
Individual alarm events are listed on the Alarms screen. Alarm events that are not currently present (inactive/OK) are displayed in black text over a green background. When an alarm event is currently present (active), the individual alarm indicator will be displayed in white text over a red background.

For analog and digital input alarms, the text on the individual alarm indicators will automatically be updated with the names entered by the operator on the configuration screen for the associated input.

Each analog input can be configured for up to four independent alarm setpoints, but only one alarm indicator per analog input is shown on the Alarms screen. The alarm indicator for each of the analog inputs shown will indicate an alarm condition if ANY of the four alarm conditions associated with that analog input is present. For a detailed breakdown of the analog input alarm events, refer to **Status > I/O > Analog Inputs 1-16** and **Status > I/O > Analog Inputs 17-23**.



The OptiPump HPS controller provides a robust set of analog and digital I/O that allows for monitoring and control of a variety of external devices. For operator simplicity, the analog and digital I/O status information is grouped by I/O type.



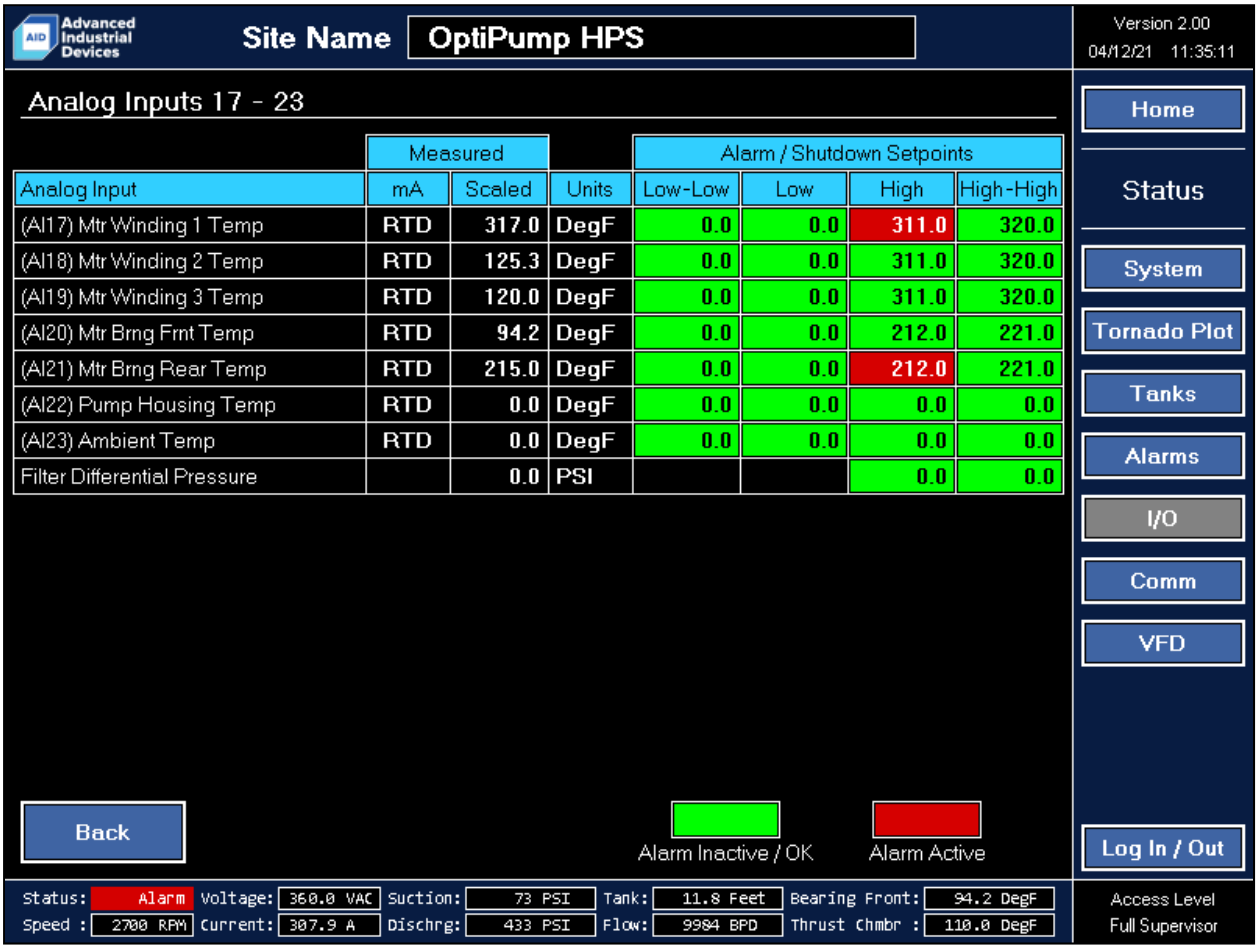
	Measured			Alarm / Shutdown Setpoints			
Analog Input	mA	Scaled	Units	Low-Low	Low	High	High-High
(AI1) Suction Pressure	11.74	73	PSI	20	0	0	100
(AI2) Discharge Pressure	5.29	433	PSI	3500	3750	0	4500
(AI3) Tank Level	10.27	11.8	Feet	0.0	0.0	0.0	0.0
(AI4) Well Casing Pressure	0.00	0	PSI	0	0	0	0
(AI5) Wellhead Pressure	8.35	409	PSI	0	0	0	0
(AI6) Thrst Chmbr Vib	5.25	0.10	In/S	0.00	0.00	0.18	0.20
(AI7) Discharge Flow	9.32	9984	BPD	0	0	0	0
(AI8) Auxiliary Flow	0.00	0	BPD	0	0	0	0
(AI9) Prsr Ctrl Valve Pos	12.00	50.0	%	0.0	0.0	0.0	0.0
(AI10) Thrst Chmbr Oil Temp	J-TC	3276.7	DegF	0.0	0.0	180.0	200.0
(AI11) Signal-Following Cmd	0.00	0.00	Hz	0.00	0.00	0.00	0.00
(AI12) Mtr Brng In Vib	5.19	0.09	In/S	0.00	0.00	0.18	0.20
(AI13) Mtr Brng Out Vib	0.00	0.00	In/S	0.00	0.00	0.18	0.20
(AI14) Auxiliary Tank 1 Lvl	0.00	0.0	Feet	0.0	0.0	0.0	0.0
(AI15) Auxiliary Tank 2 Lvl	0.00	0.0	Feet	0.0	0.0	0.0	0.0
(AI16) Thrst Chmbr Oil Temp	RTD	110.0	DegF	0.0	0.0	180.0	200.0

Analog inputs 1 through 16 are shown on the first Analog Inputs I/O status screen. Each row in the table represents a single analog input, and provides the following:

- Name (configurable, however some inputs have a dedicated function)
- Current Measured Value (based on the minimum and maximum scaling configured)
- Units (configurable or fixed, depending on the function)
- Low-Low Alarm/Shutdown Setpoint Value (configurable)
- Low Alarm/Shutdown Setpoint Value (configurable)
- High Alarm/Shutdown Setpoint Value (configurable)
- High-High Alarm/Shutdown Setpoint Value (configurable)

While the **Status > Alarms** screen groups the four individual alarm/shutdown setpoints into a single indicator, the I/O status screen displays each of the setpoints individually, and color codes the setpoints in the same manner as the alarms screen. A setpoint with no alarm event present (inactive/OK) is displayed in black text over

a green background. A setpoint with an alarm event present (active) is displayed in white text over a red background.



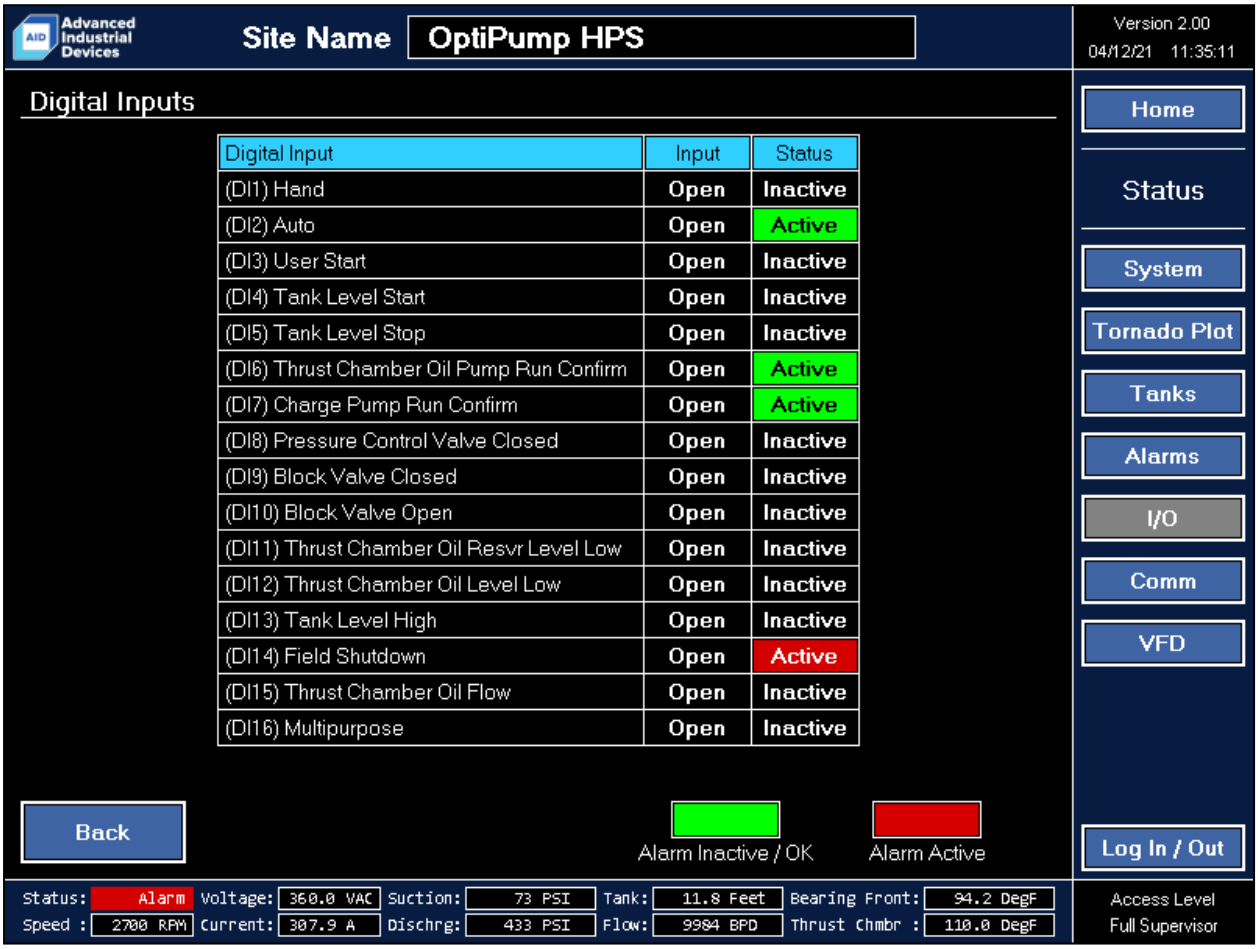
	Measured			Alarm / Shutdown Setpoints			
Analog Input	mA	Scaled	Units	Low-Low	Low	High	High-High
(AI17) Mtr Winding 1 Temp	RTD	317.0	DegF	0.0	0.0	311.0	320.0
(AI18) Mtr Winding 2 Temp	RTD	125.3	DegF	0.0	0.0	311.0	320.0
(AI19) Mtr Winding 3 Temp	RTD	120.0	DegF	0.0	0.0	311.0	320.0
(AI20) Mtr Brng Frnt Temp	RTD	94.2	DegF	0.0	0.0	212.0	221.0
(AI21) Mtr Brng Rear Temp	RTD	215.0	DegF	0.0	0.0	212.0	221.0
(AI22) Pump Housing Temp	RTD	0.0	DegF	0.0	0.0	0.0	0.0
(AI23) Ambient Temp	RTD	0.0	DegF	0.0	0.0	0.0	0.0
Filter Differential Pressure		0.0	PSI			0.0	0.0

Analog inputs 17 through 23, including the calculated filter differential pressure, are shown on the second Analog Inputs I/O status screen. Each row in the table represents a single analog input, and provides the following:

- Name (configurable, however some inputs have a dedicated function)
- Current Measured Value (based on the minimum and maximum scaling configured)
- Units (configurable or fixed, depending on the function)
- Low-Low Alarm/Shutdown Setpoint Value (configurable)
- Low Alarm/Shutdown Setpoint Value (configurable)
- High Alarm/Shutdown Setpoint Value (configurable)
- High-High Alarm/Shutdown Setpoint Value (configurable)

While the **Status > Alarms** screen groups the four individual alarm/shutdown setpoints into a single indicator, the I/O status screen displays each of the setpoints individually, and color codes the setpoints in the same

manner as the alarms screen. A setpoint with no alarm event present (inactive/OK) is displayed in black text over a green background. A setpoint with an alarm event present (active) is displayed in white text over a red background.



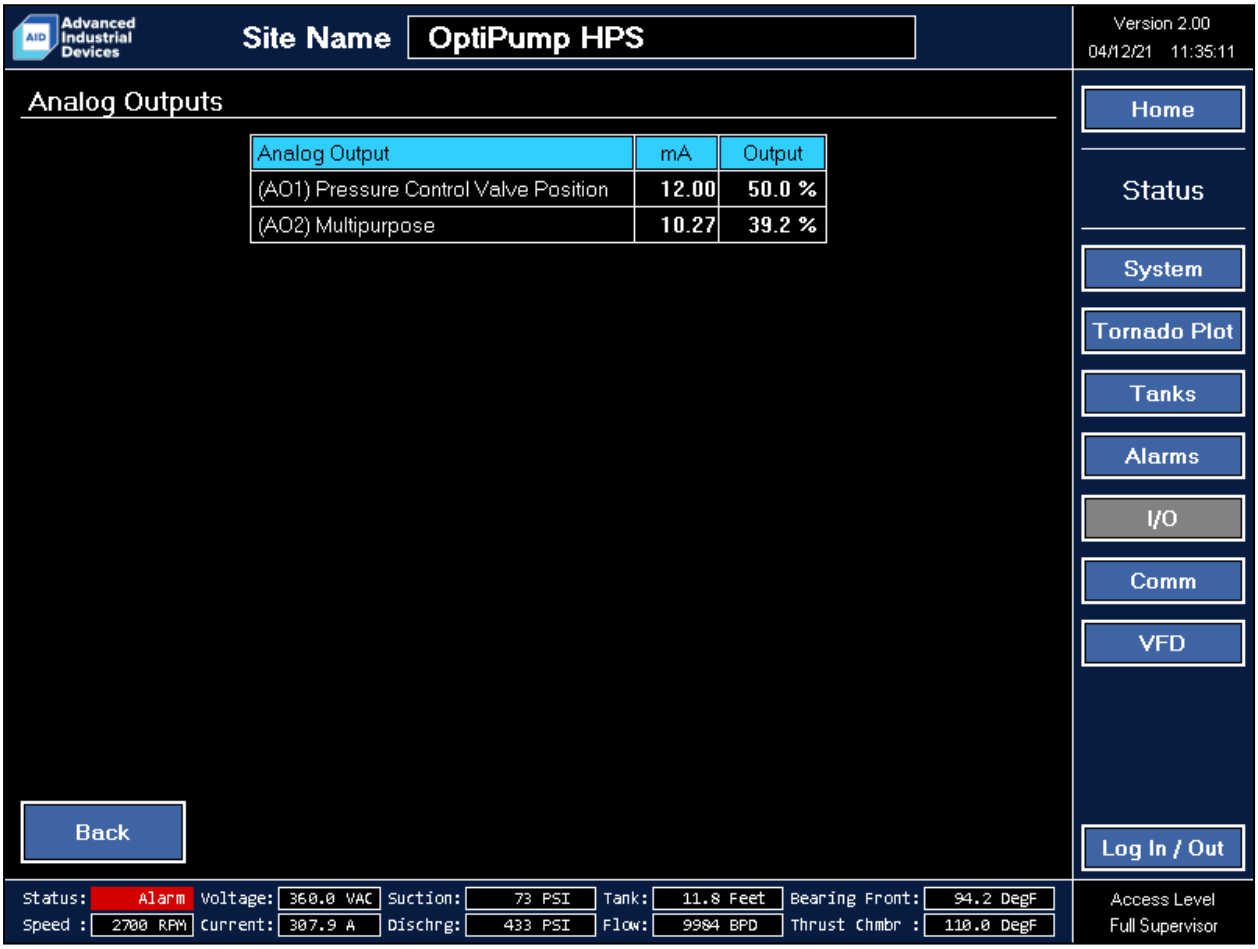
Digital Input	Input	Status
(DI1) Hand	Open	Inactive
(DI2) Auto	Open	Active
(DI3) User Start	Open	Inactive
(DI4) Tank Level Start	Open	Inactive
(DI5) Tank Level Stop	Open	Inactive
(DI6) Thrust Chamber Oil Pump Run Confirm	Open	Active
(DI7) Charge Pump Run Confirm	Open	Active
(DI8) Pressure Control Valve Closed	Open	Inactive
(DI9) Block Valve Closed	Open	Inactive
(DI10) Block Valve Open	Open	Inactive
(DI11) Thrust Chamber Oil Resvr Level Low	Open	Inactive
(DI12) Thrust Chamber Oil Level Low	Open	Inactive
(DI13) Tank Level High	Open	Inactive
(DI14) Field Shutdown	Open	Active
(DI15) Thrust Chamber Oil Flow	Open	Inactive
(DI16) Multipurpose	Open	Inactive

All 16 digital inputs are available on the single Digital Inputs status screen. Each row in the table represents a single digital input, and provides the following:

- Name (configurable, however some inputs have a dedicated function)
- Input Status (Open or Closed)
- Status (Active or Inactive - each digital input can be configured to be active when open or closed)

The status of inactive digital inputs is displayed with white text over a black background, while the status of active digital inputs is displayed with black text over a green background.

Some digital inputs can be configured for alarm and shutdown events. If the status of a digital input is active and an alarm event is present (active) the status will be displayed in white text over a red background.

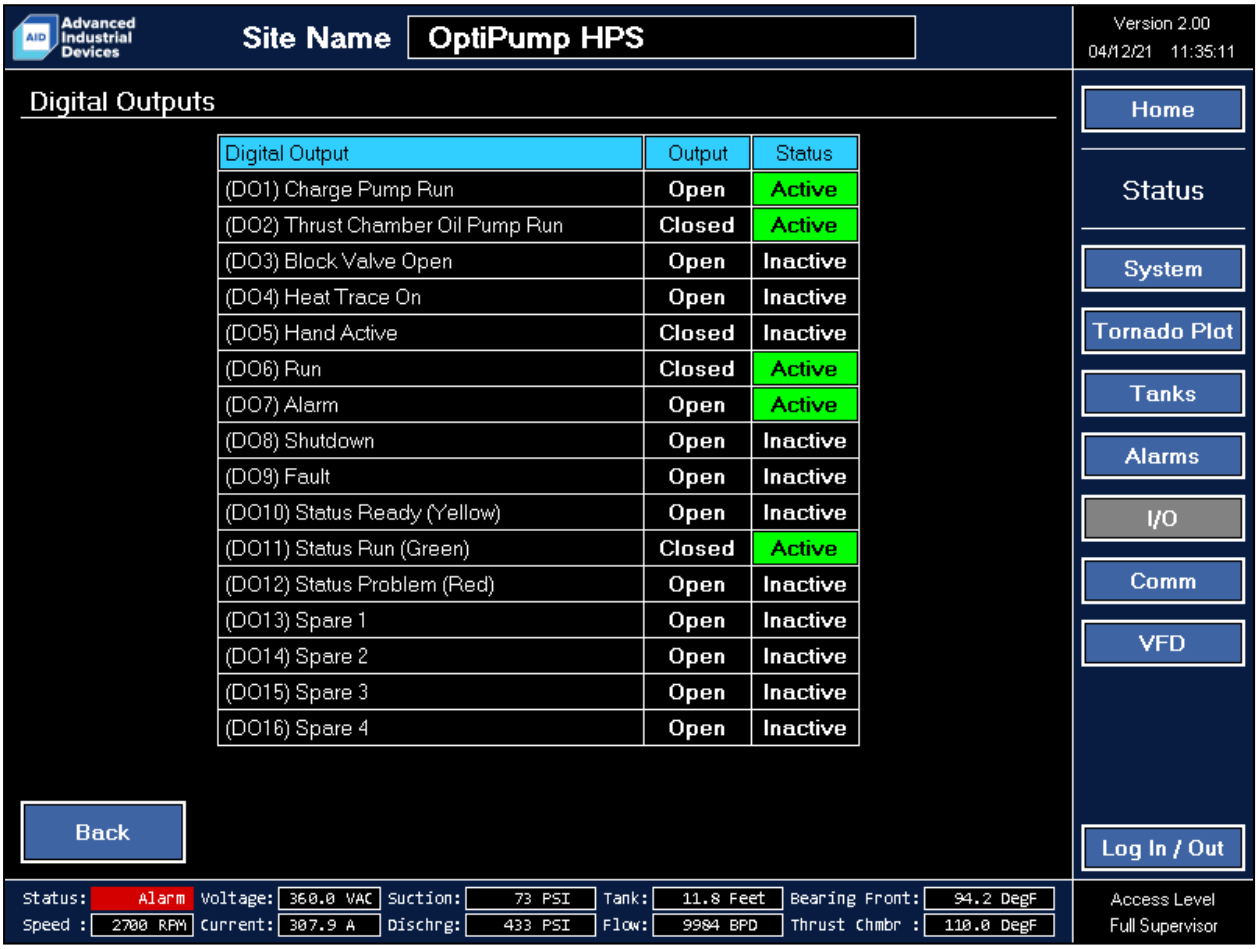


Each row in the table represents a single analog output, and provides the following information:

- Name (dedicated, not configurable)
- Current Output Value in Scaled Units

Analog Output 1 is dedicated to controlling the pressure control valve position. 100% represents commanding the pressure control valve to the fully-open position, regardless of whether the analog output is configured for 4 mA at 100% or 20 mA at 100%.

Analog Output 2 is multipurpose, and configurable by the operator.

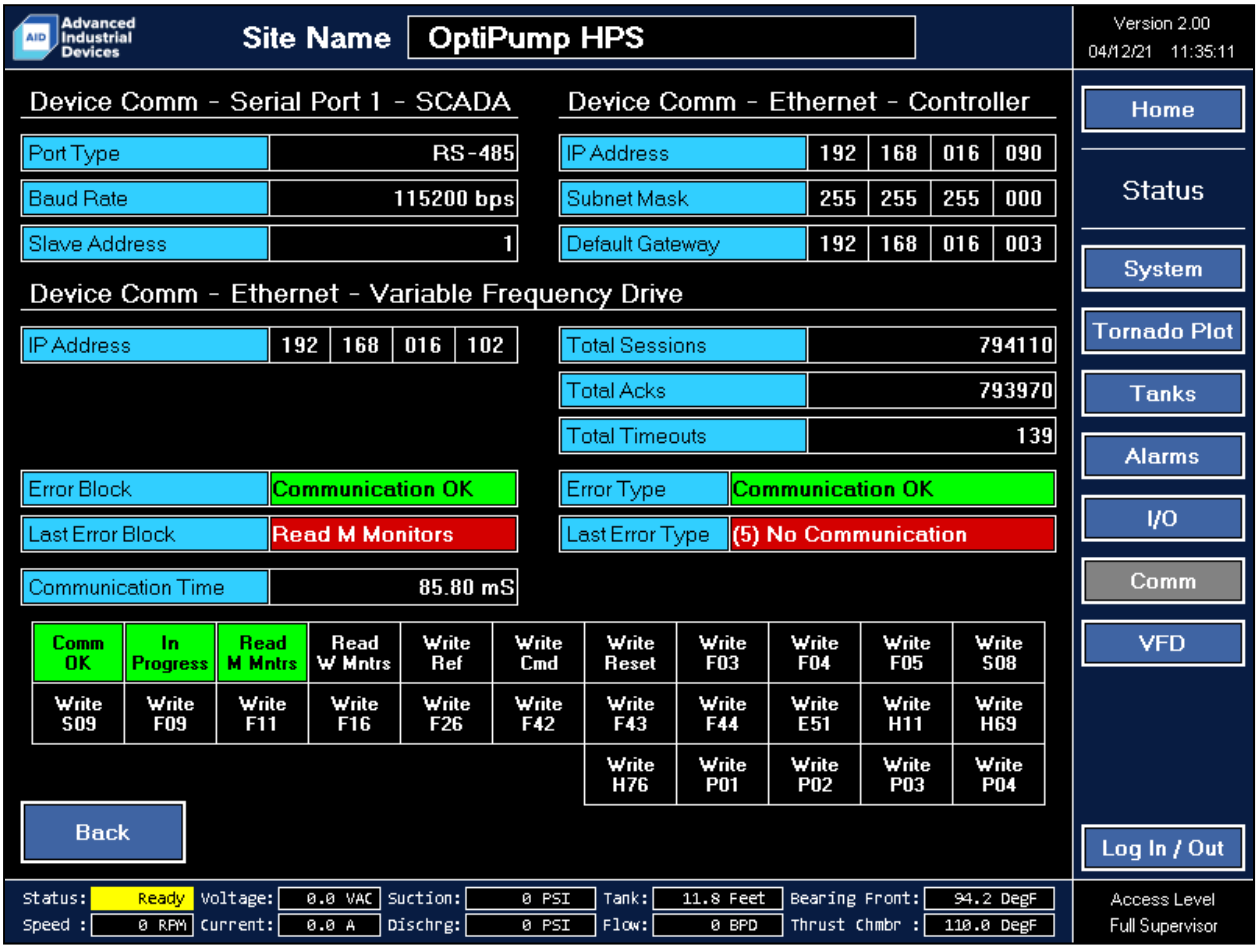


Digital Output	Output	Status
(DO1) Charge Pump Run	Open	Active
(DO2) Thrust Chamber Oil Pump Run	Closed	Active
(DO3) Block Valve Open	Open	Inactive
(DO4) Heat Trace On	Open	Inactive
(DO5) Hand Active	Closed	Inactive
(DO6) Run	Closed	Active
(DO7) Alarm	Open	Active
(DO8) Shutdown	Open	Inactive
(DO9) Fault	Open	Inactive
(DO10) Status Ready (Yellow)	Open	Inactive
(DO11) Status Run (Green)	Closed	Active
(DO12) Status Problem (Red)	Open	Inactive
(DO13) Spare 1	Open	Inactive
(DO14) Spare 2	Open	Inactive
(DO15) Spare 3	Open	Inactive
(DO16) Spare 4	Open	Inactive

The Digital Outputs status screen presents information in a similar layout to the Digital Inputs status screen. The key difference is the digital outputs do not have alarm indications, as the outputs cannot be configured for alarm or shutdown events. Each row in the table represents a single digital output, and provides the following information:

- Name (dedicated, not configurable)
- Output Status (Open or Closed)
- Status (Active or Inactive - each digital output can be configured to be active when open or closed)

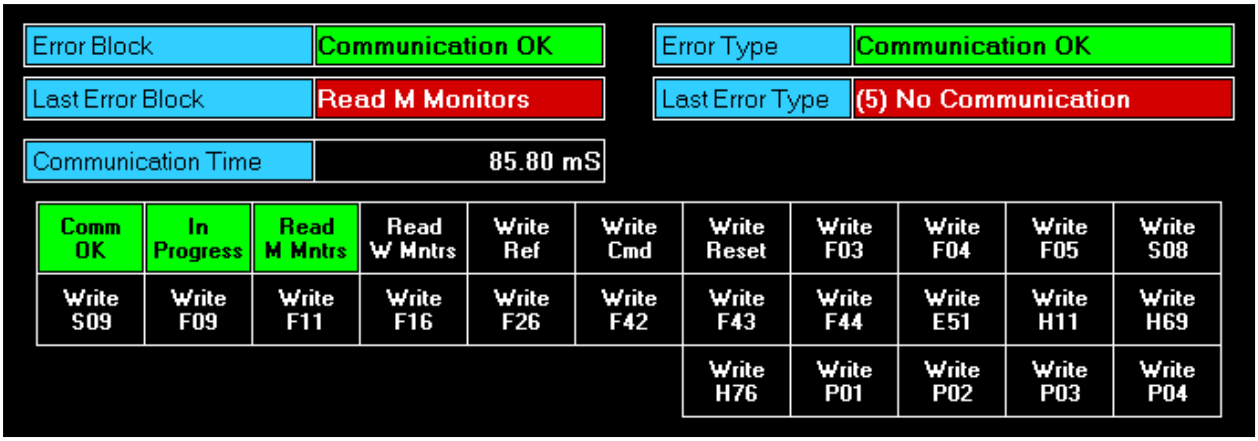
The status of inactive digital outputs is displayed with white text over a black background, while the status of the active digital outputs is displayed with black text over a green background.



The OptiPump HPS controller supports several configurable data communication methods. The Communication Status screen summarizes all of the communication configuration parameter values and key communication statistics on a single status screen. The availability of all the communication data in a single location provides the operator or technician with a quick overview in a single location, without the need for passwords or navigating multiple screens to locate the necessary information.

Ethernet communication between the OptiPump HPS controller and the variable frequency drive is required. Serial communication between the two devices is NOT supported.

Serial communication is available for SCADA communication with the OptiPump HPS controller. However, Ethernet communication is highly recommended for both speed and reliability.



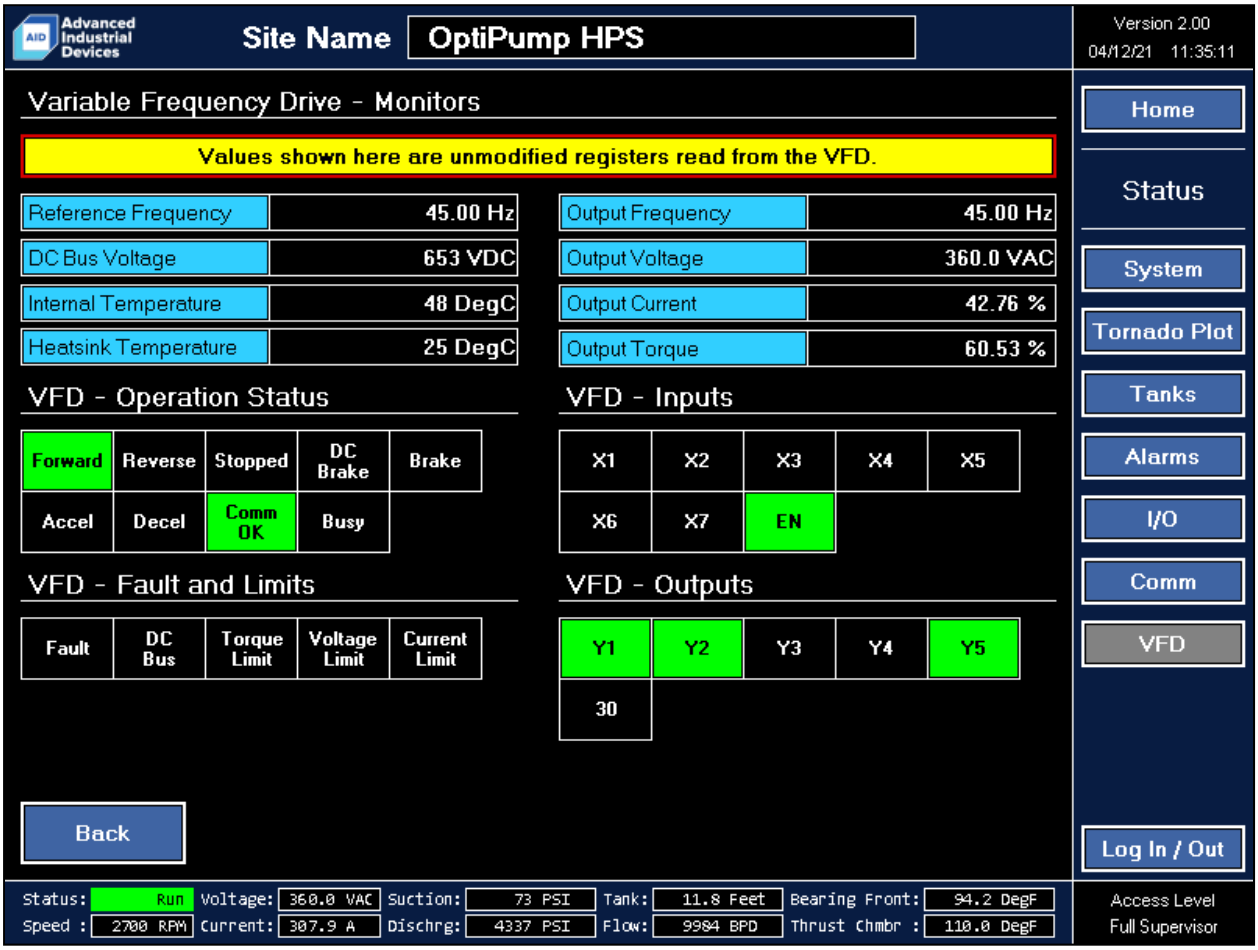
Stable, reliable Ethernet communication between the OptiPump HPS controller and the variable frequency drive is a critical component to the optimal performance of the system as a whole. Since unknown site conditions may affect the quality of the communications link at the time of installation or later when site conditions change, the Communication Status screen provides capture of communication error messages, if errors occur.

Each step in the communication process between the controller and the variable frequency drive can be noted by the operator using the 3 rows of communication indicators located at the bottom of the screen. The Comm OK indicator will remain green when communication has been established with the variable frequency drive, and will turn red if a communication error occurs. All other communication indicators will appear to blink during normal and successful communication with the variable frequency drive. A green background indicates that the step is currently running. A black background indicates that the step is currently idle.

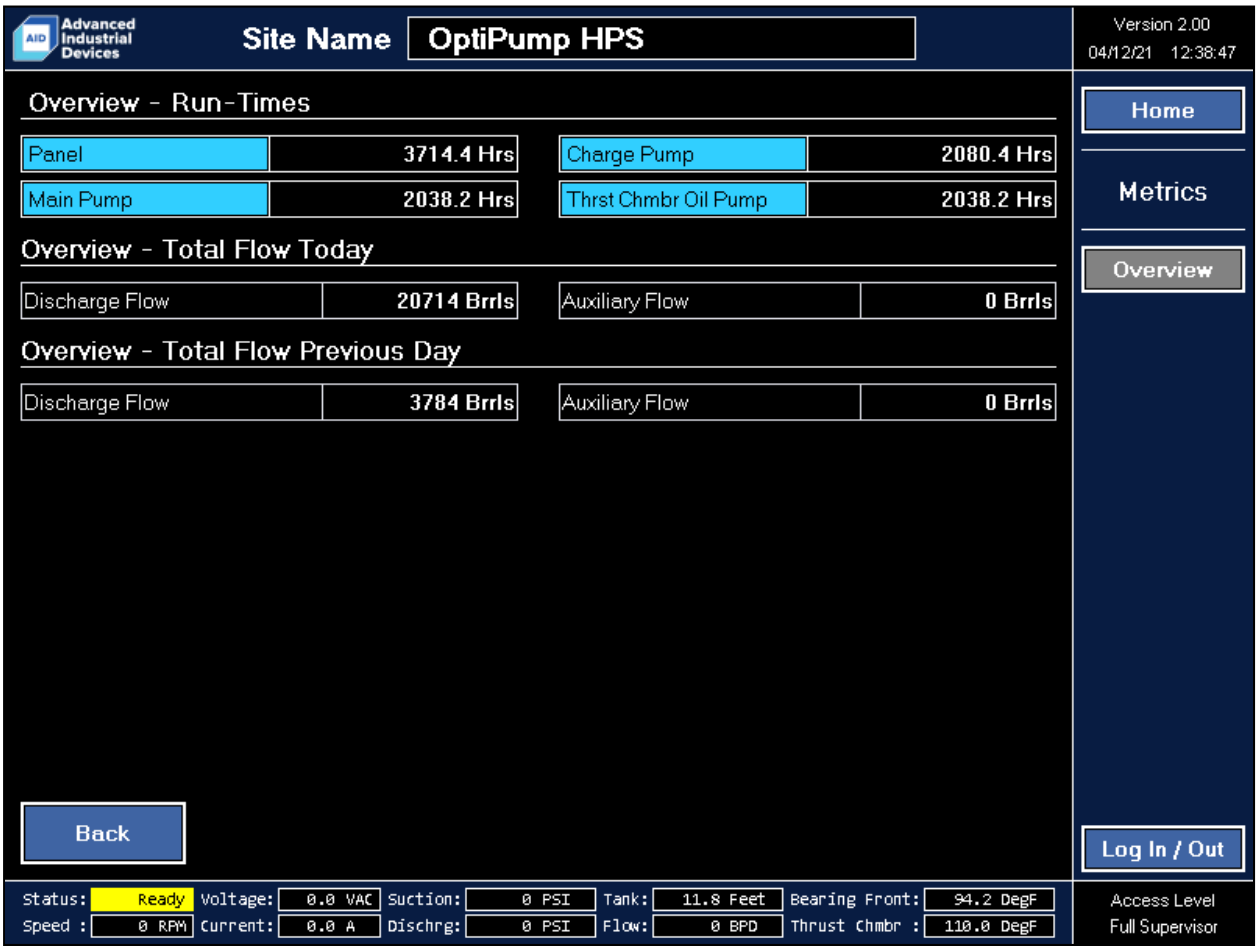
Please note that the Read indicators will blink much more often than the Write indicators, as the controller only writes values to the variable frequency drive when particular values require updating.

If a communication error does occur, the communication block that experiences the problem will be shown in the Error Block monitor and the type of communication error shown in the Error Type monitor. Once the communication error has been resolved, the values of Error Block and Error Type are moved to the Last Error Block and Last Error Type monitors, to provide some historical information if the communication error occurs only intermittently.

Finally, the Communication Time monitor displays the amount of time in mS for the entire communication loop to complete. Normally, the communication time required is approximately 100 mS. However, some communication loop passes require additional time to update several values within the variable frequency drive, so the time may vary. If, however, the operator notes that the Communication Time frequently spikes to over 1000 mS, the communication link should be investigated for possible errors in the configuration or damage to the physical communication wiring. Typically, when intermittent communication errors are present, the Total Timeouts monitor will be increasing fairly quickly, as the variable frequency drive is intermittently not responding to the requests or commands sent by the controller.



The status indicators and monitor values displayed on the Variable Frequency Drive Status screen are the values read directly from the variable frequency drive monitor registers. The values are unmodified or manipulated, and can be used for troubleshooting when checking to verify that the information being presented by the variable frequency drive to the controller for decision-making are expected and/or sensible values.



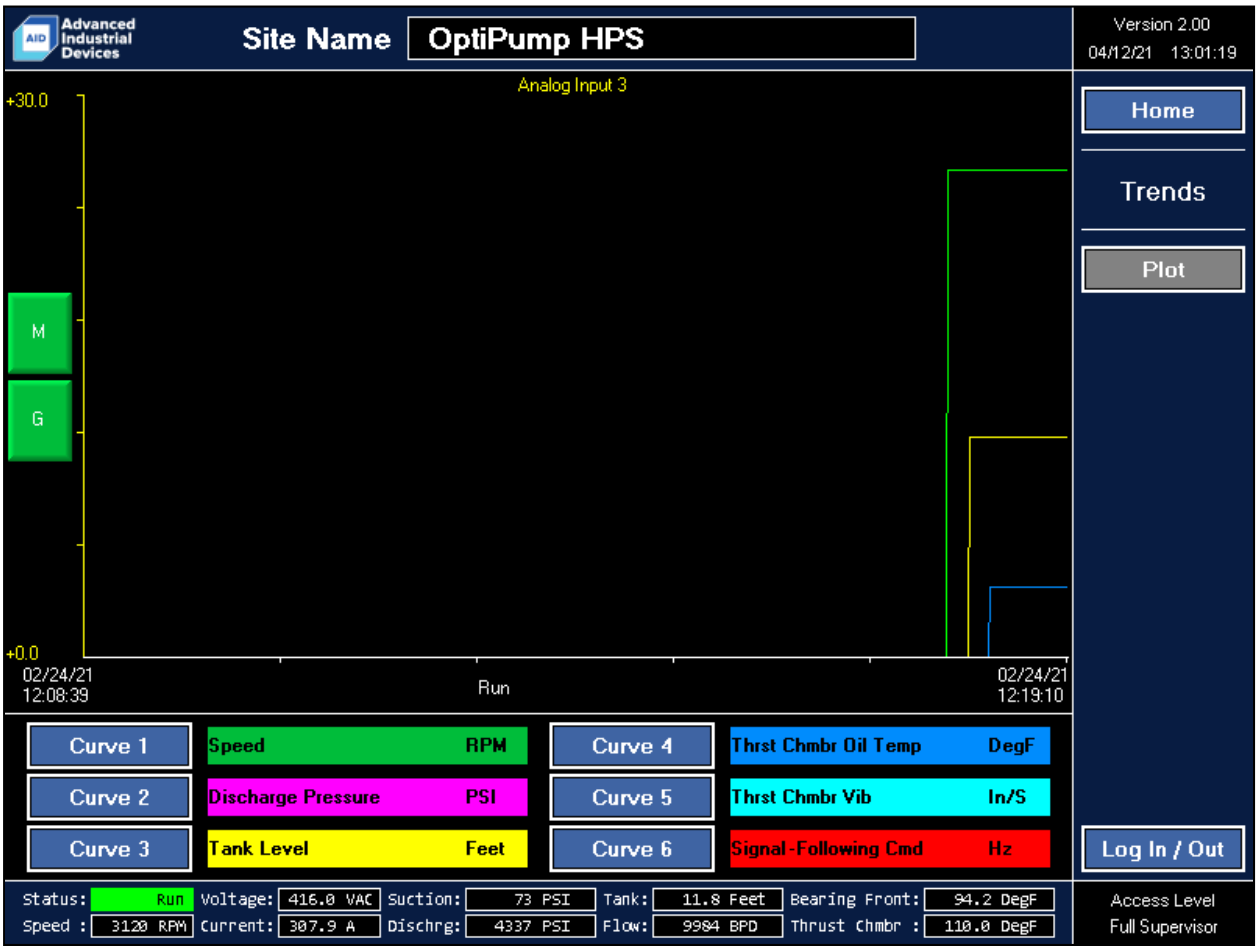
Run-time and flow data are tracked on the Metrics Overview screen. Metrics data can be used for determining when equipment maintenance should be performed and/or if daily flow performance has been affected by changes to the system.

Run-time monitors are available for the following devices:

- Panel (tracks the powered-on time, and increments even when the pumps are not running)
- Main Pump
- Charge Pump
- Thrust Chamber Oil Pump

The OptiPump HPS controller supports two flow meters: one is dedicated for the discharge flow and one for general purpose use. When the Flow Totalizer parameter is enabled for Analog Input 8, the totalized flow monitors will appear on the Metrics Overview screen (shown as the Auxiliary Flow monitors above). The Discharge Flow monitors for Analog Input 7 will always be visible.

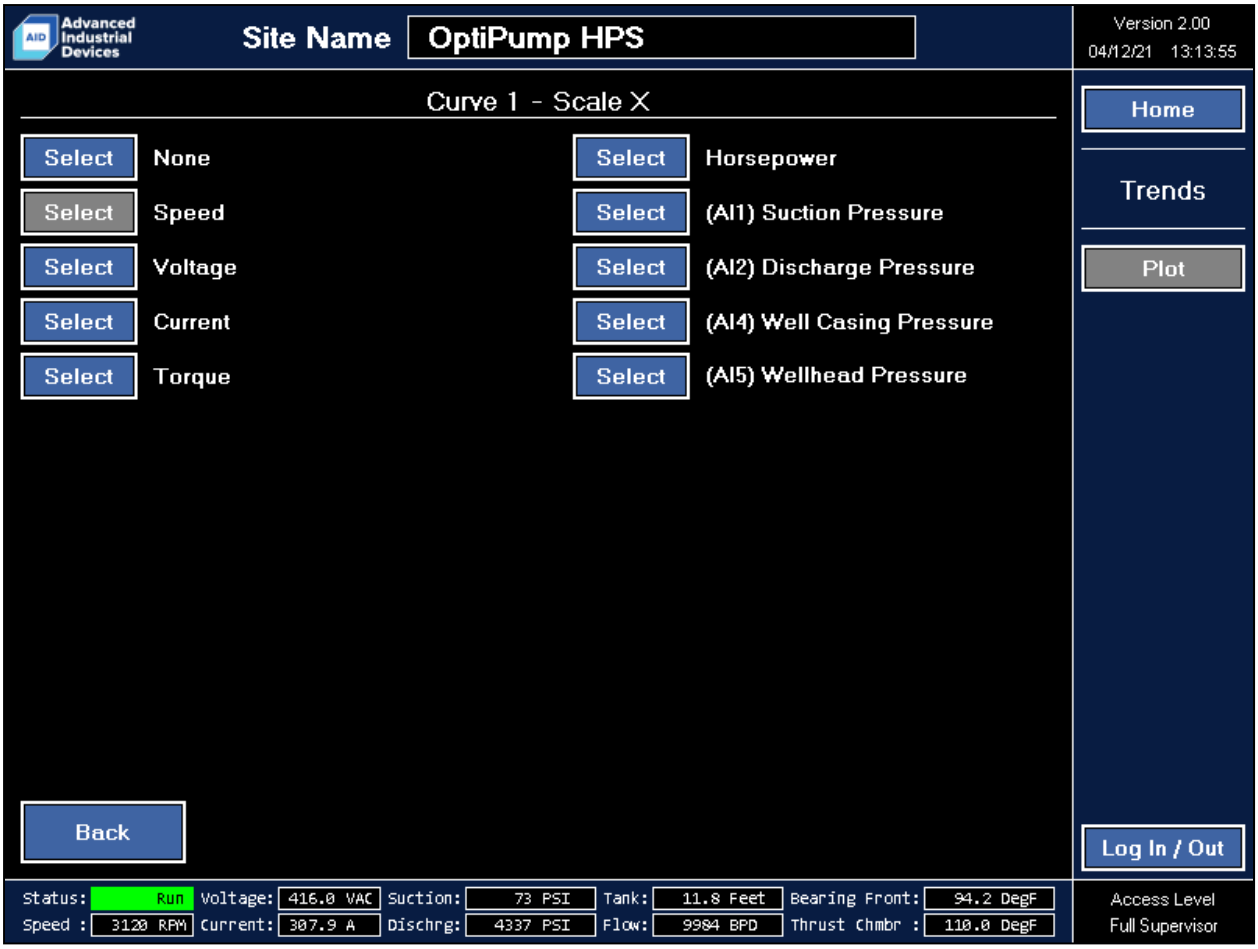
The Total Flow Today monitor value is automatically moved to the Total Flow Previous Day monitor everyday at midnight.



Live plotting of monitor values can be helpful when looking for trends, commissioning, troubleshooting, or fine-tuning a particular device response or the system overall. The OptiPump HPS controller can simultaneously plot 6 individual monitor values, called curves, on the screen.

The available monitor values that can be plotted are grouped according to the monitor scaling: by whole value, tenth, and hundredth. Plotted monitors are selected by the operator using the 6 Curve buttons at the bottom of the screen. The field immediately above the Curve buttons displays the currently active monitor value and the color of the line that will be plotted on the screen.

Depending on the data that needs to be plotted and the number of curves selected, creating the plot may require a short period of time.



Pressing a Curve button will display a curve selection screen. The currently selected monitor to be plotted is marked with a Select button with a gray background. The operator can select a different monitor value to be plotted by simply pressing the Select button next to the desired monitor, then pressing the Back button to return to the screen with the plotted data.

For analog input monitors, the analog input name configured by the operator will be shown. The monitor lists below, show the default names for reference.

Curve 1 and 2 (Scale X) Monitor Values:

- None
- Speed
- Voltage
- Current
- Torque
- Horsepower
- (AI1) Suction Pressure
- (AI2) Discharge Pressure
- (AI4) Well Casing Pressure
- (AI5) Wellhead Pressure

Curve 3 and 4 (Scale X.X) Monitor Values:

- None
- (AI3) Tank Level
- (AI7) Discharge Flow
- (AI8) Auxiliary Flow
- (AI9) Prsr Ctrl Valve Pos
- (AI10/16) Thrst Chmbr Oil Temp
- (AI14) Auxiliary Tank 1 Lvl
- (AI15) Auxiliary Tank 2 Lvl
- (AI17) Mtr Winding 1 Temp
- (AI18) Mtr Winding 2 Temp
- (AI19) Mtr Winding 3 Temp
- (AI20) Mtr Brng Frnt Temp
- (AI21) Mtr Brng Rear Temp
- (AI22) Pump Housing Temp
- (AI23) Ambient Temp

Curve 5 and 6 (Scale X.XX) Monitor Values:

- None
- (AI6) Thrst Chmbr Vib
- (AI11) Signal-Following Command
- (AI12) Mtr Brng in Vib
- (AI13) Mtr Brng Out Vib

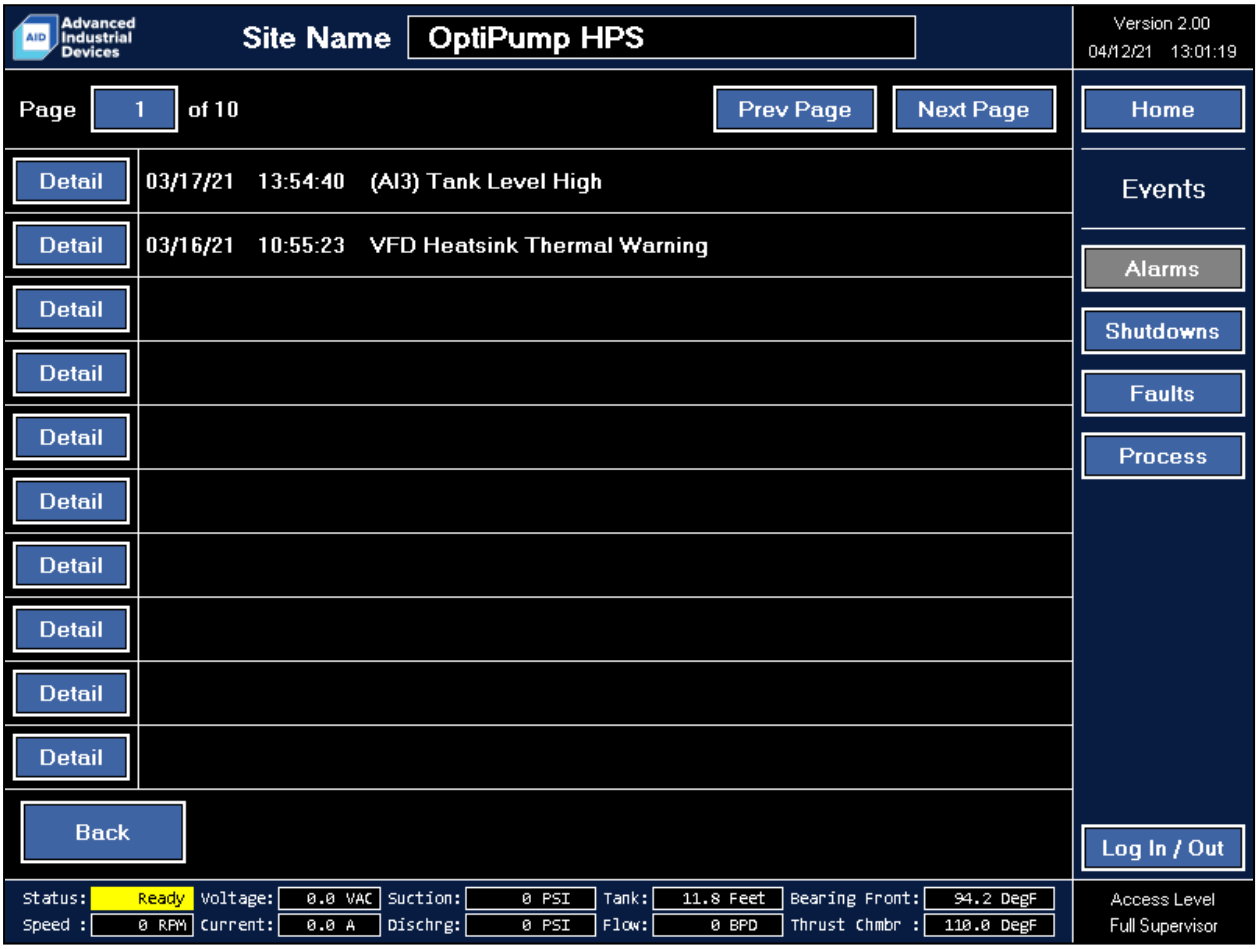
Process events create log entries of important actions that occur during operation. Process conditions that stray outside of normal operation bounds can trigger alarm, shutdown, and fault events. Some event conditions are configurable, and others have fixed limits that cannot be changed or disabled. The OptiPump HPS controller uses four classifications of events, based on severity (listed below from least to most severe):

1. Process
    - Occur during normal operation, so do not alert the operator.
    - Record that the action occurred, in case the operator needs to review the sequence to verify proper operation or investigate the actions that occurred during the lead-up to a problem.

2. Alarms
    - May occur during normal operation, so warn the operator, but continue the process.
    - When alarm event conditions are met, the controller indicates a warning message and records the event. The system continues to operate. If the alarm event conditions are no longer met while the system is running, the alarm event automatically resets/clears. Because alarm events do not stop the system, multiple alarm events may be active at the same time.

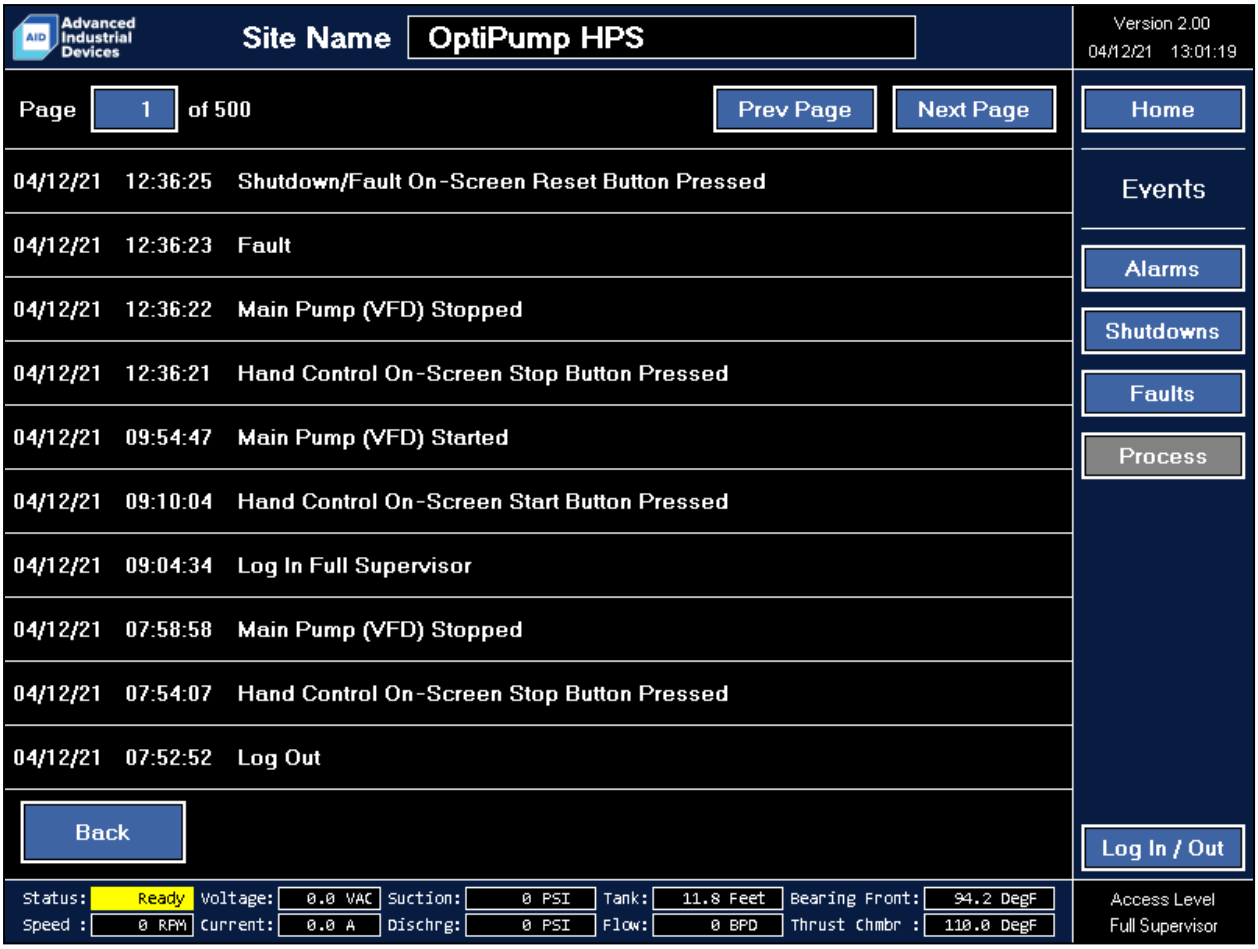
3. Shutdowns
    - Should not occur during normal operation, so stop the process.
    - When shutdown event conditions are met, the controller immediately stops the process and records the event. If running, the main pump will come to a full stop, and the Post-Run sequence will run. A shutdown event may be configured to automatically restart after a set time has elapsed or may be configured to require the operator to manually reset/clear the shutdown event.

4. Faults (Controller and Variable Frequency Drive)
    - Should never occur during normal operation and likely indicates a hardware failure, so stop the process.
    - When fault event conditions are met, the controller immediately stops the process and records the event. If running, the main pump will come to a full stop, and the Post-Run sequence will attempt to run. A fault event cannot be configured to automatically restart, and must be reset/cleared by the operator.
    - If a fault event occurs, the operator should thoroughly investigate the cause, and make any necessary repairs before restarting the system.

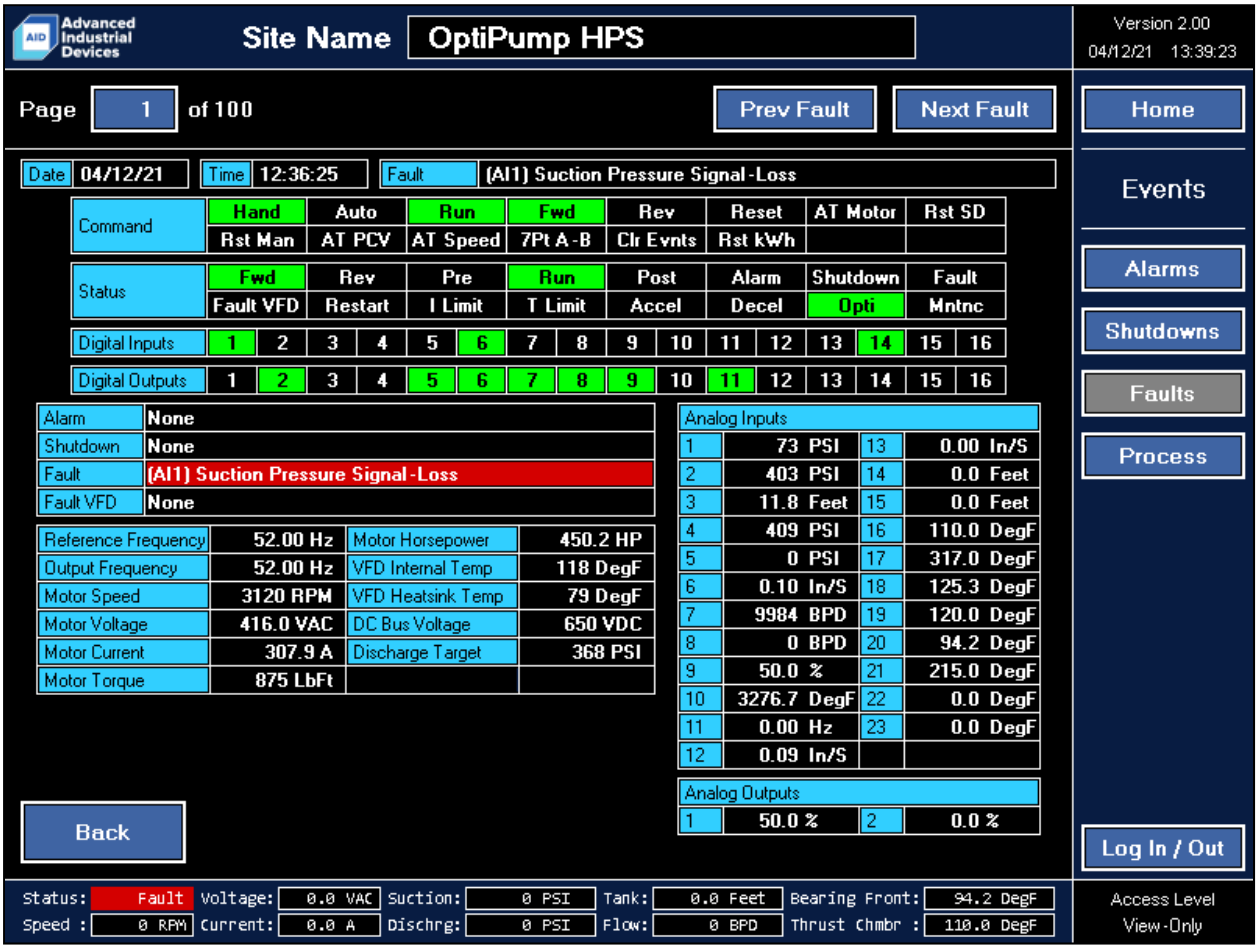


The OptiPump HPS controller can store up to 100 events per event type for alarm, shutdown and fault events, and up to 5000 process events. Events are grouped by classification. The classification can be selected from the menu located on the right side of the screen. When an event type is selected from the menu, a list of the events will be displayed, with the most recent event shown at the top. Each page within the event type displays 10 events. The Prev Page and Next Page buttons at the top of the screen move backward and forward in the list, displaying the previous or next 10 events. If known, the operator can jump to a specific page of events using the page number button in the upper left corner of the screen.

Each event shown in the list displays the date and time the event occurred, and a short text description. The Detail buttons located on the left side of the event list switch to the Event Detail screen, which displays a snapshot of the operating conditions at the time the event was set.



Process events do not record a snapshot at the time the entry is recorded. Since the system is operating normally, the SD card data logging is recommended for tracking performance in this case.



Navigation on the Event Details screen operates similarly to the Event List Screen. The Prev Page and Next Page buttons at the top of the screen move backward and forward one event at a time, displaying the snapshot data at the time of the event. If known, the operator can jump to a specific page (event) using the page number button in the upper left corner of the screen.

The snapshot data shown for the event are the same values available on the System Status and I/O Status screens. For more detail on the values, refer to the sections on the System Status and I/O Status screens.

Press the Back button located in the lower left corner of the screen to return back to the Event List screen.

Process Events	
None	Maintenance Reminder 03 Activated
Controller Power-On	Maintenance Reminder 04 Activated
Controller Power-Off	Maintenance Reminder 05 Activated
Log Out	Maintenance Reminder 06 Activated
Log In Limited Operator	Maintenance Reminder 07 Activated
Log In Full Supervisor	Maintenance Reminder 08 Activated
Log In Special Factory	Maintenance Reminder 09 Activated
HOA Switch in Hand Position	Maintenance Reminder 10 Activated
HOA Switch in Off Position	Maintenance Reminder 01 Reset
HOA Switch in Auto Position	Maintenance Reminder 02 Reset
Hand Control On-Screen Start Button Pressed	Maintenance Reminder 03 Reset
Hand Control On-Screen Stop Button Pressed	Maintenance Reminder 04 Reset
Shutdown/Fault On-Screen Reset Button Pressed	Maintenance Reminder 05 Reset
Shutdown/Fault Terminal (Digital Input) Reset	Maintenance Reminder 06 Reset
Shutdown/Fault SCADA (Communication) Reset	Maintenance Reminder 07 Reset
Block Valve Independent Commanded to Open	Maintenance Reminder 08 Reset
Block Valve Independent Commanded to Close	Maintenance Reminder 09 Reset
Main Pump (VFD) Started	Maintenance Reminder 10 Reset
Main Pump (VFD) Stopped	Persistent Data Cleared
Thrust Chamber Oil Pump Started	Panel Run-Time Cleared
Thrust Chamber Oil Pump Stopped	Main Pump Run-Time Cleared
Charge Pump Started	Charge Pump Run-Time Cleared
Charge Pump Stopped	Thrust Chamber Oil Pump Run-Time Cleared
Event Log Cleared	Alarm
Firmware Changed	Shutdown
Maintenance Reminder 01 Activated	Fault
Maintenance Reminder 02 Activated	

Alarms	
None	(AI15) Auxiliary Tank 2 Lvl Flow High
Multiple	(AI15) Auxiliary Tank 2 Lvl Low
(AI1) Suction Pressure High-High	(AI15) Auxiliary Tank 2 Lvl Low-Low
(AI1) Suction Pressure High	(AI16) Thrst Chmbr Oil Temp High-High
(AI1) Suction Pressure Low	(AI16) Thrst Chmbr Oil Temp High
(AI1) Suction Pressure Low-Low	(AI16) Thrst Chmbr Oil Temp Low
(AI2) Discharge Pressure High-High	(AI16) Thrst Chmbr Oil Temp Low-Low
(AI2) Discharge Pressure High	(AI17) Mtr Winding 1 Temp High-High
(AI2) Discharge Pressure Low	(AI17) Mtr Winding 1 Temp High
(AI2) Discharge Pressure Low-Low	(AI17) Mtr Winding 1 Temp Low
(AI3) Tank Level High-High	(AI17) Mtr Winding 1 Temp Low-Low
(AI3) Tank Level High	(AI18) Mtr Winding 2 Temp High-High
(AI3) Tank Level Low	(AI18) Mtr Winding 2 Temp High
(AI3) Tank Level Low-Low	(AI18) Mtr Winding 2 Temp Low
(AI4) Well Casing Pressure High-High	(AI18) Mtr Winding 2 Temp Low-Low
(AI4) Well Casing Pressure High	(AI19) Mtr Winding 3 Temp High-High
(AI4) Well Casing Pressure Low	(AI19) Mtr Winding 3 Temp High
(AI4) Well Casing Pressure Low-Low	(AI19) Mtr Winding 3 Temp Low
(AI5) Wellhead Pressure High-High	(AI19) Mtr Winding 3 Temp Low-Low
(AI5) Wellhead Pressure High	(AI20) Mtr Brng Frnt Temp High-High
(AI5) Wellhead Pressure Low	(AI20) Mtr Brng Frnt Temp High
(AI5) Wellhead Pressure Low-Low	(AI20) Mtr Brng Frnt Temp Low
(AI6) Thrst Chmbr Vib High-High	(AI20) Mtr Brng Frnt Temp Low-Low
(AI6) Thrst Chmbr Vib High	(AI21) Mtr Brng Rear Temp High-High
(AI6) Thrst Chmbr Vib Low	(AI21) Mtr Brng Rear Temp High
(AI6) Thrst Chmbr Vib Low-Low	(AI21) Mtr Brng Rear Temp Low
(AI7) Discharge Flow High-High	(AI21) Mtr Brng Rear Temp Low-Low
(AI7) Discharge Flow High	(AI22) Pump Housing Temp High-High
(AI7) Discharge Flow Low	(AI22) Pump Housing Temp High
(AI7) Discharge Flow Low-Low	(AI22) Pump Housing Temp Low
(AI8) Auxiliary Flow High-High	(AI22) Pump Housing Temp Low-Low
(AI8) Auxiliary Flow High	(AI23) Ambient Temp High-High
(AI8) Auxiliary Flow Low	(AI23) Ambient Temp High
(AI8) Auxiliary Flow Low-Low	(AI23) Ambient Temp Low
(AI9) Prsr Ctrl Valve Pos High-High	(AI23) Ambient Temp Low-Low
(AI9) Prsr Ctrl Valve Pos High	Filter Differential Pressure High-High
(AI9) Prsr Ctrl Valve Pos Low	Filter Differential Pressure High
(AI9) Prsr Ctrl Valve Pos Low-Low	(DI1) Hand
(AI10) Thrst Chmbr Oil Temp High-High	(DI2) Auto
(AI10) Thrst Chmbr Oil Temp High	(DI3) User Start
(AI10) Thrst Chmbr Oil Temp Low	(DI4) Tank Level Start
(AI10) Thrst Chmbr Oil Temp Low-Low	(DI5) Tank Level Stop
(AI11) Signal-Following Cmd High-High	(DI6) TC Oil Pmp Run Cnfrm
(AI11) Signal-Following Cmd High	(DI7) Charge Pmp Run Cnfrm
(AI11) Signal-Following Cmd Low	(DI8) Prsr Ctrl Valve Clsed
(AI11) Signal-Following Cmd Low-Low	(DI9) Block Valve Clsed
(AI12) Mtr Brng In Vib High-High	(DI10) Block Valve Open
(AI12) Mtr Brng In Vib High	(DI11) TC Oil Rsrvr Lvl Low
(AI12) Mtr Brng In Vib Low	(DI12) TC Oil Level Low
(AI12) Mtr Brng In Vib Low-Low	(DI13) Tank Level High
(AI13) Mtr Brng Out Vib High-High	(DI14) Field Shutdown
(AI13) Mtr Brng Out Vib High	(DI15) TC Oil Flow
(AI13) Mtr Brng Out Vib Low	(DI16) Multipurpose
(AI13) Mtr Brng Out Vib Low-Low	Main Pump Speed Mismatch
(AI14) Auxiliary Tank 1 Lvl High-High	Main Pump Out of Curve
(AI14) Auxiliary Tank 1 Lvl High	Pressure Control Valve Failed to Control Pressure
(AI14) Auxiliary Tank 1 Lvl Low	Block Valve Open
(AI14) Auxiliary Tank 1 Lvl Low-Low	Block Valve Closed
(AI15) Auxiliary Tank 2 Lvl High-High	VFD Heatsink Thermal Warning

Shutdowns

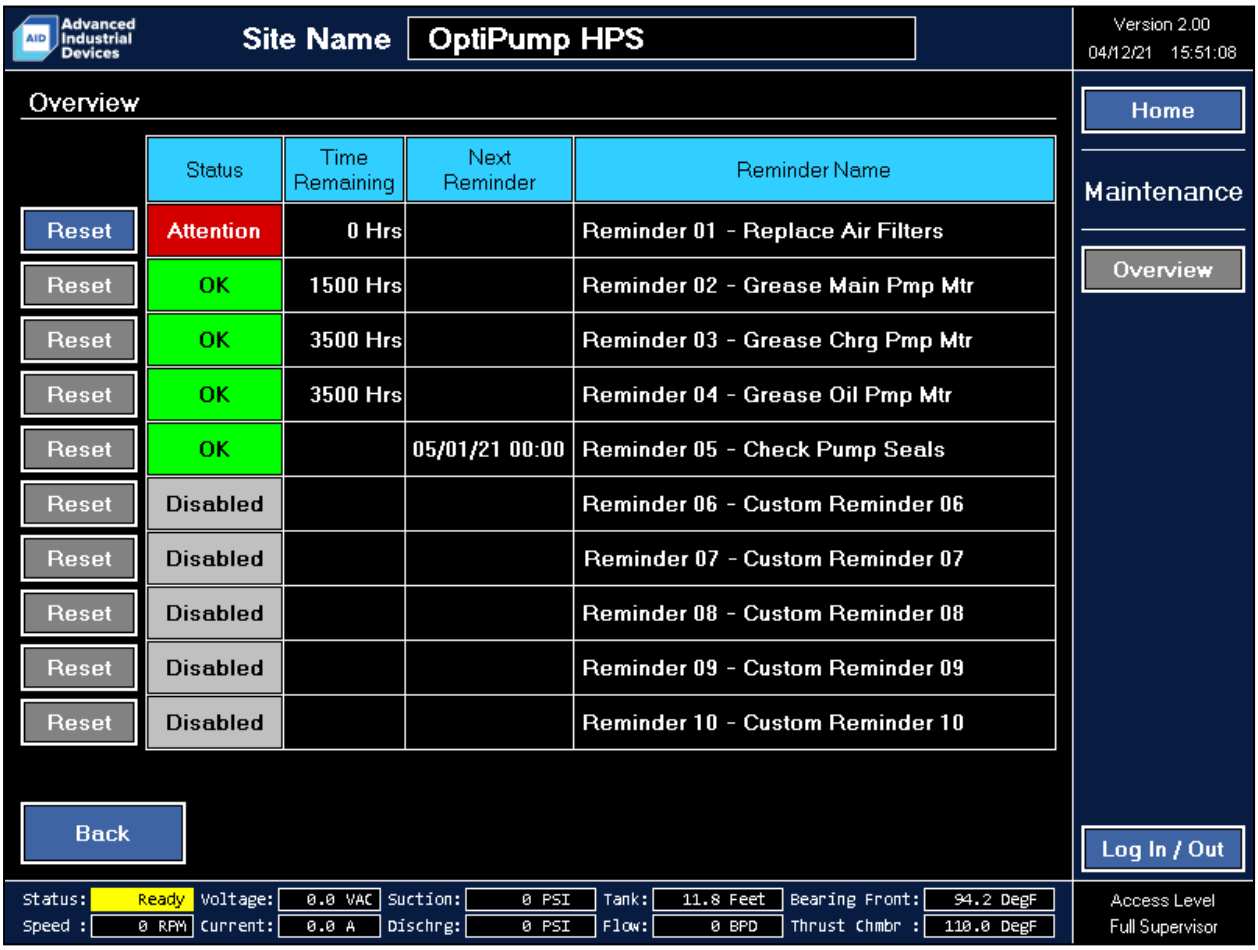
Shutdowns	
None	(AI15) Auxiliary Tank 2 Lvl Flow High
RESERVED	(AI15) Auxiliary Tank 2 Lvl Low
None	(AI15) Auxiliary Tank 2 Lvl Low-Low
Multiple	(AI16) Thrst Chmbr Oil Temp High-High
(AI1) Suction Pressure High-High	(AI16) Thrst Chmbr Oil Temp High
(AI1) Suction Pressure High	(AI16) Thrst Chmbr Oil Temp Low
(AI1) Suction Pressure Low	(AI16) Thrst Chmbr Oil Temp Low-Low
(AI1) Suction Pressure Low-Low	(AI17) Mtr Winding 1 Temp High-High
(AI2) Discharge Pressure High-High	(AI17) Mtr Winding 1 Temp High
(AI2) Discharge Pressure High	(AI17) Mtr Winding 1 Temp Low
(AI2) Discharge Pressure Low	(AI17) Mtr Winding 1 Temp Low-Low
(AI2) Discharge Pressure Low-Low	(AI18) Mtr Winding 2 Temp High-High
(AI3) Tank Level High-High	(AI18) Mtr Winding 2 Temp High
(AI3) Tank Level High	(AI18) Mtr Winding 2 Temp Low
(AI3) Tank Level Low	(AI18) Mtr Winding 2 Temp Low-Low
(AI3) Tank Level Low-Low	(AI19) Mtr Winding 3 Temp High-High
(AI4) Well Casing Pressure High-High	(AI19) Mtr Winding 3 Temp High
(AI4) Well Casing Pressure High	(AI19) Mtr Winding 3 Temp Low
(AI4) Well Casing Pressure Low	(AI19) Mtr Winding 3 Temp Low-Low
(AI4) Well Casing Pressure Low-Low	(AI20) Mtr Brng Frnt Temp High-High
(AI5) Wellhead Pressure High-High	(AI20) Mtr Brng Frnt Temp High
(AI5) Wellhead Pressure High	(AI20) Mtr Brng Frnt Temp Low
(AI5) Wellhead Pressure Low	(AI20) Mtr Brng Frnt Temp Low-Low
(AI5) Wellhead Pressure Low-Low	(AI21) Mtr Brng Rear Temp High-High
(AI6) Thrst Chmbr Vib High-High	(AI21) Mtr Brng Rear Temp High
(AI6) Thrst Chmbr Vib High	(AI21) Mtr Brng Rear Temp Low
(AI6) Thrst Chmbr Vib Low	(AI21) Mtr Brng Rear Temp Low-Low
(AI6) Thrst Chmbr Vib Low-Low	(AI22) Pump Housing Temp High-High
(AI7) Discharge Flow High-High	(AI22) Pump Housing Temp High
(AI7) Discharge Flow High	(AI22) Pump Housing Temp Low
(AI7) Discharge Flow Low	(AI22) Pump Housing Temp Low-Low
(AI7) Discharge Flow Low-Low	(AI23) Ambient Temp High-High
(AI8) Auxiliary Flow High-High	(AI23) Ambient Temp High
(AI8) Auxiliary Flow High	(AI23) Ambient Temp Low
(AI8) Auxiliary Flow Low	(AI23) Ambient Temp Low-Low
(AI8) Auxiliary Flow Low-Low	(AI15) Auxiliary Tank 2 Lvl Flow High
(AI9) Prsr Ctrl Valve Pos High-High	Filter Differential Pressure High-High
(AI9) Prsr Ctrl Valve Pos High	Filter Differential Pressure High
(AI9) Prsr Ctrl Valve Pos Low	(DI1) Hand
(AI9) Prsr Ctrl Valve Pos Low-Low	(DI2) Auto
(AI10) Thrst Chmbr Oil Temp High-High	(DI3) User Start
(AI10) Thrst Chmbr Oil Temp High	(DI4) Tank Level Start
(AI10) Thrst Chmbr Oil Temp Low	(DI5) Tank Level Stop
(AI10) Thrst Chmbr Oil Temp Low-Low	(DI6) TC Oil Pmp Run Cnfrm
(AI11) Signal-Following Cmd High-High	(DI7) Charge Pmp Run Cnfrm
(AI11) Signal-Following Cmd High	(DI8) Prsr Ctrl Valve Clsed
(AI11) Signal-Following Cmd Low	(DI9) Block Valve Clsed
(AI11) Signal-Following Cmd Low-Low	(DI10) Block Valve Open
(AI12) Mtr Brng In Vib High-High	(DI11) TC Oil Rsrvr Lvl Low
(AI12) Mtr Brng In Vib High	(DI12) TC Oil Level Low
(AI12) Mtr Brng In Vib Low	(DI13) Tank Level High
(AI12) Mtr Brng In Vib Low-Low	(DI14) Field Shutdown
(AI13) Mtr Brng Out Vib High-High	(DI15) TC Oil Flow
(AI13) Mtr Brng Out Vib High	(DI16) Multipurpose
(AI13) Mtr Brng Out Vib Low	Main Pump Speed Mismatch
(AI13) Mtr Brng Out Vib Low-Low	Main Pump Out of Curve
(AI14) Auxiliary Tank 1 Lvl High-High	Pressure Control Valve Failed to Control Pressure
(AI14) Auxiliary Tank 1 Lvl High	

Faults

Faults	
None	(AI16) Thrst Chmbr Oil Temp Signal-Loss
VFD Fault	(AI17) Mtr Winding 1 Temp Signal-Loss
(AI1) Suction Pressure Signal-Loss	(AI18) Mtr Winding 2 Temp Signal-Loss
(AI2) Discharge Pressure Signal-Loss	(AI19) Mtr Winding 3 Temp Signal-Loss
(AI3) Tank Level Signal-Loss	(AI20) Mtr Brng Frnt Temp Signal-Loss
(AI4) Well Casing Pressure Signal-Loss	(AI21) Mtr Brng Rear Temp Signal-Loss
(AI5) Wellhead Pressure Signal-Loss	(AI22) Pump Housing Temp Signal-Loss
(AI6) Thrst Chmbr Vib Signal-Loss	(AI23) Ambient Temp Signal-Loss
(AI7) Discharge Flow Signal-Loss	Block Valve Failed to Open
(AI8) Auxiliary Flow Signal-Loss	Pressure Control Valve Failed to Position
(AI9) Prsr Ctrl Valve Pos Signal-Loss	Thrust Chamber Oil Pump Failed to Run
(AI10) Thrst Chmbr Oil Temp Signal-Loss	Charge Pump Failed to Run
(AI11) Signal-Following Cmd Signal-Loss	Main Pump Failed to Run
(AI12) Mtr Brng In Vib Signal-Loss	VFD Communications Failed
(AI13) Mtr Brng Out Signal-Loss	VFD Failed to Stop at Start-up
(AI14) Auxiliary Tank 1 Lvl Signal-Loss	Battery Failure
(AI15) Auxiliary Tank 2 Signal-Loss	Hand and Auto Both Active

Faults - Variable Frequency Drive

Faults – Variable Frequency Drive	
None	(Er4) Option Card Comm Error
(OC1) Overcurrent During Accel	(Er5) Option Card Error
(OC2) Overcurrent During Decel	(Er6) Stop Key Error
(OC3) Overcurrent At Set Speed	(Er7) Auto-Tuning Error
EF Ground Fault	(Er8) RS485 Comm Port 1 Error
(OU1) Overvoltage During Accel	(OL3) Motor 3 Overload
(OU2) Overvoltage During Decel	(OL4) Motor 4 Overload
(OU3) Overvoltage At Set Speed	(OPL) Output Phase Loss
(LU) Undervoltage	(ErE) Excessive Speed Deviation
(Lin) Input Phase Loss	(ErF) Data Save Error
(FUS) DC Bus Fuse Blown	(ErP) RS485 Comm Port 2 Error
(PbF) Charging Circuit Fault	(ErH) Hardware Error
(OH1) Heatsink Overheat	(ECN) Enabled EN1/EN2 Lost
(OH2) External Shutdown	(CoF) PID Fdbck Disconnected
(OH3) Internal Overheat	(dbA) Dynamic Braking Transistor
(OH4) Motor PTC/NTC Overheat	(FAL) Internal DC Fan Failure
(dbH) Braking Resistor Overheat	(OL) Motor Overload Warn
(OL1) Motor Overload	(OH) Cooling Fin Overheat Warn
(OL2) Motor 2 Overload	(LiF) Component Life Warn
(OLU) VFD Overload	(rEF) Command Loss
(OS) Overspeed Protection	(Pid) PID Output Warn
(PG) PG Disconnected	(UTL) Low Torque Detected
(nrb) NTC Disconnected	(PTC) Thermistor Loss
(Er1) Memory Error	(rTE) Machine Life Accum Hours
(Er2) Keypad Comm Error	(CnT) Machine Life Start Count
(Er3) CPU Error	(Err) Simulated Fault



The OptiPump HPS controller includes a built-in Maintenance Reminder system that can automatically remind operators of the need to perform maintenance and other tasks at set intervals. When one or more of the Maintenance Reminders becomes active, a notification appears on the Home screen, a Modbus SCADA indication bit is set, and a Process event entry is recorded.

The Maintenance Overview screen displays the status of all 10 Maintenance Reminders:

- Status (OK, Attention, or Disabled)
- Time Remaining (hours remaining until the reminder becomes active if configured for run-time)
- Next Reminder (date and time the reminder will become active if configured for monthly)
- Reminder Name (the operator-defined name for the reminder)

When a Maintenance Reminder becomes active, the associated Reset button will also become active when the operator is logged-in as the Full Supervisor. Only the Full Supervisor can reset an active Maintenance Reminder. As a good practice, the reminder should not be reset until after the maintenance task has been performed.

When reset, a Maintenance Reminder configured for run-time based notification will reload the Time Remaining monitor with the value set in the associated Run-Time Hours parameter. For a Maintenance Reminder configured for Monthly notification, resetting the reminder will update the Next Reminder monitor with the next available date configured in the associated Day of Month parameter.

The OptiPump HPS controller is highly versatile and configurable to meet a wide range of site requirements. The flexibility built into the controller allows the equipment to be tailored to meet the specific needs of the site without the need for custom program changes.

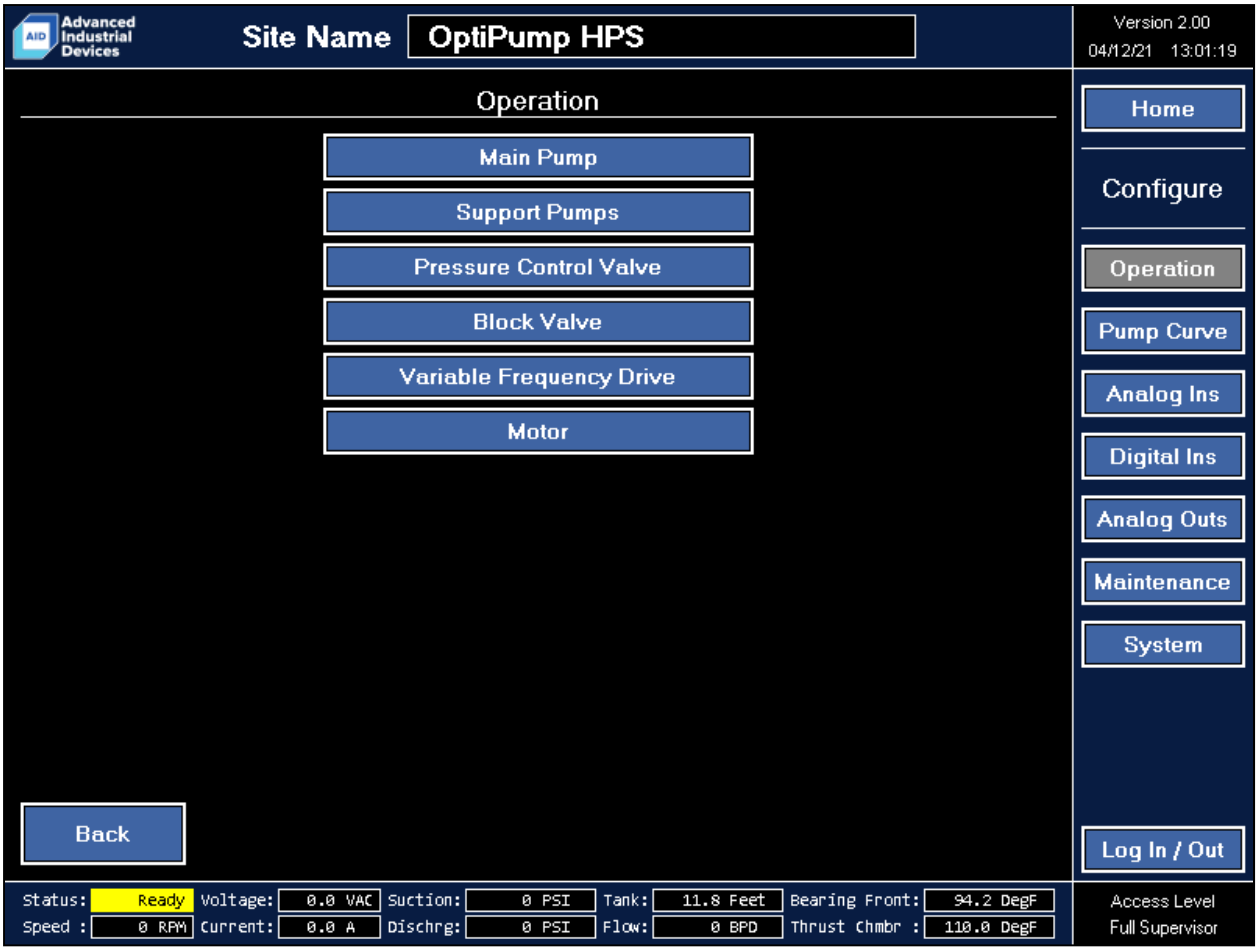
All configurable parameters are accessible via the Configure button on the Main Menu of the Home screen. Parameters are protected from modification by a password, which requires the operator to log-in prior to making changes. All parameters are viewable, but cannot be modified, without logging-in. This can be helpful when troubleshooting with personnel on site that may not be authorized to make changes, but can assist in verifying an improperly configured option before sending qualified personnel to the site.

For safety of both the equipment and personnel, only qualified operators should make changes to the configuration parameters.

Operation

Configuration parameters related to the operation of the controller and connected equipment are available in:

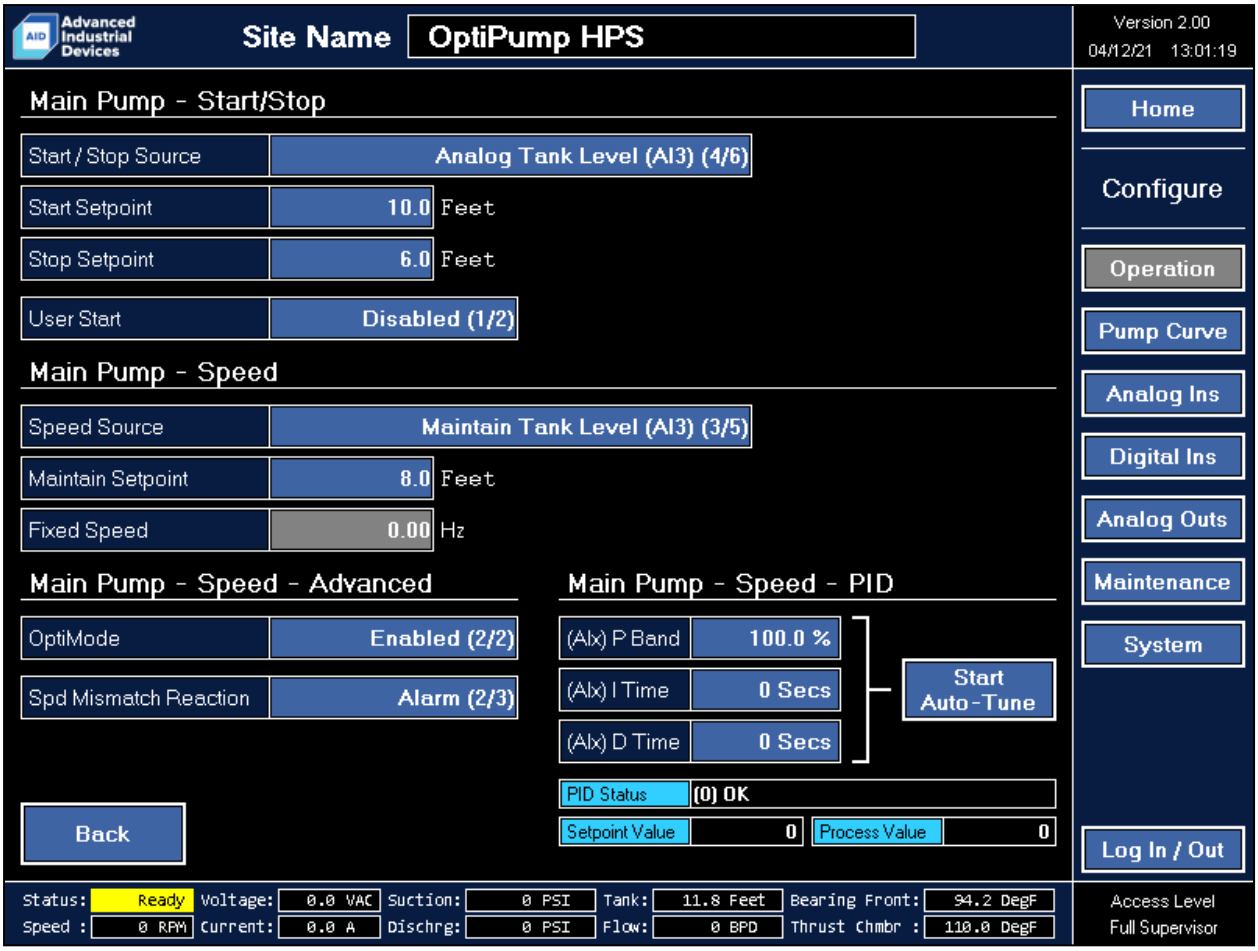
Configure > Operation



Main Pump

Configuration parameters related to the Main Pump are available in:

Configure > Operation > Main Pump



Main Pump - Start/Stop > Start / Stop Source

Start / Stop Source sets the control signal responsible for starting and stopping the main pump.

- Disabled (1/6)
  When the Start / Stop Source is set to Disabled, the system will not run. For safety, if the controller battery, which maintains the current configuration parameter values, fails, the Start / Stop Source will default to Disabled to indicate to the operator that other equipment settings have been lost and corrective action will need to be taken before restarting the system.

- Analog Suction Pressure (AI1) (2/6)
  The analog signal connected to (AI1) Suction Pressure will control the starting and stopping of the main pump. Start Setpoint and Stop Setpoint will be enabled.

- Analog Discharge Pressure (AI2) (3/6)
  The analog signal connected to (AI2) Discharge Pressure will control the starting and stopping of the main pump. Start Setpoint and Stop Setpoint will be enabled.

- Analog Tank Level (AI3) (4/6)
  The analog signal connected to (AI3) Tank Level will control the starting and stopping of the main pump. Start Setpoint and Stop Setpoint will be enabled.

- Maintained Contact Tank Level (DI4) (5/6)
  The dry contact connected to (DI4) Tank Level Start will control the starting and stopping of the main pump. The contact must be maintained in the active state in order for the system to run. If the contact becomes inactive, the system will stop. Start Setpoint and Stop Setpoint will be disabled. This option can also be used when an external control system is used to command the OptiPump HPS controller to start and stop.

- Momentary Contact Tank Level (DI4/DI5) (6/6)
  The dry contact connected to (DI4) Tank Level Start will control the starting of the main pump. The contact does NOT need to be maintained in order for the system to continue to run. The dry contact connected to (DI5) Tank Level Stop will control the stopping of the main pump. The contact does NOT need to be maintained in order for the system to stop. Start Setpoint and Stop Setpoint will be disabled. This option can be used in tank configurations that use two float switches, rather than an analog pressure transducer.

Main Pump - Start/Stop > Start Setpoint

When the Start / Stop Source is configured to use an analog input for control, the value of the analog input must meet the Start Setpoint value in order to start the main pump. If the Start Setpoint is greater than the Stop Setpoint, the system will not start until the analog input value is greater than or equal to the Start Setpoint. If the Start Setpoint is less than the Stop Setpoint, the system will not start until the analog input value is less than or equal to the Start Setpoint.

The Start Setpoint units will automatically change based on the analog input selected in Start / Stop Source.

If the Start / Stop Source is not configured to use an analog input, the Start Setpoint will be disabled.

Main Pump - Start/Stop > Stop Setpoint

When the Start / Stop Source is configured to use an analog input for control, the value of the analog input must meet the Stop Setpoint value in order to stop the main pump. If the Start Setpoint is greater than the Stop Setpoint, the system will not stop until the analog input value is less than or equal to the Stop Setpoint. If the Start Setpoint is less than the Stop Setpoint, the system will not stop until the analog input value is greater than or equal to the Stop Setpoint.

The Stop Setpoint units will automatically change based on the analog input selected in Start / Stop Source.

If the Start / Stop Source is not configured to use an analog input, the Stop Setpoint will be disabled.

Main Pump - Start/Stop > User Start

Digital input (DI3) User Start acts as a remote "run enable" permissive input.

- Disabled (1/2)
  The system will start and stop based on the conditions set by the Start / Stop Source and associated setpoints.

- Enabled (2/2)
  The system will ignore the Start / Stop Source and associated setpoints until (DI3) User Start is active. If (DI3) User Start becomes inactive, the system will stop immediately without meeting the stop conditions set by the Start / Stop Source.

Main Pump - Speed > Speed Source

Speed Source sets the control signal responsible for controlling the speed of the main pump. When using one of the maintain selections, refer to the Main Pump - Speed - Advanced configuration parameters for additional information.

- Maintain Suction Pressure (AI1) (1/5)
  The speed of the main pump will automatically change based on the feedback provided by (AI1) Suction Pressure using a PID loop to maintain the value set in Maintain Setpoint. Maintain Setpoint will be enabled. Fixed Speed will be disabled.

- Maintain Discharge Pressure (AI2) (2/5)
  The speed of the main pump will automatically change based on the feedback provided by (AI2) Discharge Pressure using a PID loop to maintain the value set in Maintain Setpoint. Maintain Setpoint will be enabled. Fixed Speed will be disabled.

- Maintain Tank Level (AI3) (3/5)
  The speed of the main pump will automatically change based on the feedback provided by (AI3) Tank Level using a PID loop to maintain the value set in Maintain Setpoint. Maintain Setpoint will be enabled. Fixed Speed will be disabled.

- Signal-Following Command (AI11) (4/5)
  The speed of the main pump will vary proportionally with the analog signal connected to (AI11) Signal-Following Command. The minimum speed will occur at 4 mA, and the maximum speed will occur at 20 mA. Maintain Setpoint will be disabled. Fixed Speed will be disabled.

- Operator Manual Entry/Fixed Speed (5/5)
  The speed of the main pump will remain fixed at the value entered. Maintain Setpoint will be disabled. This option can also be used when setting the speed via SCADA is desired.

Main Pump - Speed > Maintain Setpoint

When the Speed Source is configured to use one of the maintain analog input selections, the Maintain Setpoint value will be the value that the system attempts to maintain.

The Maintain Setpoint units will automatically change based on the analog input selected in Speed Source.

If the Speed Source is not configured to use a maintain analog input, Maintain Setpoint will be disabled.

Main Pump - Speed > Fixed Speed

When the Speed Source is set to Operator Manual Entry/Fixed Speed, the main pump will run at a speed set by Fixed Speed in Hz. The speed of the main pump will not change automatically.

If the Speed Source is not set to Operator Manual Entry/Fixed Speed, Fixed Speed will be disabled.

Main Pump – Speed – PID Monitors

Displays the status PID loop controlling speed of the main pump when Speed Source is configured to use one of the maintain analog input selections.

- (0) OK
  The PID loop is in standby.

- (1) Auto-Tune in Progress, (2) Auto-Tune in Progress, (3) Auto-Tune in Progress
  The PID auto-tune procedure is currently active.

- (4) PID Running
  The PID loop is actively controlling the speed of the main pump.

- (5) Setpoint Change in Progress, (6) Setpoint Change in Progress
  A change in the PID setpoint is currently in progress.

- (7) Integral Wind-Up, (8) Integral Wind-Down

The PID loop output has reached limits due to accumulation of the integral component.

- (9) Paused
  Control of the PID loop is currently paused. Integral and derivative values are not being calculated.

- (10) Process Value Exceeds P Band, (11) Process Value Exceeds P Band
  The process value exceeds the proportional band, so no PID calculations are being performed.

- (12) Auto-Tune Parameter Mismatch, (13) Auto-Tune Parameter Mismatch
  An error is present with the PID auto-tune values. The PID loop will operate without the auto-tune values.

- (-1) P Band Zero
  The P Band value is set to 0. Correct by entering a non-zero, positive value.

- (-2) Input Range Invalid
  The process value is out of range.

- (-3) Output Range Invalid
  The control value is out of range.

- (-4) Integral Overflow
  The integral value has reached the maximum value of 100,000.

- (-5) Error in Auto-Tune Vector Address
  A programming error in the PID loop auto-tuning feature is present.

- (-6) Setpoint Value Out of Input Range
  The setpoint value is out of range.

- (-7) Auto-Tune Error, (-8) Auto-Tune Error, (-9) Auto-Tune Error, (-10) Auto-Tune Error
  The auto-tuning procedure failed.

- (-11) Noise Exceeds 5% Input Range
  The auto-tune procedure cannot be completed successfully due to excessive process value oscillations.

- (-13) Auto-Tune Aborted
  The auto-tune procedure was aborted prior to completion.

	
The setpoint value of the speed control PID loop. No	The process value of the speed control PID loop. No

units. Scaled from -10,000 to +10,000. Used for diagnostics and troubleshooting.	units. Scaled from -10,000 to +10,000. Used for diagnostics and troubleshooting.

Main Pump - Speed - PID > (AIx) P Band

When the Speed Source is configured to use an analog input to maintain a process value (PV), the (AIx) P Band will set the proportional band around the setpoint in which the PID loop is active. If (AIx) P Band is set to more than 100.0%, the PID function is applied over the entire range.

Running the PID Auto-Tune function is recommended to automatically set this value.

Main Pump - Speed - PID > (AIx) I Time

When the Speed Source is configured to use an analog input to maintain a process value (PV), the (AIx) I Time will set the amount of time, as calculated by the PID loop, required to bring the process value to the Maintain Setpoint. If the (AIx) I Time is set too low, the PID loop will react too quickly, resulting in an overshoot of the Maintain Setpoint. If the (AIx) I Time is set too high, the PID loop will react too slowly.

Running the PID Auto-Tune function is recommended to automatically set this value.

Main Pump - Speed - PID > (AIx) D Time

When the Speed Source is configured to use an analog input to maintain a process value (PV), the (AIx) D Time will change the response of the PID loop to the rate of change in the error between the process value and Maintain Setpoint. (AIx) D Time can be difficult to adjust by hand in order to provide satisfactory results.

Running the PID Auto-Tune function is recommended to automatically set this value.

Main Pump - Speed - PID > Start Auto-Tune

When the Speed Source is configured to use an analog input to maintain a process value (PV), the Start Auto-Tune function will automatically control the speed of the main pump, causing the process value to cycle above and below the Maintain Setpoint. The cycling process allows the controller to calculate the required P Band, I Time, and D Time needed for optimal control of the application. The time required to complete the auto-tune may take several minutes.

Auto-Tune Steps (*must be logged-in as the Full Supervisor to complete these steps):

1. With the desired Speed Source selected and Maintain Setpoint set, start the system in the Auto mode.
2. Wait for the Pre-Run process to complete, and for the main pump to start.
3. Press the Start Auto-Tune button.

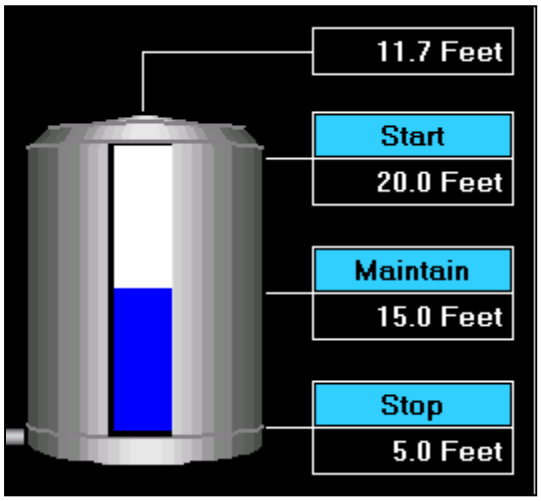
4. Wait for the PID loop to gather data on the process. The main pump will automatically speed up and slow down several times, going above and below the Maintain Setpoint value. The Start Auto-Tune button will be disabled during this process.
5. When the auto-tune process has completed, the values for P Band, I Time, and D Time will be automatically updated on the screen, and the Start Auto-Tune button will be enabled again.
6. No further adjustments are typically needed. However, the auto-tune process values can be adjusted by hand to fine-tune the response if the operator believes that the response can be further improved.

Main Pump - Speed - Advanced > OptiMode

OptiMode is designed for tank applications, and can be highly effective at lowering the electrical energy required to operate the system. The energy savings reduces the overall cost per barrel of fluid moved and extends the life of components such as bearings, by running the main pump at the minimum speed at start.

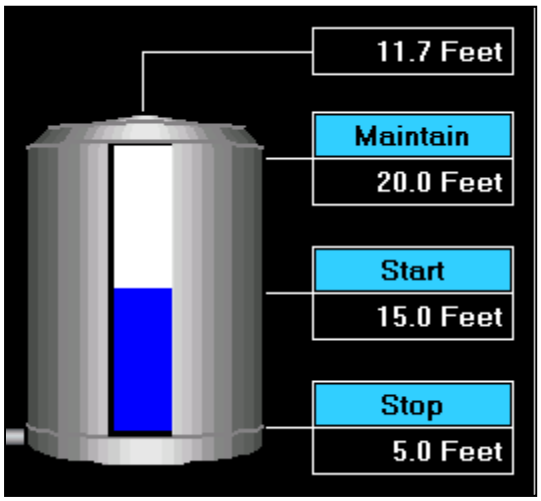
Note:
The OptiMode configuration parameter only alters the locations of the setpoints on the Home screen. The operator is still required to choose a Maintain Setpoint value ABOVE the Start Setpoint value when Eco Mode is set to Enabled.

- Disabled (1/2)
  A standard tank application places the Start Setpoint near the top of the tank, the Stop Setpoint near the bottom of the tank, and the Maintain Setpoint somewhere in between. In this configuration, the main pump often runs a maximum speed at start, then slows down as it reaches the Maintain Setpoint, and continues to run at minimum speed until reaching the Stop Setpoint. Operating in this manner can be inefficient due to running the main pump at faster speeds for shorter periods of time. Refer to the affinity law requirements for horsepower for more information.



- Enabled (2/2)
  OptiMode lowers the Start Setpoint to between the Stop Setpoint and the Maintain Setpoint. In this configuration, the main pump starts at the minimum speed. If the minimum speed is still fast enough to keep up with the incoming fluid, the main pump will continue to run at the minimum speed until the

Stop Setpoint is reached. However, if the minimum speed cannot keep up with the incoming fluid and the tank level continues to rise, the PID loop will automatically increase the speed of the main pump once the tank level reaches the Maintain Setpoint.



Main Pump - Speed - Advanced > Speed Mismatch Reaction

Reaction to the condition when the Output Frequency exceeds the Command Reference Frequency by ±0.5 Hz for a period equal to the Acceleration Time plus 5 seconds.

During normal operation, the Output Frequency should match the Command Reference Frequency. However, several conditions may cause the two frequencies to mismatch. For example:

1. Current limit is active.
2. Torque limit is active.
3. Overvoltage suppression is active due to an overhauling load.

The controller can be configured to ignore these conditions or alert the operator if these conditions occur.

- Disabled (1/3)
  A speed mismatch will be ignored.

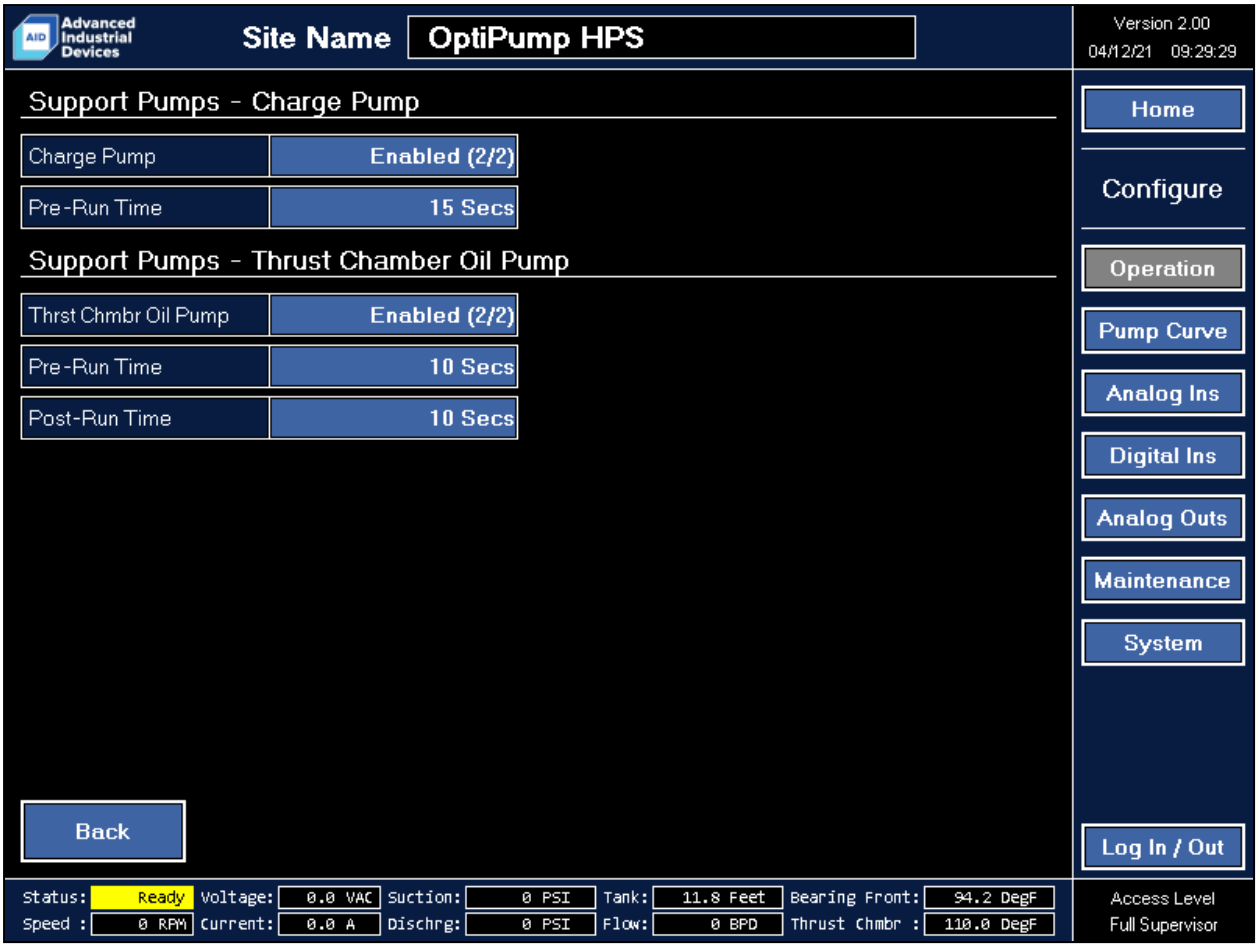
- Alarm (2/3)
  An alarm event will be indicated, but the system will continue to run.

- Shutdown (3/3)
  A shutdown event will be triggered, and the system will stop after following the Post-Run sequence.

Support Pumps

Configuration parameters related to the Support Pumps are available in:

Configure > Operation > Support Pumps



Support Pumps - Charge Pump > Charge Pump

The charge pump is a support pump connected to the suction side of the main pump, and is designed to boost the initial pressure to at least a minimum intake pressure level required by the main pump. Depending on the site design, a charge pump may or may not be required for the safe operation of the main pump.

- Disabled (1/2)
  A charge pump is not available, and will be skipped during the Pre-Run sequence.

- Enabled (2/2)
  A charge pump is installed, will be started during the Pre-Run sequence, and continue to run while the main pump is running. If the charge pump fails to confirm a running state during the Pre-Run sequence or during running of the main pump, a failed-to-run fault will be set.

Support Pumps - Charge Pump > Pre-Run Time

When Charge Pump is set to Enabled, the Pre-Run Time sets the amount of time that the charge pump will run during the Pre-Run sequence, prior to the main pump starting. The charge pump continues to run after the main pump is started.

The Pre-Run Time is disabled when Charge Pump is set to Disabled.

Support Pumps - Charge Pump > Post-Run Time

When Charge Pump is set to Enabled, the Post-Run Time sets the amount of time that the charge pump will run during the Post-Run sequence, after the main pump stops.

Support Pumps - Thrust Chamber Oil Pump > Thrust Chamber Oil Pump

The thrust chamber oil pump is a critical support pump responsible for circulating oil through a thrust chamber that is oil cooled. The thrust chamber oil pump continues to run during the Post-Run sequence, after the main pump stops, in order to remove additional heat from the thrust chamber.

- Disabled (1/2)
  A thrust chamber oil pump is not used or available, will be skipped during the Pre-Run sequence, and not run while the main pump is running. Running the system with the thrust chamber oil pump disabled should only be used when troubleshooting and for very brief periods of time (seconds only). Major main pump and thrust chamber damage will occur if the system is run for more than a few seconds with the thrust chamber oil pump disabled.

- Enabled (2/2)
  A thrust chamber oil pump is installed, will start during the Pre-Run sequence, run while the main pump is running, and continue to run during the Post-Run sequence. If the thrust chamber oil pump fails to confirm a running state during the Pre-Run sequence or during the running of the main pump, a failed-to-run fault will be set.

Support Pumps - Thrust Chamber Oil Pump > Pre-Run Time

When Thrust Chamber Oil Pump is set to Enabled, the Pre-Run Time sets the amount of time that the thrust chamber oil pump will run during the Pre-Run sequence, prior to the main pump starting. The thrust chamber oil pump continues to run after the main pump is started.

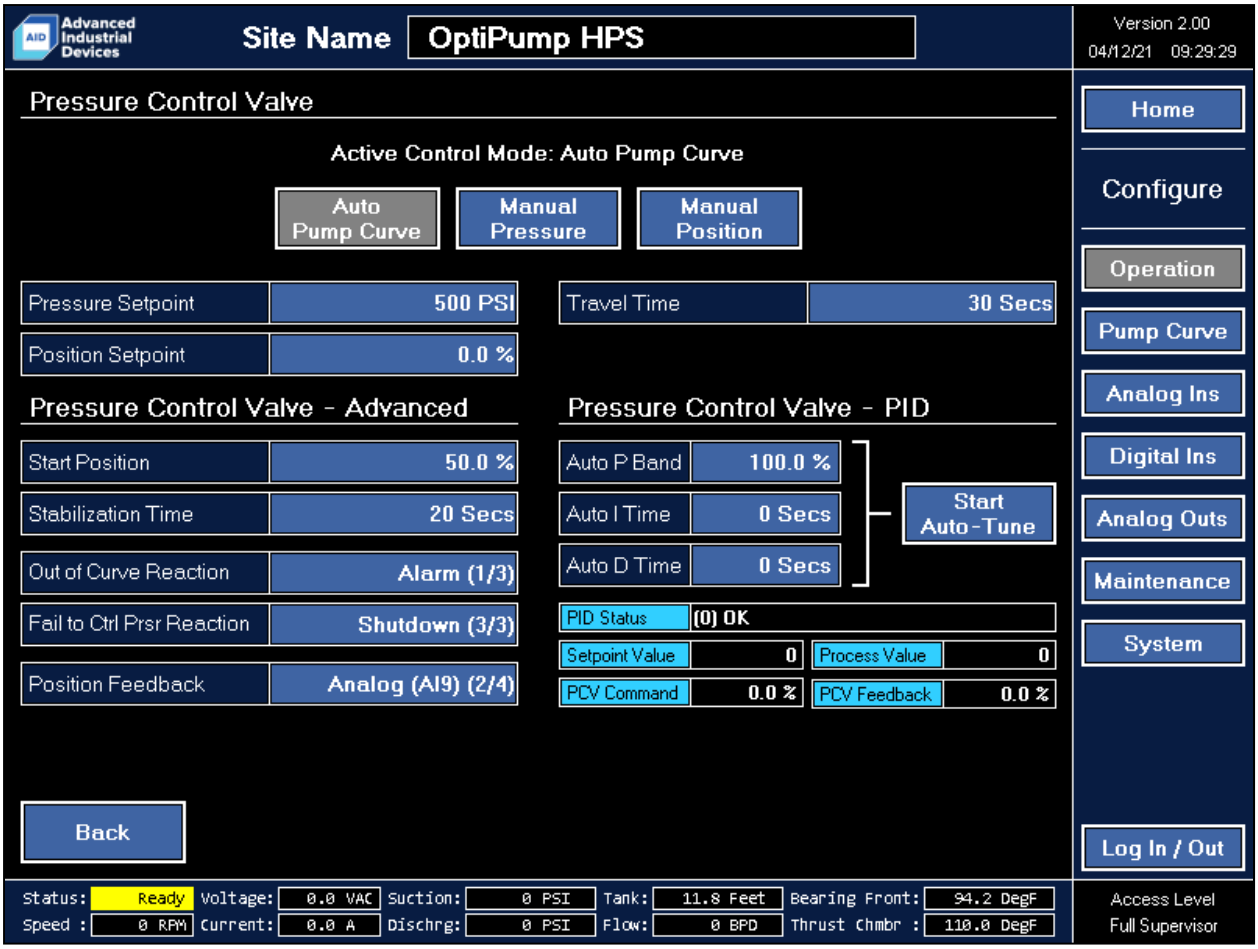
Support Pumps - Thrust Chamber Oil Pumps > Post-Run Time

When Thrust Chamber Oil Pump is set to Enabled, the Post-Run Time sets the amount of time that the thrust chamber oil pump will run during the Post-Run sequence, after the main pump stops.

Pressure Control Valve

Configuration parameters related to the Pressure Control Valve are available in:

Configure > Operation > Pressure Control Valve



Pressure Control Valve > Control Mode

A pressure control valve, installed on the discharge side of the main pump, is a required and critical component of the system. The pressure control valve is responsible for keeping the main pump in curve - a function that optimizes the efficiency of the system and, more importantly, prevents damage to the main pump and thrust chamber.

The pressure control valve position is set by the controller, using either a manual discharge pressure setpoint entered in Pressure Setpoint or an automatic discharge pressure setpoint that is determined by the controller based on the defined main pump curve. Refer to **Configure > Pump Curve** for more information.

- Auto Pump Curve
  The pressure control valve position will automatically change based on the feedback provided by (AI2) Discharge Pressure using a PID loop to maintain the discharge pressure determined by the controller using the defined main pump curve.

- Manual Pressure
  The pressure control valve position will automatically change based on the feedback provided by (AI2) Discharge Pressure using a PID loop to maintain the pressure set in Manual Setpoint. Because the main pump curve is not used to control the pressure control valve position, this mode is only recommended for short periods of time during troubleshooting or commissioning.

- Manual Position
  The pressure control valve will move immediately to the position set in Position Setpoint. The pressure control valve will move to this position even when the system is stopped or the HOA is turned to the Off position. Manually positioning the pressure control valve is intended for use during the installation and commissioning process in order to calibrate the valve position.

Valves - Pressure Control Valve > Pressure Setpoint

When Control Mode is set to Manual Pressure, the pressure control valve position will automatically change based on the feedback provided by (AI2) Discharge Pressure using a PID loop to maintain the discharge pressure entered.

Valves - Pressure Control Valve > Position Setpoint

When Control Mode is set to Manual Position, the pressure control valve will immediately move to the position entered. The pressure control valve will move to this position even when the system is stopped or the HOA is turned to the Off position.

Valves - Pressure Control Valve > Travel Time

The Travel Time sets the amount of time required for the pressure control valve to move from the fully closed to the fully open position. If the pressure control valve fails to move to the commanded position within the allotted time, a fault will be set. The specific fault that will be set varies based on the process.

The pressure control valve Travel Time is used for the following:

- Initial Position
  During the Pre-Run sequence, the pressure control valve is commanded to move to the position set in Start Position. If Position Feedback is not set to Disabled, and the pressure control valve fails to confirm before the Travel Time elapses, a pressure control valve failed-to-position fault will be set.

  If, when Position Feedback is set to Analog (AI9) or Both (AI9/DI8), the position feedback is equal to or exceeds ±5.0% around the commanded position, a pressure control valve failed-to-position fault will be set. For example, if the commanded position is 74%, a pressure control valve failed-to-position fault will be set if the position feedback is less than or equal to 69% or greater than or equal to 79%.

- Main Pump Out-of-Curve Detection
  After the Pre-Run sequence has successfully completed and the Stabilization Time has elapsed, the Travel Time is also used as a detection time for the main pump out-of-curve detection. If, while the main pump is running, the current operating point falls outside of the defined in-curve area for the time set in Travel Time, a main pump out-of-curve condition will be detected. The reaction to a main pump out-of-curve condition is set by Out of Curve Reaction.

- Pressure Control Valve Failed to Control Pressure
  After the Pre-Run sequence has successfully completed and the Stabilization Time has elapsed, the Travel Time is also used as a detection time for the detection of the pressure control valve failing to control the target discharge pressure. If, while the main pump is running, the (AI2) Discharge Pressure is equal to or exceeds ±10 PSI of the target discharge pressure for the time set in Travel Time, a pressure control valve failed-to-control pressure condition will be detected. The reaction to a pressure control valve failed-to-control condition is set by Fail to Control Pressure Reaction.

- Running Position
  After the Pre-Run sequence has successfully completed and the main pump is running, the Travel Time is also used as a detection time for the pressure control valve failing to move to the commanded position. If Position Feedback is not set to Disabled, and the pressure control valve fails to confirm before the Travel Time elapses, a pressure control valve failed-to-position fault will be set. If the pressure control valve successfully confirms the commanded position before the Travel Time elapses, the timer is reset and normal operation continues.

  If, when Position Feedback is set to Analog (AI9) or Both (AI9/DI8), the position feedback is equal to or exceeds ±5.0% around the commanded position and the Travel Time elapses, a pressure control valve failed-to-position fault will be set. For example, if the commanded position is 74%, a pressure control valve failed-to-position fault will be set if the position feedback is less than or equal to 69% or greater than or equal to 79% for the amount of time set in Travel Time.

Pressure Control Valve – PID Monitors

Displays the status PID loop controlling the position of the pressure control valve when Control Mode is configured for Auto Pump Curve or Manual Pressure.

- (0) OK
  The PID loop is in standby.

- (1) Auto-Tune in Progress, (2) Auto-Tune in Progress, (3) Auto-Tune in Progress
  The PID auto-tune procedure is currently active.

- (4) PID Running
  The PID loop is actively controlling the speed of the main pump.

- (5) Setpoint Change in Progress, (6) Setpoint Change in Progress
  A change in the PID setpoint is currently in progress.

- (7) Integral Wind-Up, (8) Integral Wind-Down
  The PID loop output has reached limits due to accumulation of the integral component.

- (9) Paused
  Control of the PID loop is currently paused. Integral and derivative values are not being calculated.

- (10) Process Value Exceeds P Band, (11) Process Value Exceeds P Band
  The process value exceeds the proportional band, so no PID calculations are being performed.

- (12) Auto-Tune Parameter Mismatch, (13) Auto-Tune Parameter Mismatch
  An error is present with the PID auto-tune values. The PID loop will operate without the auto-tune values.

- (-1) P Band Zero
  The P Band value is set to 0. Correct by entering a non-zero, positive value.

- (-2) Input Range Invalid
  The process value is out of range.

- (-3) Output Range Invalid
  The control value is out of range.

- (-4) Integral Overflow
  The integral value has reached the maximum value of 100,000.

- (-5) Error in Auto-Tune Vector Address
  A programming error in the PID loop auto-tuning feature is present.

- (-6) Setpoint Value Out of Input Range
  The setpoint value is out of range.

- (-7) Auto-Tune Error, (-8) Auto-Tune Error, (-9) Auto-Tune Error, (-10) Auto-Tune Error
  The auto-tuning procedure failed.

- (-11) Noise Exceeds 5% Input Range
  The auto-tune procedure cannot be completed successfully due to excessive process value oscillations.

- (-13) Auto-Tune Aborted
  The auto-tune procedure was aborted prior to completion.

	
The setpoint value of the pressure control valve position PID loop. No units. Scaled from -10,000 to +10,000. Used for diagnostics and troubleshooting.	The process value of the pressure control valve position PID loop. No units. Scaled from -10,000 to +10,000. Used for diagnostics and troubleshooting.
	
The current position the pressure control valve is being commanded to move.	The current position of the pressure control valve when Position Feedback is configured to use (AI9) Pressure Control Valve Position.

Pressure Control Valve - PID > Auto P Band

The Auto P Band sets the proportional band around the discharge pressure setpoint in which the PID loop is active. If Auto P Band is set to more than 100.0%, the PID function is applied over the entire range.

Running the PID Auto-Tune function is recommended to automatically set this value.

Pressure Control Valve - PID > Auto I Time

The Auto I Time sets the amount of time, as calculated by the PID loop, required to bring the (AI3) Discharge Pressure to the target discharge pressure. If Auto I Time is set too low, the PID loop will react too quickly, resulting in an overshoot of the target discharge pressure. If the Auto I Time is set too high, the PID loop will react too slowly.

Running the PID Auto-Tune function is recommended to automatically set this value.

Pressure Control Valve - PID > Auto D Time

The Auto D Time changes the response of the PID loop to the rate of change in the error between (AI3) Discharge Pressure and the target discharge pressure. Auto D Time can be difficult to adjust by hand in order to provide satisfactory results.

Running the PID Auto-Tune function is recommended to automatically set this value.

Pressure Control Valve - PID > Start Auto-Tune

The Start Auto-Tune function will automatically control the position of the pressure control valve, causing the discharge pressure to cycle above and below the target discharge pressure. The main pump will move in and out of curve during this process. The cycling process allows the controller to calculate the required P Band, I Time, and D Time needed for optimal control of the pressure control valve. The time required to complete the auto-tune may take several minutes.

In order to reduce the number of variables in the process, Manual Pressure is the recommended setting for Control Method. Running the main pump at a fixed speed can also improve the results of the auto-tune.

Auto-Tune Steps (*must be logged-in as the Full Supervisor to complete these steps):

1. Set **Main Pump - Speed > Speed Source** to Operator Manual Entry/Fixed Speed and **Main Pump - Speed > Fixed Speed** to an acceptable value for the main pump.
2. Set Control Mode to Manual Pressure and Pressure Setpoint to an acceptable target discharge pressure at the speed chosen in Step 1, then start the system in the Auto mode.
3. Wait for the Pre-Run process to complete, the main pump to start, and the Stabilization Time to elapse.
4. Press the Start Auto-Tune button.
5. Wait for the PID loop to gather data on the process. The pressure control valve will automatically change position, resulting in the (AI3) Discharge Pressure value increasing and decreasing around the discharge pressure set in Manual Pressure. The Start Auto-Tune button will be disabled during this process.
6. When the auto-tune process has completed, the values for P Band, I Time, and D Time will be automatically updated on the screen, and the Start Auto-Tune button will be enabled again.
7. Stop the system.
8. No further adjustments are typically needed. However, the auto-tune process values can be adjusted by hand to fine-tune the response if the operator believes that the response can be further improved.
9. Once a successful auto-tune has completed and the pressure control valve reaction accurately maintains the target discharge pressure, return **Main Pump - Speed > Speed Source** and Control Method to the values necessary for operation of the system.

Pressure Control Valve - Advanced > Start Position

During the Pre-Run sequence, the pressure control valve will be commanded from the fully closed position to the Start Position. The starting position of the pressure control valve should be chosen to allow the main pump to be relatively close to the expected in-curve discharge pressure at the expected speed.

Pressure Control Valve - Advanced > Stabilization Time

The stabilization time provides a short delay after the main pump starts to allow the main pump to come up to speed and pressurize the wellhead/pipeline before enabling the automatic control of the pressure control valve.

After the Pre-Run sequence has successfully completed and the main pump is running, the pressure control valve Start Position will be held for the value set in Stabilization Time.

Pressure Control Valve - Advanced > Out of Curve Reaction

After the Pre-Run sequence has successfully completed, the main pump is running, and the Stabilization Time has elapsed, the controller enables out-of-curve detection for the main pump. If the main pump is determined to be out of the acceptable curve area for the time set in Travel Time, a main pump out-of-curve condition will be detected.

The controller can be configured to react to an out-of-curve condition in several ways:

- Disabled (1/3)
  A main pump out-of-curve condition will be ignored.

- Alarm (2/3)
  An alarm event will be indicated, but the system will continue to run.

- Shutdown (3/3)
  A shutdown event will be triggered, and the system will stop after following the Post-Run sequence.

Pressure Control Valve - Advanced > Fail to Control Pressure Reaction

After the Pre-Run sequence has successfully completed, the main pump is running, and the Stabilization Time has elapsed, the controller enables the pressure control valve failed-to-control pressure detection. Reaction to the condition will occur when the discharge pressure exceeds the target discharge pressure by ±10 PSI for a period equal to the Travel Time.

The controller can be configured to react to a failed-to-control pressure condition in several ways:

- Disabled (1/3)
  A failed-to-control pressure condition will be ignored.

- Alarm (2/3)
  An alarm event will be indicated, but the system will continue to run.

- Shutdown (3/3)
  A shutdown event will be triggered, and the system will stop after following the Post-Run sequence.

Pressure Control Valve - Advanced > Position Feedback

For the best operational results and system performance, the feedback for the position of the pressure control valve should be implemented using an analog input, (AI9) Pressure Control Valve Position. However, the OptiPump HPS controller supports a number of different feedback options to allow for variability of the field equipment.

- Disabled (1/4)
  The pressure control valve does not provide feedback to the controller. The fail-to-control pressure condition and fail-to-position fault related to the pressure control valve are disabled. The pressure control valve will still be commanded to desired positions, but without feedback, the controller can only assume the pressure control valve has moved.

- Analog (AI9) (2/4)
  The pressure control valve position uses an analog input connected to (AI9) Pressure Control Valve Position to indicate 0-100% open.

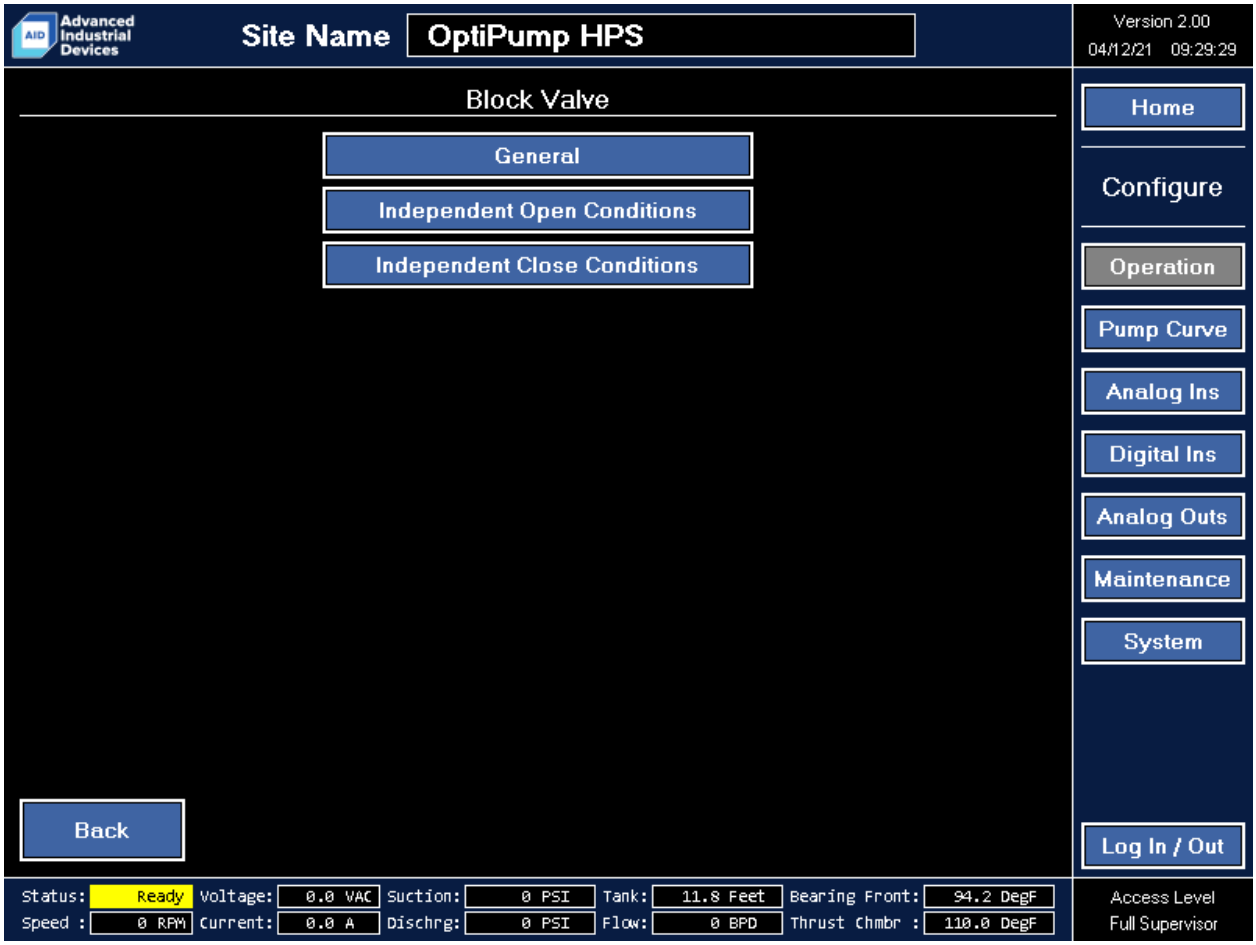
- Digital (DI8) (3/4)
  The pressure control valve position is indicated using a digital input by connecting a dry contact to (DI8) Pressure Control Valve Closed. (DI8) Pressure Control Valve Closed is active when the pressure control valve is fully closed and inactive when the pressure control valve is at some other position other than fully closed.

- Both (AI9/DI8) (4/4)
  The pressure control valve position is indicated using both an analog input connected to (AI9) Pressure Control Valve Position and a digital input connected to (DI8) Pressure Control Valve Closed.

Block Valve

Configuration parameters related to the Block Valve are available in:

Configure > Operation > Block Valve



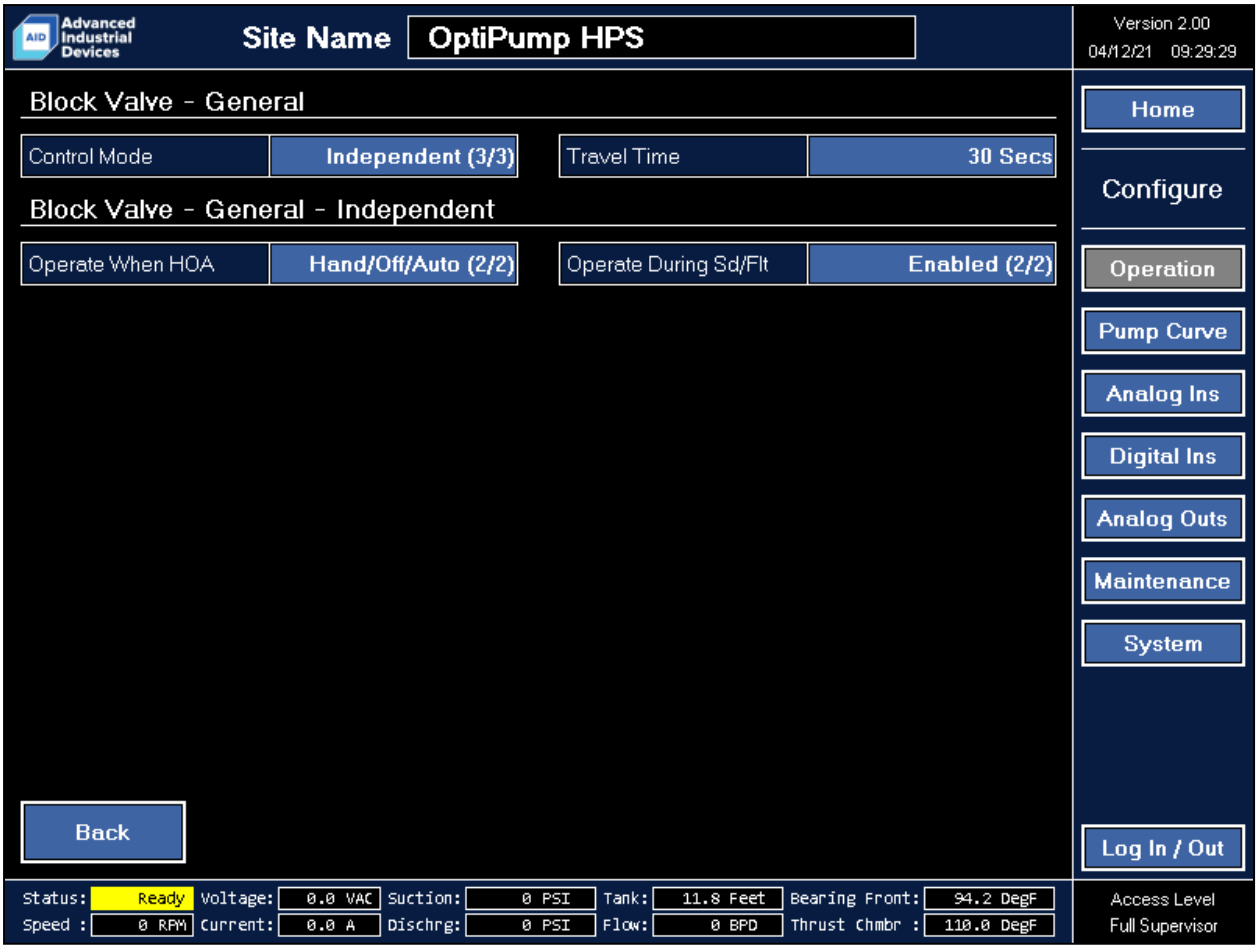
An optional block valve (also referred to as a slam valve), designed to isolate the inlet to the facility when the tanks are full or the wellhead/pipeline from the system when the main pump is stopped, may be installed ahead of the facility or on the discharge side of the main pump, depending on the site requirements. The OptiPump HPS controller enables the block valve to be configured in the field by the operator using a highly customizable control system, all without the need for site-customized firmware to be written.

A Process event will be recorded any time the block valve is commanded to open or close.

General

General configuration parameters related to the Block Valve are available in:

Configure > Operation > Block Valve > General



Block Valve - General > Control Mode

The block valve operation is highly configurable by the operator. Please note that the block valve is NOT the pressure control valve, and is NOT designed to keep the main pump in-curve.

- Disabled (1/3)
  An optional block valve is not available, and will not be used during operation of the system.

- Run Sequence (2/3)
  An optional block valve is installed, will be commanded to fully open during the Pre-Run sequence, remain open while the main pump is running, and will be commanded to fully close during the Post-Run sequence. The Run Sequence mode is intended for use when the block valve is installed on the discharge side of the main pump.

- Independent (3/3)
  An optional block valve is installed, and will operate fully independent of the main pump system. The block valve will open and close based on conditions configured by the operator. The block valve will operate regardless of whether or not the main pump is stopped or running.

  When operating in the Independent mode, if both open and close conditions are simultaneously met, the closing of the block valve takes priority.

Block Valve - General > Travel Time

When the Control Mode is set to Run Sequence or Independent, the Travel Time sets the amount of time required for the block valve to move from the fully closed to fully open and fully open to fully closed position. If the block valve fails to confirm a commanded position after the Travel Time elapses, a block valve failed-to-open fault will be set. Adding 5 to 10 seconds to the required travel time can help to prevent nuisance failed-to-open faults when the travel time of the block valve is inconsistent.

Block Valve - General - Independent > Operate When HOA

When the Control Mode is set to Independent, the block valve can be configured to operate depending on the position of the HOA switch.

- Hand/Auto (1/2)
  The block valve will operate if the open and close conditions are met when the HOA switch is in the Hand or Auto position. If the HOA switch is in the Off position, the block valve will be commanded to the closed position.

- Hand/Off/Auto (2/2)
  The block valve will operate if the open and close conditions are met, regardless of the position of the HOA switch.

Operate When HOA is disabled when Control Mode is set to Disabled or Run Sequence.

Block Valve - General - Independent > Operate During Sd/Flt

When the Control Mode is set to Independent, the block valve operation can also be configured to operate even when a shutdown or fault is currently active. This allows the block valve to continue to attempt to operate regardless of the state of the system.

- Disabled (1/2)
  The block valve will move to the closed position if ANY shutdown or fault is active.

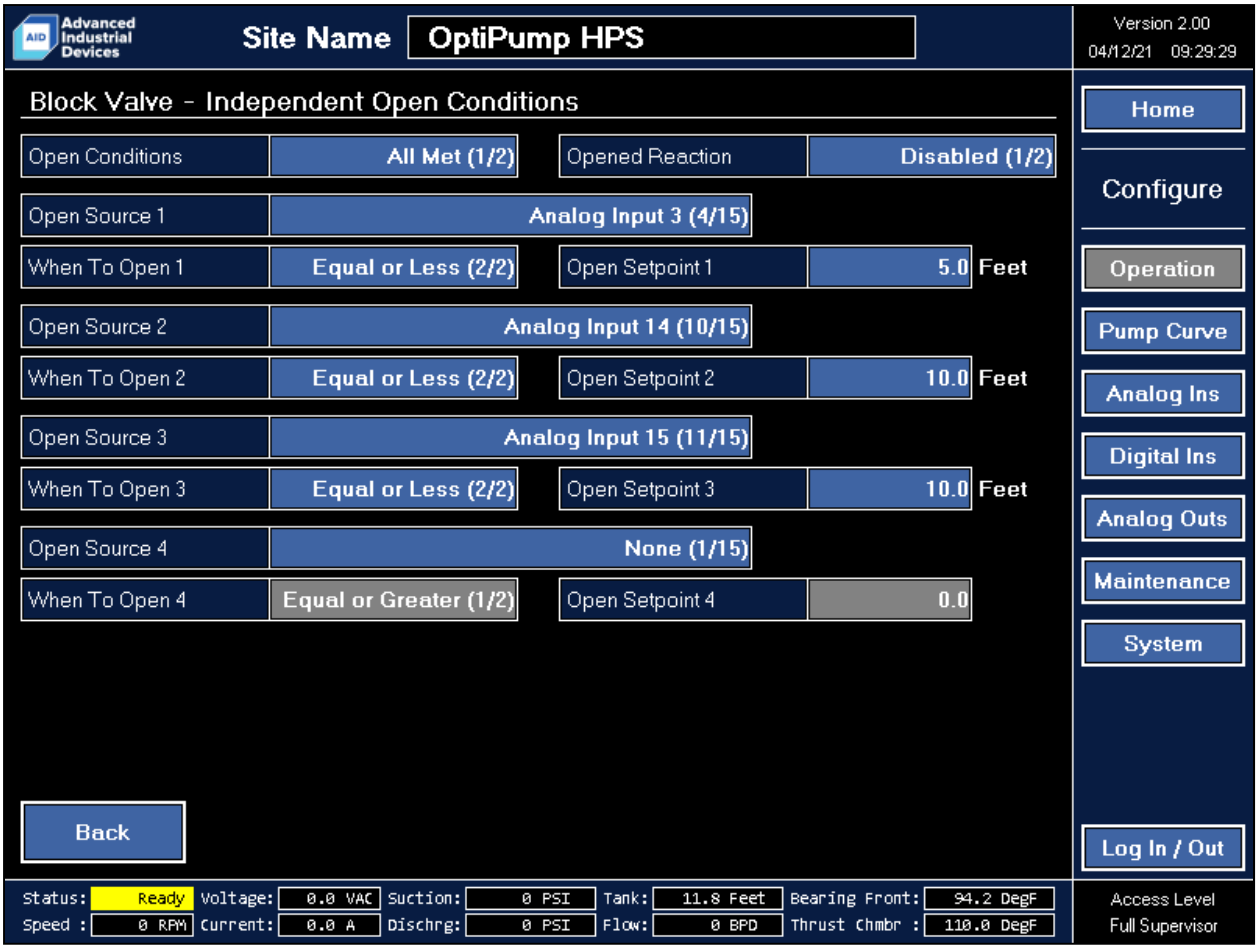
- Enabled (2/2)
  The block valve will attempt to continue to operate based on the open and close conditions, even when a shutdown or fault event is currently active. This includes if the block valve fails to open and close.

Operate During Sd/Flt is disabled when Control Mode is set to Disabled or Run Sequence.

Independent Open Conditions

Configuration parameters related to the Independent Open Conditions of the Block Valve are available in:

Configure > Operation > Block Valve > Independent Open Conditions



Block Valve – Independent Open Conditions > Open Conditions

The block valve can be commanded to open based on up to four conditions configured by the operator. The command to open the block valve can be required to meet any or all of the four conditions configured.

If an Open Source is set to None, that source is NOT included in the decision making process.

- All Met (1/2)
  The block valve will be commanded to open only when **ALL** four of the open source conditions are met.

- Any Met (2/2)
  The block valve will be commanded to open if **ANY** one of the four open source conditions is met.

Block Valve – Independent Open Conditions > Opened Reaction

In cases were an alert or notification is needed any time the block valve is open, the Open Reaction can be configured to set an alarm.

- Disabled (1/2)
  No alarm will be set when the block valve is confirmed in the open position.

- Alarm (2/2)
  A block valve open alarm will be set when the block valve is confirmed in the open position. This alarm will automatically clear when the block valve is no longer confirmed in the open position.

Block Valve – Independent Open Conditions > Open Source 1
Block Valve – Independent Open Conditions > Open Source 2
Block Valve – Independent Open Conditions > Open Source 3
Block Valve – Independent Open Conditions > Open Source 4

The analog or digital input used to determine if the block valve should be commanded to open. If an analog input is selected as an Open Source, the When To Open and Open Setpoint will also need to be configured. If a digital input is selected as an Open Source, the condition will be met any time the digital input is active.

- None (1/15)
  The Open Source condition will NOT be used to determine if the block valve should be commanded to open.

- Analog Input 1 (2/15)
  (AI1) Suction Pressure will be used to determine if the block valve should be commanded to open.

- Analog Input 2 (3/15)
  (AI2) Discharge Pressure will be used to determine if the block valve should be commanded to open.

- Analog Input 3 (4/15)
  (AI3) Tank Level will be used to determine if the block valve should be commanded to open.

- Analog Input 4 (5/15)
  (AI4) Well Casing Pressure will be used to determine if the block valve should be commanded to open.

- Analog Input 5 (6/15)
  (AI5) Wellhead Pressure will be used to determine if the block valve should be commanded to open.

- Analog Input 11 (7/15)
  (AI11) Signal-Following Cmd will be used to determine if the block valve should be commanded to open.

- Analog Input 12 (8/15)

(AI12) Mtr Brng In Vib will be used to determine if the block valve should be commanded to open.

- Analog Input 13 (9/15)
  (AI13) Mtr Brng Out Vib will be used to determine if the block valve should be commanded to open.

- Analog Input 14 (10/15)
  (AI14) Auxiliary Tank 1 Lvl will be used to determine if the block valve should be commanded to open.

- Analog Input 15 (11/15)
  (AI15) Auxiliary Tank 2 Lvl will be used to determine if the block valve should be commanded to open.

- Digital Input 13 (12/15)
  (DI13) Tank Level High will be used to determine if the block valve should be commanded to open.

- Digital Input 14 (13/15)
  (DI14) Field Shutdown will be used to determine if the block valve should be commanded to open.

- Digital Input 15 (14/15)
  (DI15) Thrust Chamber Oil Flow will be used to determine if the block valve should be commanded to open.

- Digital Input 16 (15/15)
  (DI16) Multipurpose will be used to determine if the block valve should be commanded to open.

Block Valve – Independent Open Conditions > When To Open 1
Block Valve – Independent Open Conditions > When To Open 2
Block Valve – Independent Open Conditions > When To Open 3
Block Valve – Independent Open Conditions > When To Open 4

When an analog input has been selected as an Open Source, the When To Open value also needs to be configured. When To Open determines if the Open Source condition is met when the measured value is equal to or **GREATER** than the setpoint or when the measured value is equal to or **LESS** than the setpoint.

- Equal or Greater (1/2)
  The condition will be met if the measured value of the analog input is equal to or greater than the value of the associated setpoint.

- Equal or Less (2/2)
  The condition will be met if the measured value of the analog input is equal to or less than the value of the associated setpoint.

When To Open is disabled when the associated Open Source is set to None or a digital input.

Block Valve – Independent Open Conditions > Open Setpoint 1
Block Valve – Independent Open Conditions > Open Setpoint 2
Block Valve – Independent Open Conditions > Open Setpoint 3
Block Valve – Independent Open Conditions > Open Setpoint 4

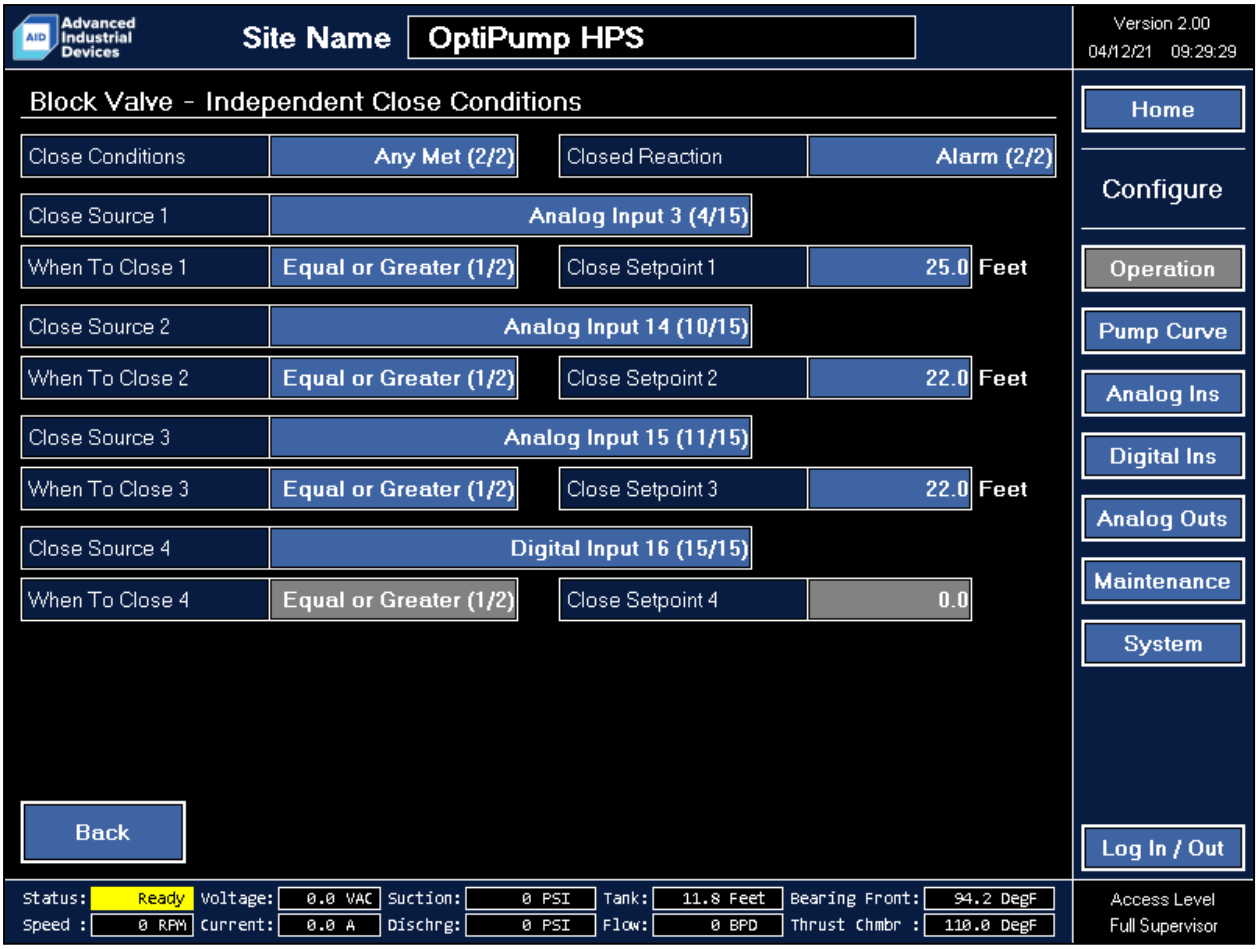
When an analog input has been selected as an Open Source, the Open Setpoint value also needs to be configured. The Open Setpoint is the scaled value of the analog input that must be met in order for the Open Source condition to be met. The Open Source condition can also be met if the scaled value of the analog input is greater than or less than the value of Open Setpoint, depending on how the associated When To Open parameter is configured.

Open Setpoint is disabled when the associated Open Source is set to None or a digital input.

Independent Close Conditions

Configuration parameters related to the Independent Close Conditions of the Block Valve are available in:

Configure > Operation > Block Valve > Independent Close Conditions



Block Valve – Independent Close Conditions > Close Conditions

The block valve can be commanded to close based on up to four conditions configured by the operator. The command to close the block valve can be required to meet any or all of the four conditions configured.

If a Close Source is set to None, that source is NOT included in the decision making process.

- All Met (1/2)
  The block valve will be commanded to close only when **ALL** four of the close source conditions are met.

- Any Met (2/2)
  The block valve will be commanded to close if **ANY** one of the four close source conditions is met.

Block Valve – Independent Close Conditions > Closed Reaction

In cases were an alert or notification is needed any time the block valve is closed, the Closed Reaction can be configured to set an alarm.

- Disabled (1/2)
  No alarm will be set when the block valve is confirmed in the closed position.

- Alarm (2/2)
  A block valve closed alarm will be set when the block valve is confirmed in the closed position. This alarm will automatically clear when the block valve is no longer confirmed in the closed position.

Block Valve – Independent Close Conditions > Close Source 1
Block Valve – Independent Close Conditions > Close Source 2
Block Valve – Independent Close Conditions > Close Source 3
Block Valve – Independent Close Conditions > Close Source 4

The analog or digital input used to determine if the block valve should be commanded to close. If an analog input is selected as a Close Source, the When To Close and Close Setpoint will also need to be configured. If a digital input is selected as a Close Source, the condition will be met any time the digital input is active.

- None (1/15)
  The Close Source condition will NOT be used to determine if the block valve should be commanded to close.

- Analog Input 1 (2/15)
  (AI1) Suction Pressure will be used to determine if the block valve should be commanded to close.

- Analog Input 2 (3/15)
  (AI2) Discharge Pressure will be used to determine if the block valve should be commanded to close.

- Analog Input 3 (4/15)
  (AI3) Tank Level will be used to determine if the block valve should be commanded to close.

- Analog Input 4 (5/15)
  (AI4) Well Casing Pressure will be used to determine if the block valve should be commanded to close.

- Analog Input 5 (6/15)
  (AI5) Wellhead Pressure will be used to determine if the block valve should be commanded to close.

- Analog Input 11 (7/15)
  (AI11) Signal-Following Cmd will be used to determine if the block valve should be commanded to close.

- Analog Input 12 (8/15)

(AI12) Mtr Brng In Vib will be used to determine if the block valve should be commanded to close.

- Analog Input 13 (9/15)
  (AI13) Mtr Brng Out Vib will be used to determine if the block valve should be commanded to close.

- Analog Input 14 (10/15)
  (AI14) Auxiliary Tank 1 Lvl will be used to determine if the block valve should be commanded to close.

- Analog Input 15 (11/15)
  (AI15) Auxiliary Tank 2 Lvl will be used to determine if the block valve should be commanded to close.

- Digital Input 13 (12/15)
  (DI13) Tank Level High will be used to determine if the block valve should be commanded to close.

- Digital Input 14 (13/15)
  (DI14) Field Shutdown will be used to determine if the block valve should be commanded to close.

- Digital Input 15 (14/15)
  (DI15) Thrust Chamber Oil Flow will be used to determine if the block valve should be commanded to close.

- Digital Input 16 (15/15)
  (DI16) Multipurpose will be used to determine if the block valve should be commanded to close.

Block Valve – Independent Close Conditions > When To Close 1
Block Valve – Independent Close Conditions > When To Close 2
Block Valve – Independent Close Conditions > When To Close 3
Block Valve – Independent Close Conditions > When To Close 4

When an analog input has been selected as an Close Source, the When To Close value also needs to be configured. When To Close determines if the Close Source condition is met when the measured value is equal to or **GREATER** than the setpoint or when the measured value is equal to or **LESS** than the setpoint.

- Equal or Greater (1/2)
  The condition will be met if the measured value of the analog input is equal to or greater than the value of the associated setpoint.

- Equal or Less (2/2)
  The condition will be met if the measured value of the analog input is equal to or less than the value of the associated setpoint.

When To Close is disabled when the associated Close Source is set to None or a digital input.

Block Valve – Independent Close Conditions > Close Setpoint 1
Block Valve – Independent Close Conditions > Close Setpoint 2
Block Valve – Independent Close Conditions > Close Setpoint 3
Block Valve – Independent Close Conditions > Close Setpoint 4

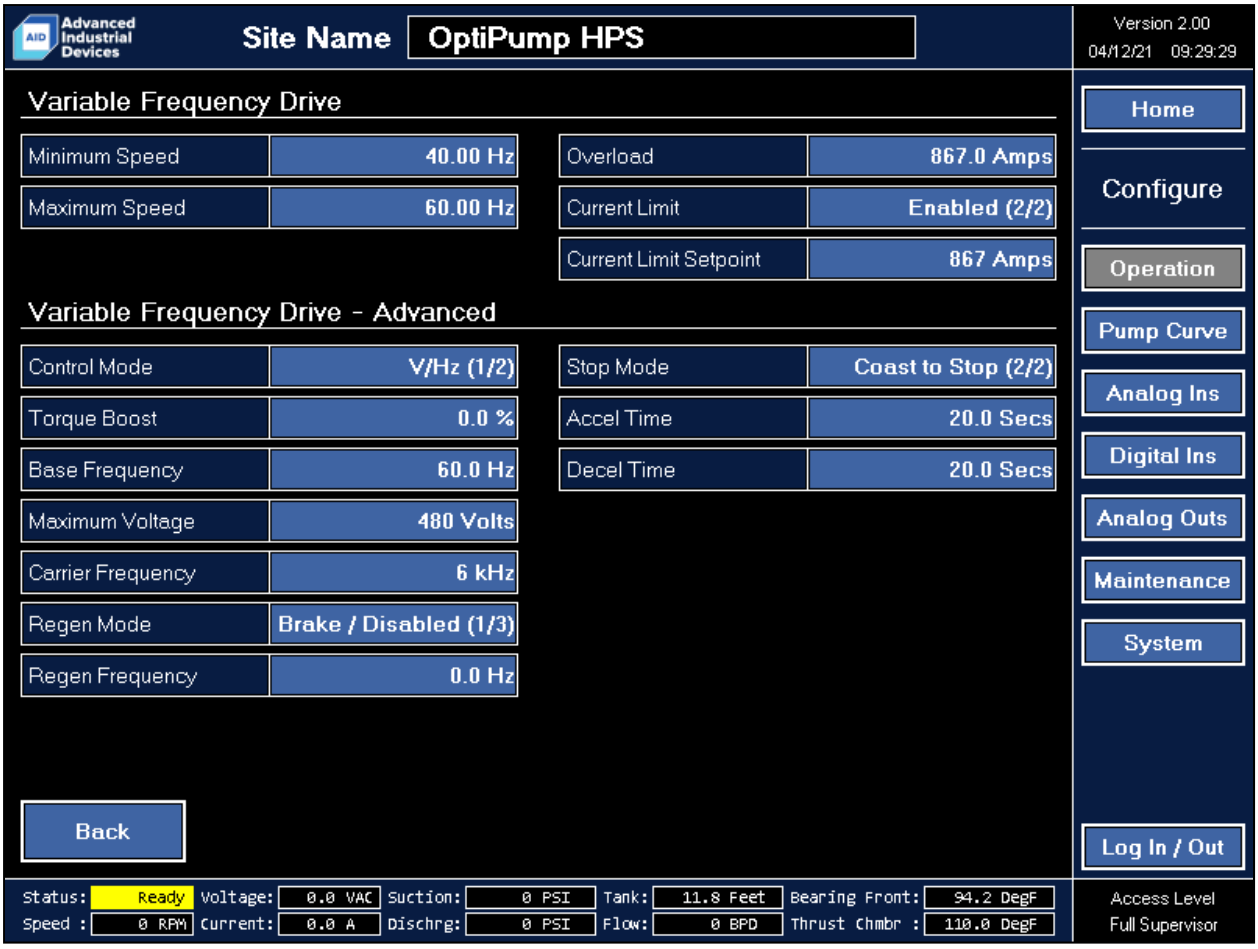
When an analog input has been selected as a Close Source, the Close Setpoint value also needs to be configured. The Close Setpoint is the scaled value of the analog input that must be met in order for the Close Source condition to be met. The Close Source condition can also be met if the scaled value of the analog input is greater than or less than the value of Close Setpoint, depending on how the associated When To Close parameter is configured.

Close Setpoint is disabled when the associated Close Source is set to None or a digital input.

Variable Frequency Drive

Configuration parameters related to the Variable Frequency Drive are available in:

Configure > Operation > Variable Frequency Drive



Variable Frequency Drive > Minimum Speed

Is the slowest speed that the system will operate at when in a run condition. The only time that the system would not run at least at this minimum speed is because there is a current limit or torque limit being activated on the main motor of the system. In this case it is common to see the speed of the motor not go above 2 – or 3Hz and occurs automatically to prevent the damage of the motor or the VFD.

Variable Frequency Drive > Maximum Speed

Is the maximum speed the system will run. The only time the system can run faster than this value is if automatic regeneration protection mode is turned on and the system is experiencing an event that is causing a regenerative condition. The speed increase is very temporary and will go away automatically when the

regenerative condition goes away. **This setting can only be changed when the main pump motor is not running.**

Variable Frequency Drive > Overload

The Overload setting is just what it sounds like. This is the motor overload that you want set for the main pump motor. This setting can be set to a maximum of either the motor FLA + its safety factor or the maximum running amperage the VFD in the panel is capable of (which ever value is lower). It is recommended that the overload be set at least 4 or 5 amps over the motor nameplate FLA to avoid nuisance overload shutdown events.

Variable Frequency Drive > Current Limit
Variable Frequency Drive > Current Limit Setpoint

If current limit is enabled then the VFD in the panel will reduce the speed of the motor to automatically bring the current the motor is drawing below the set value the operator puts into Current Limit Setpoint.

Variable Frequency Drive - Advanced > Control Mode

The control mode has two possible settings of V/Hz (volts to hertz mode) and torque vector mode. On an H-Pump it is extremely unlikely that torque vector mode will be needed or even helpful so leave this setting in V/Hz mode. If torque vector mode is felt to be required then s special motor to VFD tuning process must be done. If torque vector is desired contact the factory on how to perform the Auto-tuning procedure to allow torque vector mode to work correctly.

Variable Frequency Drive - Advanced > Torque Boost

Torque boost can be very beneficial on a hard starting system. Torque boost will overexcite the motor by sending a higher level of voltage at a low speed when starting (starting only) to create extra low speed torque in the motor to get past the hard start. If a torque boost is desired the starting point should not be too aggressive and 2.0 is a reasonable number to begin with.

Variable Frequency Drive - Advanced > Base Frequency

Base frequency is the motor driving speed that maximum available motor voltage will be applied to the motor. Since the base speed of a 60Hz motor is at 60 Hz it is typical to leave this value at the default of 60Hz. **This setting can only be changed when the main pump motor is not running.**

Variable Frequency Drive - Advanced > Maximum Voltage

Maximum voltage is the voltage that the VFD will put out to the motor when running at or above the base Frequency. It is typical to leave this value at the default setting. **This setting can only be changed when the main pump motor is not running.**

Variable Frequency Drive - Advanced > Carrier Frequency

The carrier frequency affects how smooth electrically the sine wave output from the VFD is to the motor. The higher the number the smoother the sine wave is to the motor. This should not be confused with motor harmonics or common mode current and does not relate to this at all. The lower the carrier frequency the lower the heat generation of your VFD will be. The cooling system on the OptiPump HPS has been tuned to allow a maximum carrier frequency of 6.0. If the system experience over heating issues in the installation lowering the carrier frequency from 6.0 to 4.0 or even 2.0 will make the system operate cooler. The motor will accept all carrier frequencies but you will find audible noise coming from the motor gets stronger at lower carrier frequencies. The higher level of audible noise does not hurt the motor, but may become a human issue if the installation is near a populated structure and noise is undesirable.

Variable Frequency Drive - Advanced > Regen Mode

Automatic regeneration control can be disabled, controlled by motor torque or controlled by VFD DC bus voltage. If automatic regeneration is required then the operator must also set a value for the Regen Frequency.

Variable Frequency Drive - Advanced > Regen Frequency

Is the maximum amount of speed greater than what the current speed of the motor is to allow the system to try and automatically prevent regeneration. So for example if this value were set to 10Hz then if the motor were running at 45 HZ and a regeneration event occurred then the system would allow the motor to automatically speed up to 55Hz to try and prevent the regeneration from creating a DC bus overvoltage shutdown condition.

Variable Frequency Drive - Advanced > Stop Mode

This setting is only effective when there is a stop command present to the VFD inside the OptiPump HPS system. The setting of this value to coast to stop is the common setting and a stop command to the pump will simple cut off voltage to the motor and let the fluid pressure stop the pump. If a controlled stop is desirable then set to Decelerate. Deceleration will be controlled by what the operator sets for Decel Time. Setting the deceleration time too aggressively will essentially guarantee an overvoltage fault on the VFD every time the system stops. So if decelerate is needed then do not set a short deceleration time. Sometimes the system will be unable to reliably stop the motor with just deceleration and a special setting for DC injection braking is required. Contact the factory if this is the case for your system for specialty settings.

Variable Frequency Drive - Advanced > Accel Time

This is the amount of time that the VFD will take to bring the main pump motor from a full stop to 100% speed. So if the pump is already at 50% speed then it will take 1/2 the time set here to get from 50% to 100% speed.

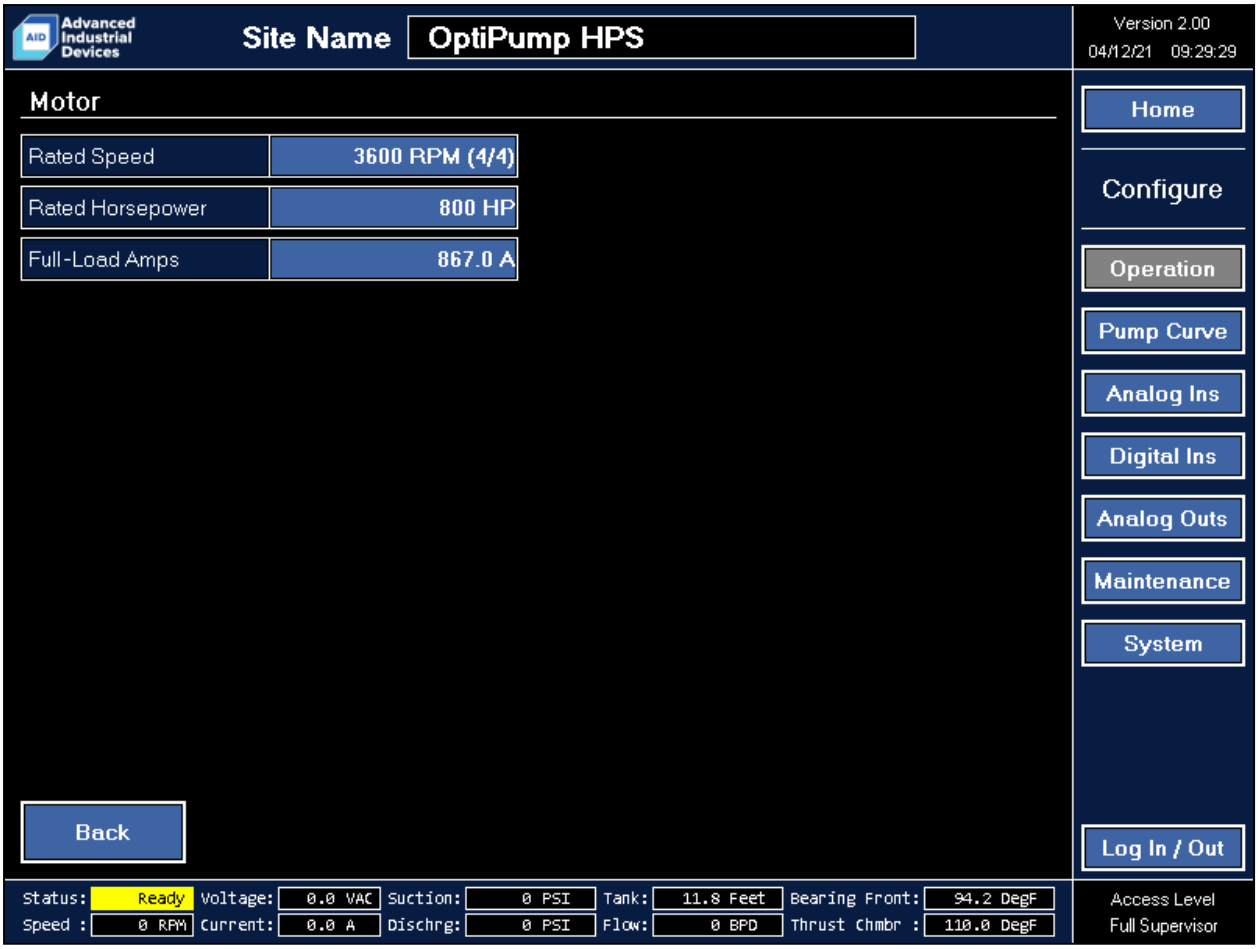
Variable Frequency Drive - Advanced > Decel Time

This is the amount of time the VFD will take to bring the main motor from full speed to zero speed.

Motor

Configuration parameters related to the Motor are available in:

Configure > Operation > Motor



Motor > Rated Speed

Select the motor speed that closest matches your motors name plate speed.

Motor > Rated Horsepower

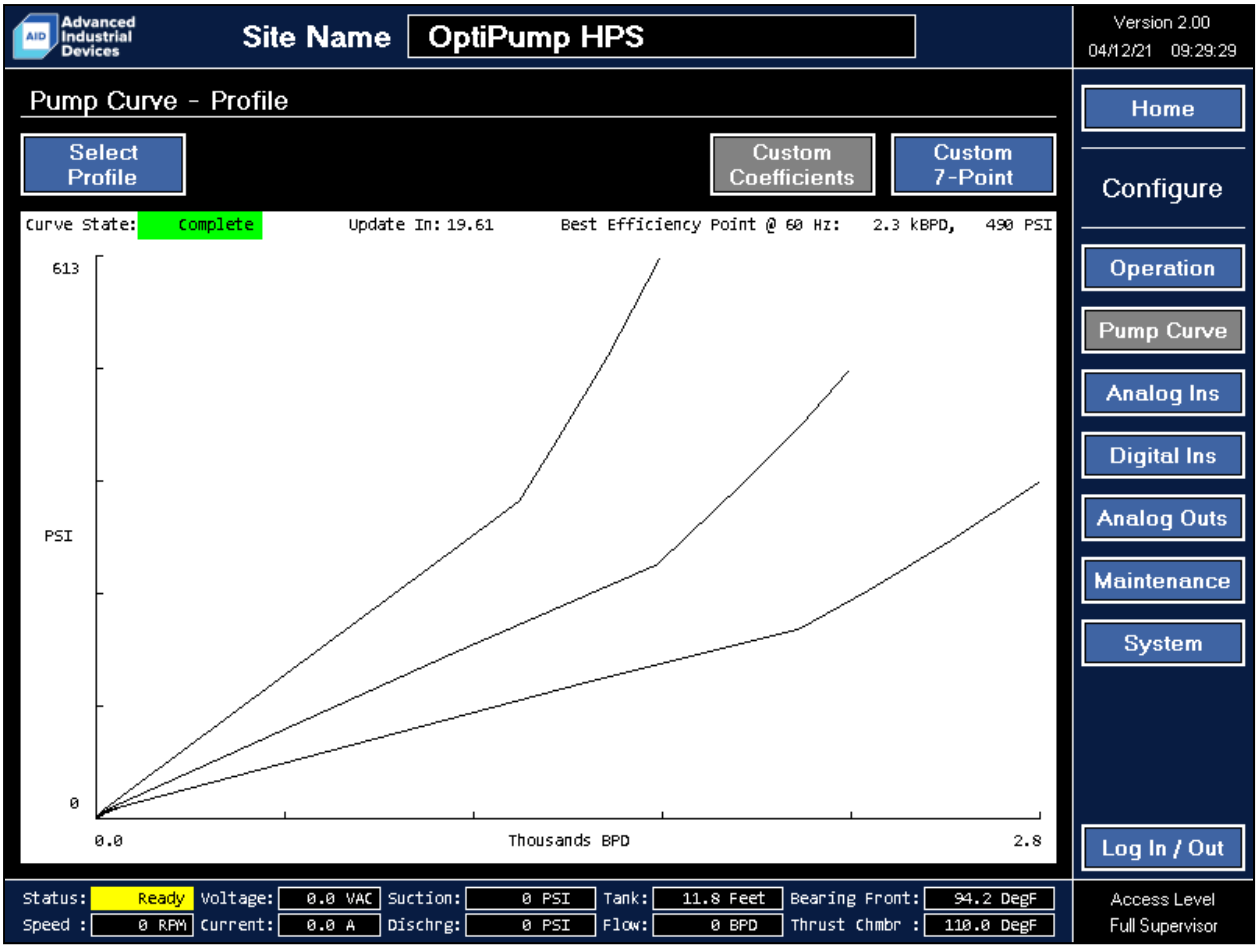
Enter in the nameplate horse power of your motor.

Motor > Full-Load Amps

Enter in the full load amps (FLA) from the nameplate of your motor (No safety factor or overload value here just the nameplate amps).

Configuration parameters related to the Pump Curve are available in:

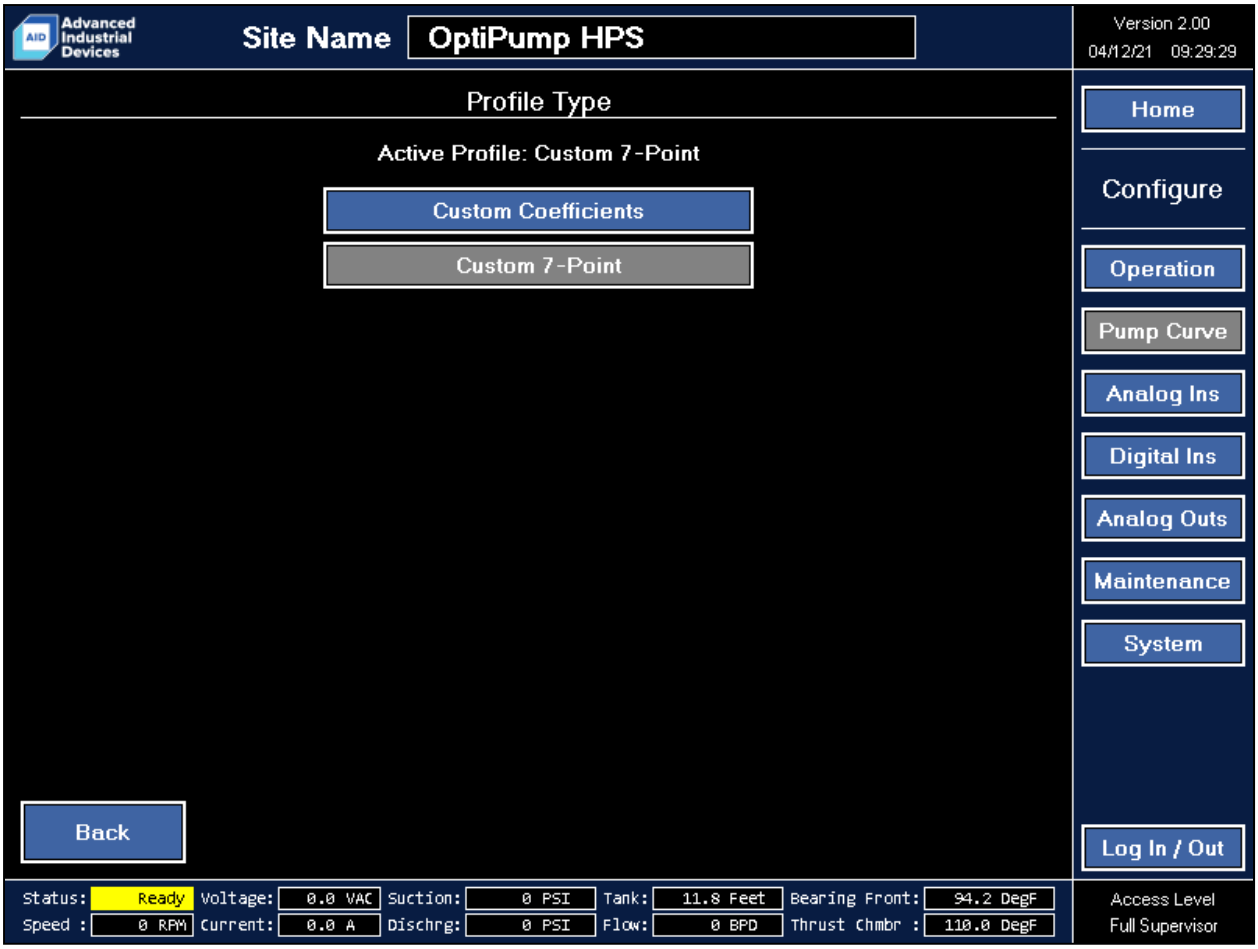
Configure > Pump Curve



The pump curve for the main pump is a critical component for the safe and reliable use of the system. The pump curve is responsible for defining the limits of the acceptable in-curve area that result in the best operational efficiency and longest life of the equipment.

When configuring the pump curve, the Pump Curve Profile screen will display the pump curve for the active profile. The x-axis is flow, while the y-axis is discharge pressure. The best efficiency point (BEP) at 60 Hz is displayed in the upper right corner of the plot, and marked with the intersecting red lines when used with the Custom Coefficients profile. Only one of the two profile buttons at the top of the screen will be active at a time, and is determined by the active profile selected using the Select Profile button in the upper left corner of the screen.

Depending on the complexity of the pump curve, the curve may require a short period of time to plot.



The OptiPump HPS controller supports two types of pump profiles, which are used to define the main pump curve. The active profile is displayed at the top of the screen, and the button is shown with a gray background when logged-in.

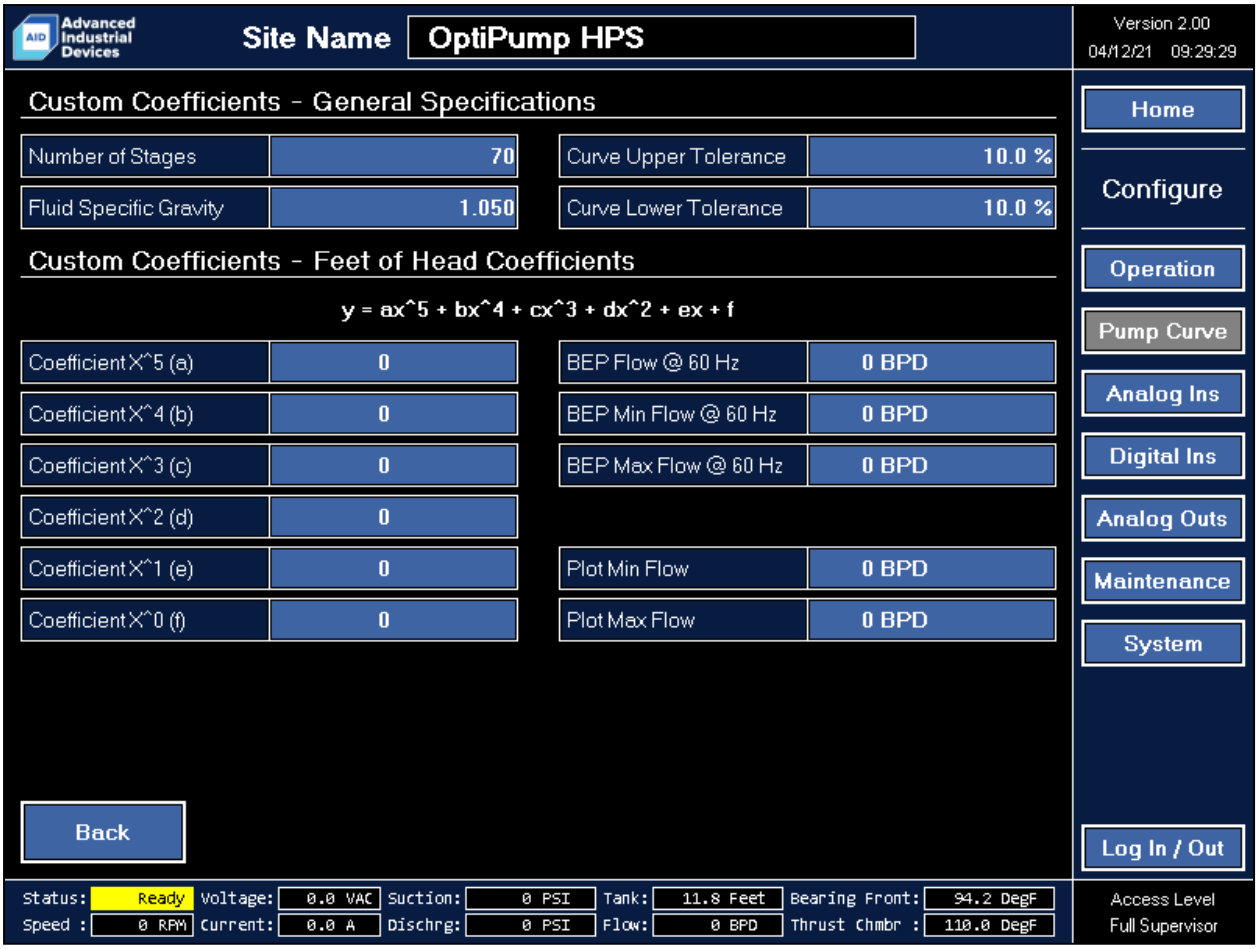
1. Custom Coefficients
   For the more advanced operator, the pump curve can be defined using the coefficients for the pump curve equation, as well as setting the best operating point.

2. Custom 7-Point
   The 7-point profile approximates the pump curve using 7 points. While simpler to understand than the custom coefficients profile, more parameters are required to define the approximate pump curve. The OptiPump HPS controller, however, helps simplify the process by automatically generating many of the parameters required to define the Tornado Plot bounds.

Custom Coefficients

Configuration parameters related to the Custom Coefficients Pump Curve Profile are available in:

Configure > Pump Curve > Custom Coefficients



When pump stages or pumps with known curve coefficients are used, the Custom Coefficients profile can provide more control over the process than a typical point approximation curve. However, the stage or pump coefficients must be known and entered manually. If the coefficients are unavailable, try requesting the specifications and factory test sheets for the pump, which may provide the information.

Custom Coefficients - General Specifications > Number of Stages

The number of the stages used in main pump.

Custom Coefficients - General Specifications > Fluid Specific Gravity

Enter the approximate specific gravity of the fluid being moved by the main pump.

Custom Coefficients - General Specifications > Curve Upper Tolerance

The upper tolerance defines the upper pump curve limit as a percentage of the current output frequency. The upper tolerance pump curve is calculated using the affinity laws to scale the 60 Hz pump curve to a faster speed. The up-scaled pump curve is then used to determine the upper limit discharge pressure based on the measured flow. If the measured discharge pressure exceeds the calculated upper limit, the main pump is considered to be running out-of-curve.

Custom Coefficients - General Specifications > Curve Lower Tolerance

The lower tolerance defines the lower pump curve limit as a percentage of the current output frequency. The lower tolerance pump curve is calculated using the affinity laws to scale the 60 Hz pump curve to a slower speed. The down-scaled pump curve is then used to determine the lower limit discharge pressure based on the measured flow. If the measured discharge pressure exceeds (goes below) the calculated lower limit, the main pump is considered to be running out-of-curve.

Custom Coefficients - Feet of Head Coefficients > Coefficient X...

Enter the feet of head (pressure) coefficients for a single pump curve stage. If the coefficients are provided for the overall pump, rather than a single stage within the pump, enter the coefficients, then a value of 1 for the Number of Stages configuration parameter.

Custom Coefficients - Feet of Head Coefficients > BEP Flow @ 60 Hz

Enter the best efficiency point (BEP) flow at 60 Hz for the main pump.

Custom Coefficients - Feet of Head Coefficients > BEP Minimum Flow @ 60 Hz

Enter the best efficiency point (BEP) minimum flow at 60 Hz for the main pump. The BEP minimum flow point is used to create the upper boundary of the Tornado Plot funnel.

Custom Coefficients - Feet of Head Coefficients > BEP Maximum Flow @ 60 Hz

Enter the best efficiency point (BEP) maximum flow at 60 Hz for the main pump. The BEP maximum flow point is used to create the lower boundary of the Tornado Plot funnel.

Custom Coefficients - Feet of Head Coefficients > Plot Minimum Flow

Occasionally, the pump curve coefficients do not accurately reflect performance outside a set range of flow rates. The Plot Minimum Flow value sets the minimum flow rate to use when plotting the pump curve and Tornado Plot. The minimum value is often 0 BPD, and a good starting point if the value is unknown.

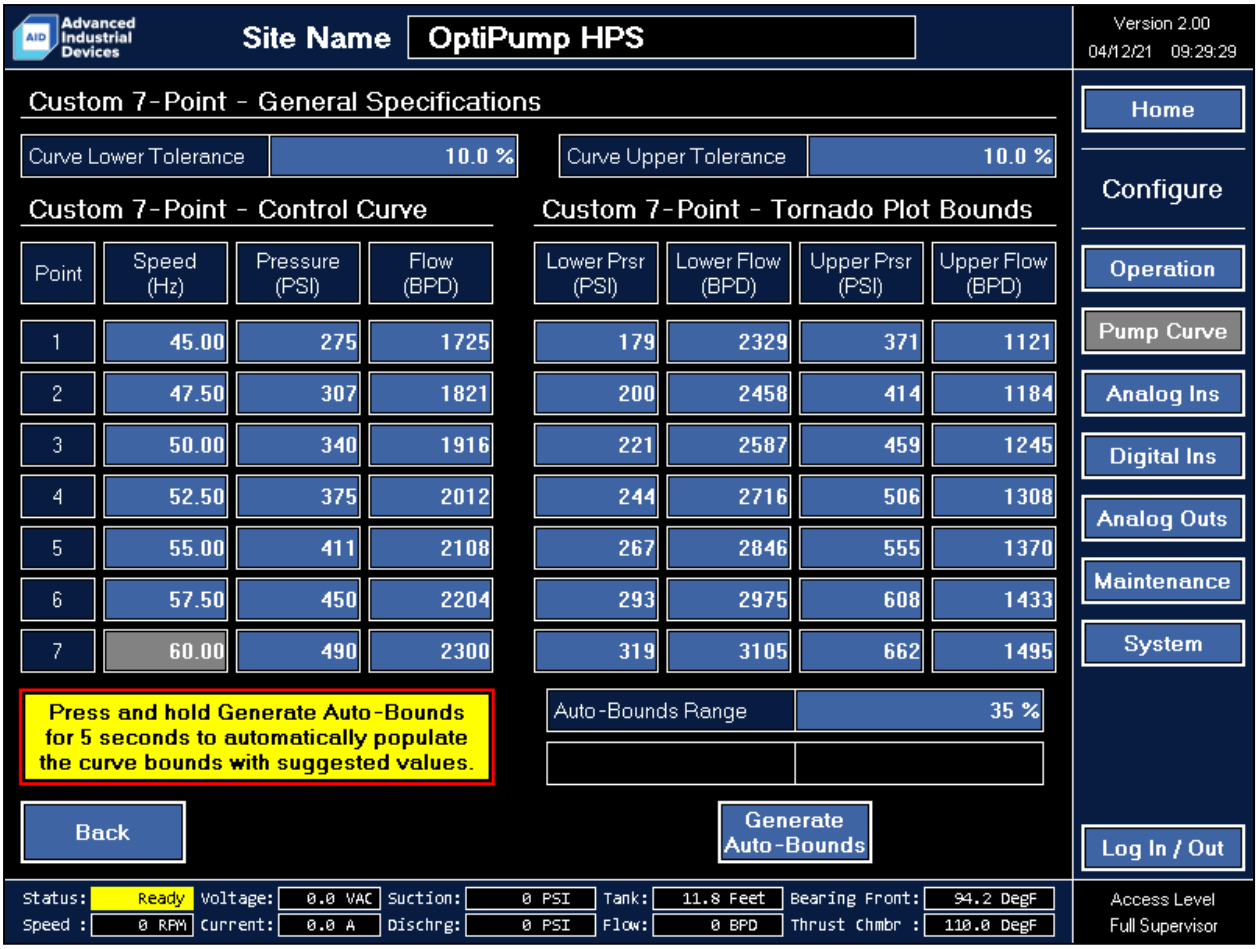
Custom Coefficients - Feet of Head Coefficients > Plot Maximum Flow

Occasionally, the pump curve coefficients do not accurately reflect performance outside a set range of flow rates. The Plot Maximum Flow value sets the maximum flow rate to use when plotting the pump curve and Tornado Plot. Unfortunately, no common maximum flow rate value exists, so using slightly more than the BEP Maximum Flow @ 60 Hz value can be a good starting point if the value is unknown.

Custom 7-Point

Configuration parameters related to the Custom 7-Point Pump Curve Profile are available in:

Configure > Pump Curve > Custom 7-Point



When detailed information about the main pump is unavailable, or the main pump has become worn, the Custom 7-Point profile can be used to approximate the performance curve. The profile uses 7 operator-defined points at increasing speeds to set the flow and pressure along the best efficiency curve. Since each point can be individually set by the operator, performance can be tailored for the characteristics of the equipment at the site. The boundaries of the Tornado Plot can also be operator-defined, though the numerous values that are required can be tedious to enter. The OptiPump HPS controller includes a feature to automatically set the Tornado Plot boundaries to simplify the process and provide good starting points for customization.

Custom 7-Point - General Specifications > Curve Lower Tolerance

The lower tolerance defines the lower pump curve limit as a percentage of the current output frequency. The lower tolerance pump curve is calculated using the affinity laws to scale the 60 Hz pump curve to a slower speed. The down-scaled pump curve is then used to determine the lower limit discharge pressure based on the

measured flow. If the measured discharge pressure exceeds (goes below) the calculated lower limit, the main pump is considered to be running out-of-curve.

Custom 7-Point - General Specifications > Curve Upper Tolerance

The upper tolerance defines the upper pump curve limit as a percentage of the current output frequency. The upper tolerance pump curve is calculated using the affinity laws to scale the 60 Hz pump curve to a faster speed. The up-scaled pump curve is then used to determine the upper limit discharge pressure based on the measured flow. If the measured discharge pressure exceeds the calculated upper limit, the main pump is considered to be running out-of-curve.

Custom 7-Point - Control Curve > Points

Enter the desired speed for Points 1 through 6, and the associated target discharge pressure and flow rate associated with each speed. Point 7 is fixed at 60 Hz, so refer to the pump datasheet, if available, for the best efficiency point (BEP) at 60 Hz values.

Custom 7-Point - Tornado Plot Bounds > Points

The points defined for the Tornado Plot bounds define the upper and lower boundaries of the tornado funnel. Due to the large number of configuration parameters associated with these points, the Generate Auto-Bounds feature is highly recommended.

Custom 7-Point - Tornado Plot Bounds > Auto-Bounds Range

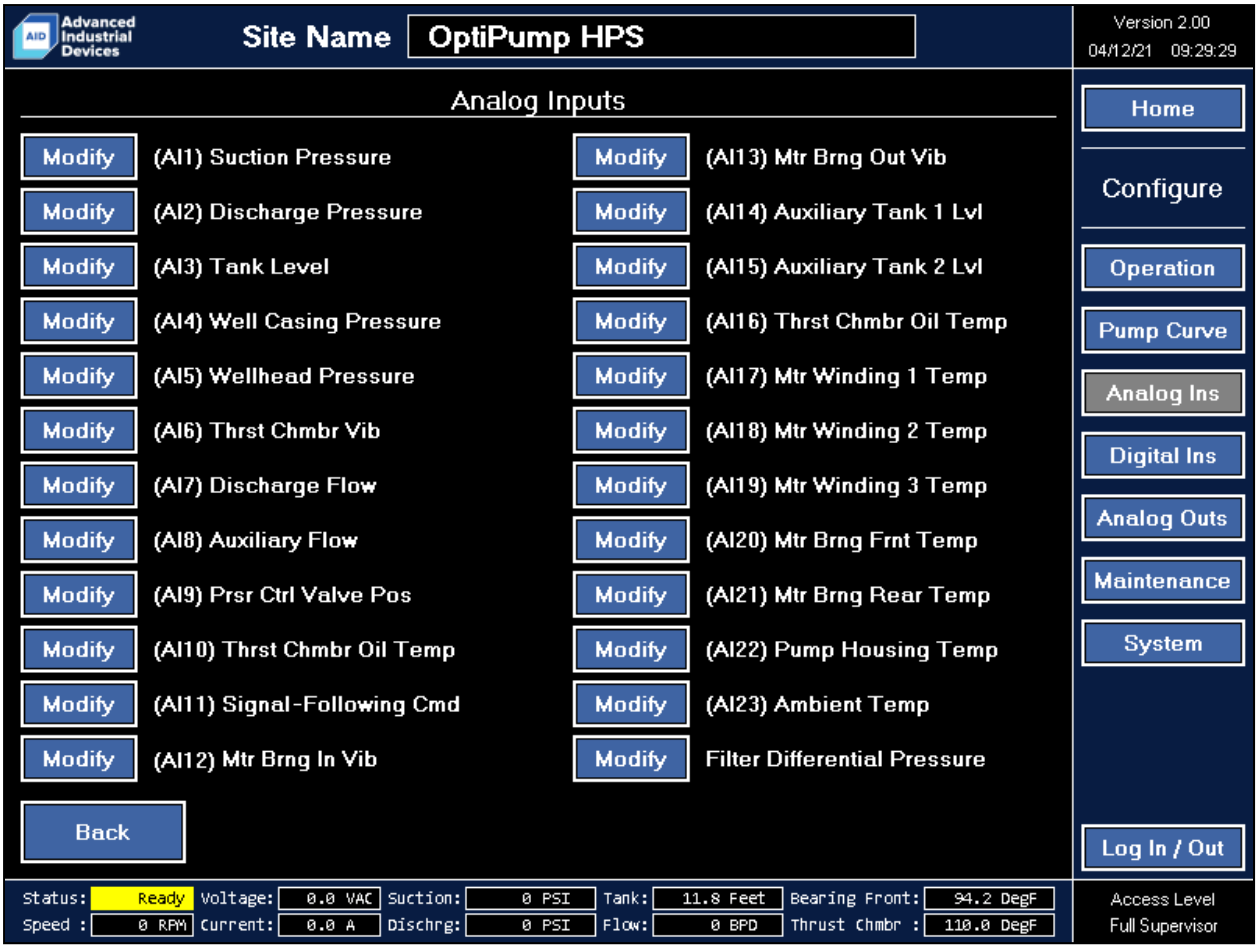
The large number of configurable parameters associated with the Tornado Plot bounds can be tedious to configure by hand through some trial and error. The OptiPump HPS controller can automatically generate typical Tornado Plot bounds using the Generate Auto-Bounds feature. The Auto-Bounds Range sets the percent tolerance around the Control Curve Points for the pressure and flow values.

To use the Generate Auto-Bounds feature, enter a value for Auto-Bounds Range (the smaller the value, the narrower the Tornado Plot funnel), then press and hold the Generate Auto-Bounds button for 5 seconds. When the Generate-Auto Bounds button is pressed, a countdown timer will appear and the controller will begin calculating the points. When the timer reaches zero and the green status "Done" appears, the process is complete. To see the newly generated pump curve with Tornado Plot bounds, press the Back button to return the Pump Curve screen.

Analog Inputs

Configuration parameters related to the analog inputs are available in:

Configure > Analog Ins



Analog inputs available to the operator include:

- 13 4-20 mA
- 1 J-Type Thermocouple
- 8 100-Ohm Platinum RTD (α=0.0385)

The analog inputs are connected to 5 different controller I/O modules. I/O module wiring is indicated for each individual input on subsequent pages.

Note:
When installed in a panel provided by Advanced Industrial Devices, the analog and digital inputs and outputs may be prewired to terminals mounted inside the panel or in a field device wiring hip-box. In this case, please refer to the wiring diagram included with the panel for field device connection locations.

The analog inputs for the OptiPump HPS controller are designed to be highly flexible and customizable by the operator to meet the needs of a site without requiring custom firmware. Several analog inputs have a dedicated function, as well as fixed units. However, in general, the names and units of most of the analog inputs are customizable by the operator. For analog inputs that have a fixed function or other fixed parameters, a note will appear on the configuration screen informing the operator of the options available.

Scale Minimum, Scale Maximum, Units

The operator can configure the analog input minimum and maximum scaling of the sensor. In addition the setting can be made for the system to shut down or ignore a sensor failure.

The math conversion for the units is not automatically performed for the operator and any conversions required to change the units from the sensor to match the units on the screen must be done by the operator and input on the settings screen for that analog input.

Example: 1 PSI = 2.31 Feet, so if a 0-10 PSI sensor is being used for a tank level measurement, then the minimum sensor range would be 0 and the maximum sensor range would be 10 x 2.31 = 23.1 Feet.

Reactions

All 4 setpoint reactions can be individually configured as one of the following:

- Disabled (1/3)
  The setpoint value will be ignored.

- Alarm (2/3)
  An alarm event will be indicated, but the system will continue to run.

- Shutdown (3/3)
  A shutdown event will be triggered, and the system will stop after following the Post-Run sequence.

Setpoints

There are four setpoints available for this analog input and they are:

- High-High Setpoint
- High Setpoint
- Low Setpoint
- Low-Low Setpoint

Start Delay

Is a setting that the system will wait for the unit to be running and then after a run condition has been met will wait for the timer to run out before ever looking for an alarm/shutdown condition on that analog input. Once the start delay time is complete it will not be used again until the next system start.

Detection Delay

After the start delay is complete the system will then look at the detection delay. If an Alarm/Shutdown condition is held for the amount of time in this setting then the system will either alarm or shutdown.

Restart Type

- Manual (1/2)
  If on shutdown the operator wants the system to require a positive action to force a reset then a manual restart is what is needed.

- Timed (2/2)
  If the operator wants the shutdown to automatically reset itself when/if the shutdown condition clears then set an automatic reset and set an appropriate restart delay.

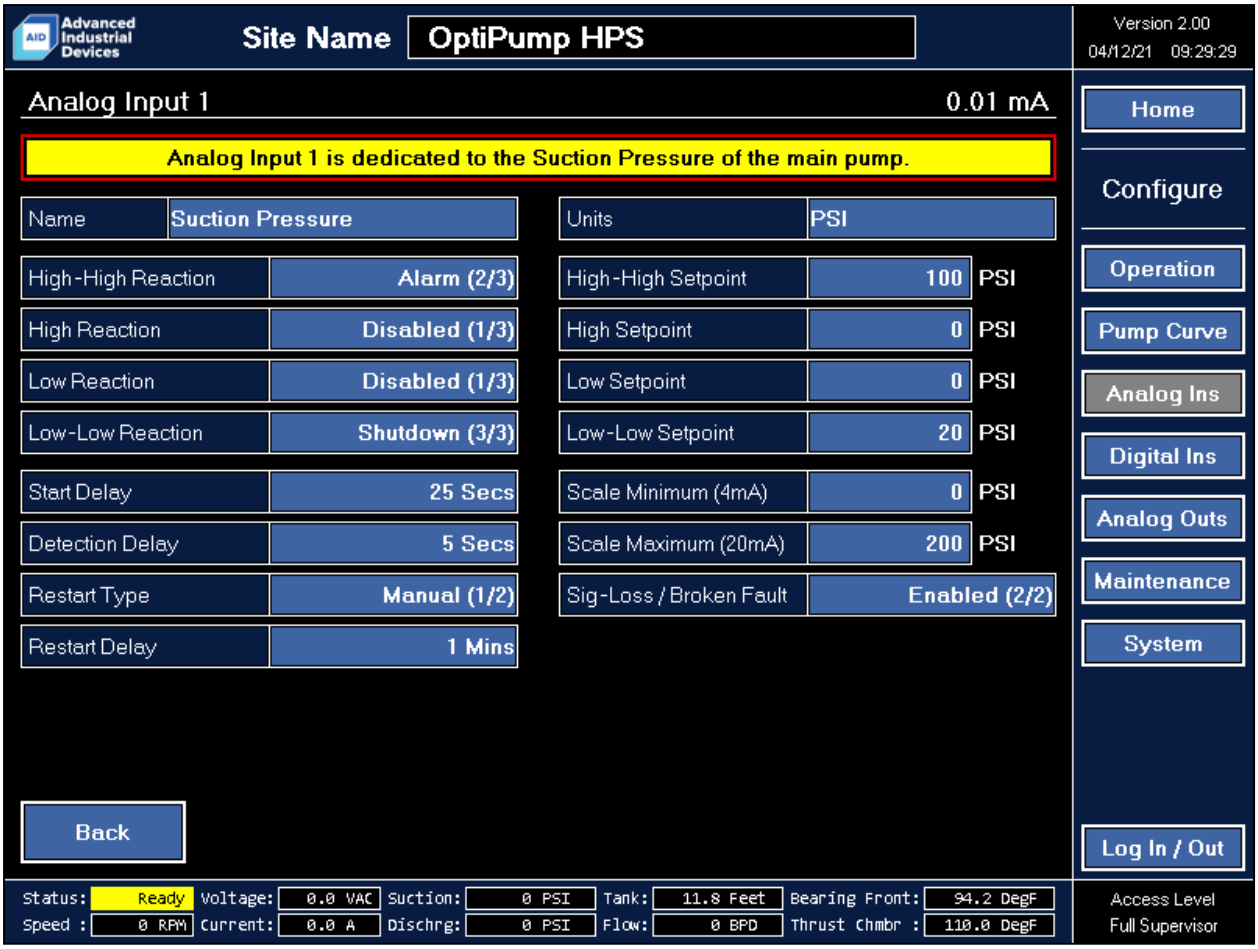
Restart Delay

When a shutdown event occurs, and is configured for a timed restart, the shutdown event will automatically reset after this delay has expired.

(AI1) Suction Pressure

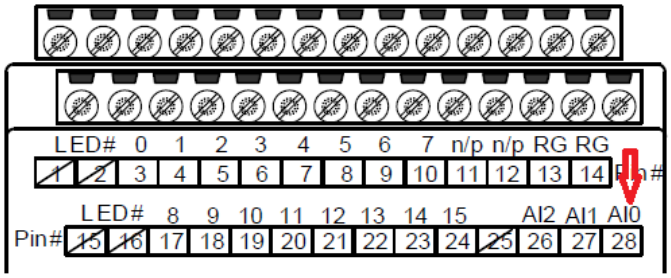
Configuration parameters related to Analog Input 1 are available in:

Configure > Analog Ins > Analog Input 1



The function of Analog Input 1 is dedicated to the suction pressure of the main pump. Both the name and units can be modified by the operator.

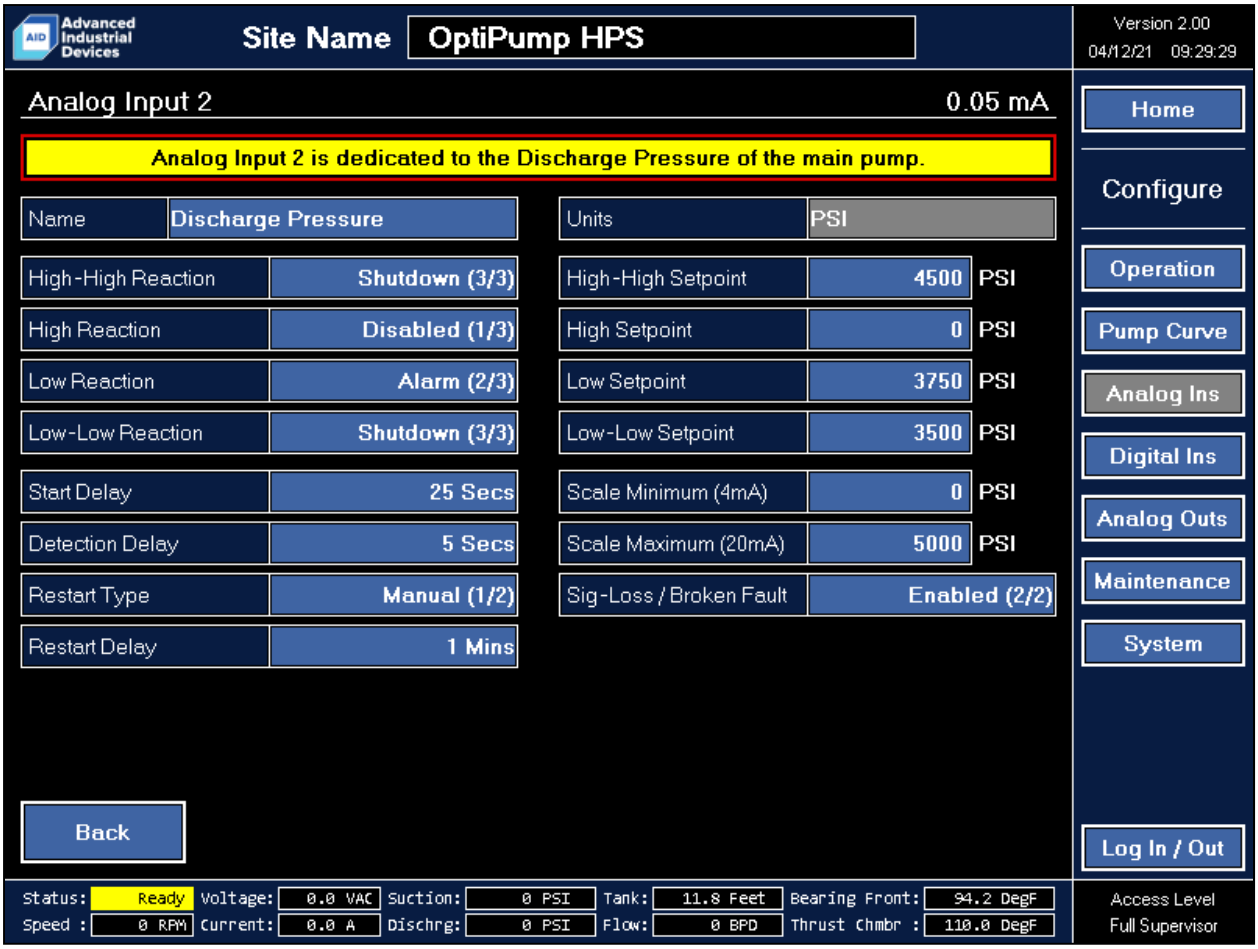
The 4-20ma signal is connected to terminal AI0 on the I/O module labeled IO-D16A3-TO16.



(AI2) Discharge Pressure

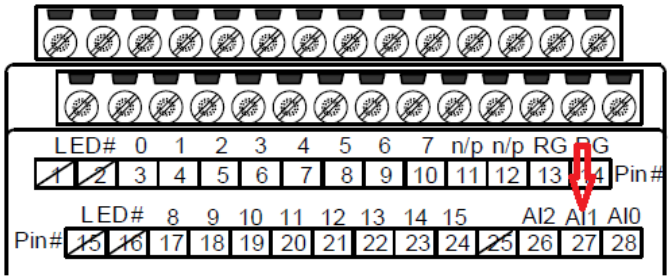
Configuration parameters related to Analog Input 2 are available in:

Configure > Analog Ins > Analog Input 2



The function of Analog Input 2 is dedicated to the discharge pressure of the main pump. The name can be modified by the operator, but the units are fixed and must be scaled in PSI.

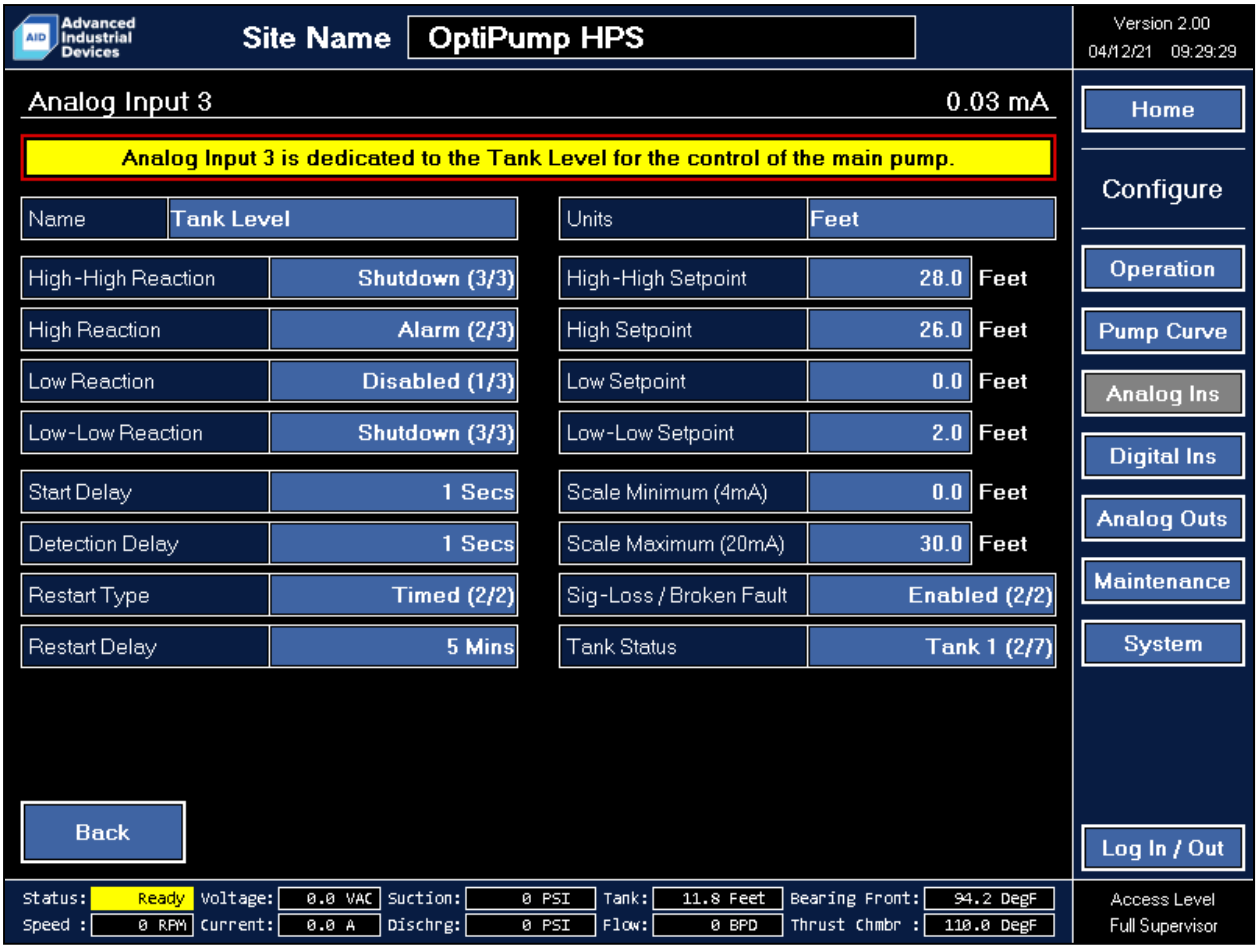
The 4-20ma signal is connected to terminal AI1 on the I/O module labeled IO-D16A3-TO16.



(AI3) Tank Level

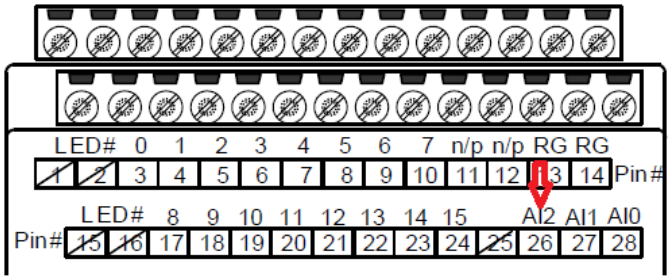
Configuration parameters related to Analog Input 3 are available in:

Configure > Analog Ins > Analog Input 3



The function of Analog Input 3 is dedicated to the tank level that can control both the start/stop and speed of the main pump. The name can be modified by the operator, as well as the units.

The 4-20ma signal is connected to terminal AI2 on the I/O module labeled IO-D16A3-TO16.



Analog Input 3 > Tank Status

Analog Input 3 can be assigned to any of the 6 tanks shown on the Tanks status screen. If Tank Status is set to Disabled, Analog Input 3 will not be assigned to any of the tanks on the Tanks status screen, but will still be shown as the main tank on the Home screen.

When assigning analog inputs to tanks on the Tanks status screen, be sure to assign only ONE analog input per tank.

- Disabled (1/7)
  Analog Input 3 will not be shown on the Tanks status screen, but will still be shown as the main tank on the Home screen.

- Tank 1 (2/7)
  Analog Input 3 will be shown as Tank 1 on the Tanks status screen.

- Tank 2 (3/7)
  Analog Input 3 will be shown as Tank 2 on the Tanks status screen.

- Tank 3 (4/7)
  Analog Input 3 will be shown as Tank 3 on the Tanks status screen.

- Tank 4 (5/7)
  Analog Input 3 will be shown as Tank 4 on the Tanks status screen.

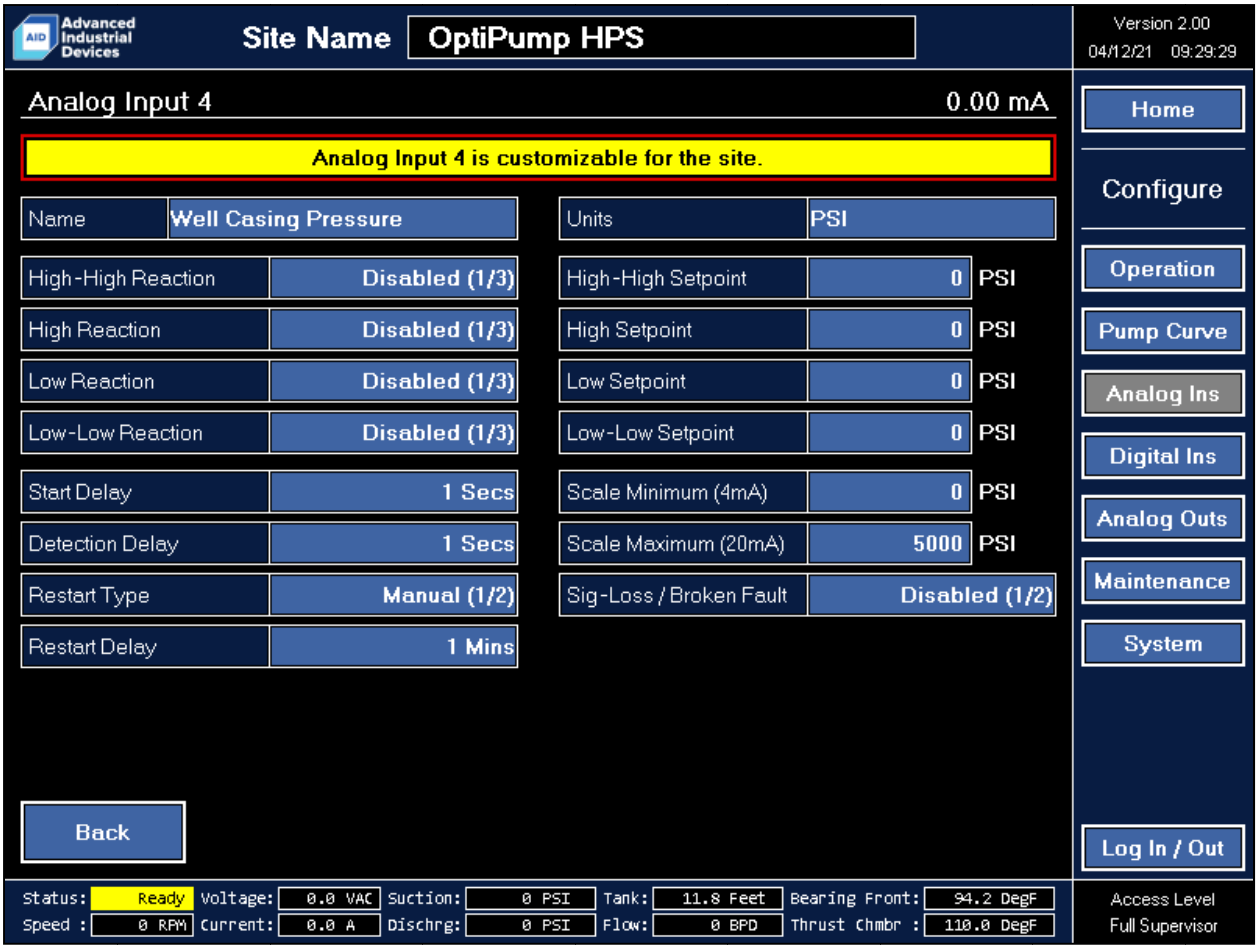
- Tank 5 (6/7)
  Analog Input 3 will be shown as Tank 5 on the Tanks status screen.

- Tank 6 (7/7)
  Analog Input 3 will be shown as Tank 6 on the Tanks status screen.

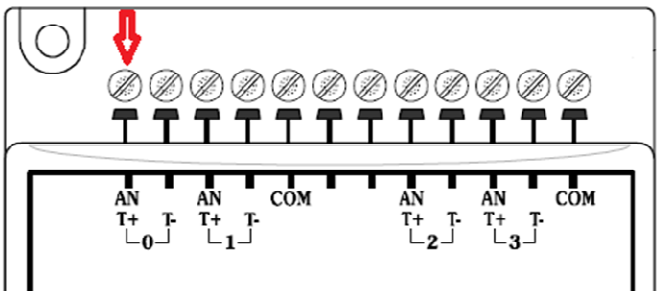
(AI4) Well Casing Pressure

Configuration parameters related to Analog Input 4 are available in:

Configure > Analog Ins > Analog Input 4



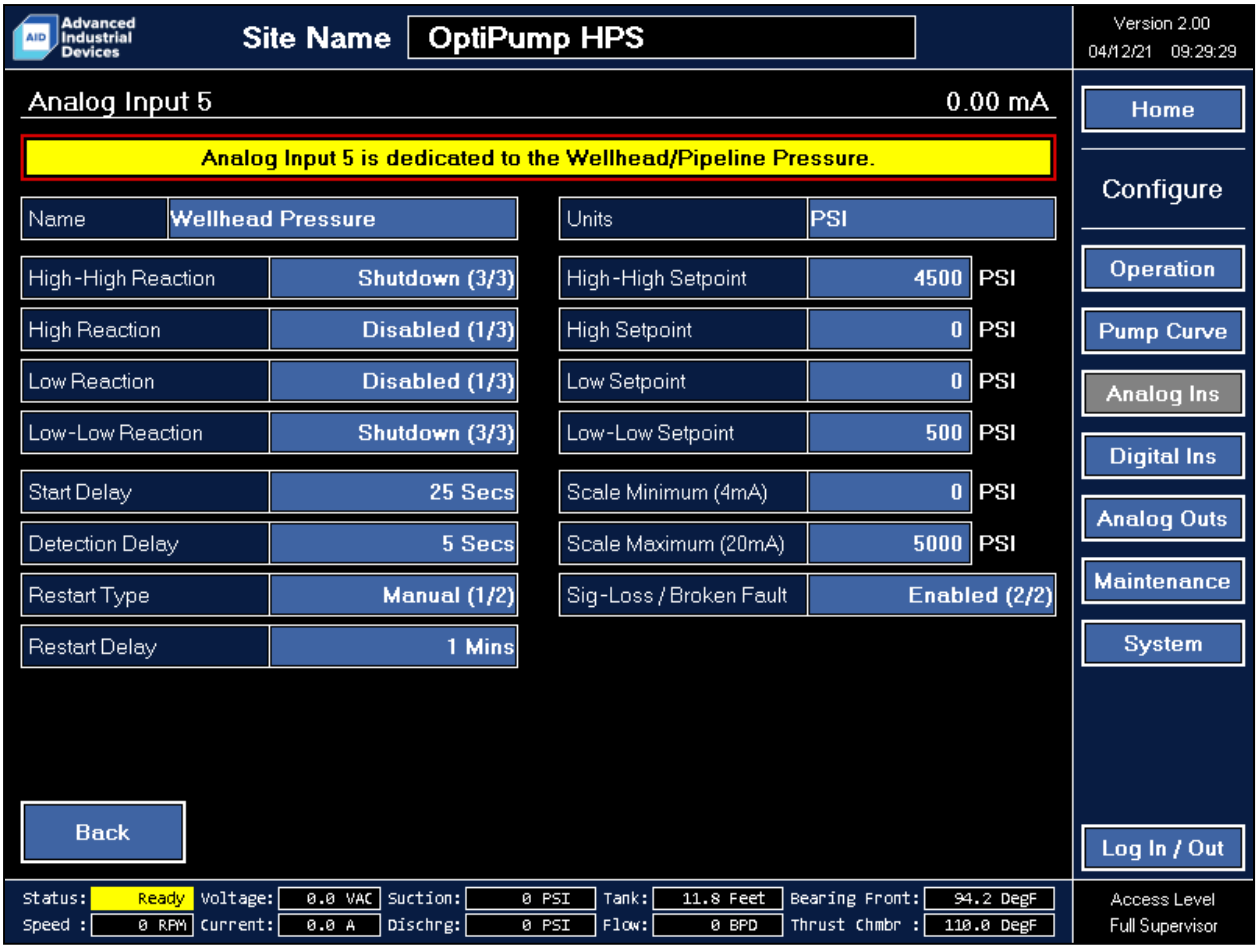
The 4-20ma signal is connected to terminal T+/AN of group 0 on the I/O module labeled IO-ATC8.



(AI5) Wellhead Pressure

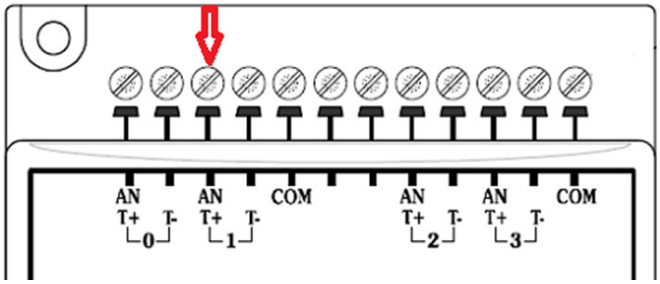
Configuration parameters related to Analog Input 5 are available in:

Configure > Analog Ins > Analog Input 5



The function of Analog Input 5 is dedicated to the wellhead/pipeline pressure, as show on the flow diagram on the Home screen. The name can be modified by the operator, as well as the units.

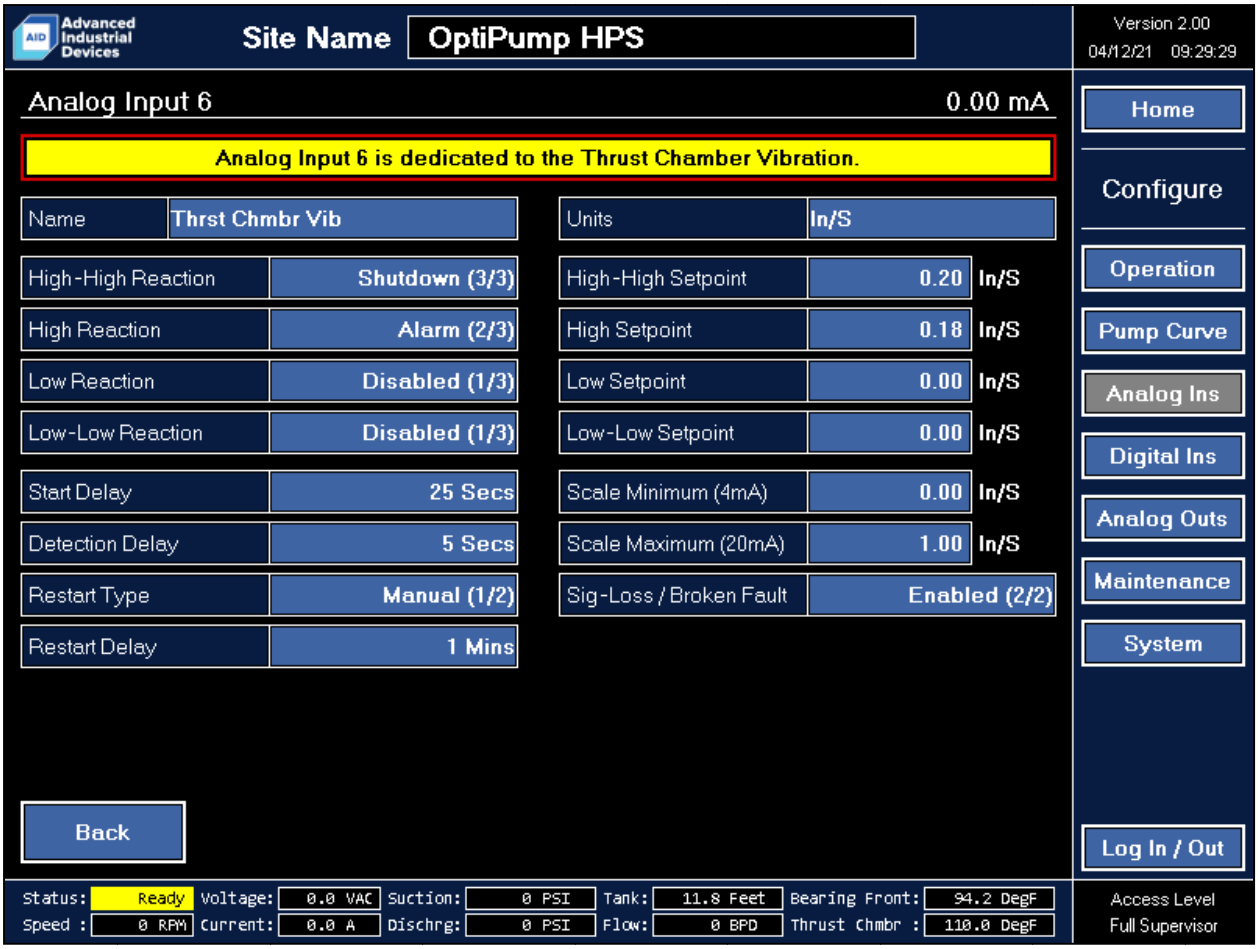
The 4-20ma signal is connected to terminal T+/AN of group 1 on the I/O module labeled IO-ATC8.



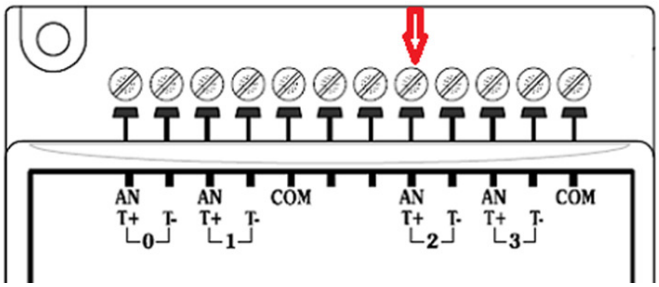
(AI6) Thrst Chmbr Vib

Configuration parameters related to Analog Input 6 are available in:

Configure > Analog Ins > Analog Input 6



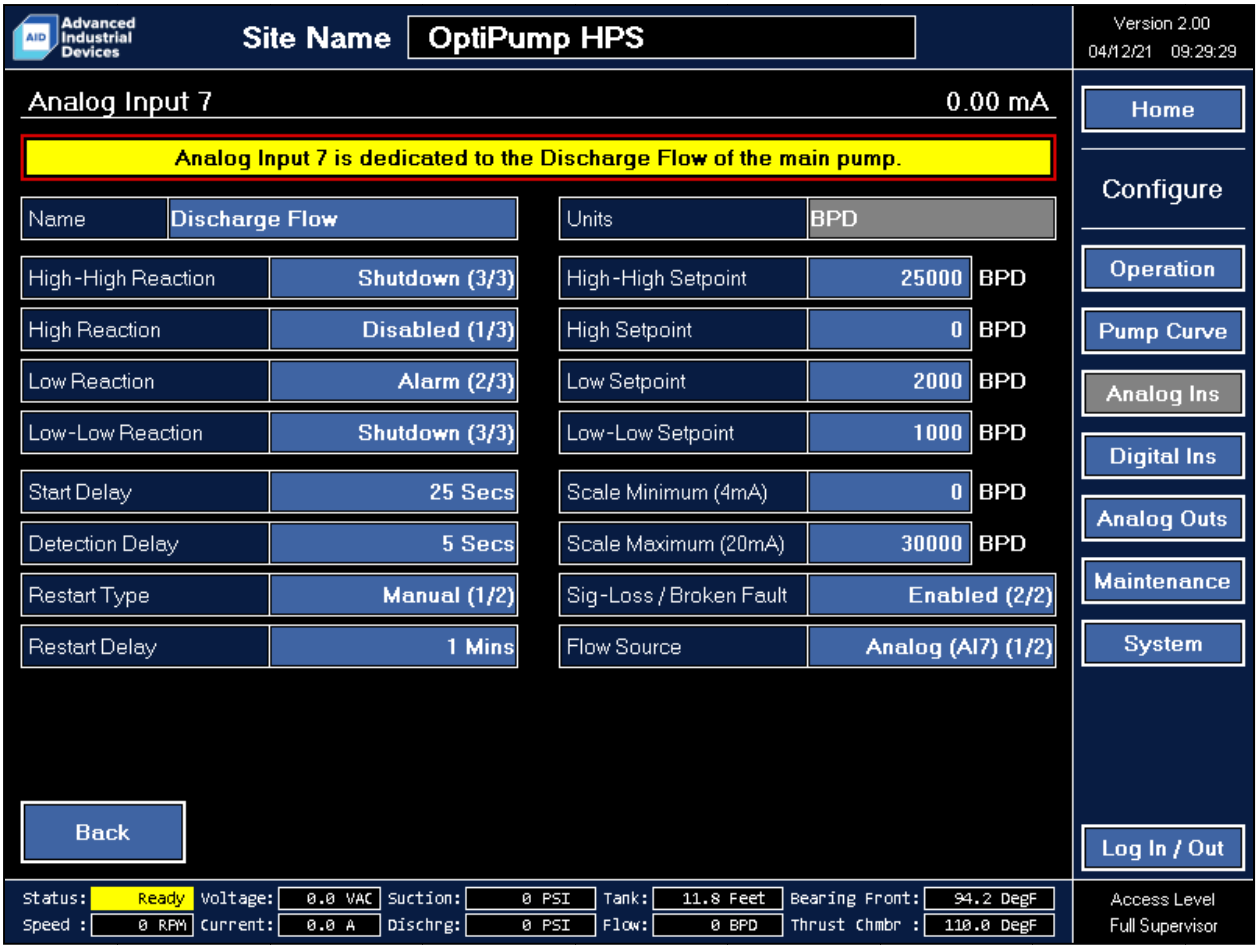
The 4-20ma signal is connected to terminal T+/AN of group 2 on the I/O module labeled IO-ATC8.



(AI7) Discharge Flow

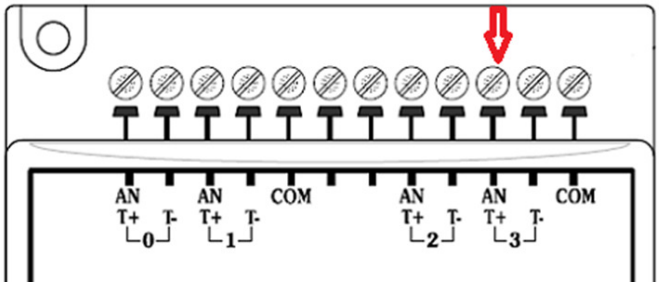
Configuration parameters related to Analog Input 7 are available in:

Configure > Analog Ins > Analog Input 7



The function of Analog Input 7 is dedicated to the discharge flow rate of the main pump. The name can be modified by the operator. However, the units are fixed in barrels per day (BPD), as required for the automatic operation of the pressure control valve and pump curve.

The 4-20ma signal is connected to terminal T+/AN of group 3 on the I/O module labeled IO-ATC8.



Analog Input 7 > Flow Source

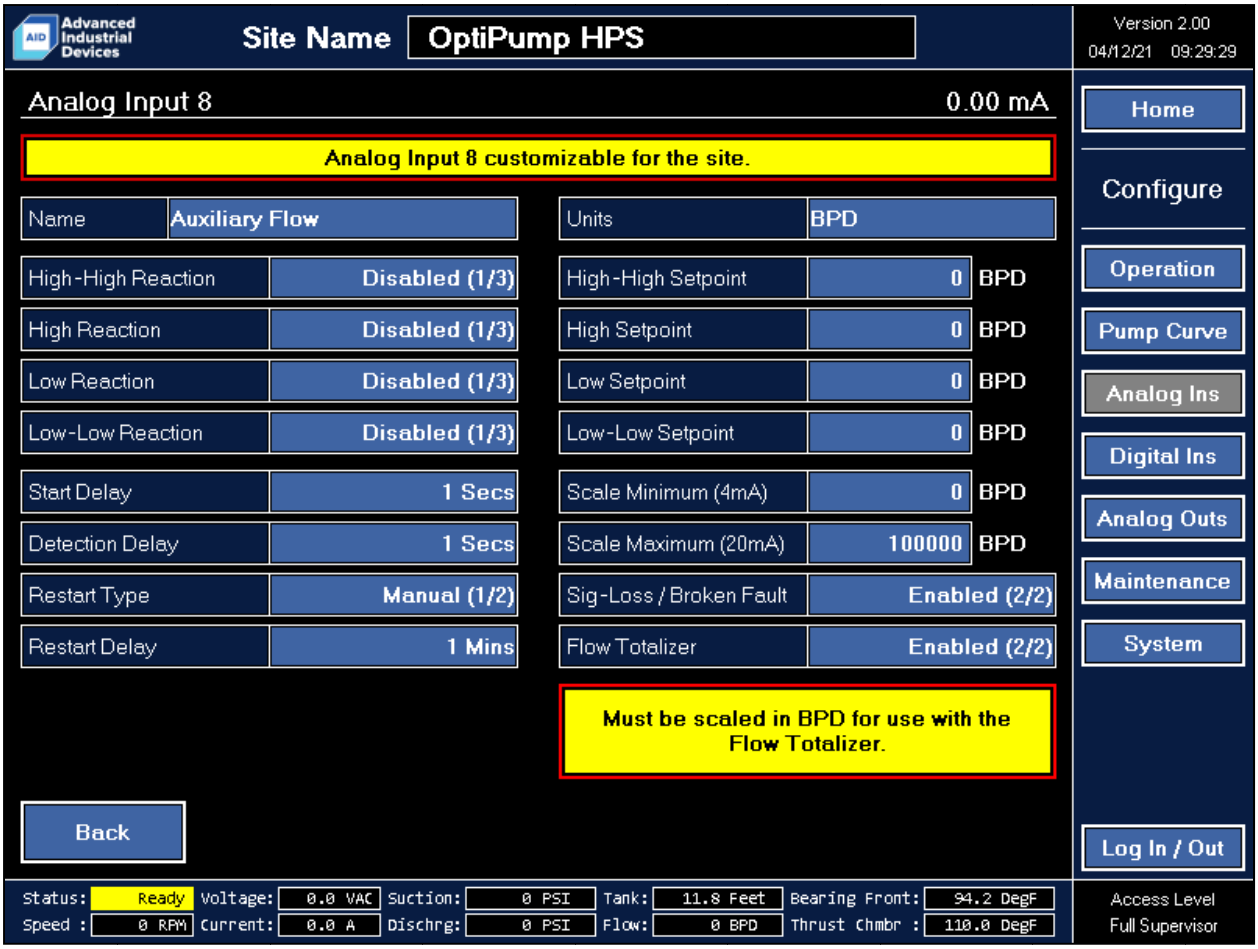
- Analog (AI7) (1/2)
  If a flow meter is installed, Analog Input 7 will be used to measure the flow rate. The Scale Minimum and Scale Maximum parameters must be configured.

- Calculated (2/2)
  If a flow meter is NOT installed, a calculated value for the estimated flow rate will be used. The calculated flow rate is based on the pump curve configured in **Configure > Pump Curve**. When set to Calculated, the Scale Minimum and Scale Maximum parameters do NOT affect the value, and are not required to be set.

(AI8) Auxiliary Flow

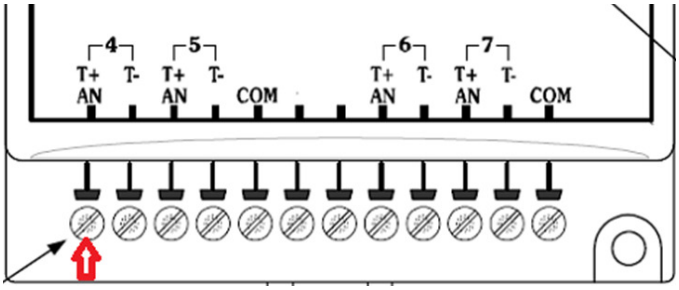
Configuration parameters related to Analog Input 8 are available in:

Configure > Analog Ins > Analog Input 8



The function of Analog Input 8 is not dedicated, but does support an additional parameter and expanded scaling, as compared to the other analog inputs, that allows for the use for a second, auxiliary flow meter.

The 4-20ma signal is connected to terminal T+/AN of group 4 on the I/O module labeled IO-ATC8.



Analog Input 8 > Flow Totalizer

When used as a flow input, the flow may optionally be totalized, similar to (AI7) Discharge Flow. When the totalizing feature is enabled, barrels per day (BPD) are the recommended units.

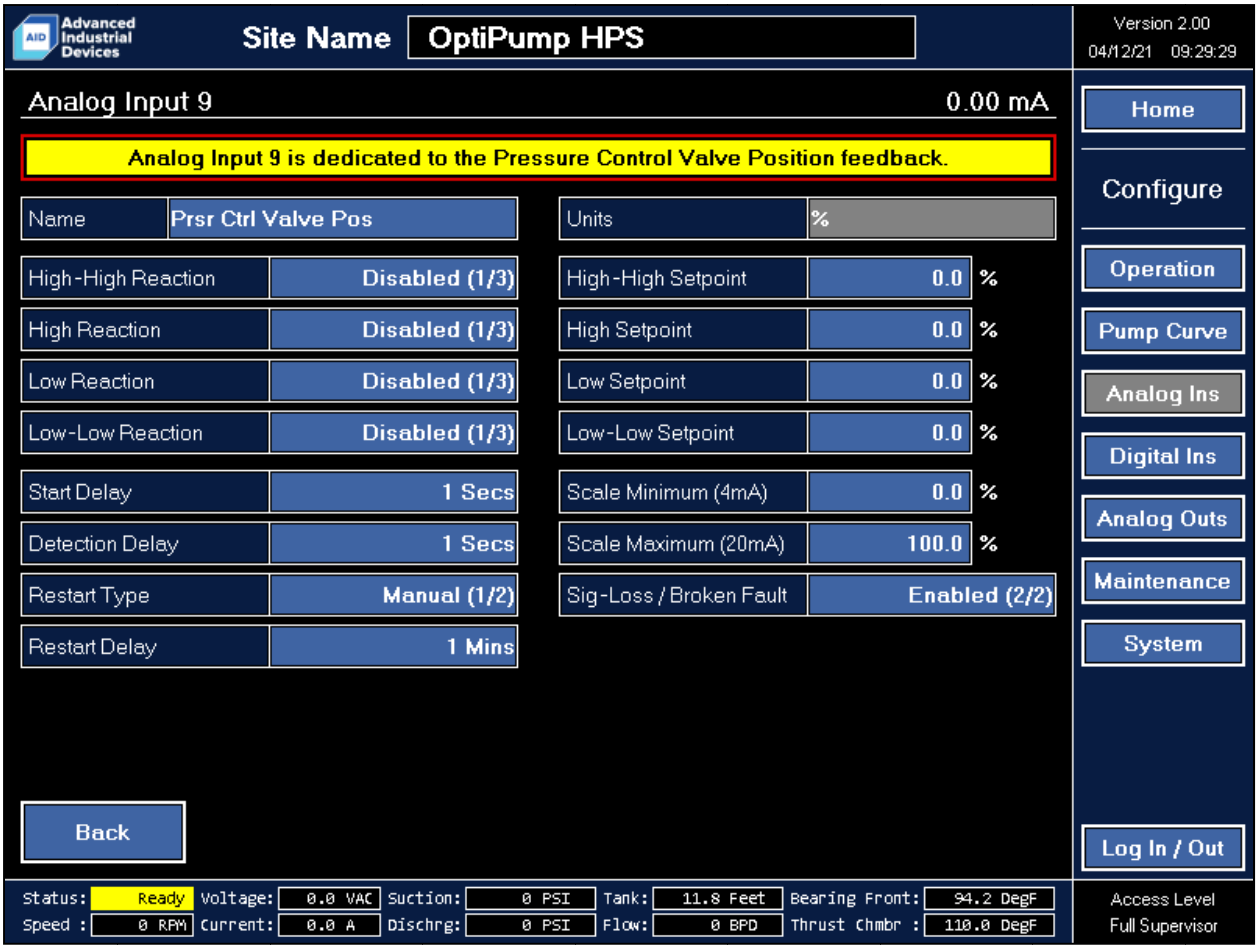
- Disabled (1/2)
  The flow totalizer is not used, and will be hidden on the Metrics Overview screen.

- Enabled (2/2)
  The flow totalizer will accumulate and track the total flow for the current and previous days, and will be shown on the Metrics Overview screen.

(AI9) Prsr Ctrl Valve Pos

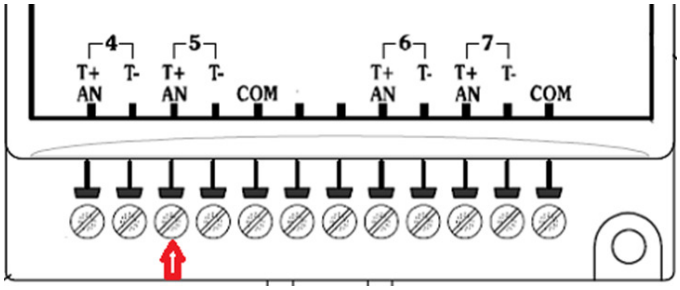
Configuration parameters related to Analog Input 9 are available in:

Configure > Analog Ins > Analog Input 9



The function of Analog Input 9 is dedicated to the feedback of the pressure control valve position. The name can be modified by the operator, but the units are fixed and must be scaled in percent.

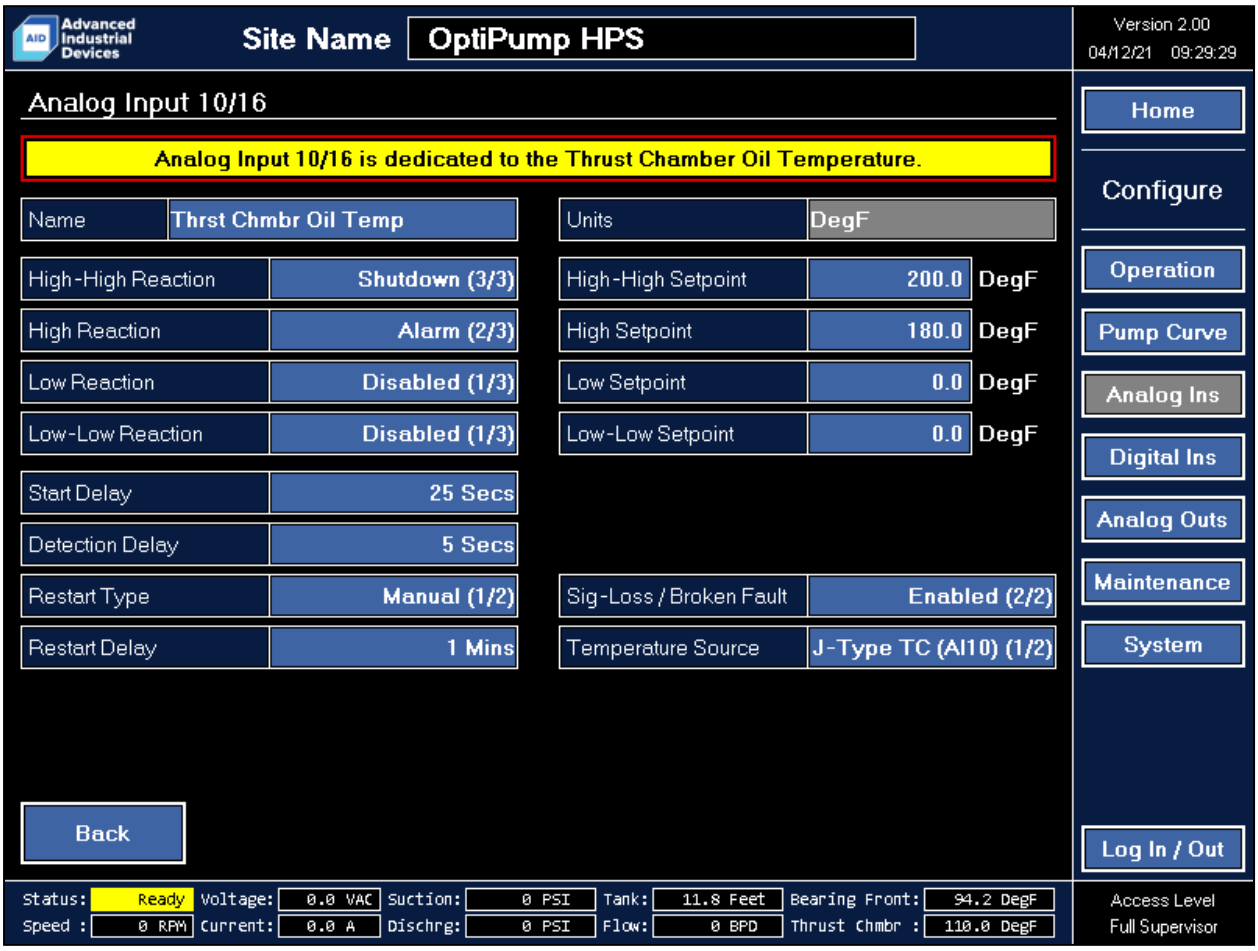
The 4-20ma signal is connected to terminal T+/AN of group 5 on the I/O module labeled IO-ATC8.



(AI10/16) Thrst Chmbr Oil Temp

Configuration parameters related to Analog Input 10 (J-Type Thermocouple) and Analog Input 16 (RTD) are available in:

Configure > Analog Ins > Analog Input 10/16



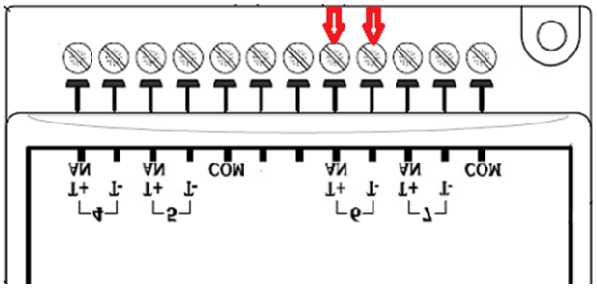
The function of Analog Input 10 and Analog Input 16 are both dedicated to the thrust chamber oil temperature. The name can be modified by the operator, but the units are fixed in degrees Fahrenheit. However, only one of these analog inputs may be used at a time. Analog Input 10 is used when a J-type thermocouple is used to measure the thrust chamber oil temperature. Analog Input 16 is used when a RTD is used to measure the thrust chamber oil temperature.

Pressing the Modify button on the **Configure > Analog Ins** screen for either Analog Input 10 or Analog Input 16 will load the same configuration page shown above.

Analog Input 10/16 > Temperature Source

Analog Input 10 and Analog Input 16 have the same purpose, but use two different temperature sensing types. The operator must select the sensor type installed.

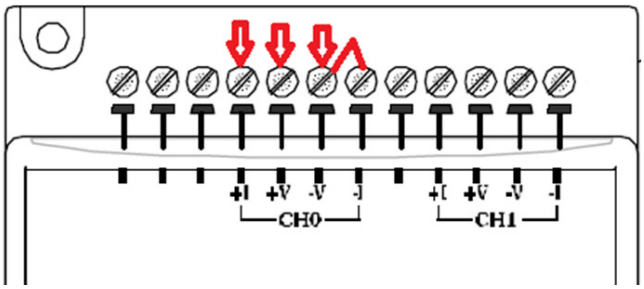
- J-Type TC (AI10) (1/2)
  The thermocouple is connected to the I/O module labeled IO-ATC8. The red, insulated thermocouple wire is connected to terminal T-. The white thermocouple wire is connected to terminal T+.



- RTD (AI16) (2/2)
  If the operator selects the use of a **100 ohm platinum RTD,** with alpha = 0.0385, the sensor connection will **NOT USE I/O module labeled IO-ATC8**. The sensor will connect instead to the first of the IO-PT400 modules in the string of controller modules in group CH0. A 100 ohm RTD will have either 3 or 4 wires to connect depending on the make and model. If the RTD does not have 3 or 4 wires, the sensor is likely NOT a 100 ohm RTD or a RTD to 4-20ma converter is installed in the temperature sensor and cannot be connected to either location shown here.

  For a 3-wire, 100 ohm RTD connection, the two white wires connect to terminal I+ and V+ and the red wire connects to terminal V- with a jumper wire connecting terminals V- and I-. For a 4-wire, 100 ohm RTD connection, the two white wires connect to terminals I+ and V+ and the two red wires connect to terminals V- and I-.

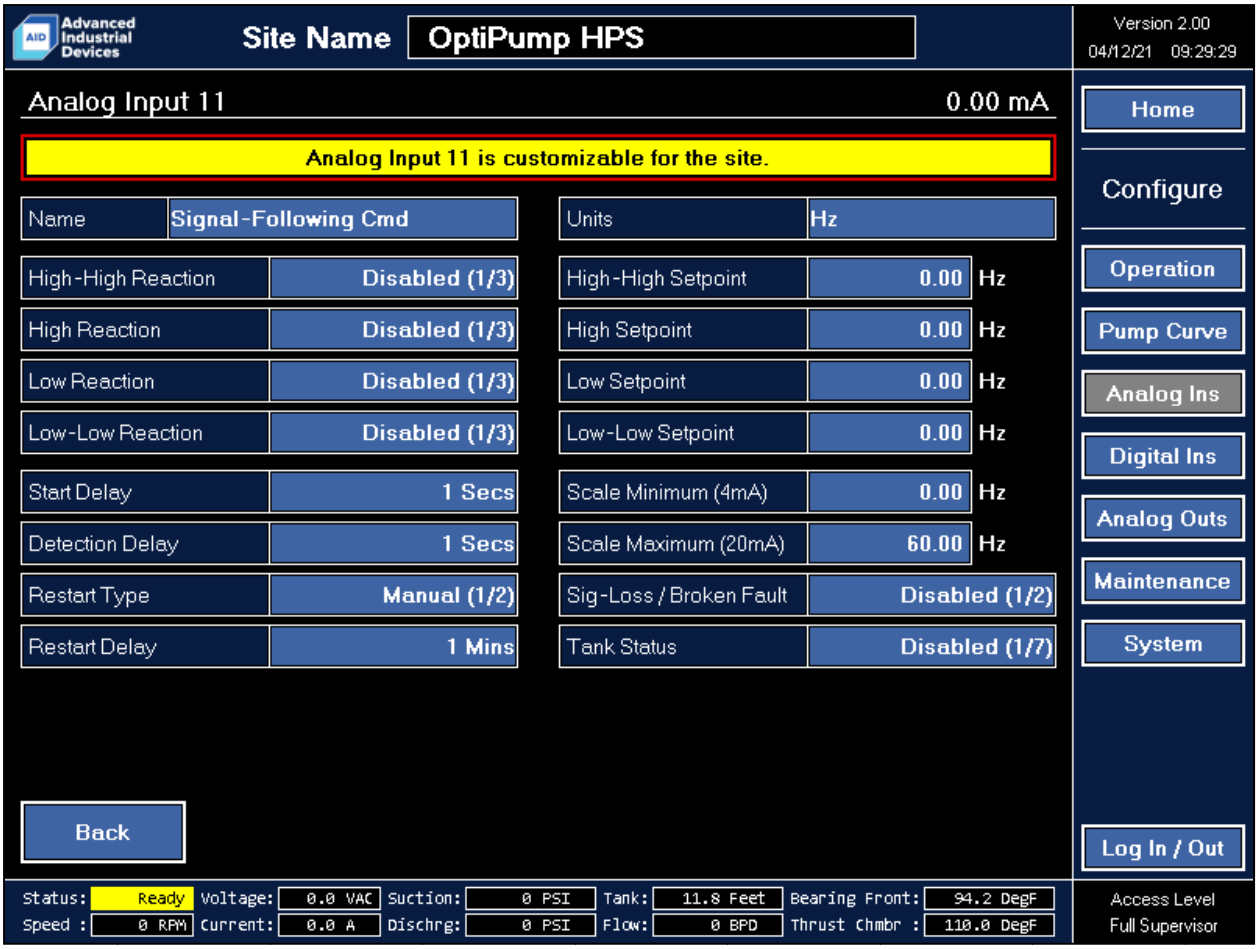
  A typical 3-wire, 100 ohm RTD connection is shown below.



(AI11) Signal-Following Cmd

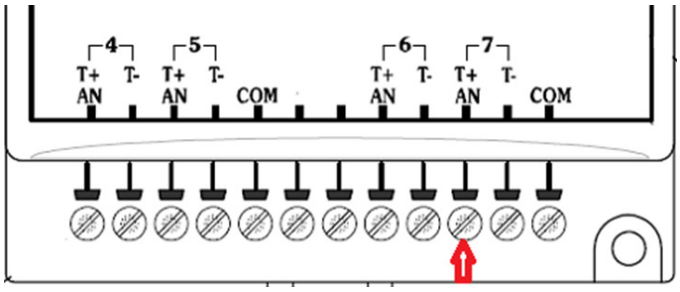
Configuration parameters related to Analog Input 11 are available in:

Configure > Analog Ins > Analog Input 11



The function of Analog Input 11 is not dedicated, but can be used as an external speed command. For example, Analog Input 11 can be used to receive a speed command from another site controller. The name can be modified by the operator, as well as the units.

The 4-20ma signal is connected to terminal T+/AN of group 7 on the I/O module labeled IO-ATC8.



Analog Input 11 > Tank Status

Analog Input 11 can be assigned to any of the 6 tanks shown on the Tanks status screen. If Tank Status is set to Disabled, Analog Input 11 will not be assigned to any of the tanks on the Tanks status screen.

When assigning analog inputs to tanks on the Tanks status screen, be sure to assign only ONE analog input per tank.

- Disabled (1/7)
  Analog Input 11 will not be shown on the Tanks status screen.

- Tank 1 (2/7)
  Analog Input 11 will be shown as Tank 1 on the Tanks status screen.

- Tank 2 (3/7)
  Analog Input 11 will be shown as Tank 2 on the Tanks status screen.

- Tank 3 (4/7)
  Analog Input 11 will be shown as Tank 3 on the Tanks status screen.

- Tank 4 (5/7)
  Analog Input 11 will be shown as Tank 4 on the Tanks status screen.

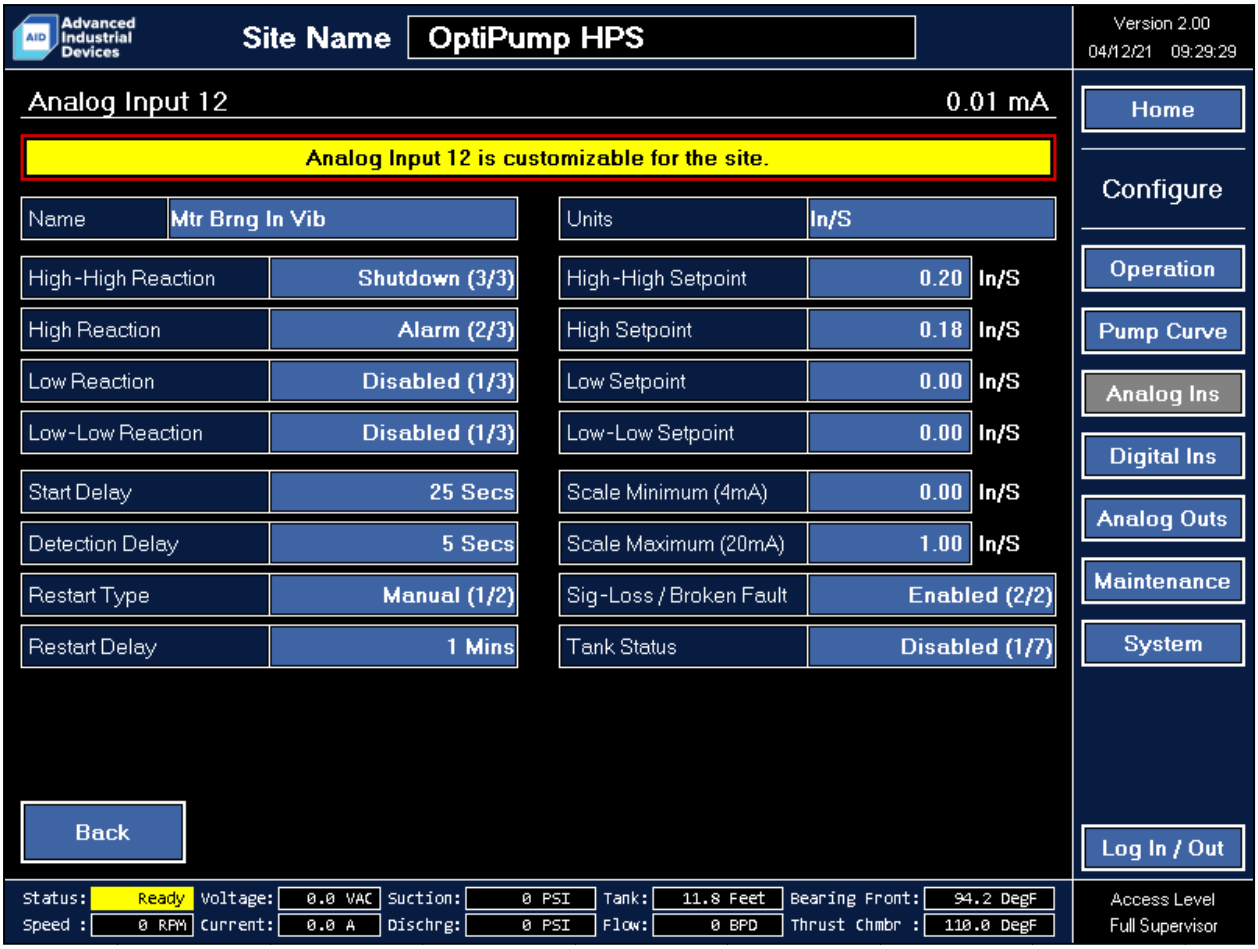
- Tank 5 (6/7)
  Analog Input 11 will be shown as Tank 5 on the Tanks status screen.

- Tank 6 (7/7)
  Analog Input 11 will be shown as Tank 6 on the Tanks status screen.

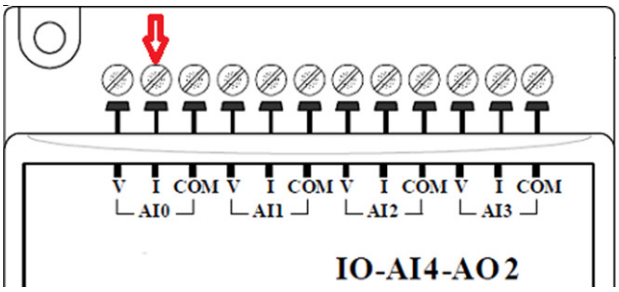
(AI12) Mtr Brng In Vib

Configuration parameters related to Analog Input 12 are available in:

Configure > Analog Ins > Analog Input 12



The 4-20ma signal is connected to terminal I of group AI0 on the I/O module labeled IO-AI4-AO2.



Analog Input 12 > Tank Status

Analog Input 12 can be assigned to any of the 6 tanks shown on the Tanks status screen. If Tank Status is set to Disabled, Analog Input 12 will not be assigned to any of the tanks on the Tanks status screen.

When assigning analog inputs to tanks on the Tanks status screen, be sure to assign only ONE analog input per tank.

- Disabled (1/7)
  Analog Input 12 will not be shown on the Tanks status screen.

- Tank 1 (2/7)
  Analog Input 12 will be shown as Tank 1 on the Tanks status screen.

- Tank 2 (3/7)
  Analog Input 12 will be shown as Tank 2 on the Tanks status screen.

- Tank 3 (4/7)
  Analog Input 12 will be shown as Tank 3 on the Tanks status screen.

- Tank 4 (5/7)
  Analog Input 12 will be shown as Tank 4 on the Tanks status screen.

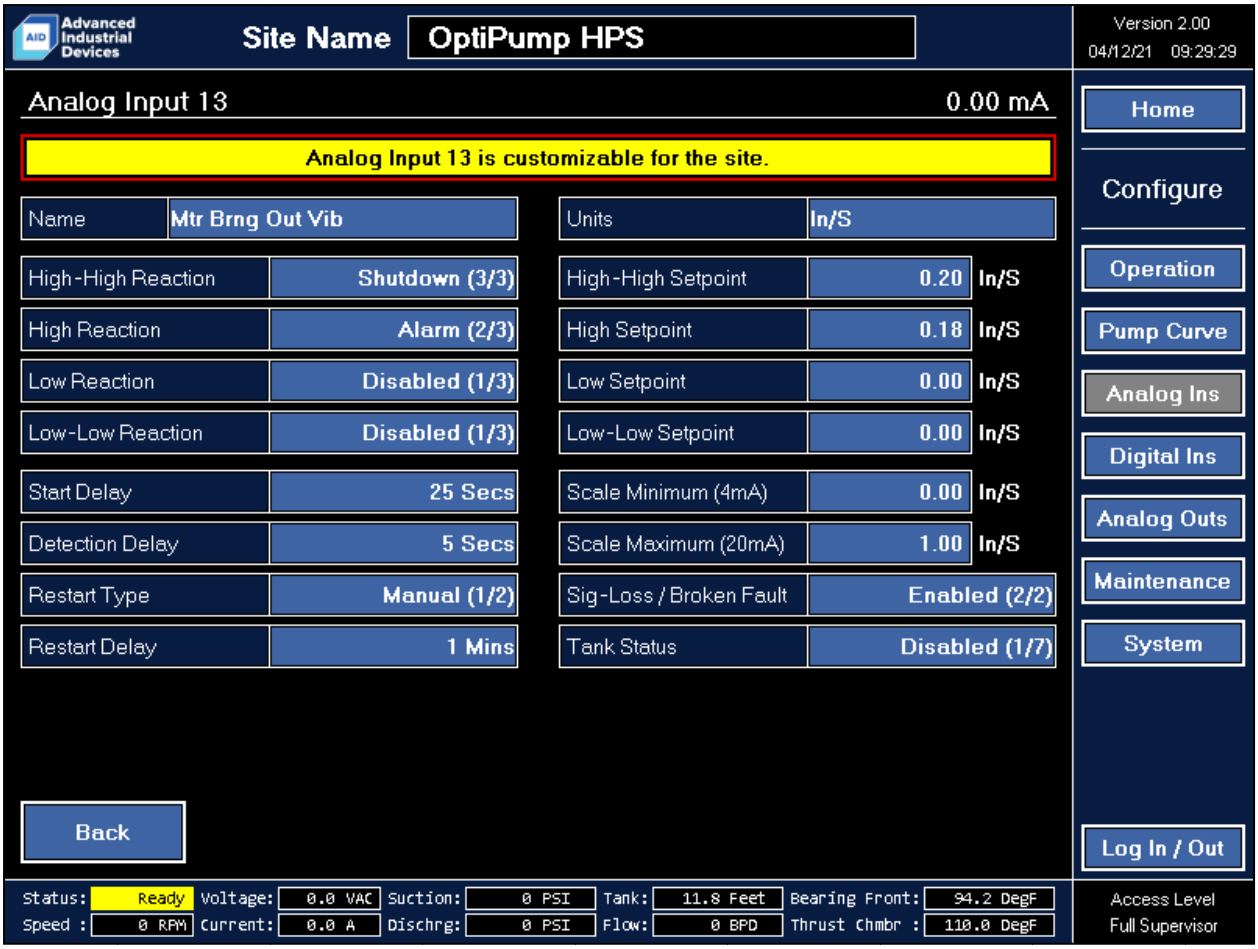
- Tank 5 (6/7)
  Analog Input 12 will be shown as Tank 5 on the Tanks status screen.

- Tank 6 (7/7)
  Analog Input 12 will be shown as Tank 6 on the Tanks status screen.

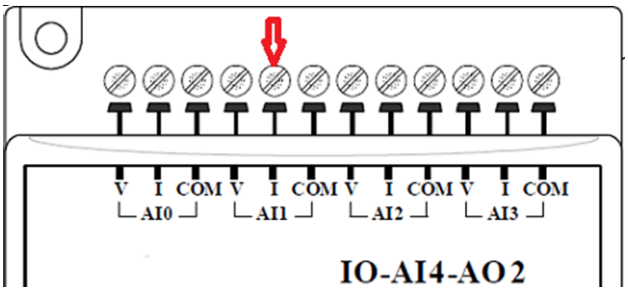
(AI13) Mtr Brng Out Vib

Configuration parameters related to Analog Input 13 are available in:

Configure > Analog Ins > Analog Input 13



The 4-20ma signal is connected to terminal I of group AI1 on the I/O module labeled IO-AI4-AO2.



Analog Input 13 > Tank Status

Analog Input 13 can be assigned to any of the 6 tanks shown on the Tanks status screen. If Tank Status is set to Disabled, Analog Input 13 will not be assigned to any of the tanks on the Tanks status screen.

When assigning analog inputs to tanks on the Tanks status screen, be sure to assign only ONE analog input per tank.

- Disabled (1/7)
  Analog Input 13 will not be shown on the Tanks status screen.

- Tank 1 (2/7)
  Analog Input 13 will be shown as Tank 1 on the Tanks status screen.

- Tank 2 (3/7)
  Analog Input 13 will be shown as Tank 2 on the Tanks status screen.

- Tank 3 (4/7)
  Analog Input 13 will be shown as Tank 3 on the Tanks status screen.

- Tank 4 (5/7)
  Analog Input 13 will be shown as Tank 4 on the Tanks status screen.

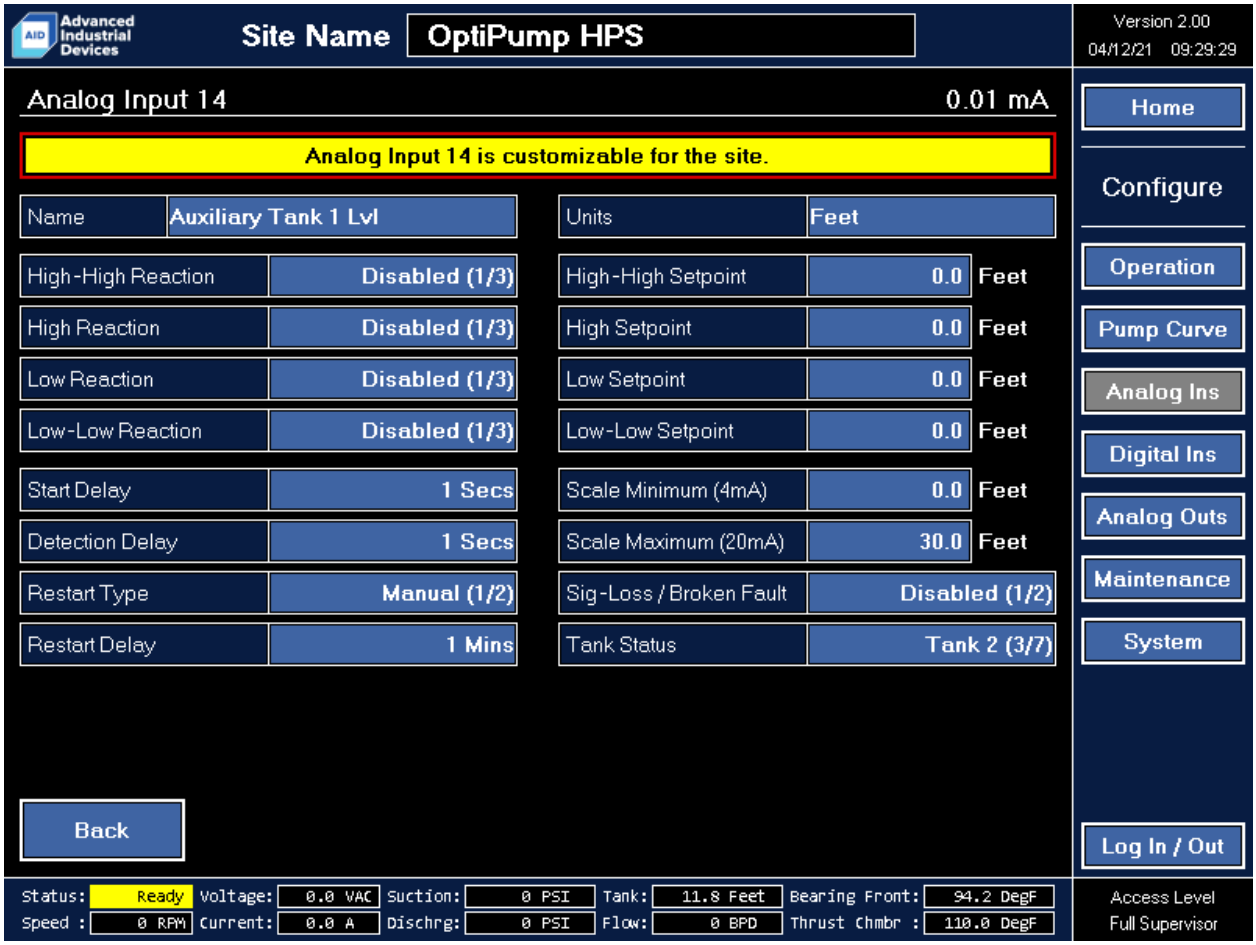
- Tank 5 (6/7)
  Analog Input 13 will be shown as Tank 5 on the Tanks status screen.

- Tank 6 (7/7)
  Analog Input 13 will be shown as Tank 6 on the Tanks status screen.

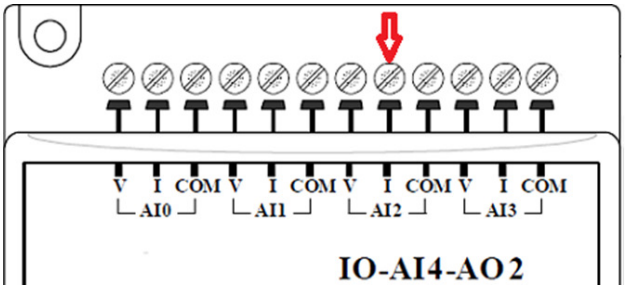
(AI14) Auxiliary Tank 1 Lvl

Configuration parameters related to Analog Input 14 are available in:

Configure > Analog Ins > Analog Input 14



The 4-20ma signal is connected to terminal I of group AI2 on the I/O module labeled IO-AI4-AO2.



Analog Input 14 > Tank Status

Analog Input 14 can be assigned to any of the 6 tanks shown on the Tanks status screen. If Tank Status is set to Disabled, Analog Input 14 will not be assigned to any of the tanks on the Tanks status screen.

When assigning analog inputs to tanks on the Tanks status screen, be sure to assign only ONE analog input per tank.

- Disabled (1/7)
  Analog Input 14 will not be shown on the Tanks status screen.

- Tank 1 (2/7)
  Analog Input 14 will be shown as Tank 1 on the Tanks status screen.

- Tank 2 (3/7)
  Analog Input 14 will be shown as Tank 2 on the Tanks status screen.

- Tank 3 (4/7)
  Analog Input 14 will be shown as Tank 3 on the Tanks status screen.

- Tank 4 (5/7)
  Analog Input 14 will be shown as Tank 4 on the Tanks status screen.

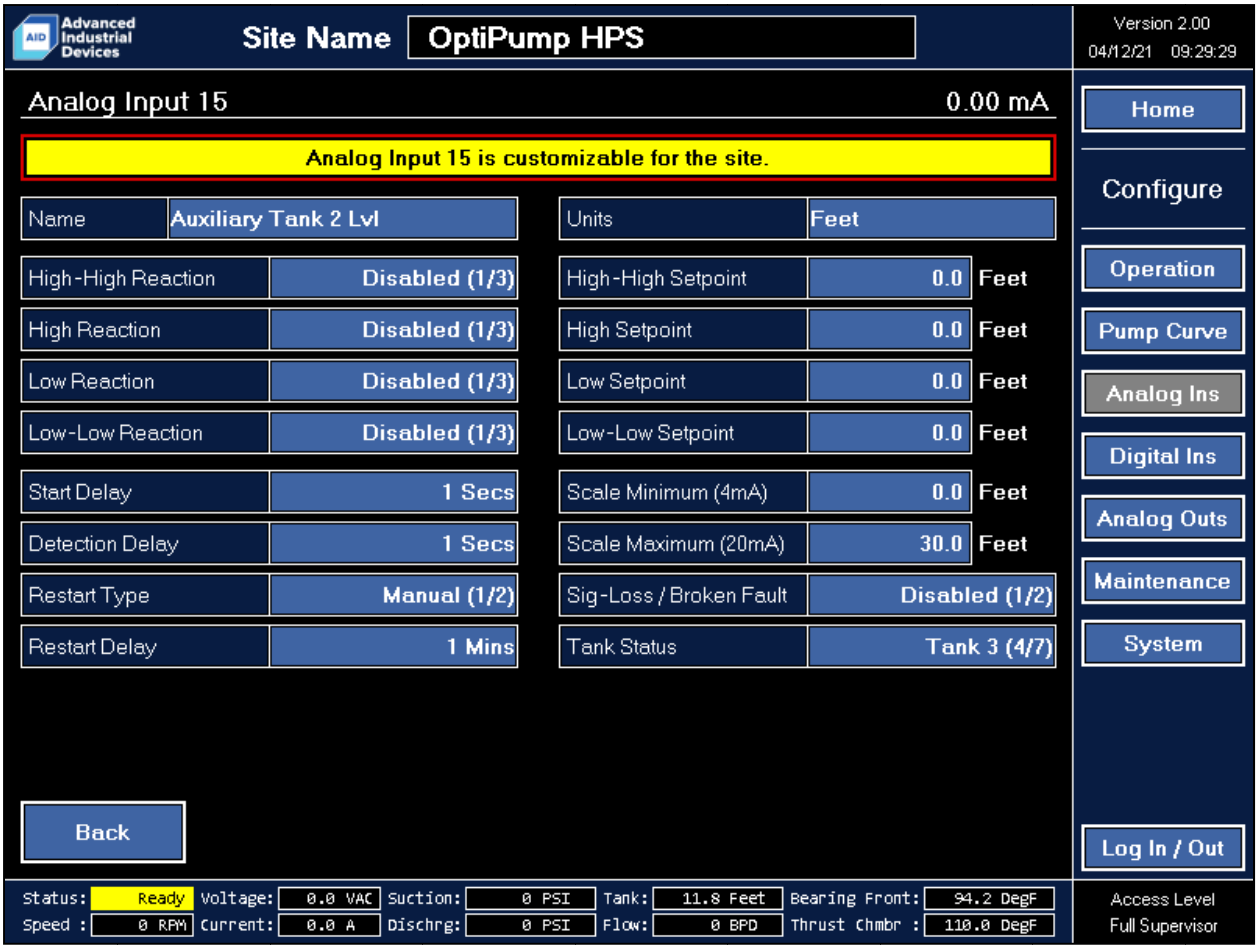
- Tank 5 (6/7)
  Analog Input 14 will be shown as Tank 5 on the Tanks status screen.

- Tank 6 (7/7)
  Analog Input 14 will be shown as Tank 6 on the Tanks status screen.

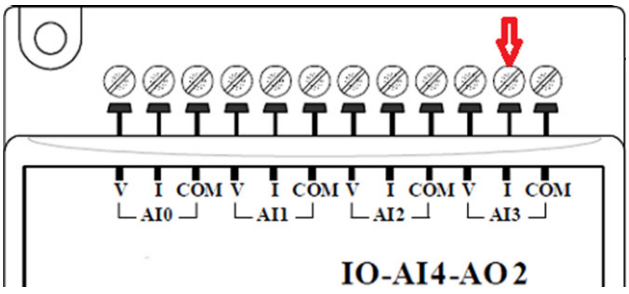
(AI15) Auxiliary Tank 2 Lvl

Configuration parameters related to Analog Input 15 are available in:

Configure > Analog Ins > Analog Input 15



The 4-20ma signal is connected to terminal I of group AI3 on the I/O module labeled IO-AI4-AO2.



Analog Input 15 > Tank Status

Analog Input 15 can be assigned to any of the 6 tanks shown on the Tanks status screen. If Tank Status is set to Disabled, Analog Input 15 will not be assigned to any of the tanks on the Tanks status screen.

When assigning analog inputs to tanks on the Tanks status screen, be sure to assign only ONE analog input per tank.

- Disabled (1/7)
  Analog Input 15 will not be shown on the Tanks status screen.

- Tank 1 (2/7)
  Analog Input 15 will be shown as Tank 1 on the Tanks status screen.

- Tank 2 (3/7)
  Analog Input 15 will be shown as Tank 2 on the Tanks status screen.

- Tank 3 (4/7)
  Analog Input 15 will be shown as Tank 3 on the Tanks status screen.

- Tank 4 (5/7)
  Analog Input 15 will be shown as Tank 4 on the Tanks status screen.

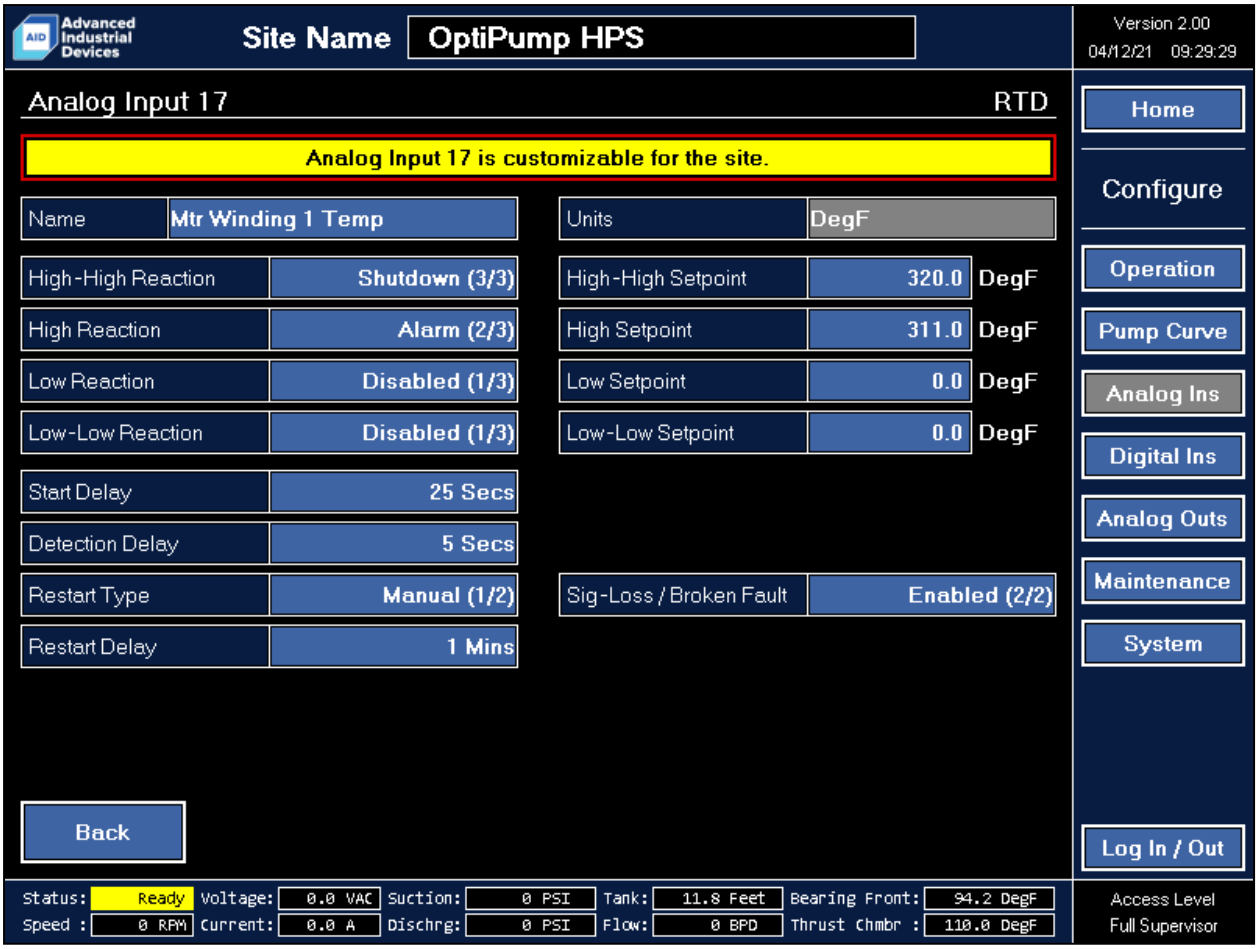
- Tank 5 (6/7)
  Analog Input 15 will be shown as Tank 5 on the Tanks status screen.

- Tank 6 (7/7)
  Analog Input 15 will be shown as Tank 6 on the Tanks status screen.

(AI17) Mtr Winding 1 Temp

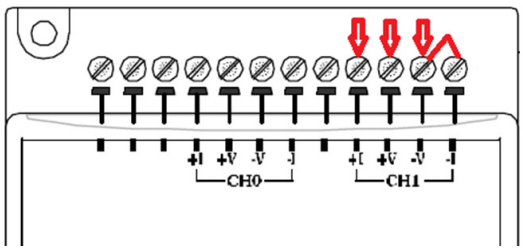
Configuration parameters related to Analog Input 17 are available in:

Configure > Analog Ins > Analog Input 17



Analog Input 17 is dedicated to measuring a temperature with a RTD sensor. The name can be modified by the operator, but the units are fixed in degrees Fahrenheit.

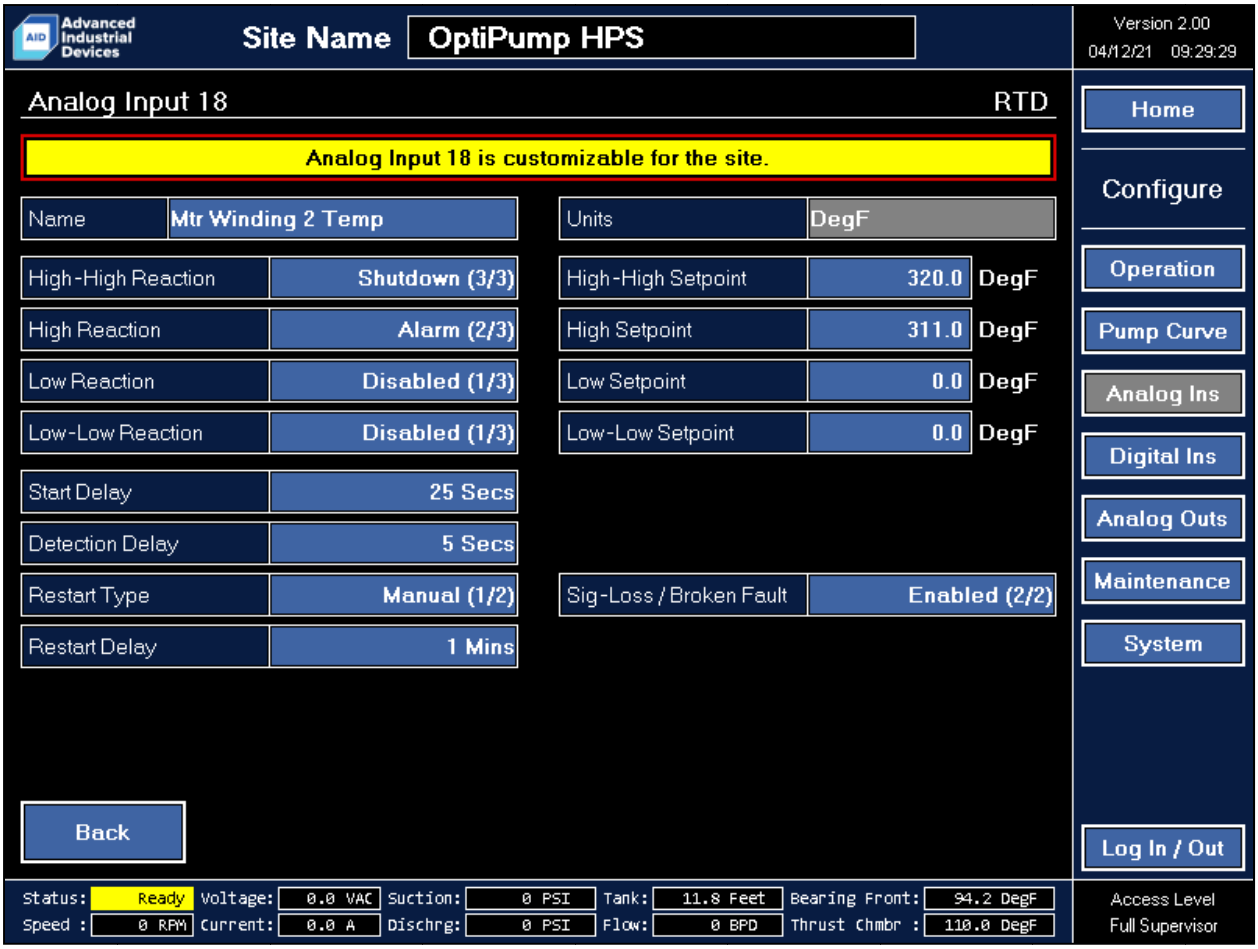
A 100 ohm RTD signal wire is connected to the I/O module labeled IO-PT400 and is the first of these modules. The sensor is connected to terminals +I, +V, -V in group CH1. Refer to **Configure > Analog Ins > Analog Input 10/16** for more information on connect a RTD sensor.



(AI18) Mtr Winding 2 Temp

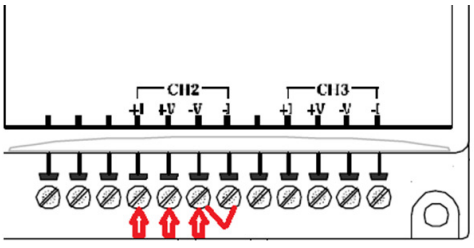
Configuration parameters related to Analog Input 18 are available in:

Configure > Analog Ins > Analog Input 18



Analog Input 18 is dedicated to measuring a temperature with a RTD sensor. The name can be modified by the operator, but the units are fixed in degrees Fahrenheit.

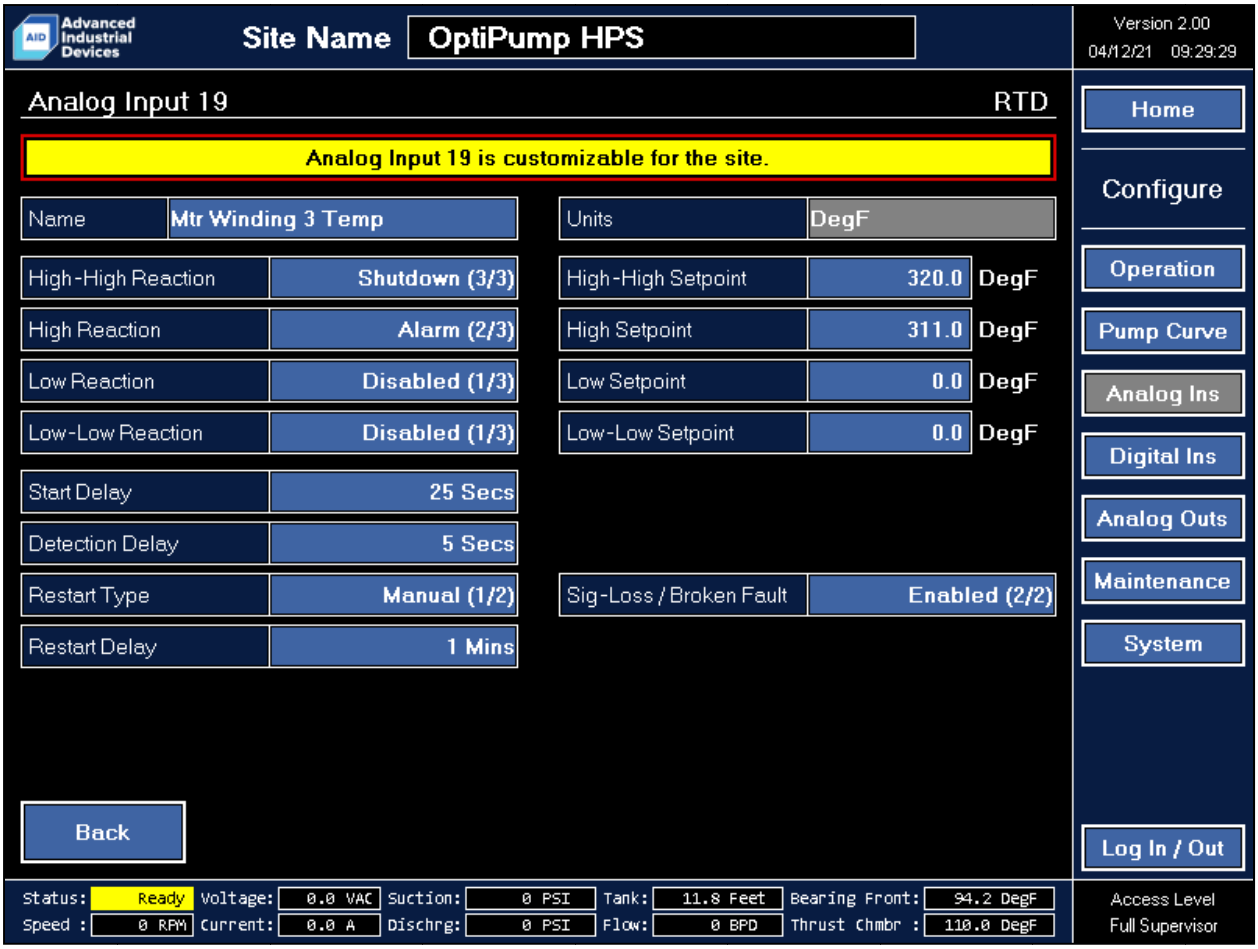
A 100 ohm RTD signal wire is connected to the I/O module labeled IO-PT400 and is the first of these modules. The sensor is connected to terminals +I, +V, -V in group CH2. Refer to **Configure > Analog Ins > Analog Input 10/16** for more information on connect a RTD sensor.



(AI19) Mtr Winding 3 Temp

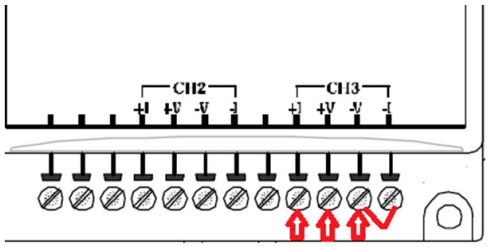
Configuration parameters related to Analog Input 19 are available in:

Configure > Analog Ins > Analog Input 19



Analog Input 19 is dedicated to measuring a temperature with a RTD sensor. The name can be modified by the operator, but the units are fixed in degrees Fahrenheit.

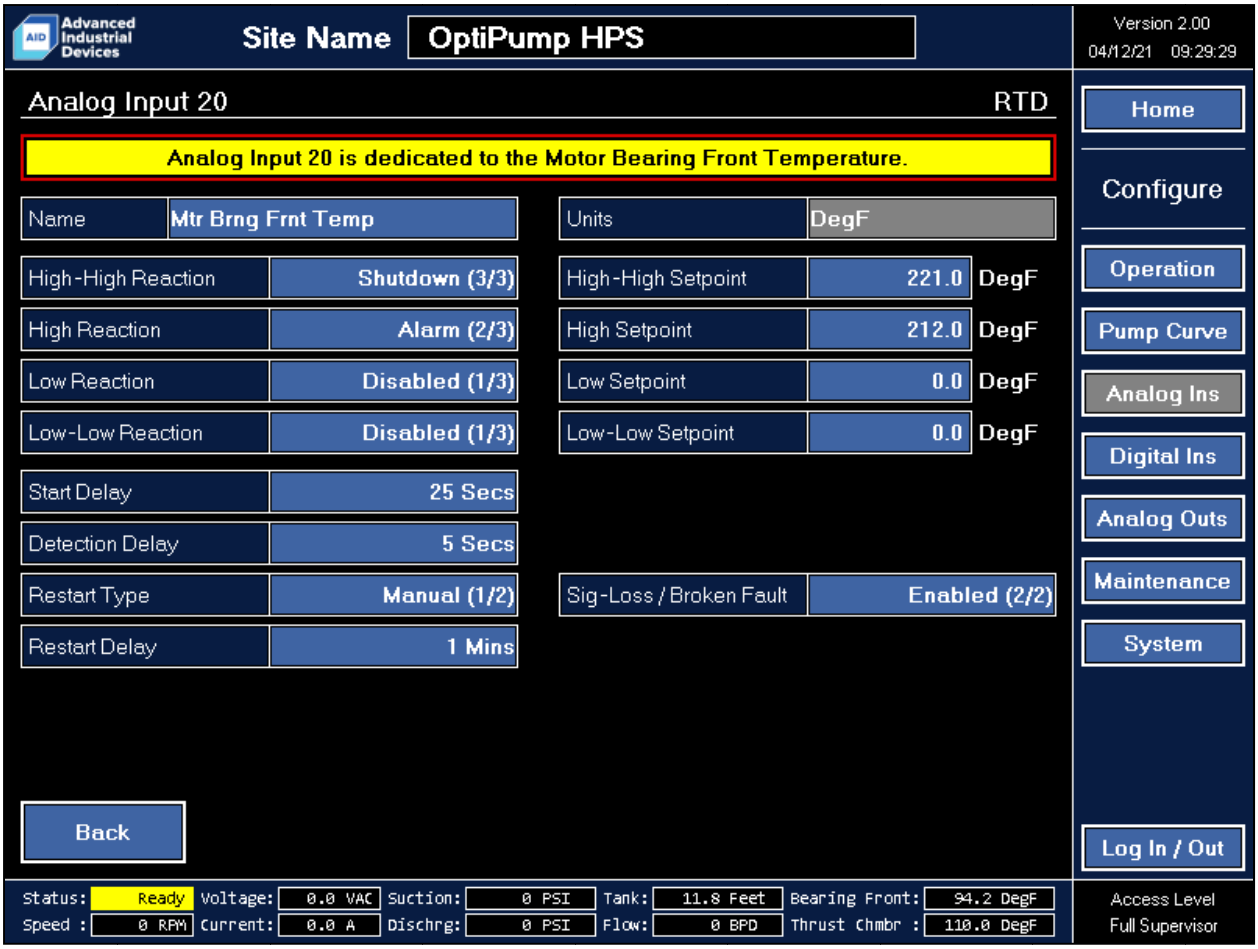
A 100 ohm RTD signal wire is connected to the I/O module labeled IO-PT400 and is the first of these modules. The sensor is connected to terminals +I, +V, -V in group CH3. Refer to **Configure > Analog Ins > Analog Input 10/16** for more information on connect a RTD sensor.



(AI20) Motor Bearing Front Temperature

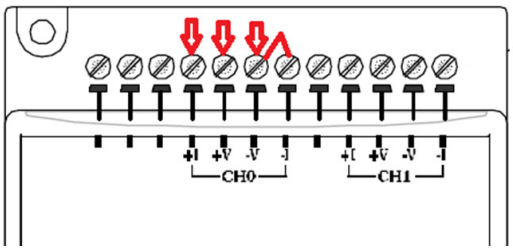
Configuration parameters related to Analog Input 20 are available in:

Configure > Analog Ins > (AI20) Motor Bearing Front Temperature



Analog Input 20 is dedicated to measuring a temperature with a RTD sensor. The name can be modified by the operator, but the units are fixed in degrees Fahrenheit.

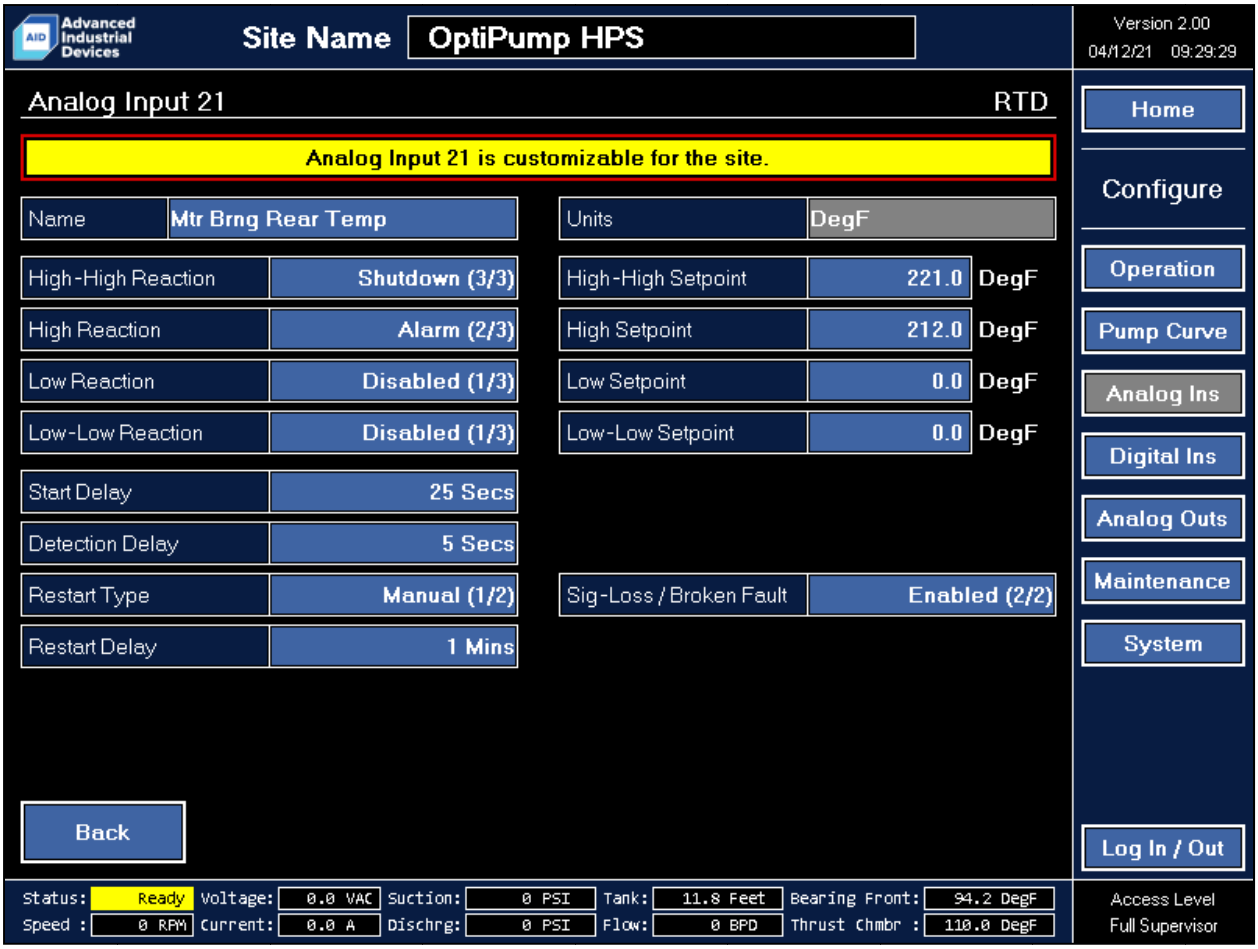
A 100 ohm RTD signal wire is connected to the I/O module labeled IO-PT400 and is the second of these modules. The sensor is connected to terminals +I, +V, -V in group CH0. Refer to **Configure > Analog Ins > Analog Input 10/16** for more information on connect a RTD sensor.



(AI21) Mtr Brng Rear Temp

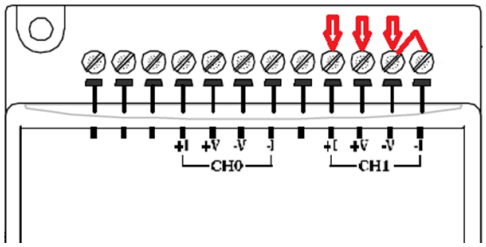
Configuration parameters related to Analog Input 21 are available in:

Configure > Analog Ins > Analog Input 21



Analog Input 21 is dedicated to measuring a temperature with a RTD sensor. The name can be modified by the operator, but the units are fixed in degrees Fahrenheit.

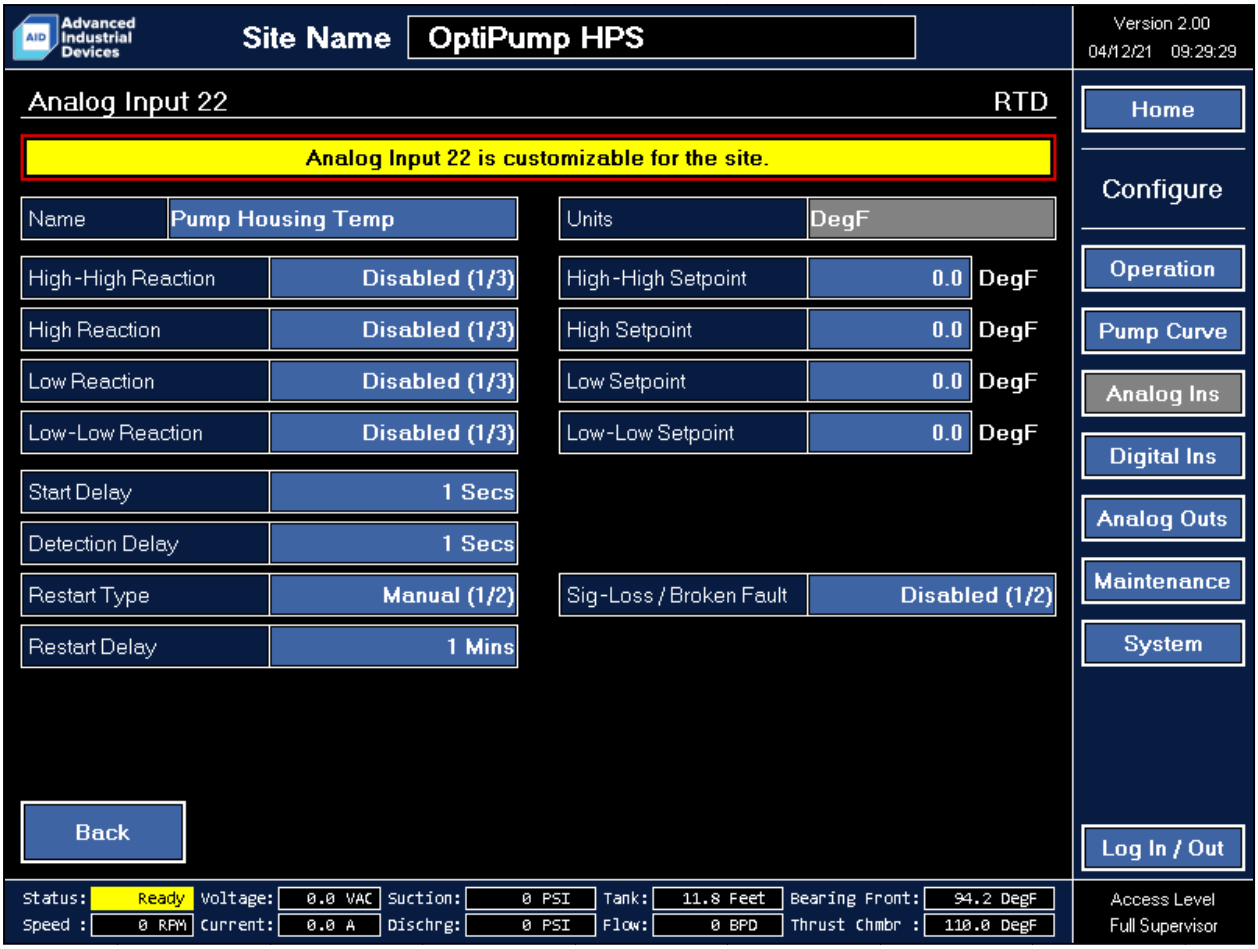
A 100 ohm RTD signal wire is connected to the I/O module labeled IO-PT400 and is the second of these modules. The sensor is connected to terminals +I, +V, -V in group CH1. Refer to **Configure > Analog Ins > Analog Input 10/16** for more information on connect a RTD sensor.



(AI22) Pump Housing Temp

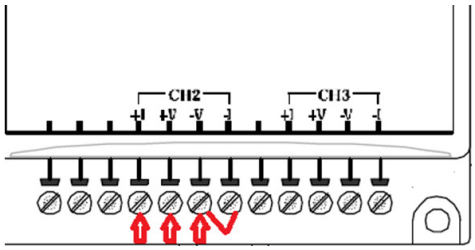
Configuration parameters related to Analog Input 22 are available in:

Configure > Analog Ins > Analog Input 22



Analog Input 22 is dedicated to measuring a temperature with a RTD sensor. The name can be modified by the operator, but the units are fixed in degrees Fahrenheit.

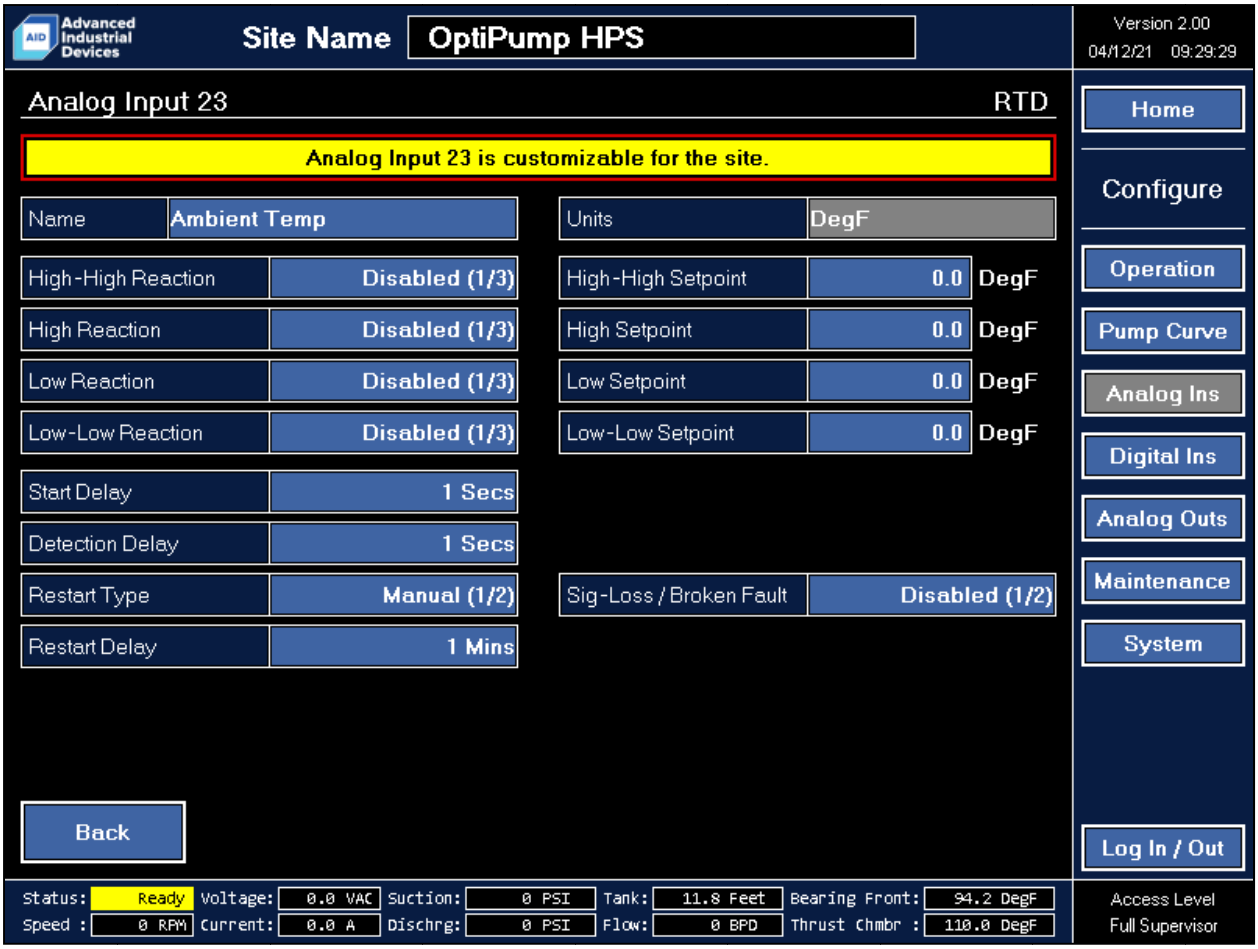
A 100 ohm RTD signal wire is connected to the I/O module labeled IO-PT400 and is the second of these modules. The sensor is connected to terminals +I, +V, -V in group CH2. Refer to **Configure > Analog Ins > Analog Input 10/16** for more information on connect a RTD sensor.



(AI23) Ambient Temp

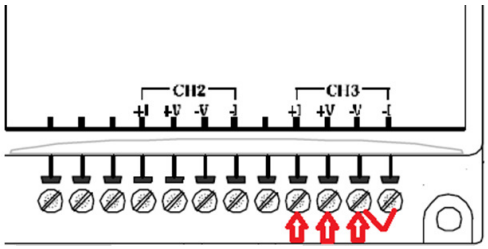
Configuration parameters related to Analog Input 23 are available in:

Configure > Analog Ins > Analog Input 23



Analog Input 23 is dedicated to measuring a temperature with a RTD sensor. The name can be modified by the operator, but the units are fixed in degrees Fahrenheit.

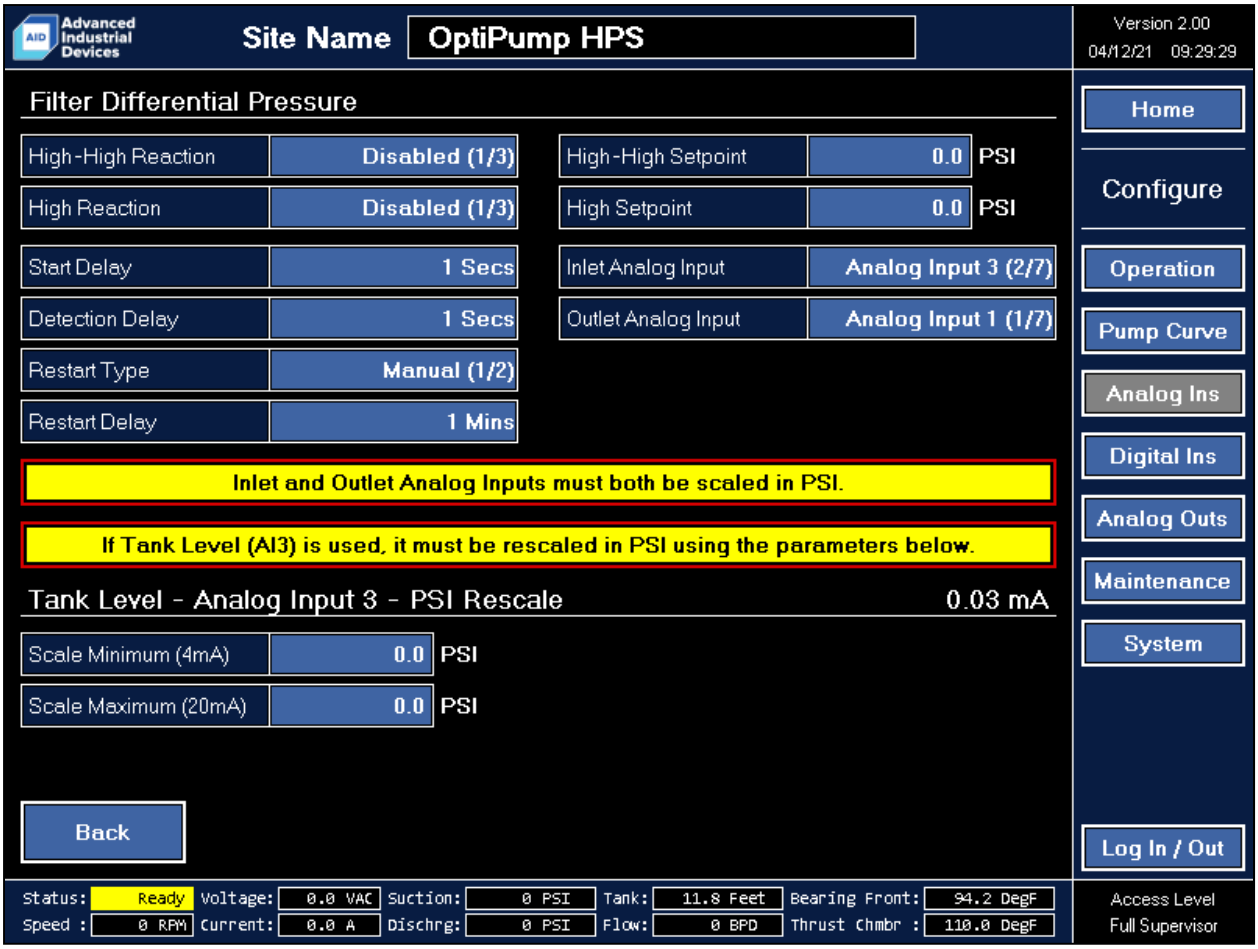
A 100 ohm RTD signal wire is connected to the I/O module labeled IO-PT400 and is the second of these modules. The sensor is connected to terminals +I, +V, -V in group CH3. Refer to **Configure > Analog Ins > Analog Input 10/16** for more information on connect a RTD sensor.



Filter Differential Pressure

Configuration parameters related to the Filter Differential Pressure are available in:

Configure > Analog Ins > Filter Differential Pressure



The filter differential pressure is based on two sensors. The operator must select a combination of two sensors to enable this feature. The filter differential pressure is calculated by subtracting the outlet pressure from the inlet pressure.

Both of the selected analog inputs must be scaled in PSI.

Filter Differential Pressure > Inlet Analog Input

The analog input used to measure the pressure at the inlet of the filter.

- Analog Input 1 (1/7)
- Analog Input 3 (2/7)
- Analog Input 11 (3/7)
- Analog Input 12 (4/7)
- Analog Input 13 (5/7)
- Analog Input 14 (6/7)
- Analog Input 15 (7/7)

Filter Differential Pressure > Outlet Analog Input

The analog input used to measure the pressure at the outlet of the filter.

- Analog Input 1 (1/7)
- Analog Input 3 (2/7)
- Analog Input 11 (3/7)
- Analog Input 12 (4/7)
- Analog Input 13 (5/7)
- Analog Input 14 (6/7)
- Analog Input 15 (7/7)

Note:
If one of the two analog inputs selected is Analog Input 3 (2/7) (the main tank level), the input must be rescaled to PSI, as the tank level is typically scaled in feet. Use the following two configuration parameters to rescale (AI3) Tank Level internally for use with the filter differential pressure. This rescaling does NOT affect the parameters on the **Configure > Analog Ins > Analog Input 3** screen.

Filter Differential Pressure - Tank Level - Analog Input 3 - PSI Rescale > Scale Minimum (4mA)

Pressure value in PSI measured by the transducer connected to Analog Input 3 at 4 mA.

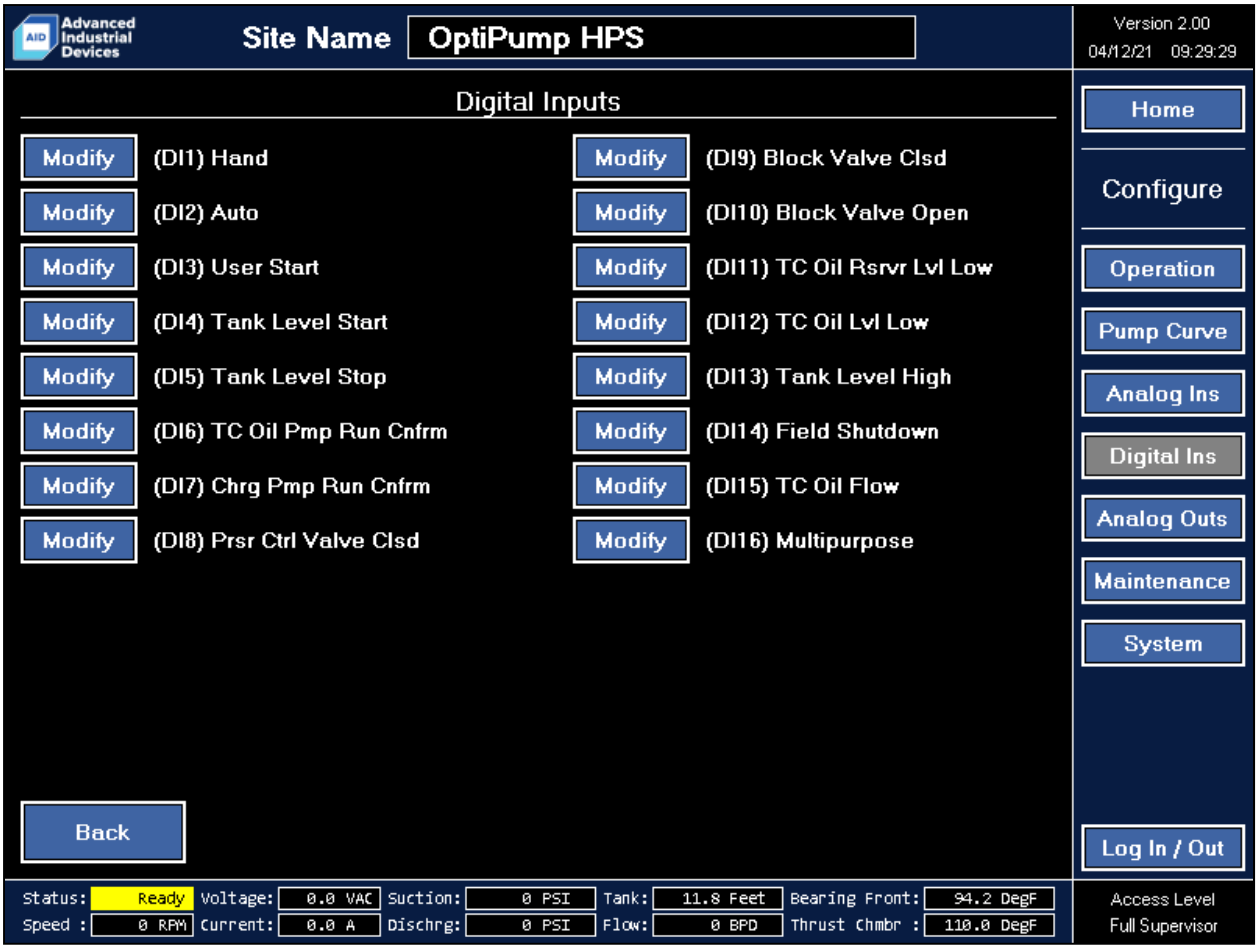
Filter Differential Pressure - Tank Level - Analog Input 3 - PSI Rescale > Scale Minimum (20mA)

Pressure value in PSI measured by the transducer connected to Analog Input 3 at 20 mA.

Digital Inputs

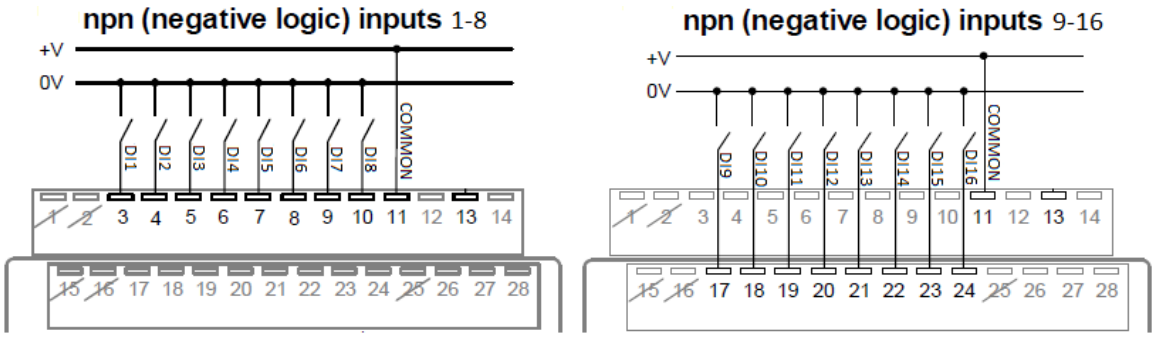
Configuration parameters related to the digital inputs are available in:

Configure > Digital Ins



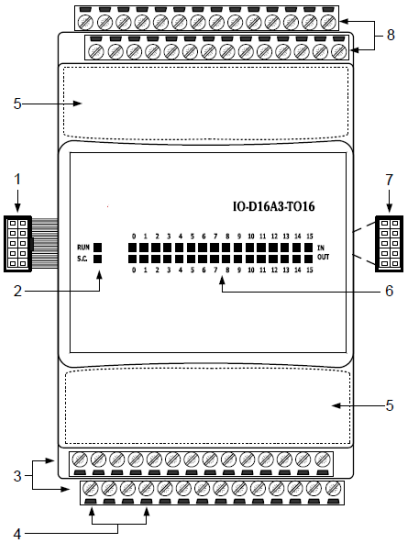
The digital inputs are connected to a single controller I/O module. Most digital inputs have a dedicated purpose, but can be renamed by the operator in order to tailor the controller configuration to the site requirements.

Digital inputs are on/off, dry-contact, switch inputs that are either open or closed.



Component Identification

1	Module-to-module connector
2	Status indicators
3	Output connectors
4	Output power supply connection points
5	I/O address labels (provided with module)
6	Input/output status indicators
7	Module-to-module connector port
8	Input connectors



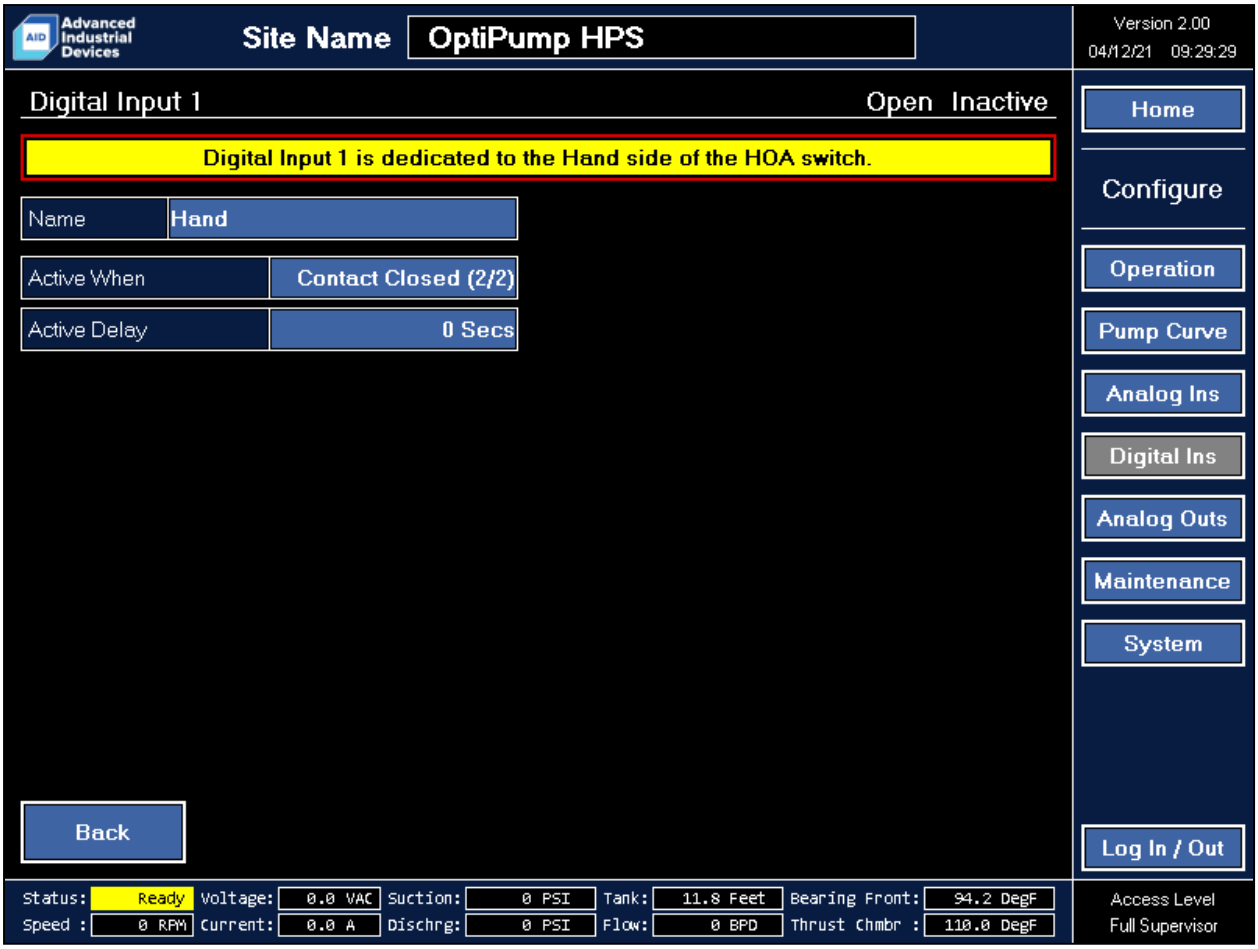
- Failure to comply with appropriate safety guidelines can cause severe personal injury or damage to property.

- Only qualified personnel should service and operate this device.
- When power is turned on, do not connect or disconnect the device to avoid damaging the system.

(DI1) Hand

Configuration parameters related to Digital Input 1 are available in:

Configure > Digital Ins > Digital Input 1



The function of Digital Input 1 is dedicated to the Hand function of the HOA switch. The name can be modified by the operator.

Digital Input 1 > Active When

Determines when the digital input is considered to be active and to perform the assigned function.

- Contact Open (1/2)
  The digital input will be active when the contact to the input is open.

- Contact Closed (2/2)
  The digital input will be active when the contact to the input is closed.

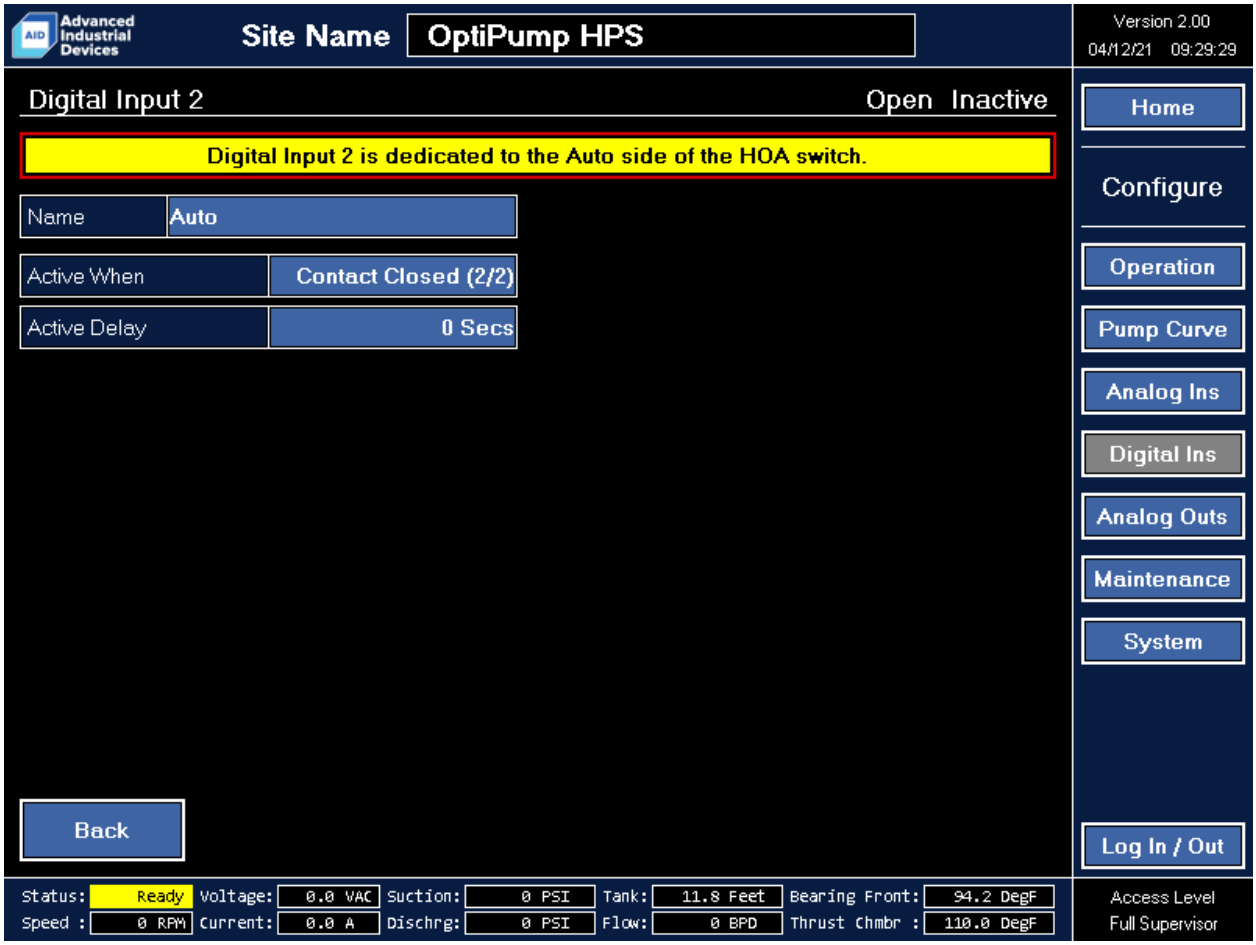
Digital Input 1 > Active Delay

The amount of time required for the input to be open or closed before activating the function. This feature can be used to debounce the input.

(DI2) Auto

Configuration parameters related to Digital Input 2 are available in:

Configure > Digital Ins > Digital Input 2



The function of Digital Input 2 is dedicated to the Auto function of the HOA switch. The name can be modified by the operator.

Digital Input 2 > Active When

Determines when the digital input is considered to be active and to perform the assigned function.

- Contact Open (1/2)
  The digital input will be active when the contact to the input is open.

- Contact Closed (2/2)
  The digital input will be active when the contact to the input is closed.

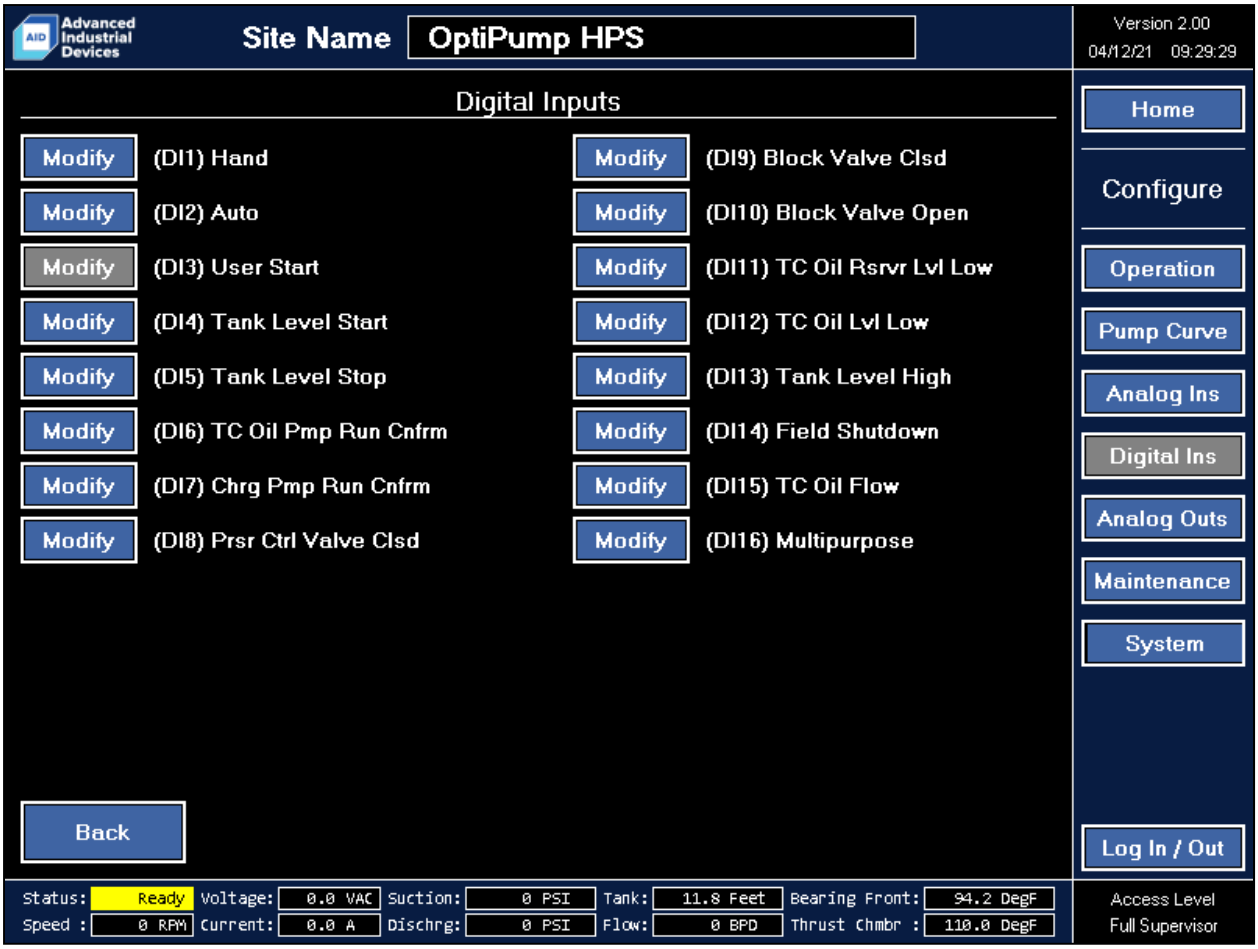
Digital Input 2 > Active Delay

The amount of time required for the input to be open or closed before activating the function. This feature can be used to debounce the input.

(DI3) User Start

Configuration parameters related to Digital Input 3 are available in:

Configure > Digital Ins > Digital Input 3



The function of Digital Input 3 is dedicated to the User Start function. The User Start function allows a remote start signal from external equipment to act as a permissive when running in Auto. Refer to **Configure > Operation > Main Pump - Start/Stop** for more information. The name can be modified by the operator.

Digital Input 3 > Active When

Determines when the digital input is considered to be active and to perform the assigned function.

- Contact Open (1/2)
  The digital input will be active when the contact to the input is open.

- Contact Closed (2/2)
  The digital input will be active when the contact to the input is closed.

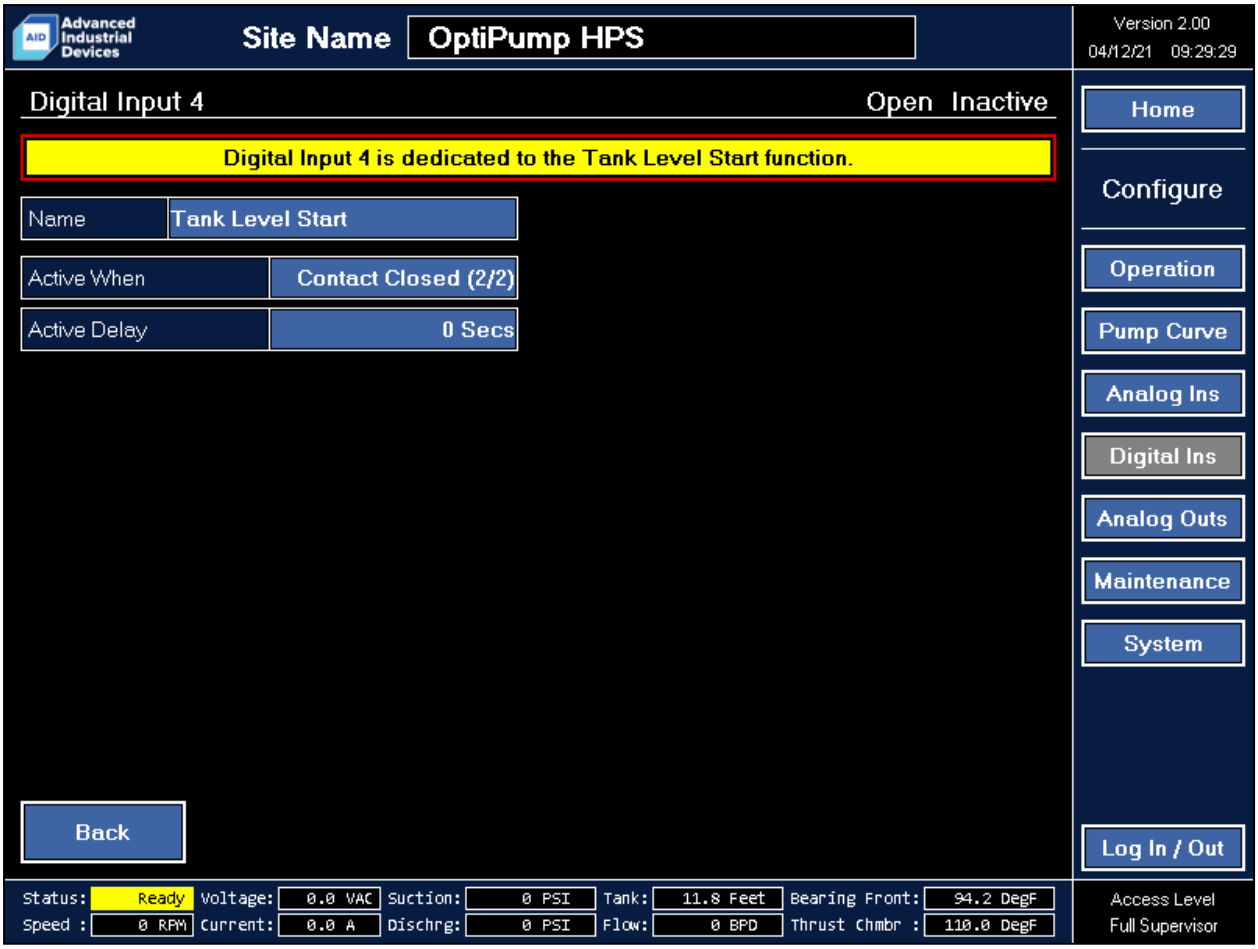
Digital Input 3 > Active Delay

The amount of time required for the input to be open or closed before activating the function. This feature can be used to debounce the input.

(DI4) Tank Level Start

Configuration parameters related to Digital Input 4 are available in:

Configure > Digital Ins > Digital Input 4



The function of Digital Input 4 is dedicated to Tank Level Start. Depending on the configuration, Digital Input 4 can control the starting and stopping of the system in Auto mode. Refer to **Configure > Operation > Main Pump - Start/Stop** for more information. The name can be modified by the operator.

Digital Input 4 > Active When

Determines when the digital input is considered to be active and to perform the assigned function.

- Contact Open (1/2)
  The digital input will be active when the contact to the input is open.

- Contact Closed (2/2)
  The digital input will be active when the contact to the input is closed.

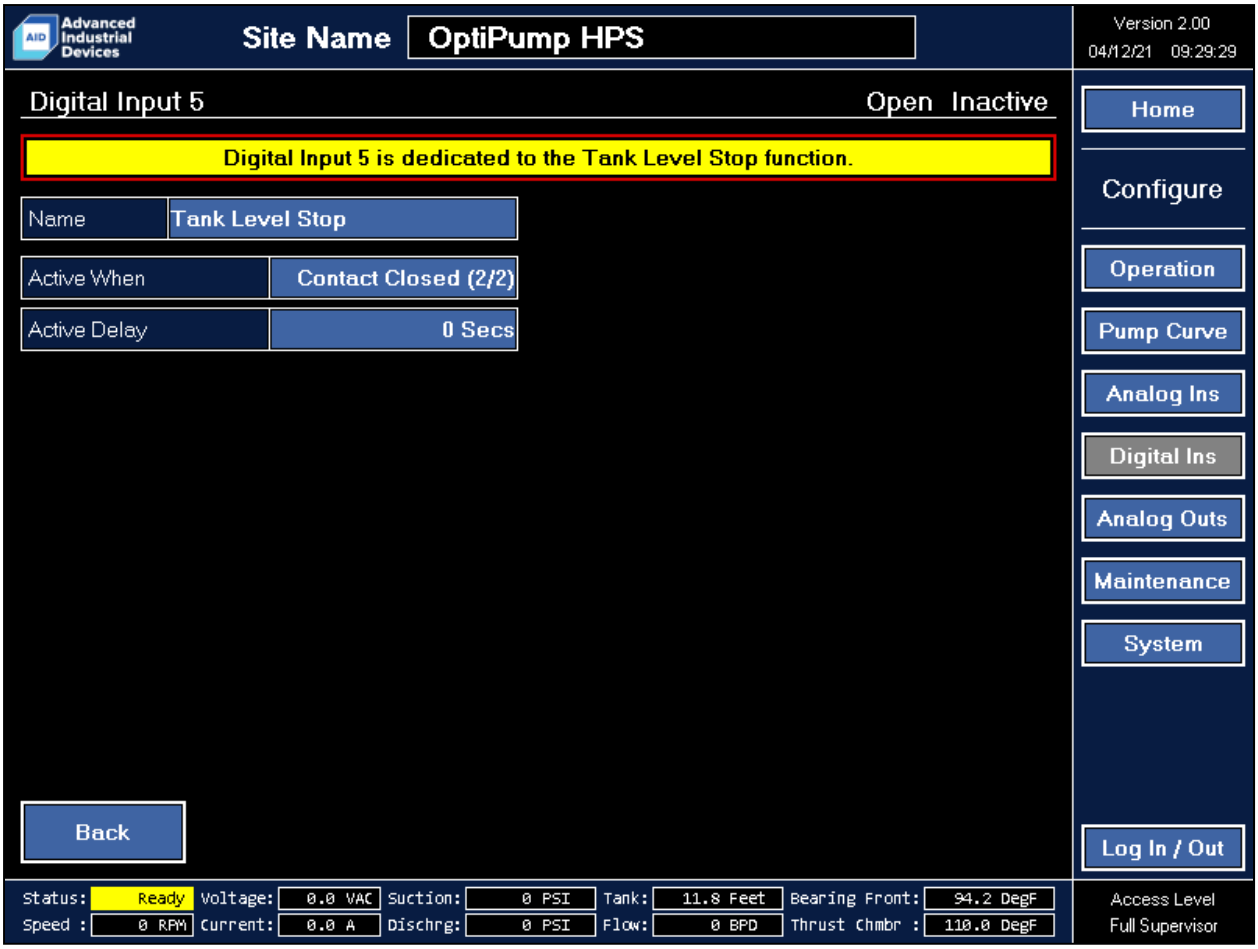
Digital Input 4 > Active Delay

The amount of time required for the input to be open or closed before activating the function. This feature can be used to debounce the input.

(DI5) Tank Level Stop

Configuration parameters related to Digital Input 5 are available in:

Configure > Digital Ins > Digital Input 5



The function of Digital Input 5 is dedicated to Tank Level Stop. Depending on the configuration, Digital Input 5 can control the starting and stopping of the system in Auto mode. Refer to **Configure > Operation > Main Pump - Start/Stop** for more information. The name can be modified by the operator.

Digital Input 5 > Active When

Determines when the digital input is considered to be active and to perform the assigned function.

- Contact Open (1/2)
  The digital input will be active when the contact to the input is open.

- Contact Closed (2/2)
  The digital input will be active when the contact to the input is closed.

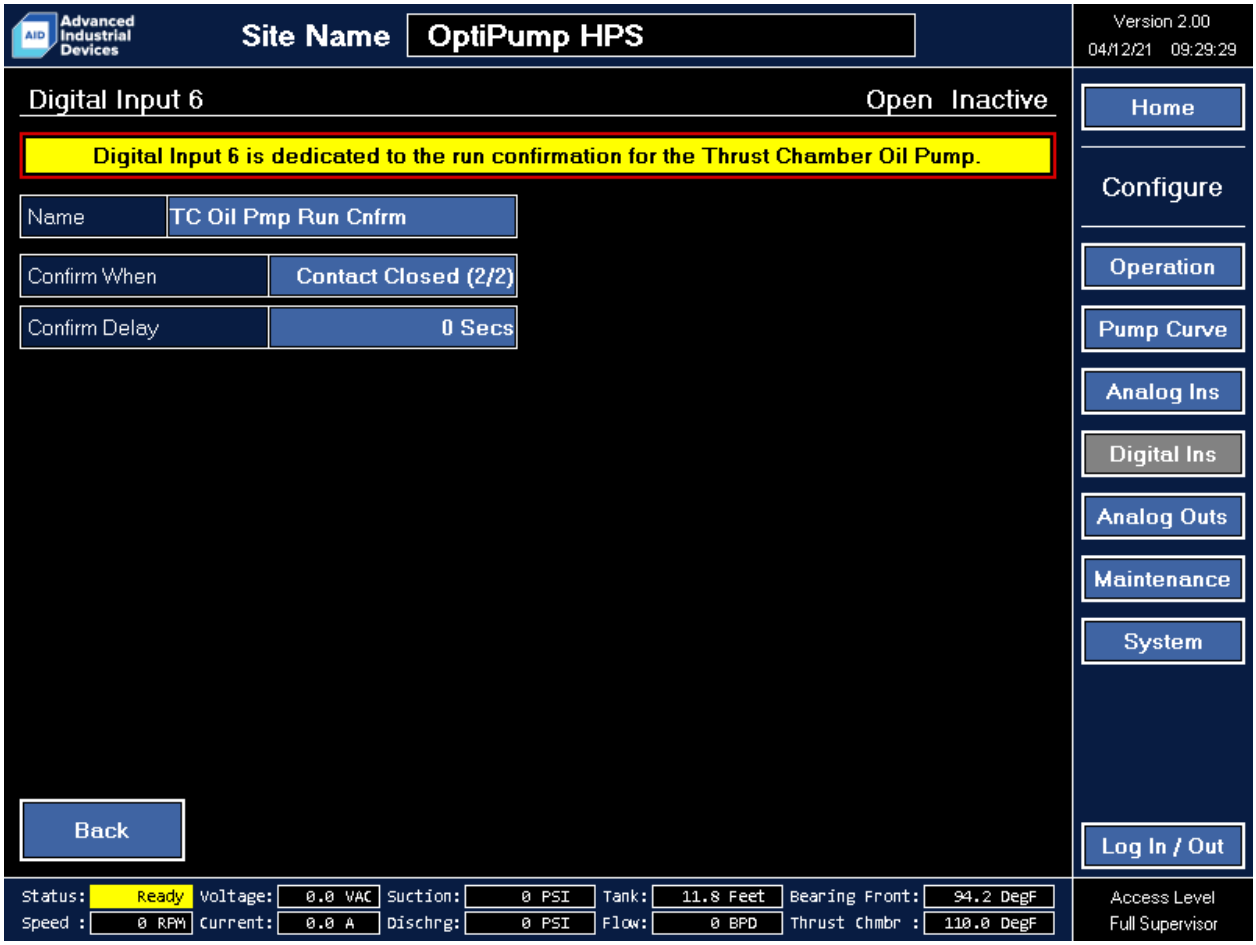
Digital Input 5 > Active Delay

The amount of time required for the input to be open or closed before activating the function. This feature can be used to debounce the input.

(DI6) TC Oil Pmp Run Cnfrm

Configuration parameters related to Digital Input 6 are available in:

Configure > Digital Ins > Digital Input 6



The function of Digital Input 6 is dedicated to the run confirmation of the thrust chamber oil pump. When used on a system with a thrust chamber oil pump, Digital Input 6 is used to provide feedback to the controller that the thrust chamber oil pump is actively running. Refer to **Configure > Operation > Support Pumps - Thrust Chamber Oil Pump** for more information. The name can be modified by the operator.

Note:

If the system was purchased with a thrust chamber oil pump motor starter pre-installed, this connection will be pre-wired to the motor starter auxiliary contact.

Digital Input 6 > Confirm When

Determines when the digital input is considered to be active and to confirm that the thrust chamber oil pump is actively running.

- Contact Open (1/2)
  The thrust chamber oil pump is actively running when the contact to the input is open.

- Contact Closed (2/2)
  The thrust chamber oil pump is actively running when the contact to the input is closed.

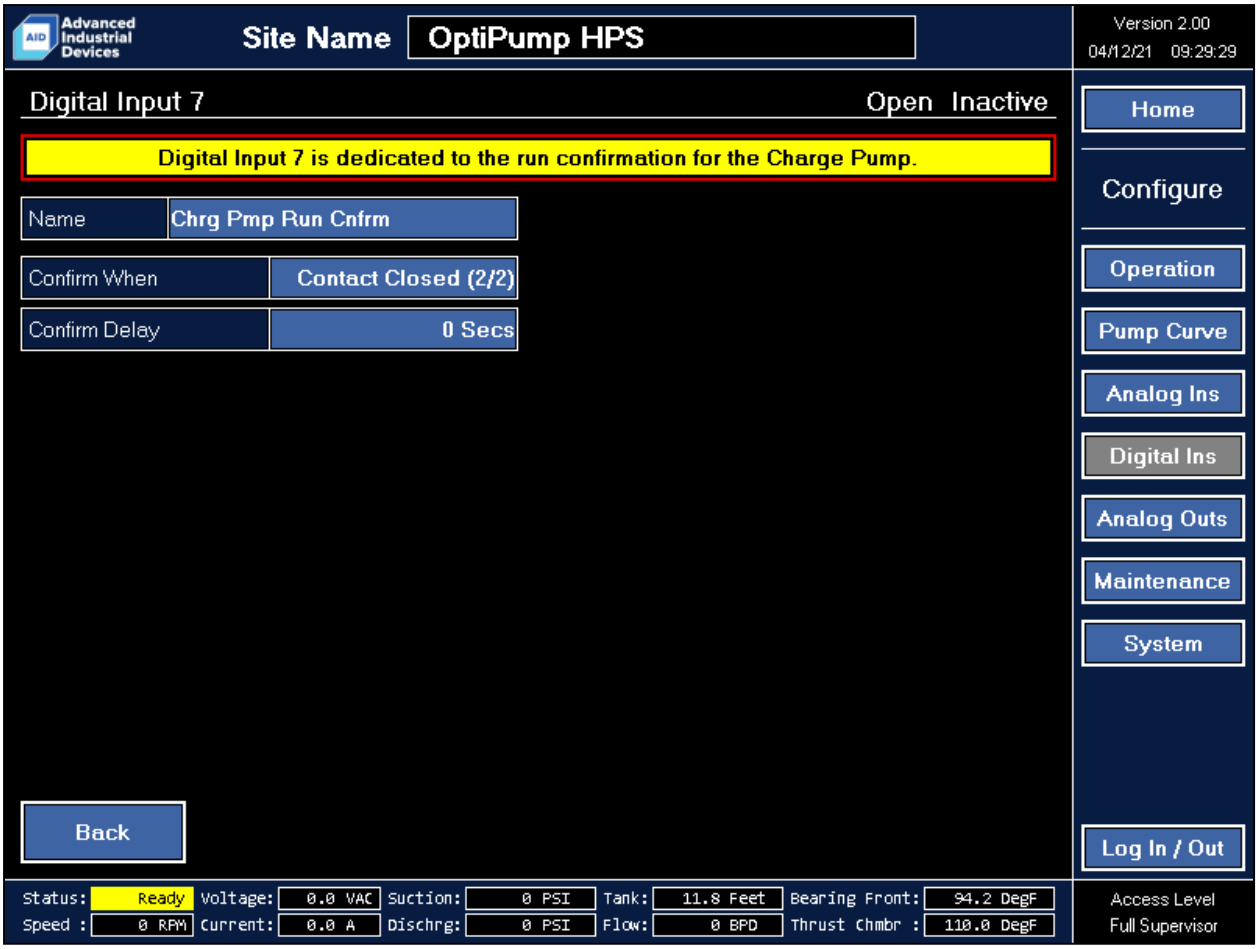
Digital Input 6 > Confirm Delay

The amount of time required for the input to be open or closed before confirming that the thrust chamber oil pump is actively running. This feature can be used to debounce the input.

(DI7) Chrg Pmp Run Cnfrm

Configuration parameters related to Digital Input 7 are available in:

Configure > Digital Ins > Digital Input 7



The function of Digital Input 7 is dedicated to the run confirmation of charge pump. When used on a system with a charge pump, Digital Input 7 is used to provide feedback to the controller that the charge pump is actively running. Refer to **Configure > Operation > Support Pumps - Charge Pump** for more information. The name can be modified by the operator.

Note:

If the system was purchased with a charge pump motor starter pre-installed, this connection will be pre-wired to the motor starter auxiliary contact.

Digital Input 7 > Confirm When

Determines when the digital input is considered to be active and to confirm that the charge pump is actively running.

- Contact Open (1/2)
  The charge pump is actively running when the contact to the input is open.

- Contact Closed (2/2)
  The charge pump is actively running when the contact to the input is closed.

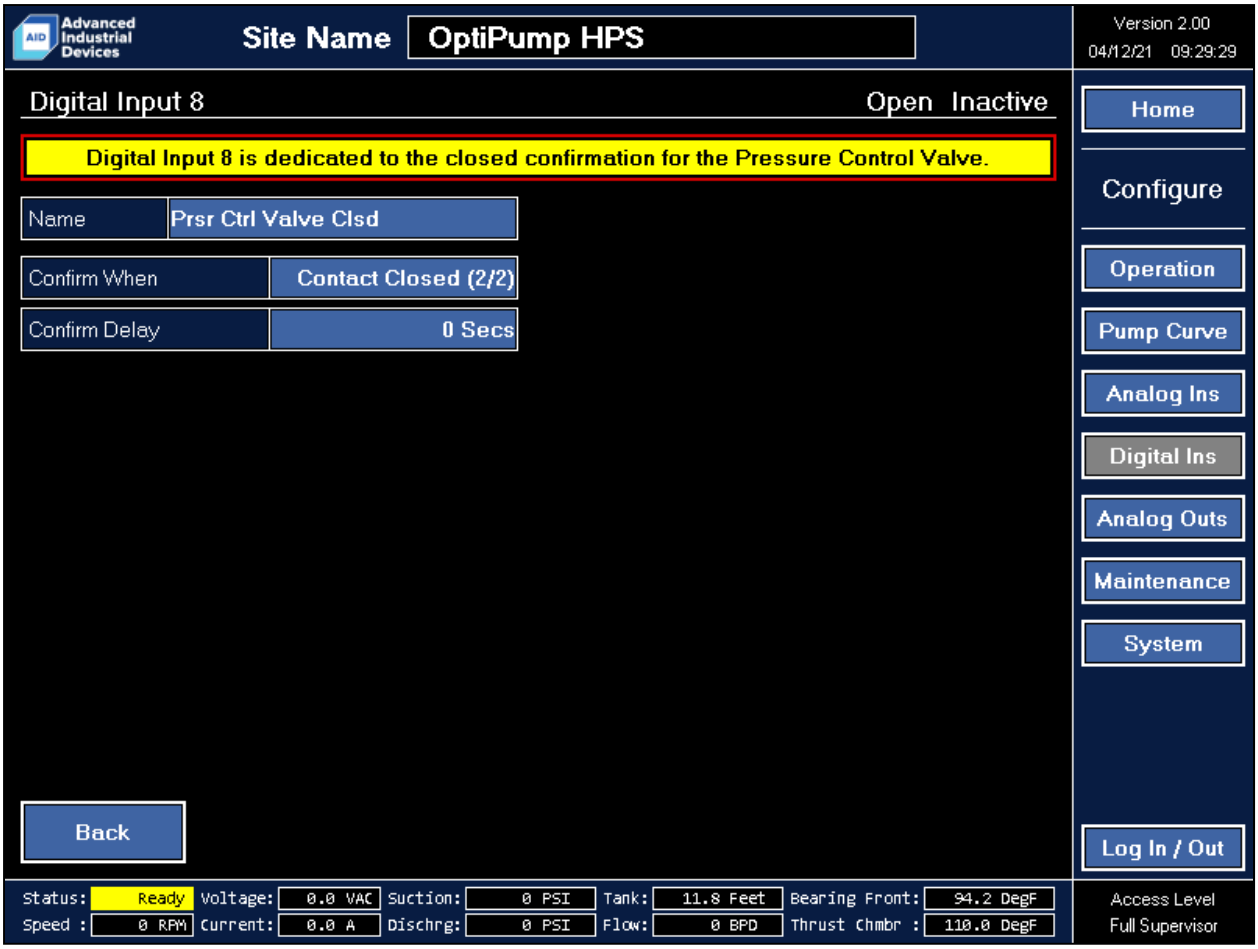
Digital Input 7 > Confirm Delay

The amount of time required for the input to be open or closed before confirming that the charge pump is actively running. This feature can be used to debounce the input.

(DI8) Prsr Ctrl Valve Clsd

Configuration parameters related to Digital Input 8 are available in:

Configure > Digital Ins > Digital Input 8



The function of Digital Input 8 is dedicated to the closed confirmation of the pressure control valve. When used on a system with pressure control valve position indication contacts, Digital Input 8 is used to provide feedback to the controller that the pressure control valve is in the fully closed position. Refer to **Configure > Operation > Pressure Control Valve** for more information. The name can be modified by the operator.

Note:

Not all installations have pressure control valve position indication contacts available. Be sure to refer to the documentation or contact the manufacturer of the pressure control valve to verify proper installation.

Digital Input 8 > Confirm When

Determines when the digital input is considered to be active and to confirm that the pressure control valve is in the fully closed position.

- Contact Open (1/2)
  The pressure control valve is currently in the fully closed position when the contact to the input is open.

- Contact Closed (2/2)
  The pressure control valve is currently in the fully closed position when the contact to the input is closed.

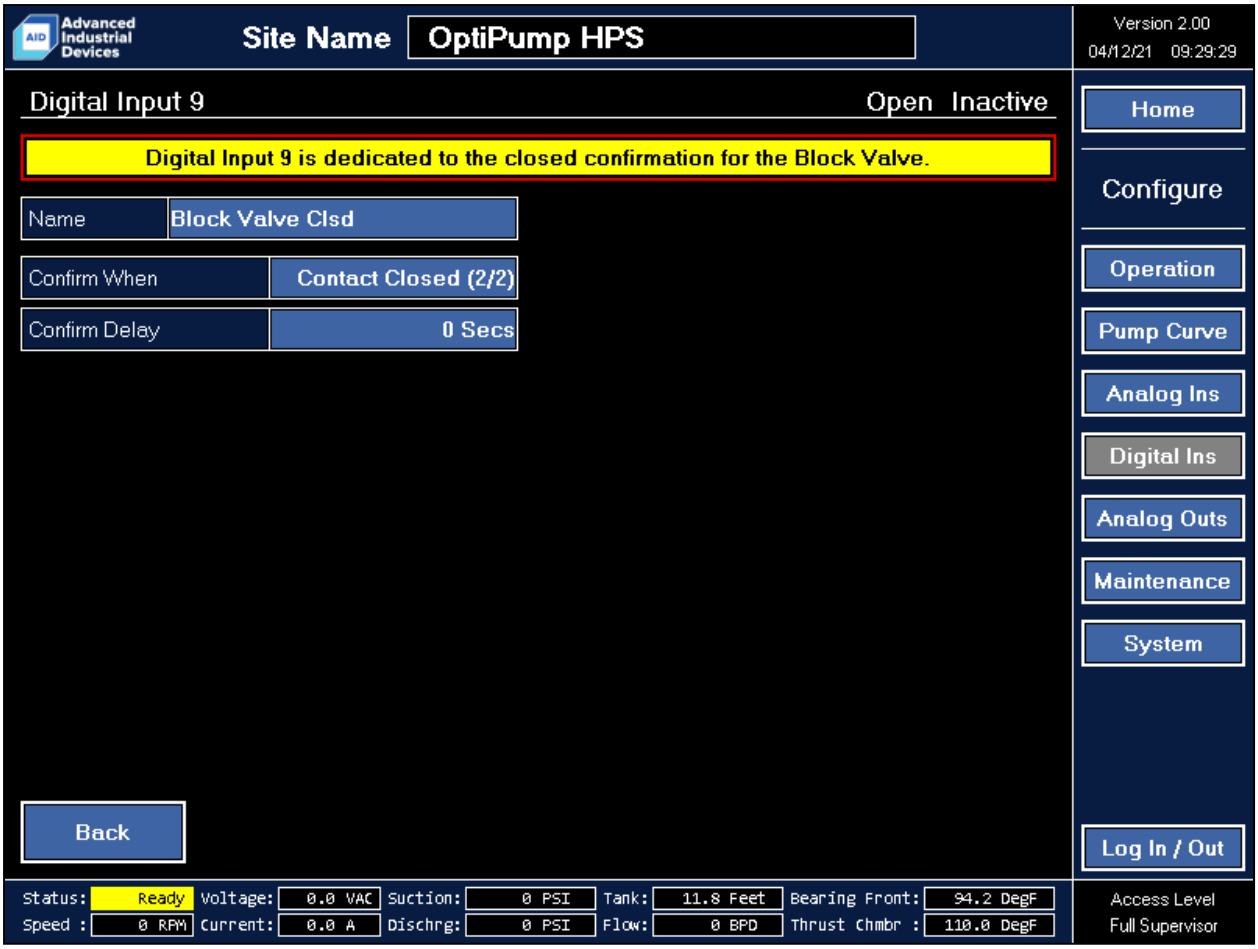
Digital Input 8 > Confirm Delay

The amount of time required for the input to be open or closed before confirming that the pressure control valve is in the fully closed position. This feature can be used to debounce the input.

(DI9) Block Valve Clsd

Configuration parameters related to Digital Input 9 are available in:

Configure > Digital Ins > Digital Input 9



The function of Digital Input 9 is dedicated to the closed confirmation of the block valve. When used on a system with a block valve, Digital Input 9 is used to provide feedback to the controller that the block valve is in the fully closed position. Refer to **Configure > Operation > Block Valve** for more information. The name can be modified by the operator.

Note:

Not all installations use a block valve (a block valve is another valve, separate from the pressure control valve). Be sure to refer to the documentation or contact the manufacturer for the block valve, if installed, to verify proper installation.

Digital Input 9 > Confirm When

Determines when the digital input is considered to be active and to confirm that the block valve is in the fully closed position.

- Contact Open (1/2)
  The block valve is currently in the fully closed position when the contact to the input is open.

- Contact Closed (2/2)
  The block valve is currently in the fully closed position when the contact to the input is closed.

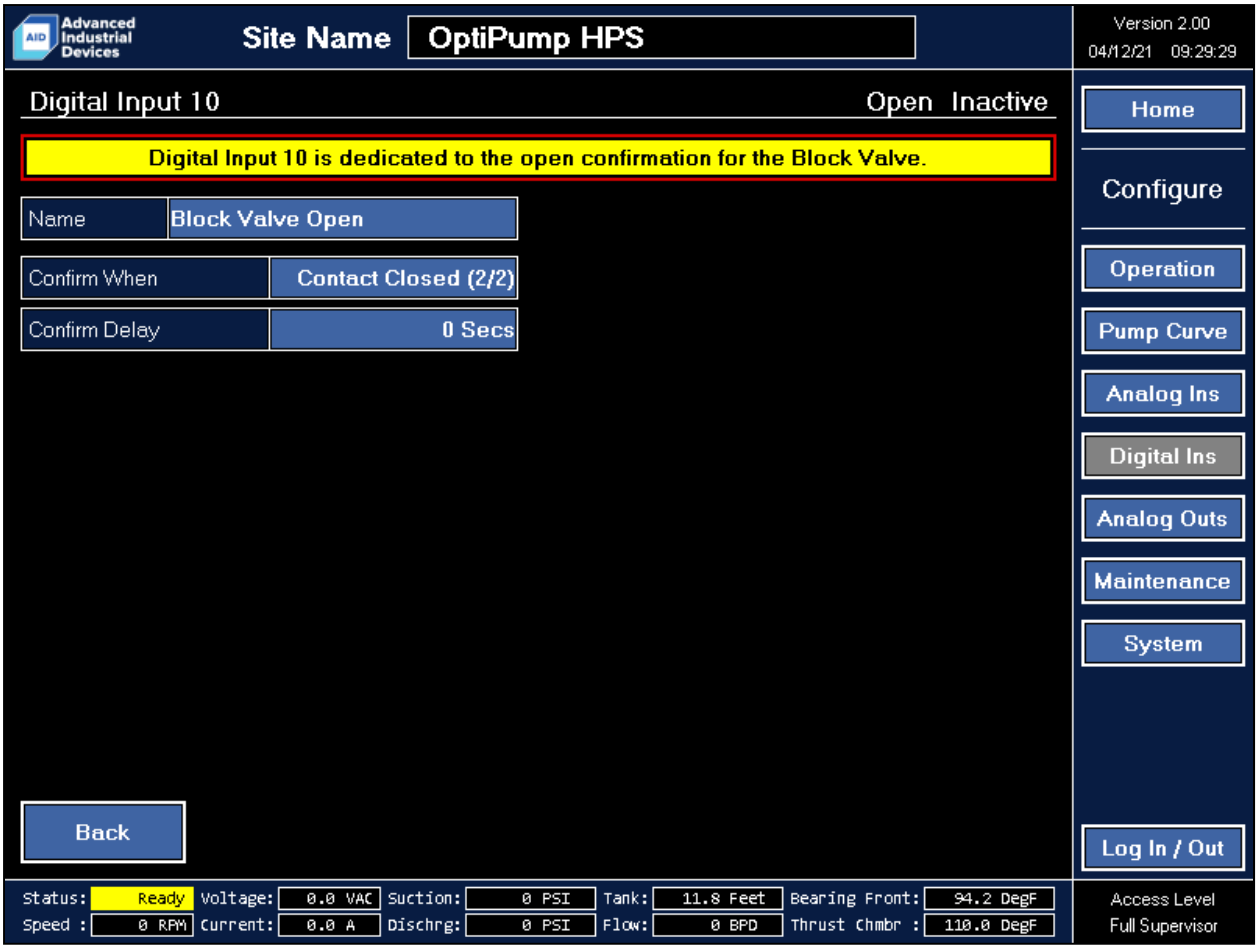
Digital Input 9 > Confirm Delay

The amount of time required for the input to be open or closed before confirming that the block valve is in the fully closed position. This feature can be used to debounce the input.

(DI10) Block Valve Open

Configuration parameters related to Digital Input 10 are available in:

Configure > Digital Ins > Digital Input 10



The function of Digital Input 10 is dedicated to the open confirmation of the block valve. When used on a system with a block valve, Digital Input 10 is used to provide feedback to the controller that the block valve is in the fully open position. Refer to **Configure > Operation > Block Valve** for more information. The name can be modified by the operator.

Note:

Not all installations use a block valve (a block valve is another valve, separate from the pressure control valve). Be sure to refer to the documentation or contact the manufacturer for the block valve, if installed, to verify proper installation.

(DI10) Block Valve Open > Confirm When

Determines when the digital input is considered to be active and to confirm that the block valve is in the fully open position.

- Contact Open (1/2)
  The block valve is currently in the fully open position when the contact to the input is open.

- Contact Closed (2/2)
  The block valve is currently in the fully open position when the contact to the input is closed.

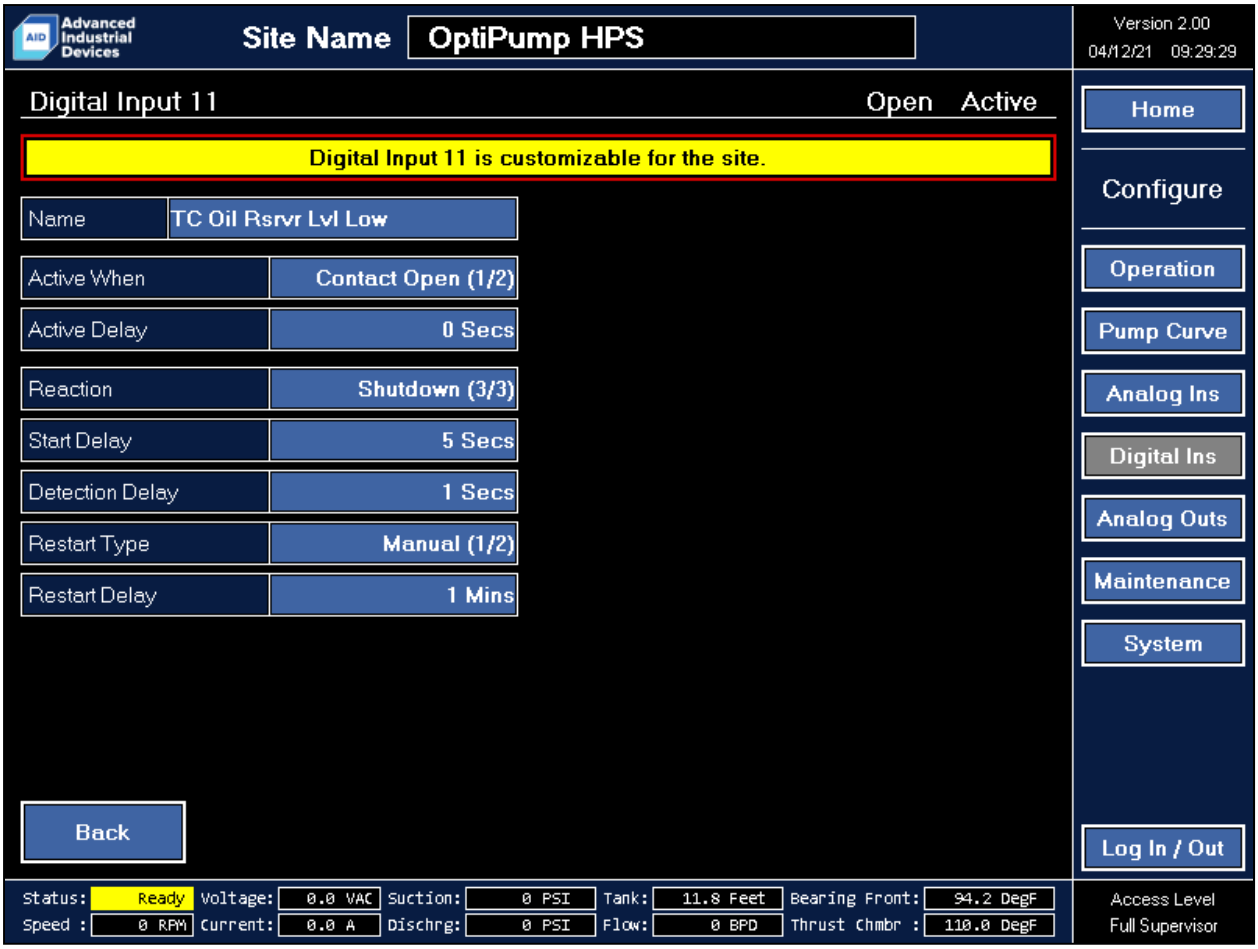
(DI10) Block Valve Open > Confirm Delay

The amount of time required for the input to be open or closed before confirming that the block valve is in the fully open position. This feature can be used to debounce the input.

(DI11) TC Oil Rsrvr Lvl Low

Configuration parameters related to Digital Input 11 are available in:

Configure > Digital Ins > Digital Input 11



Digital Input 11 does not have a dedicated function, but is configured to indicate a low level in the thrust chamber oil reservoir by default. The name can be modified by the operator.

Digital Input 11 > Active When

Determines when the digital input is considered to be active.

- Contact Open (1/2)
  The digital input indication will be active when the contact to the input is open.

- Contact Closed (2/2)
  The digital input indication will be active when the contact to the input is closed.

Digital Input 11 > Active Delay

The amount of time required for the input to be open or closed before indicating that the digital input is active. This feature can be used to debounce the input.

Digital Input 11 > Reaction

- Disabled (1/3)
  The input will be ignored. Use this option if the input will not be used.

- Alarm (2/3)
  An alarm event will be indicated, but the system will continue to run.

- Shutdown (3/3)
  A shutdown event will be triggered, and the system will stop after following the Post-Run sequence.

Digital Input 11 > Start Delay

The amount of time the controller will wait for the main pump to be running before ever looking for an alarm/shutdown condition on the digital input. Once the start delay time is complete it will not be used again until the next system start.

Digital Input 11 > Detection Delay

After the start delay is complete, the controller will then use the detection delay. If an alarm/shutdown condition is present for the amount of time in this setting, the controller will set an alarm or shutdown event depending on the setting of Reaction.

Digital Input 11 > Restart Type

- Manual (1/2)
  If a shutdown event occurs, a manual restart will require an operator to either locally or remotely, via SCADA, reset the shutdown event before the system will restart.

- Timed (2/2)
  If a shutdown event occurs, a timed restart will automatically reset the shutdown event after the time set in Restart Delay.

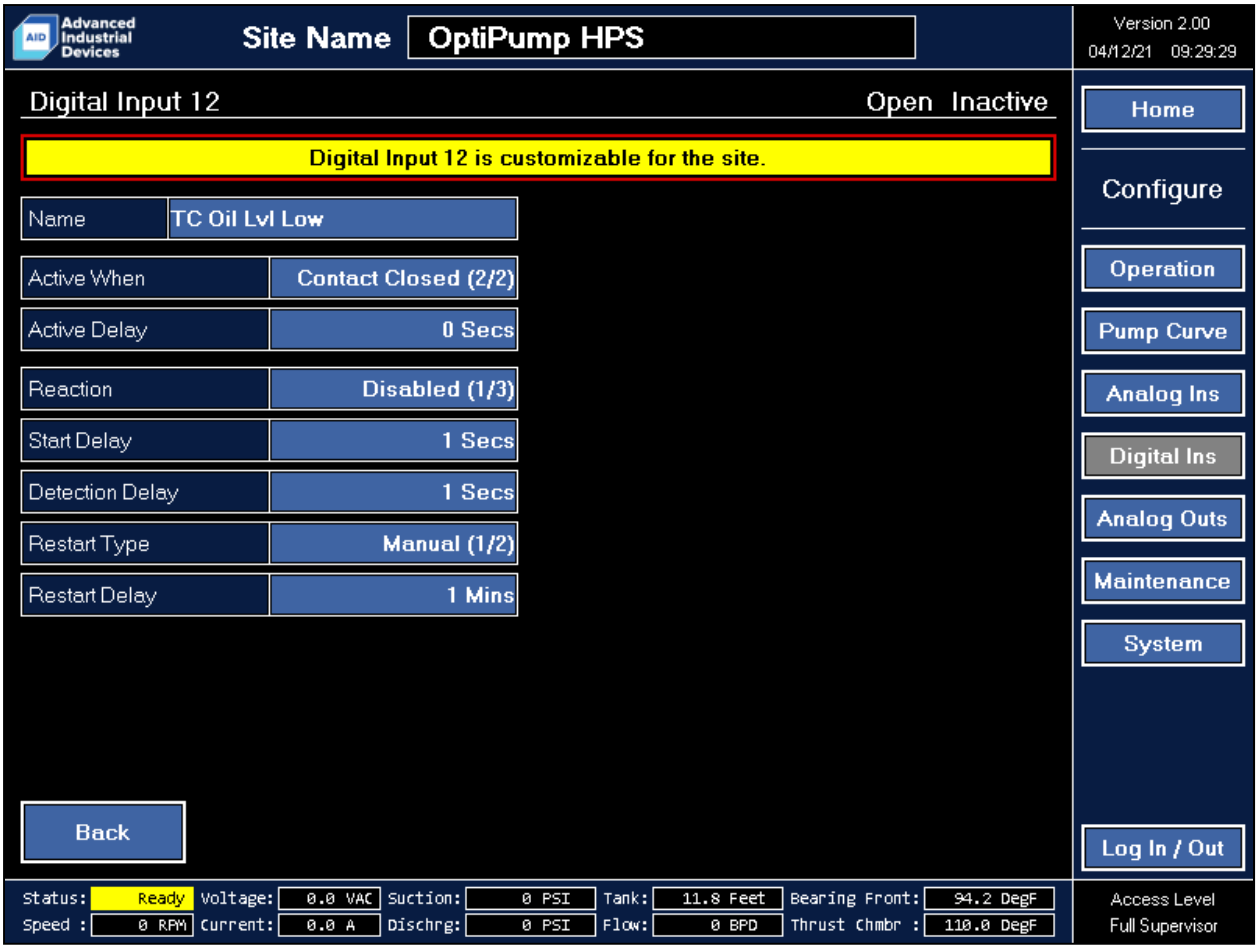
Digital Input 11 > Restart Delay

When a shutdown event occurs, and is configured for a timed restart, the shutdown event will automatically reset after this delay has expired.

(DI12) Thrst Chmbr Oil Lvl Low

Configuration parameters related to Digital Input 12 are available in:

Configure > Digital Ins > Digital Input 12



Digital Input 12 does not have a dedicated function, but is configured to indicate a low oil level in the thrust chamber by default. The name can be modified by the operator.

Digital Input 12 > Active When

Determines when the digital input is considered to be active.

- Contact Open (1/2)
  The digital input indication will be active when the contact to the input is open.

- Contact Closed (2/2)
  The digital input indication will be active when the contact to the input is closed.

Digital Input 11 > Active Delay

The amount of time required for the input to be open or closed before indicating that the digital input is active. This feature can be used to debounce the input.

Digital Input 12 > Reaction

- Disabled (1/3)
  The input will be ignored. Use this option if the input will not be used.

- Alarm (2/3)
  An alarm event will be indicated, but the system will continue to run.

- Shutdown (3/3)
  A shutdown event will be triggered, and the system will stop after following the Post-Run sequence.

Digital Input 12 > Start Delay

The amount of time the controller will wait for the main pump to be running before ever looking for an alarm/shutdown condition on the digital input. Once the start delay time is complete it will not be used again until the next system start.

Digital Input 12 > Detection Delay

After the start delay is complete, the controller will then use the detection delay. If an alarm/shutdown condition is present for the amount of time in this setting, the controller will set an alarm or shutdown event depending on the setting of Reaction.

Digital Input 12 > Restart Type

- Manual (1/2)
  If a shutdown event occurs, a manual restart will require an operator to either locally or remotely, via SCADA, reset the shutdown event before the system will restart.

- Timed (2/2)
  If a shutdown event occurs, a timed restart will automatically reset the shutdown event after the time set in Restart Delay.

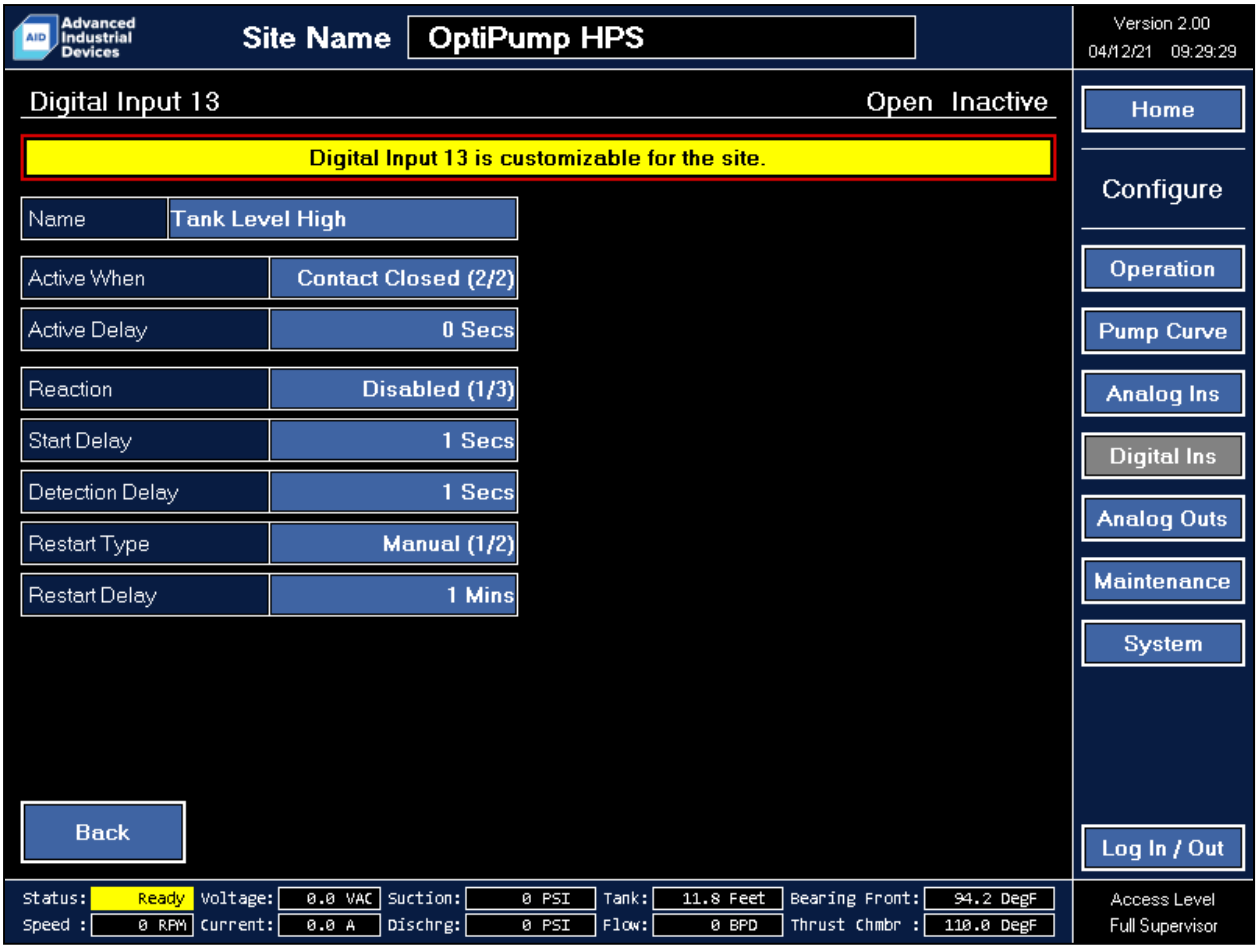
Digital Input 12 > Restart Delay

When a shutdown event occurs, and is configured for a timed restart, the shutdown event will automatically reset after this delay has expired.

(DI13) Tank Level High

Configuration parameters related to Digital Input 13 are available in:

Configure > Digital Ins > Digital Input 13



Digital Input 13 does not have a dedicated function, but is configured to indicate a high tank level condition by default. The name can be modified by the operator.

Digital Input 13 > Active When

Determines when the digital input is considered to be active.

- Contact Open (1/2)
  The digital input indication will be active when the contact to the input is open.

- Contact Closed (2/2)
  The digital input indication will be active when the contact to the input is closed.

Digital Input 13 > Active Delay

The amount of time required for the input to be open or closed before indicating that the digital input is active. This feature can be used to debounce the input.

Digital Input 13 > Reaction

- Disabled (1/3)
  The input will be ignored. Use this option if the input will not be used.

- Alarm (2/3)
  An alarm event will be indicated, but the system will continue to run.

- Shutdown (3/3)
  A shutdown event will be triggered, and the system will stop after following the Post-Run sequence.

Digital Input 13 > Start Delay

The amount of time the controller will wait for the main pump to be running before ever looking for an alarm/shutdown condition on the digital input. Once the start delay time is complete it will not be used again until the next system start.

Digital Input 13 > Detection Delay

After the start delay is complete, the controller will then use the detection delay. If an alarm/shutdown condition is present for the amount of time in this setting, the controller will set an alarm or shutdown event depending on the setting of Reaction.

Digital Input 13 > Restart Type

- Manual (1/2)
  If a shutdown event occurs, a manual restart will require an operator to either locally or remotely, via SCADA, reset the shutdown event before the system will restart.

- Timed (2/2)
  If a shutdown event occurs, a timed restart will automatically reset the shutdown event after the time set in Restart Delay.

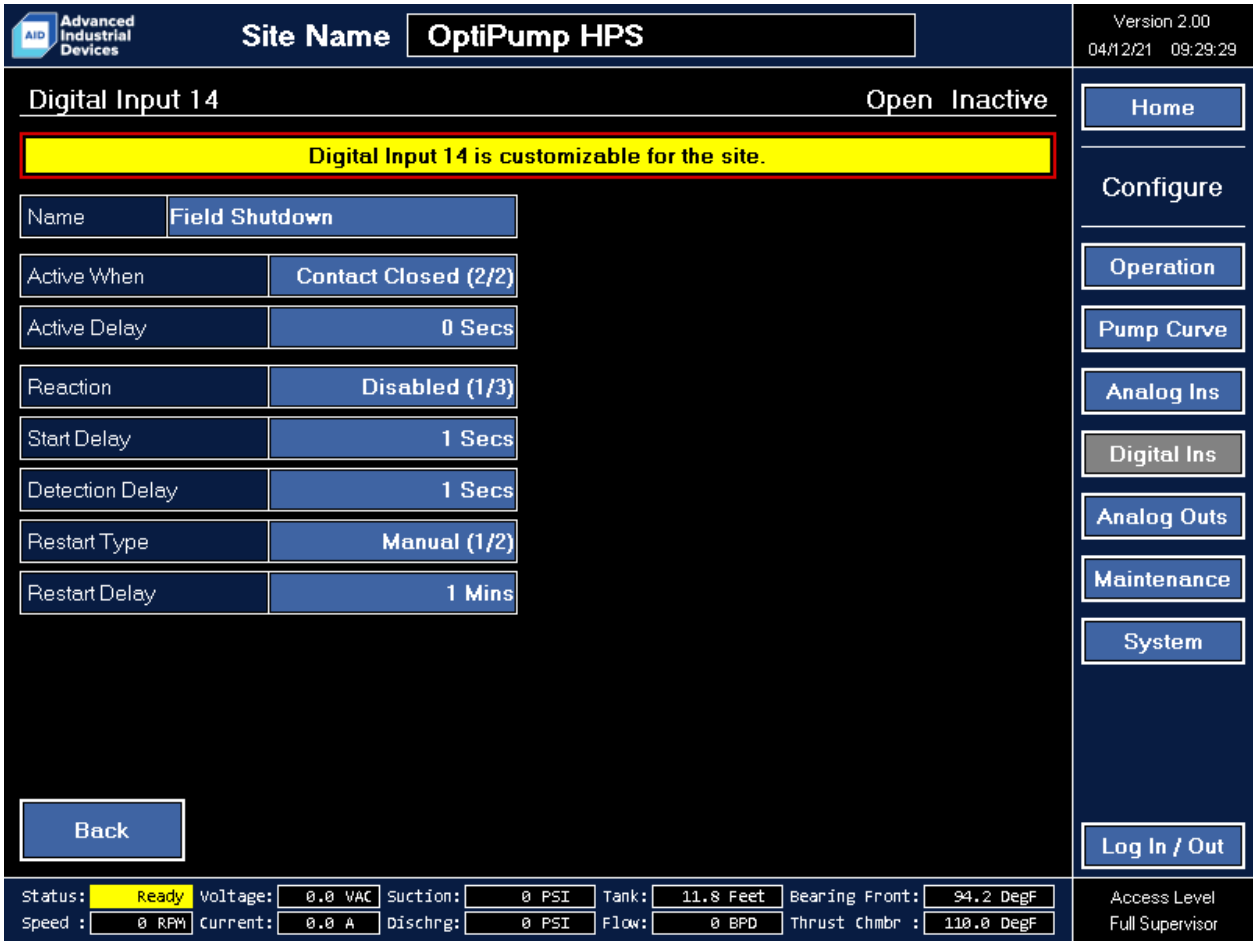
Digital Input 13 > Restart Delay

When a shutdown event occurs, and is configured for a timed restart, the shutdown event will automatically reset after this delay has expired.

(DI14) Field Shutdown

Configuration parameters related to Digital Input 14 are available in:

Configure > Digital Ins > Digital Input 14



Digital Input 14 does not have a dedicated function, but is configured to indicate a general purpose field shutdown by default. The name can be modified by the operator.

Digital Input 14 > Active When

Determines when the digital input is considered to be active.

- Contact Open (1/2)
  The digital input indication will be active when the contact to the input is open.

- Contact Closed (2/2)
  The digital input indication will be active when the contact to the input is closed.

Digital Input 14 > Active Delay

The amount of time required for the input to be open or closed before indicating that the digital input is active. This feature can be used to debounce the input.

Digital Input 14 > Reaction

- Disabled (1/3)
  The input will be ignored. Use this option if the input will not be used.

- Alarm (2/3)
  An alarm event will be indicated, but the system will continue to run.

- Shutdown (3/3)
  A shutdown event will be triggered, and the system will stop after following the Post-Run sequence.

Digital Input 14 > Start Delay

The amount of time the controller will wait for the main pump to be running before ever looking for an alarm/shutdown condition on the digital input. Once the start delay time is complete it will not be used again until the next system start.

Digital Input 14 > Detection Delay

After the start delay is complete, the controller will then use the detection delay. If an alarm/shutdown condition is present for the amount of time in this setting, the controller will set an alarm or shutdown event depending on the setting of Reaction.

Digital Input 14 > Restart Type

- Manual (1/2)
  If a shutdown event occurs, a manual restart will require an operator to either locally or remotely, via SCADA, reset the shutdown event before the system will restart.

- Timed (2/2)
  If a shutdown event occurs, a timed restart will automatically reset the shutdown event after the time set in Restart Delay.

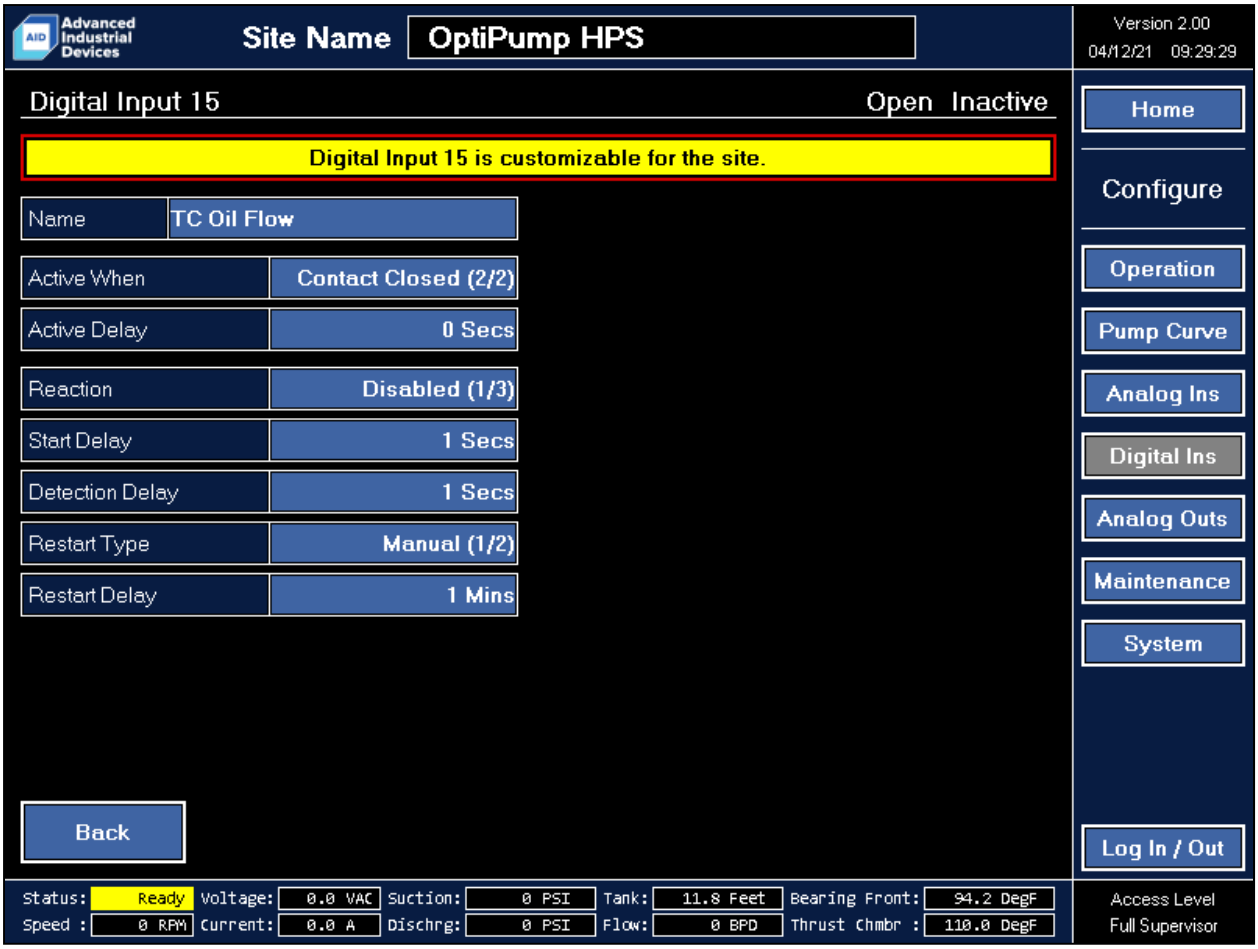
Digital Input 14 > Restart Delay

When a shutdown event occurs, and is configured for a timed restart, the shutdown event will automatically reset after this delay has expired.

(DI15) TC Oil Flow

Configuration parameters related to Digital Input 15 are available in:

Configure > Digital Ins > Digital Input 15



Digital Input 15 does not have a dedicated function, but is configured to indicate low thrust chamber oil flow by default. The name can be modified by the operator.

Digital Input 15 > Active When

Determines when the digital input is considered to be active.

- Contact Open (1/2)
  The digital input indication will be active when the contact to the input is open.

- Contact Closed (2/2)
  The digital input indication will be active when the contact to the input is closed.

Digital Input 15 > Active Delay

The amount of time required for the input to be open or closed before indicating that the digital input is active. This feature can be used to debounce the input.

Digital Input 15 > Reaction

- Disabled (1/3)
  The input will be ignored. Use this option if the input will not be used.

- Alarm (2/3)
  An alarm event will be indicated, but the system will continue to run.

- Shutdown (3/3)
  A shutdown event will be triggered, and the system will stop after following the Post-Run sequence.

Digital Input 15 > Start Delay

The amount of time the controller will wait for the main pump to be running before ever looking for an alarm/shutdown condition on the digital input. Once the start delay time is complete it will not be used again until the next system start.

Digital Input 15 > Detection Delay

After the start delay is complete, the controller will then use the detection delay. If an alarm/shutdown condition is present for the amount of time in this setting, the controller will set an alarm or shutdown event depending on the setting of Reaction.

Digital Input 15 > Restart Type

- Manual (1/2)
  If a shutdown event occurs, a manual restart will require an operator to either locally or remotely, via SCADA, reset the shutdown event before the system will restart.

- Timed (2/2)
  If a shutdown event occurs, a timed restart will automatically reset the shutdown event after the time set in Restart Delay.

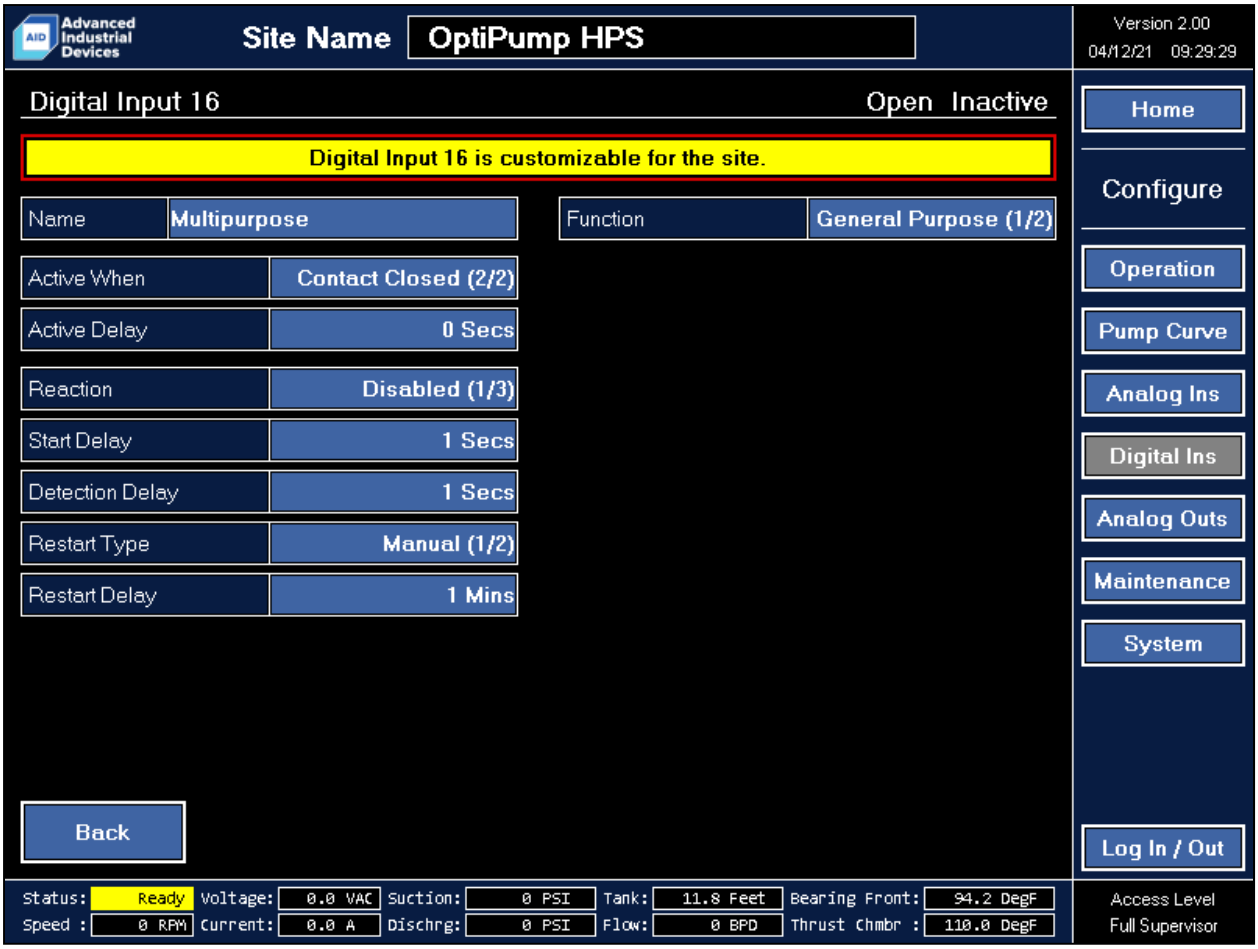
Digital Input 15 > Restart Delay

When a shutdown event occurs, and is configured for a timed restart, the shutdown event will automatically reset after this delay has expired.

(DI16) Multipurpose

Configuration parameters related to Digital Input 16 are available in:

Configure > Digital Ins > Digital Input 16



Digital Input 16 is a multipurpose digital input that can be used for annunciation, alarm indication, shutdown event triggering, or remote resetting of shutdown or fault events. The name can be modified by the operator.

Digital Input 16 > Function

While most of the digital inputs have either a dedicated purpose or are general purpose, the function of Digital Input 16 is configurable by the operator.

- General Purpose (1/2)
  The digital input will operate similar to one of the other digital inputs without a dedicated function. The configured Reaction determines what will occur when the input becomes active.

- Reset (2/2)
  If a shutdown or fault event is currently set, the input will reset the shutdown or fault when the input is active.

Digital Input 16 > Active When

Determines when the digital input is considered to be active.

- Contact Open (1/2)
  The digital input indication will be active when the contact to the input is open.

- Contact Closed (2/2)
  The digital input indication will be active when the contact to the input is closed.

Digital Input 16 > Active Delay

The amount of time required for the input to be open or closed before indicating that the digital input is active. This feature can be used to debounce the input.

Digital Input 16 > Reaction

Generally, the Reaction should be set to Disabled when Function is configured for Reset.

- Disabled (1/3)
  The input will be ignored. Use this option if the input will not be used.

- Alarm (2/3)
  An alarm event will be indicated, but the system will continue to run.

- Shutdown (3/3)
  A shutdown event will be triggered, and the system will stop after following the Post-Run sequence.

Digital Input 16 > Start Delay

The amount of time the controller will wait for the main pump to be running before ever looking for an alarm/shutdown condition on the digital input. Once the start delay time is complete it will not be used again until the next system start.

Digital Input 16 > Detection Delay

After the start delay is complete, the controller will then use the detection delay. If an alarm/shutdown condition is present for the amount of time in this setting, the controller will set an alarm or shutdown event depending on the setting of Reaction.

Digital Input 16 > Restart Type

- Manual (1/2)
  If a shutdown event occurs, a manual restart will require an operator to either locally or remotely, via SCADA, reset the shutdown event before the system will restart.

- Timed (2/2)
  If a shutdown event occurs, a timed restart will automatically reset the shutdown event after the time set in Restart Delay.

Digital Input 16 > Restart Delay

When a shutdown event occurs, and is configured for a timed restart, the shutdown event will automatically reset after this delay has expired.

Analog Outputs

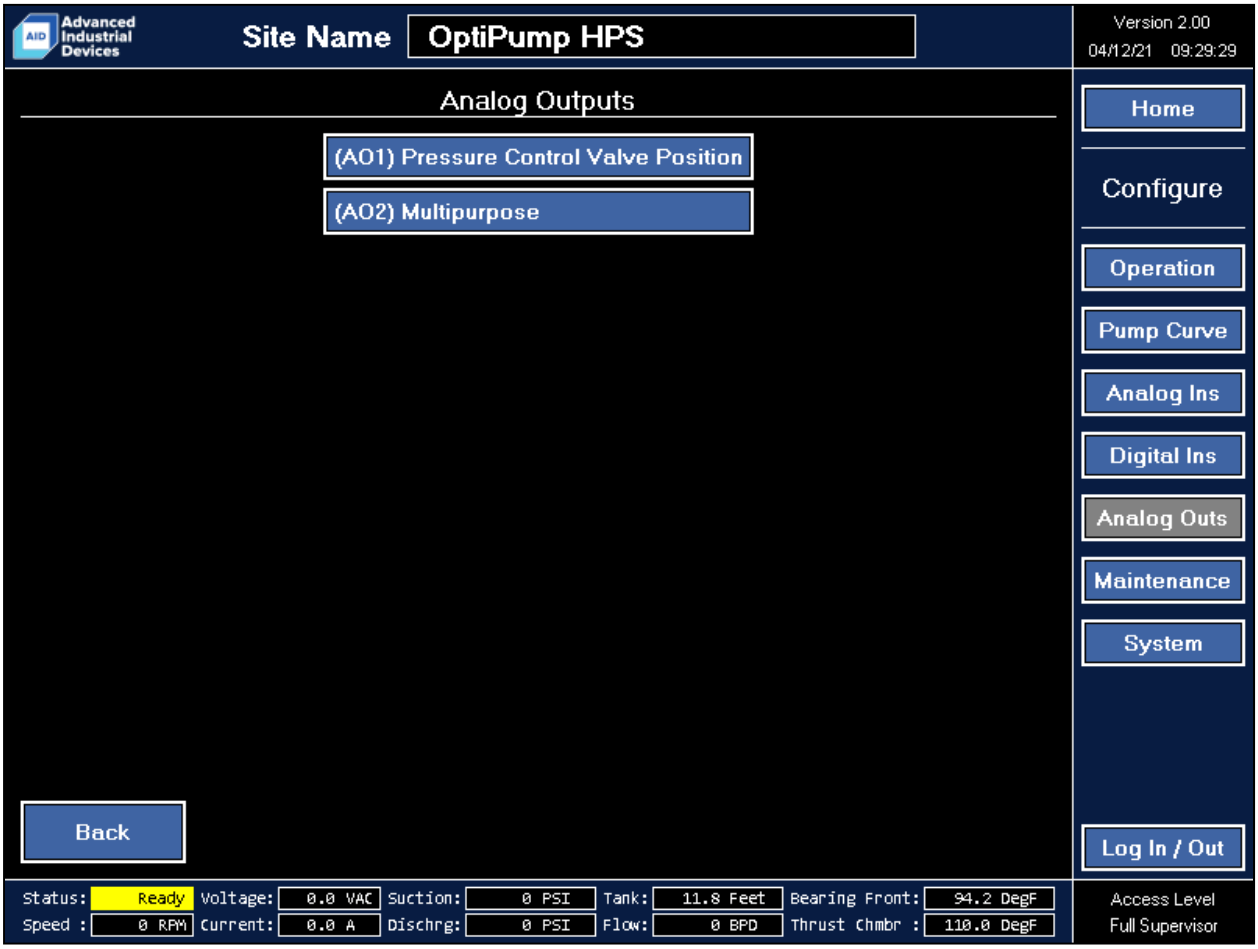
Analog outputs available to the operator include:

- 1 4-20 mA
- 2 4-20 mA

The analog outputs are connected to one of the controller I/O modules. I/O module wiring is indicated for each individual output on subsequent pages.

Configuration parameters related to the Analog Outputs are available in:

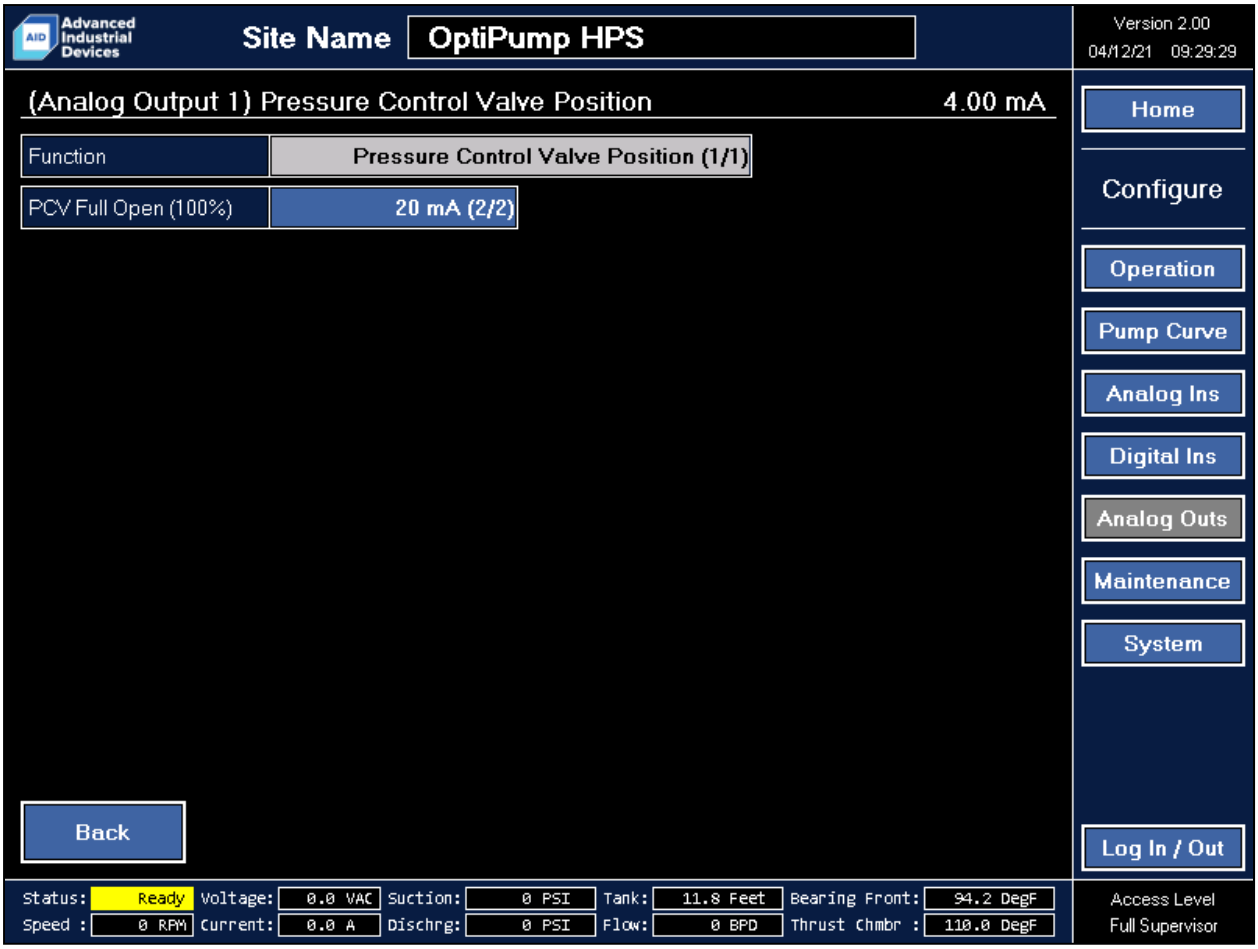
Configure > Analog Outs



(AO1) Pressure Control Valve Position

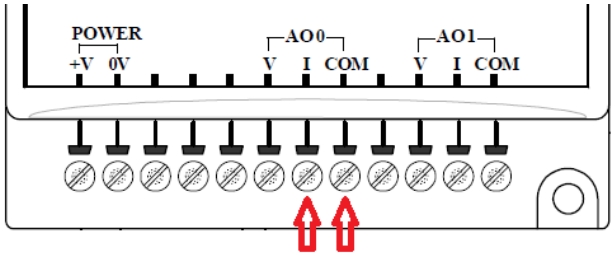
Configuration parameters related to Analog Output 1 are available in:

Configure > Analog Outs > (AO1) Pressure Control Valve Position



The function of Analog Output 1 is dedicated to the pressure control valve position command, and is responsible for moving the pressure control valve to the desired position.

The 4-20ma signal is connected to terminals I and COM of group AO0 on the I/O module labeled IO-AI4-AO2.



(AO1) Pressure Control Valve Position > Function

The Function for (AO1) Pressure Control Valve Position is dedicated, and cannot be changed by the operator.

(AO1) Pressure Control Valve Position > Full Open (100%)

Depending on the brand and model of pressure control valve used, the signal value used to command the valve to the full open position may differ from installation to installation. Select the value that matches the signal value required by the valve to reach the full open position.

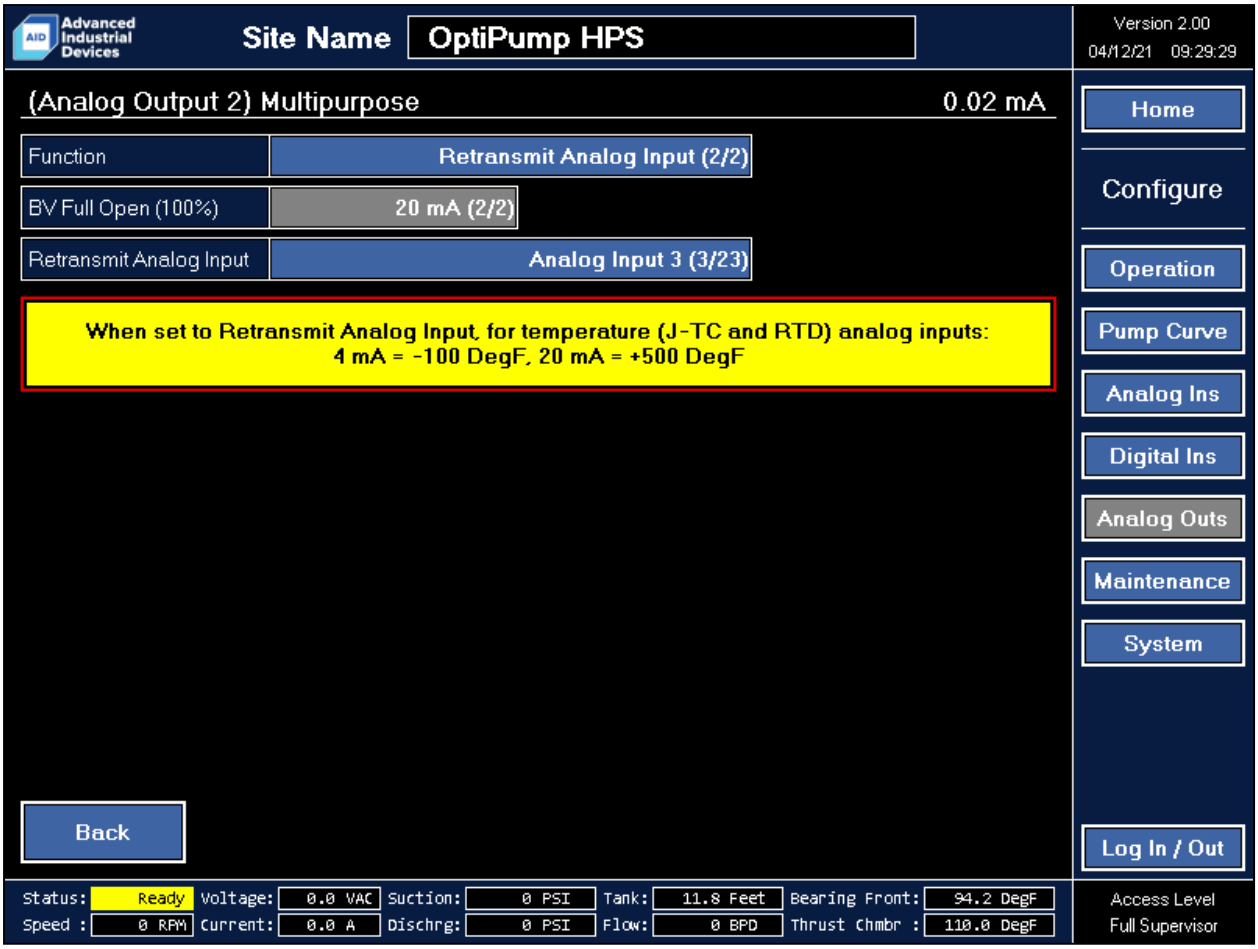
- 4 mA (1/2)
  The pressure control valve is in the full open position when sending a 4 mA command signal.

- 20 mA (2/2)
  The pressure control valve is in the full open position when sending a 20 mA command signal.

(AO2) Multipurpose

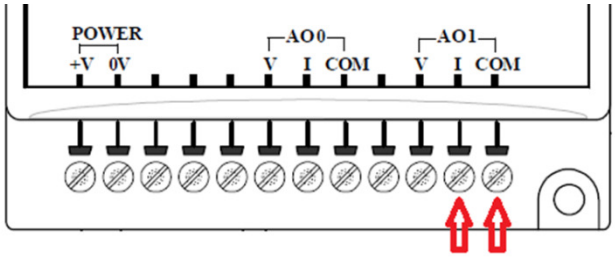
Configuration parameters related to Analog Output 2 are available in:

Configure > Analog Outs > (AO2) Multipurpose



The function of Analog Output 2 is dedicated to the pressure control valve position command, and is responsible for moving the pressure control valve to the desired position.

The 4-20ma signal is connected to terminals I and COM of group AO1 on the I/O module labeled IO-AI4-AO2.



(AO2) Pressure Control Valve Position > Function

The function of the (AO2) Multipurpose output is configurable by the operator.

- Block Valve Position (1/2)
  The analog output will be used to command the position of an optional block valve.

- Retransmit Analog Input (2/2)
  The analog output will retransmit one of the connected analog inputs selected by the operator.

(AO2) Pressure Control Valve Position > BV Full Open (100%)

When an optional block valve is installed, the block valve may require positioning commands via a 4-20 mA signal, rather than digital output contact closures. Depending on the make and model of the block valve control module used, the signal value used to command the valve to the full open position may differ from site to site. Select the value that matches the signal value required by the block valve control module to reach the full open position.

BV Full Open (100%) is disabled when Function is set to Retransmit Analog Input.

- 4 mA (1/2)
  The block valve is in the full open position when sending a 4 mA command signal.

- 20 mA (2/2)
  The block valve is in the full open position when sending a 20 mA command signal.

(AO2) Pressure Control Valve Position > Retransmit Analog Input

Occasionally, some installations may require simultaneously connecting a sensor to equipment other than just the OptiPump HPS controller. In this case, the OptiPump HPS controller can retransmit any one of the analog inputs connected via Analog Output 2.

When a temperature input is selected to retransmit, the OptiPump HPS controller will automatically scale the J-type thermocouple or RTD signal as: 4 mA = -100 °F and 20 mA = +500 °F.

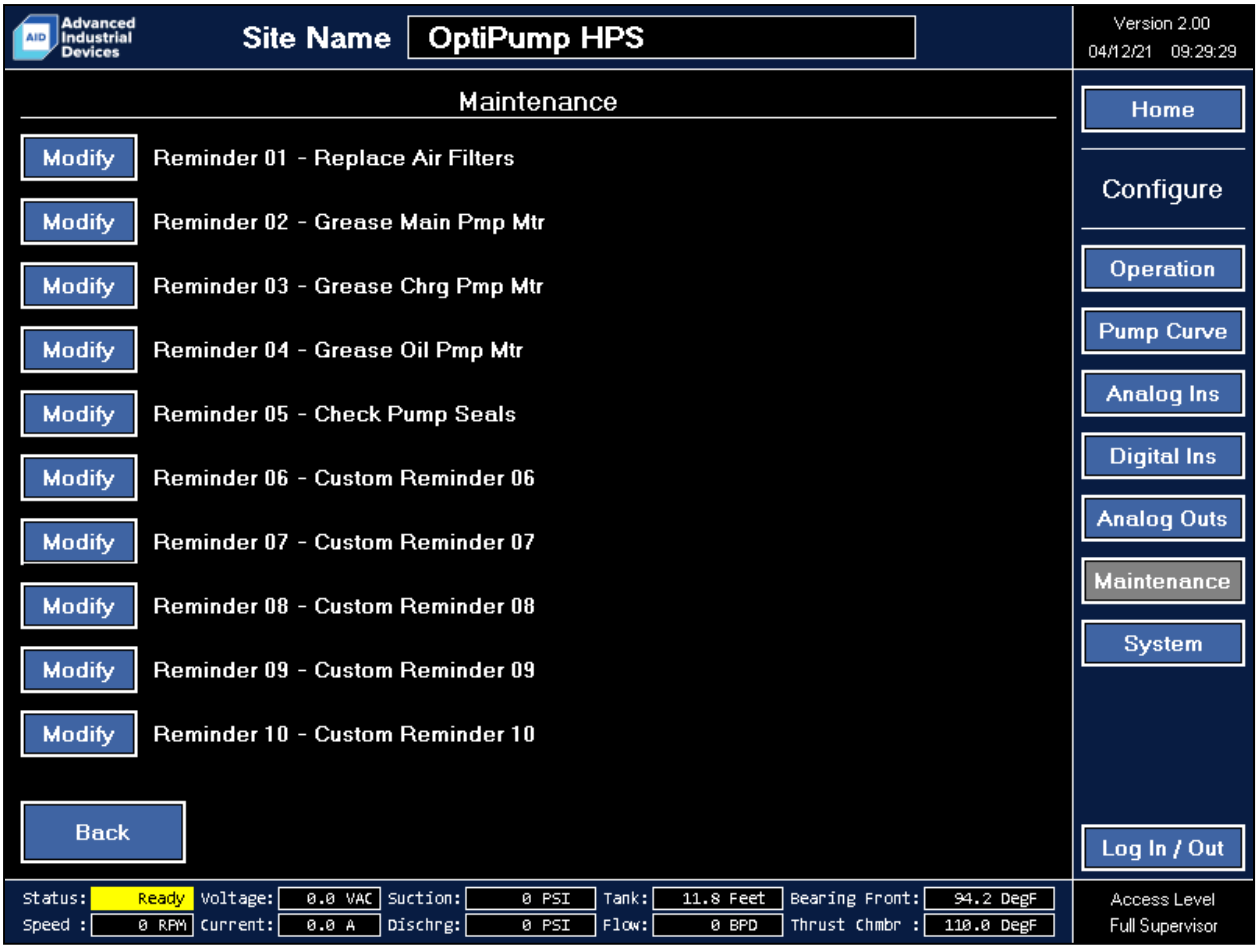
Retransmit Analog Input is disabled when Function is set to Block Valve Position.

- Analog Input 1 (1/23)
- Analog Input 2 (2/23)
- Analog Input 3 (3/23)
- Analog Input 4 (4/23)
- Analog Input 5 (5/23)
- Analog Input 6 (6/23)
- Analog Input 7 (7/23)
- Analog Input 8 (8/23)
- Analog Input 9 (9/23)
- Analog Input 10 (10/23)
- Analog Input 11 (11/23)
- Analog Input 12 (12/23)
- Analog Input 13 (13/23)
- Analog Input 14 (14/23)
- Analog Input 15 (15/23)
- Analog Input 16 (16/23)
- Analog Input 17 (17/23)
- Analog Input 18 (18/23)
- Analog Input 19 (19/23)
- Analog Input 20 (20/23)
- Analog Input 21 (21/23)
- Analog Input 22 (22/23)
- Analog Input 23 (23/23)

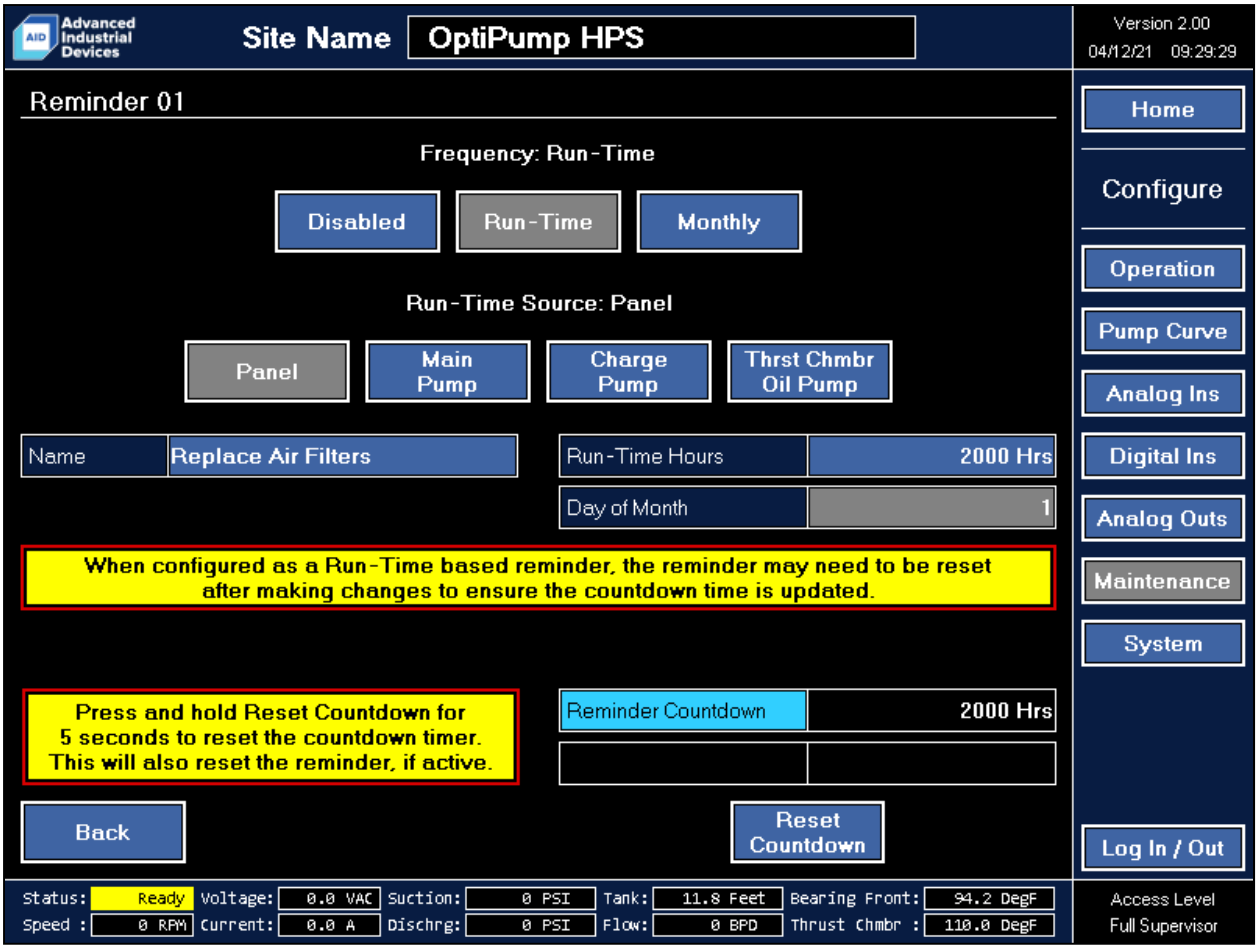
Maintenance Reminders

Configuration parameters related to the Maintenance Reminder system are available in:

Configure > Maintenance



The OptiPump HPS controller includes a built-in Maintenance Reminder system that can automatically remind operators of the need to perform maintenance and other tasks at set intervals. 10 customizable Maintenance Reminders are available, each with independent reminder conditions.



Frequency

Frequency defines how often the reminder to should be activated.

- Disabled
  The reminder will not be used.

- Run-Time
  The reminder will activate based on the run-time hours of the device selected by Run-Time Source.

- Monthly
  The reminder will activate monthly, based on the day of the month entered in the Day of Month parameter.

Run-Time Source

When Frequency is configured for Run-Time, the reminder will be activated based on the run-time hours of one of the following devices:

- Panel
  The panel run-time hours track any time the panel is powered on, regardless of whether or not the main pump is running.

- Main Pump
  The main pump run-time hours track the time the main pump is running.

- Charge Pump
  The charge pump run-time hours track the time the charge pump is running.

- Thrst Chmbr Oil Pump
  The thrust chamber oil pump run-time hours track the time the thrust chamber oil pump is running.

Name

A 20 character alphanumeric reminder name can be set by the operator for each of the 10 Maintenance Reminders. Since proper equipment maintenance is critical to the warranty and longevity of the equipment, the name should be chosen to provide facility personnel with a clear understanding of the maintenance task that needs to be performed.

Run-Time Hours

The Run-Time Hours are the number of hours of the selected Run-Time Source device at which the reminder should activate.

Run-Time Hours is disabled when Frequency is set to Disabled or Monthly.

Note:
If the maintenance task has been performed prior to the reminder activating, the Reminder Countdown hours can be reset immediately by holding down the Reset Countdown button for 5 seconds. When the Reset Countdown button is pressed, a 5 second countdown timer will appear. When the Hold status changes to Done, the reset is complete.

	The Reminder Countdown monitor is shown as a reference to the amount of run-time remaining until the reminder activates.

Day of Month

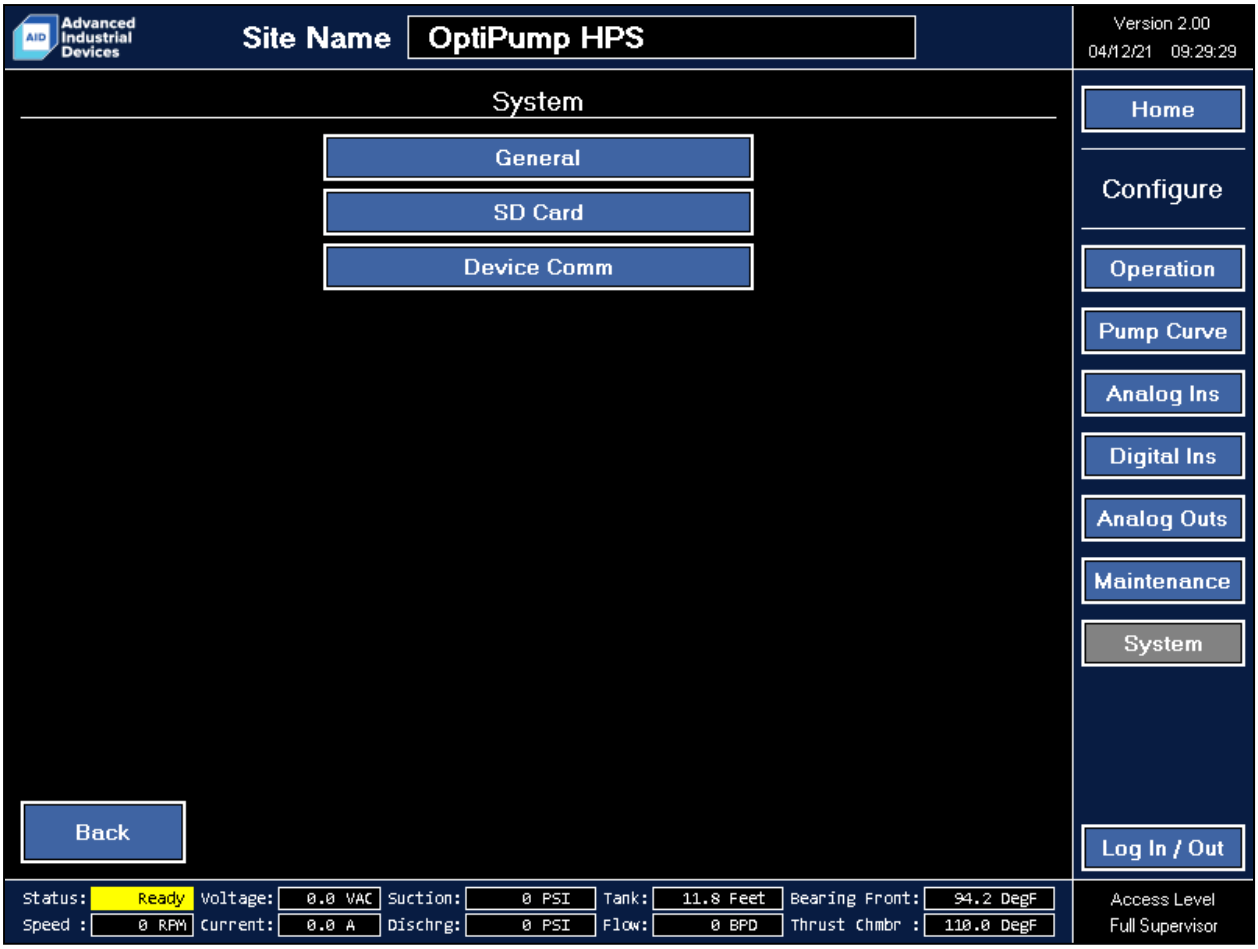
When Frequency is configured for Monthly reminders, the reminder will activate every month on the Day of Month entered by the operator.

Day of Month is disabled when Frequency is set to Disabled or Run-Time.

System

Configuration parameters related to the System are available in:

Configure > System

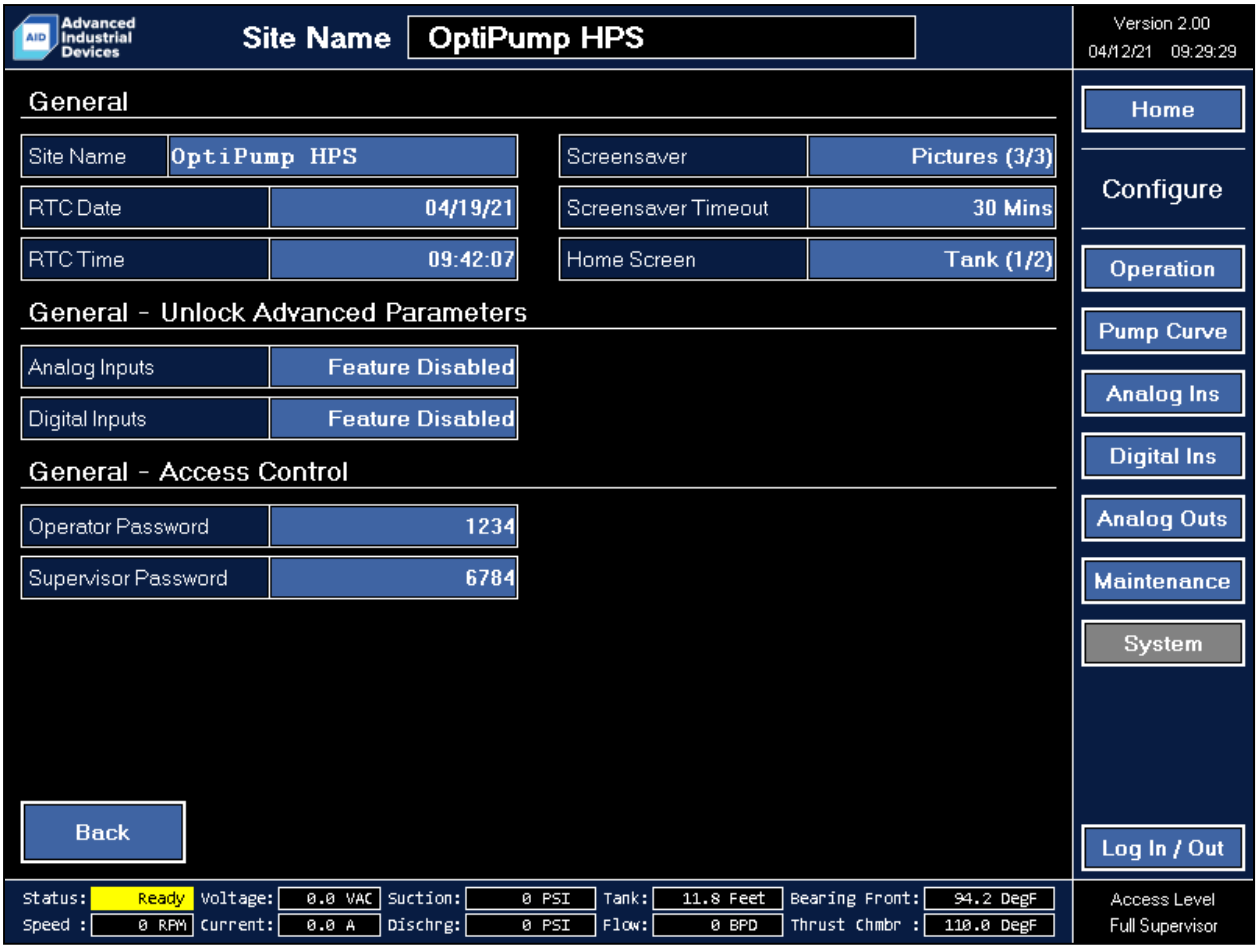


System configuration parameters contain settings related to the overall performance of the controller, which includes items such as the date and time, SD card data logging, and device communication.

General

General system configuration parameters are available in:

Configure > System > General



General > Site Name

A 20 character alphanumeric site name can be set by the operator to uniquely identify an installation. The site name will be displayed at the top of all screens, as well as in the SD card data log.

General > RTC Date

The real-time clock (RTC) date. The RTC date is used to timestamp events and data samples in the log.

General > RTC Time

The real-time clock (RTC) time in 24-hour format. The RTC time is used to timestamp events and data samples in the log.

General > Screensaver

- Disabled (1/3)
  The screen will always remain on. The display will return to the Home screen after 30 minutes of operator inactivity (touchscreen is not pressed).

- Blank (2/3)
  After the period of operator inactivity (touchscreen is not pressed) specified in Screensaver Timeout, the display will return to the Home screen and turn off the screen backlight. Pressing anywhere on the touchscreen will "wake" the display.

- Pictures (3/3)
  After the period of operator inactivity (touchscreen is not pressed) specified in Screensaver Timeout, the display will begin cycling through a series of product and application pictures. Pressing anywhere on the touchscreen will return the display to the Home screen.

General > Screensaver Timeout

The period of operator inactivity (touchscreen is not pressed) required before the screensaver activates. This value only applies when Screensaver is enabled.

General - Unlock Advanced Parameters > Analog Inputs

This feature is currently disabled and unavailable.

General - Unlock Advanced Parameters > Digital Inputs

This feature is currently disabled and unavailable.

General - Access Control > Operator Password

The 4-digit numeric password required to log-in as the Limited Operator access level. Refer to the **Operator Access Level – Log In/Out** section for more information.

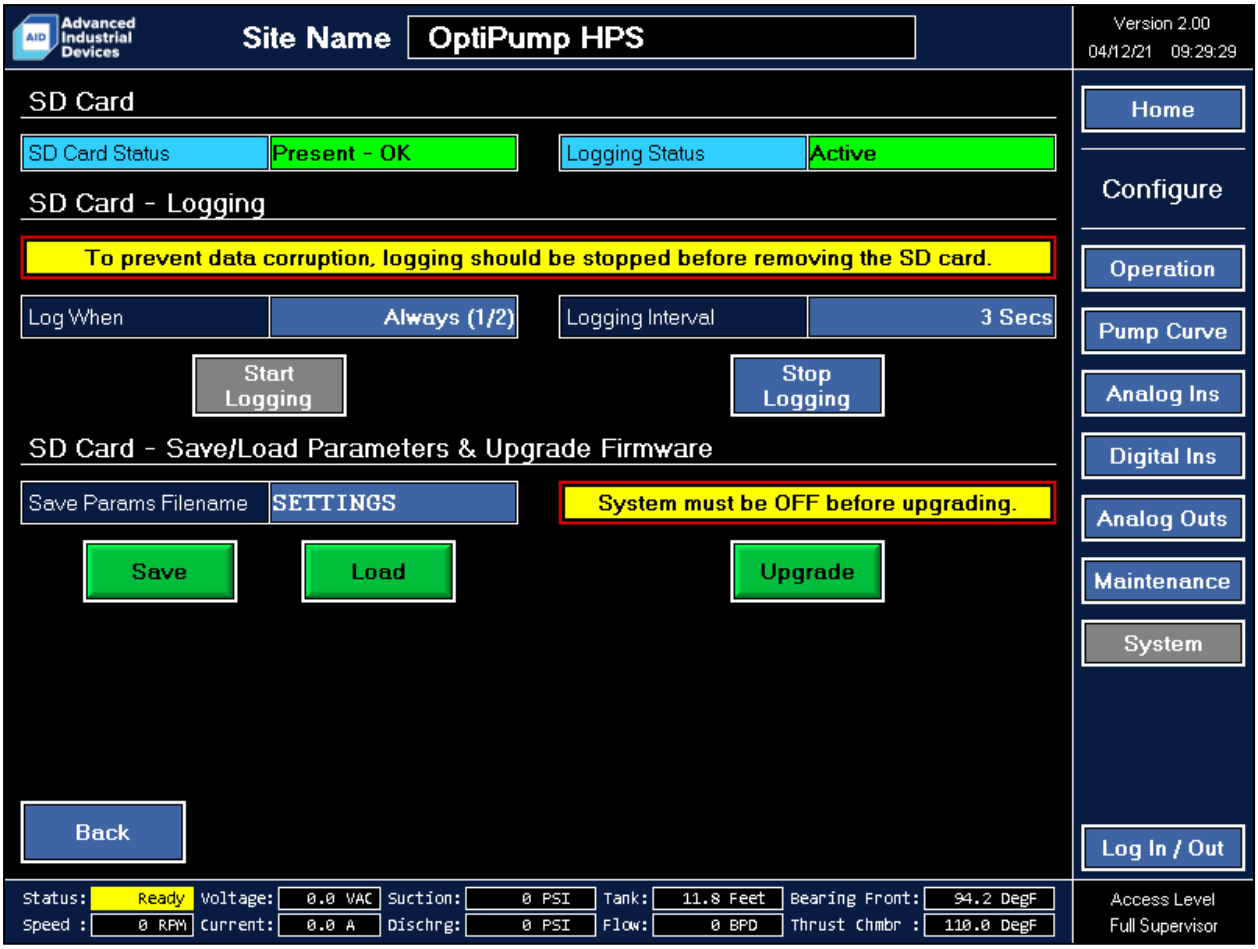
General - Access Control > Supervisor Password

The 4-digit numeric password required to log-in as the Full Supervisor access level. Refer to the **Operator Access Level – Log In/Out** section for more information.

SD Card

SD Card system configuration parameters are available in:

Configure > System > General



The OptiPump HPS controller supports a standard microSD card, which can be used for periodic data logging, saving/loading configuration parameter values, and upgrading the controller firmware. The microSD card MUST be specially formatted in order for the controller to properly recognize and use the microSD card. Refer to the **SD Card Formatting** section for more detailed information on this process.

Note:

The HOA switch should be in the Off position before saving or loading configuration parameters to/from the microSD card or upgrading the controller firmware.

Data Logging

The data logging system records numerous samples in multiple comma-separated value (CSV) files on the microSD card. Each data sample within the log is a snapshot of the operational conditions present at that time. The CSV files are located on the microSD card in the following folders:

- EXCEL\EXCEL1
- EXCEL\EXCEL2
- EXCEL\EXCEL3
- EXCEL\EXCEL4

Each EXCEL folder can contain up to 64 CSV files, and each CSV file can contain up to 30,000 data samples. The CSV files are numerically named 1 through 64, in the order the files are created. When an EXCEL folder has reached the 64 file limit, the next EXCEL folder in the rotation is used, and the filename starts back at 1. This scheme allows for continuous data logging by overwriting the oldest log when no unused log files exist.

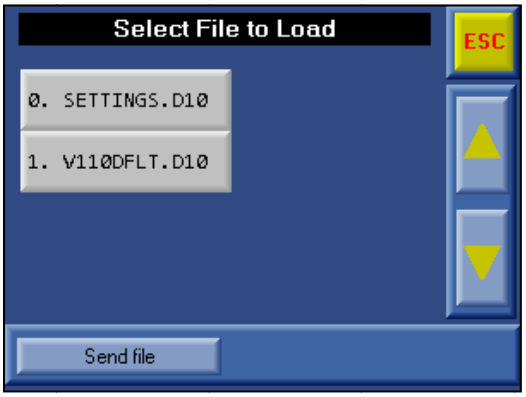
In order reduce the chances of data corruption, the data logging system should be stopped prior to removing the microSD card from the controller. If the logging status is currently active, simply press the Stop Logging button to suspend data logging, or power down the controller, before removing the microSD card.

Save/Load Parameters

The current configuration parameter values can be saved in a file on the microSD card for safe keeping (as a backup) or for reuse at other installation sites of similar configuration. The file format is a binary data file, and can only be read by the controller. The file is saved in the USER_APP folder on the microSD card, with a .D10 file extension.

To save the current configuration parameters to the microSD card, set the desired filename, without the .D10 file extension, in the Save Params Filename parameter, then press the green Save button immediately below the filename parameter. The controller will pause momentarily while the values are saved to the microSD card.

To load configuration parameter values from a .D10 file on the microSD card, press the green Load button. The file browser will open and display a list of .D10 files present in the USER_APP folder on the microSD card. Select the desired saved settings file by pressing on the filename in the list, then press the Send File button.
.



The controller will pause momentarily while the values are loaded from the microSD card.

SD Card > SD Card Status

A display-only (monitor) value that provides the current status of the microSD card.

No SD Card	The microSD card is not installed in the controller.
Present - Read-Only	The microSD card is correctly installed in the controller, but is marked as read-only. The controller will be unable to save parameter values or write logging data.
Present - OK	The microSD card is installed correctly and writable. All features that depend on the SD card will be available.

SD Card > Logging Status

A display-only (monitor) value that provides the current status of the data logging system that writes samples to the microSD card.

Stopped	Data logging to the microSD card is currently stopped. Periodic operational conditions will NOT be saved.
Active	Data logging to the microSD card is currently active and recording operational condition samples to the log.

SD Card - Logging > Log When

In order to provide flexibility for how data samples are recorded to the log, the data logging system can be configured to continuously record data samples, even when the system is not running, or only when the system is actively running.

- Always (1/2)
  The data logging system records data samples continuously, even when the pump system is stopped. This option can be helpful when sensor data needs to be recorded prior to the pump system entering the run state. Because data samples are logged even when stopped, this option can fill the log with long periods of little data if the pump system is off for long periods.

- Running Only (2/2)
  The data logging system records data samples ONLY when the system is actively running. This option can be helpful when the pump system is stopped or off for long periods of time, and can extend the total time recorded in the data log before overwrites occur.

SD Card - Logging > Logging Interval

The logging interval specifies the time between data samples in the log. Data samples can be recorded as fast a once every 1 second, or as slowly as once every 1 hour. Because the size of the log is limited by the number of data samples, the overall length of time the log will record can be extended by increasing the logging interval time. Short logging intervals can be used when troubleshooting quickly changing operational conditions.

SD Card - Save/Load Parameters & Upgrade Firmware > Save Params Filename

The filename of the configuration parameters that will be saved to the microSD card. This field applies ONLY when SAVING configuration parameters to the microSD card, and does NOT apply when LOADING configuration parameters.

SD Card - Save/Load Parameters & Upgrade Firmware > Upgrade

The OptiPump HPS controller supports field upgrades of the controller firmware. Controller firmware upgrades provide bug fixes and new features. However, technical support and/or engineering should be consulted prior to installing a firmware upgrade, in order to fully understand the changes between the firmware versions and the impact the changes may have on the operation of the equipment at the installation site.

The firmware upgrade file must be located in the SYSTEM folder on the microSD card, and end in the .C10 file extension.

Firmware upgrades may be installed using two methods:

- Method 1 - **Configure > System > SD Card - Save/Load Parameters & Upgrade Firmware**

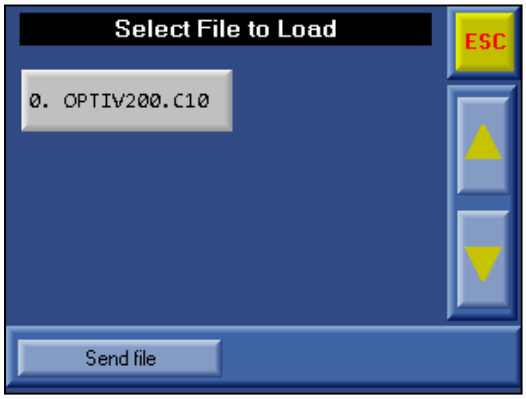
  Method 1, the recommended method, uses the standard configuration interface to install firmware upgrades, and is the most operator-friendly method of performing this function.

  The upgrade file must exist in the SYSTEM folder on the microSD card. The upgrade file is often provided via email. The microSD card should be removed from the controller, and the supplied .C10 firmware upgrade file should be copied to the SYSTEM folder on the microSD card. Once the .C10 firmware upgrade file has been copied, the microSD card must be reinstalled in the controller.

  The SD card status should indicate that the microSD card is present and OK.

  Press the green Upgrade button to start the process.

  A list of the firmware upgrade files in the SYSTEM folder will be displayed. Press the desired firmware upgrade file to be installed, then press the Send File button.



  The controller will switch to the firmware upgrade mode while the process is ongoing, and will automatically reboot after the process completes.

  The success or failure of the controller firmware upgrade process can be verified by checking the version of the firmware shown in the upper right corner of the Home screen with version displayed prior to the start of the firmware upgrade process.

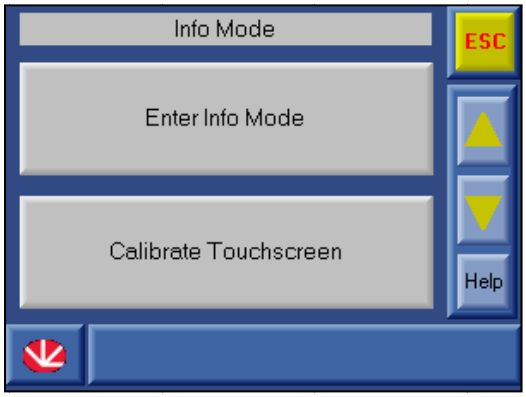
- Method 2 - **Info Mode**

  In the event that the controller firmware upgrade process does not correctly load using the standard configuration interface, a special mode, called Info Mode, may be used to upgrade the controller firmware outside of the standard configuration interface.

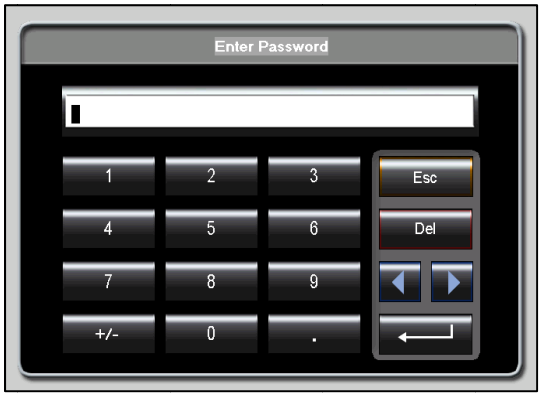
  The upgrade file must exist in the SYSTEM folder on the microSD card. The upgrade file is often provided via email. The microSD card should be removed from the controller, and the supplied .C10 firmware

upgrade file should be copied to the SYSTEM folder on the microSD card. Once the .C10 firmware upgrade file has been copied, the microSD card must be reinstalled in the controller.

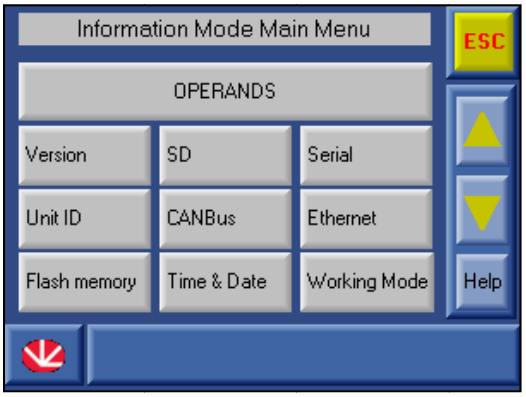
While on the **Configure > System > SD Card** screen, press and hold the anywhere in the black background area below the **SD Card - Save/Load Parameters & Upgrade Firmware** section. After a few seconds, the Info Mode screen will appear. Press the Enter Info Mode button.

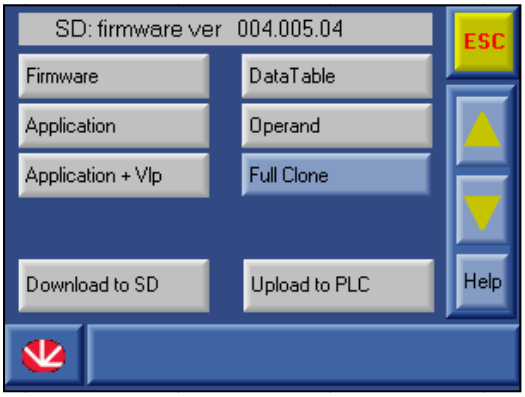


Enter the password "1111", and press Enter.

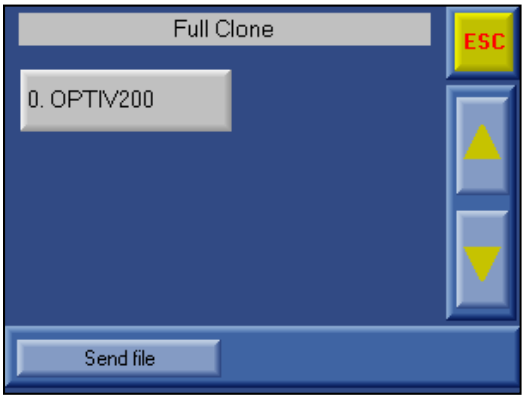


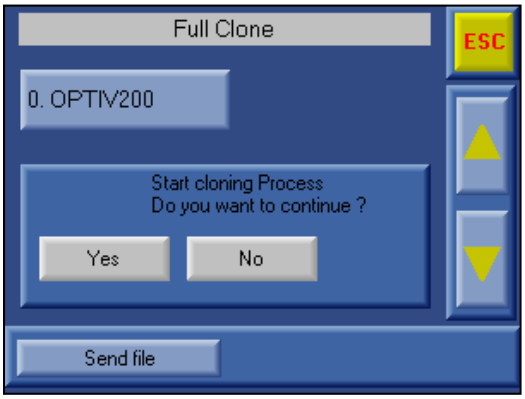
Press the SD button, then press the Full Clone button. When the Full Close button is pressed, the Upload to PLC button at the bottom of the screen will become active. Press the Upload to PLC button.





A list of the firmware upgrade files in the SYSTEM folder will be displayed. Press the desired firmware upgrade file to be installed, then press the Send File button. The controller will request confirmation of the firmware upgrade process. Press the Yes button to initiate the transfer process.





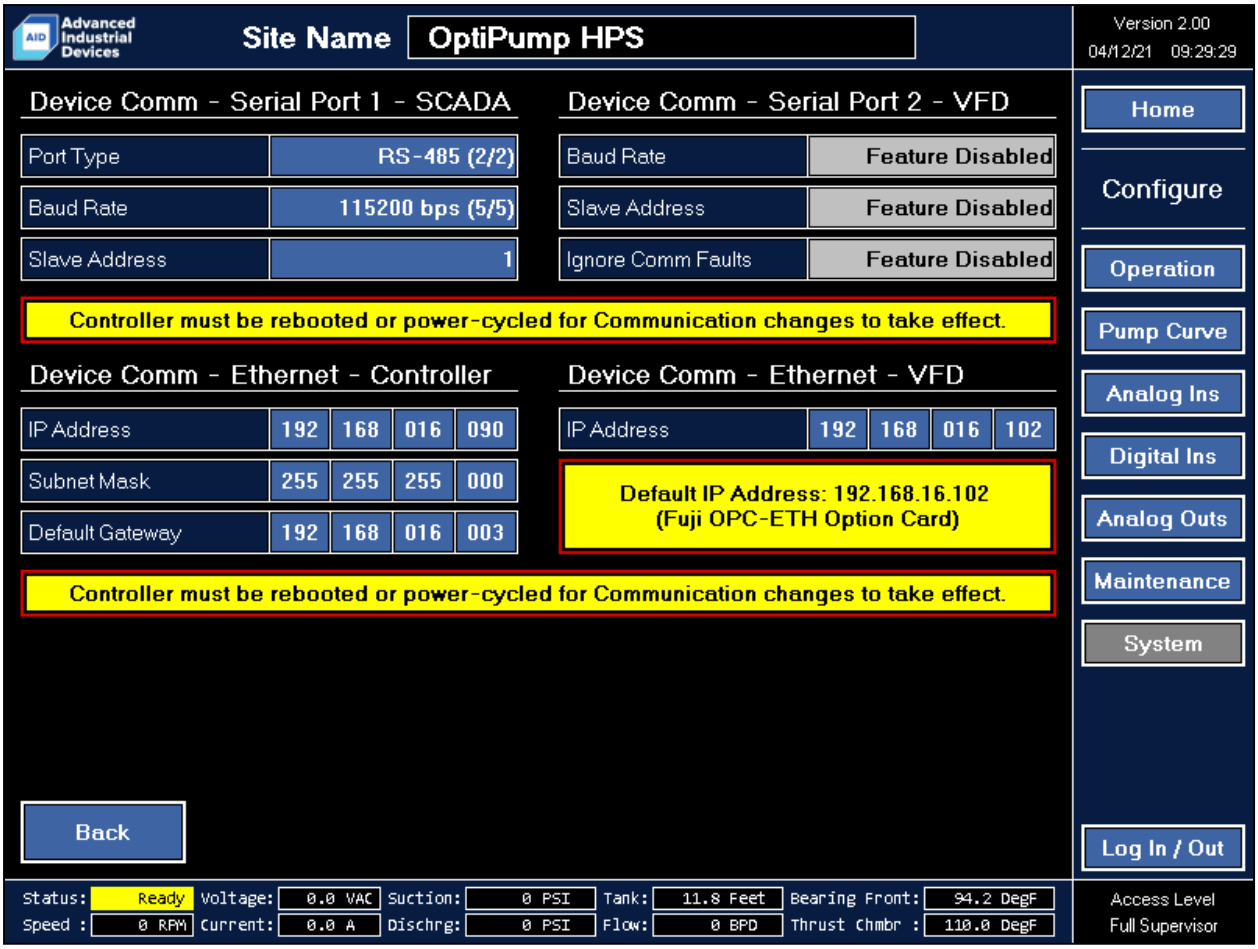
The controller will switch to the firmware upgrade mode while the process is ongoing, and will automatically reboot after the process completes.

The success or failure of the controller firmware upgrade process can be verified by checking the version of the firmware shown in the upper right corner of the Home screen with version displayed prior to the start of the firmware upgrade process.

Device Communication

Device communication configuration parameters are available in:

Configure > System > Device Communication



The OptiPump HPS controller supports two external device communication ports. The Ethernet port provides communication with both the variable frequency drive and with SCADA devices. One serial port is dedicated to communication with SCADA devices.

Note:

The controller must be rebooted or power-cycled in order for the changes made to the communication configuration parameters to take effect.

Communication ports available:

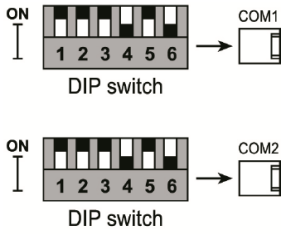
- Port 1
  Configurable serial communication with the controller as a Modbus RTU slave device.

- Port 2
  Disabled.

- Port 3
  Configurable Ethernet communication with the variable frequency drive and SCADA devices as a Modbus TCP/IP slave device. For SCADA communication, the Modbus TCP/IP port is set to 502, and cannot be changed.

For serial communication ports, the hardware must be physically configured using DIP switches that must also match the associated configuration parameter. The hardware DIP switches are located on the back of the controller, and are configured using the table below.

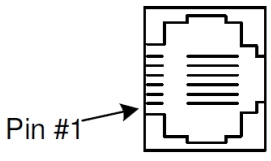
	Switch Settings					
	1	**2**	**3**	**4**	**5**	**6**
RS232*	**ON**	**ON**	**ON**	OFF	**ON**	OFF
RS485	OFF	OFF	OFF	**ON**	OFF	**ON**
RS485 with termination**	**ON**	**ON**	OFF	**ON**	OFF	**ON**



The serial communication ports use a standard RJ-11 socket. The pinout for the sockets is shown below. Note that the pinout is different depending on the port type configured.

RS232	
Pin #	**Description**
1*	DTR signal
2	0V reference
3	TXD signal
4	RXD signal
5	0V reference
6*	DSR signal

RS485**		**Controller Port**
Pin #	**Description**	
1	A signal (+)	
2	(RS232 signal)	
3	(RS232 signal)	
4	(RS232 signal)	
5	(RS232 signal)	
6	B signal (-)	



Device Communication - Serial Port 1 - SCADA > Port Type

The serial port for SCADA communication can be configured for either RS-232 or RS-485 communication. The serial port type must match the port type used by the SCADA monitoring device.

Device Communication - Serial Port 1 - SCADA > Baud Rate

The baud rate for the serial SCADA communication port should be configured to match the baud rate of the SCADA monitoring device.

Device Communication - Serial Port 1 - SCADA > Slave Address

The serial port SCADA slave address specifies the address of the controller on the serial Modbus RTU network. The slave address must be unique for all devices on the serial Modbus RTU network when multiple slave devices share the serial communication bus.

Device Communication - Serial Port 2 - VFD > Baud Rate

Feature disabled.

Device Communication - Serial Port 2 - VFD > Slave Address

Feature disabled.

Device Communication - Serial Port 2 - VFD > Ignore Communication Faults

Feature disabled.

Device Communication - Ethernet > IP Address

The IP address assigned to the controller. This address must be set by the operator. DHCP is NOT supported.

Device Communication - Ethernet > Subnet Mask

The subnet mask used by the controller. The subnet mask must be set by the operator. DHCP is NOT supported.

Device Communication - Ethernet > Default Gateway

The default gateway used by the controller. Setting the default gateway is optional, depending on the network. DHCP is not supported.

Monitors (16-Bit Holding Registers) - Read-Only (0x03)

Address	Description	Scaling	Units	Minimum	Maximum	Values	Notes
0	Version Software/Firmware/Program	x					
1	HOA State	x				0 = Off 1 = Hand 2 = Auto	
2	Command Reference (x.xx Hz)	x.xx	Hz				
7	Index Alarm (Future SD Log)	N/A	N/A				
8	Index Shutdown (Future SD Log)	N/A	N/A				
9	Index Fault (Future SD Log)	N/A	N/A				
10	Raw Analog Input 1	x	N/A	0	1023		1024 = Out of Range
11	Raw Analog Input 2	x	N/A	0	1023		1024 = Out of Range
12	Raw Analog Input 3	x	N/A	0	1023		1024 = Out of Range
13	Raw Analog Input 4	x	N/A	0	16383		-1 = Below Range 16384 = Above Range 32767 = Greatly Below/Above Range
14	Raw Analog Input 5	x	N/A	0	16383		-1 = Below Range 16384 = Above Range 32767 = Greatly Below/Above Range
15	Raw Analog Input 6	x	N/A	0	16383		-1 = Below Range 16384 = Above Range 32767 = Greatly Below/Above Range
16	Raw Analog Input 7	x	N/A	0	16383		-1 = Below Range 16384 = Above Range 32767 = Greatly Below/Above Range
17	Raw Analog Input 8	x	N/A	0	16383		-1 = Below Range 16384 = Above Range 32767 = Greatly Below/Above Range
18	Raw Analog Input 9	x	N/A	0	16383		-1 = Below Range 16384 = Above Range 32767 = Greatly Below/Above Range
19	Raw Analog Input 10	x.x	DegF				32767 = Greatly Below/Above Range
20	Raw Analog Input 11	x	N/A	0	16383		-1 = Below Range 16384 = Above Range 32767 = Greatly Below/Above Range
21	Raw Analog Input 12	x	N/A	0	4095		4096 = Exceeds Range
22	Raw Analog Input 13	x	N/A	0	4095		4097 = Exceeds Range
23	Raw Analog Input 14	x	N/A	0	4095		4098 = Exceeds Range
24	Raw Analog Input 15	x	N/A	0	4095		4099 = Exceeds Range
25	Raw Analog Input 16	x.x	DegF	-58.0	860.0		-10000 = Short Circuit

							10000 = Open Circuit
26	Raw Analog Input 17	x.x	DegF	-58.0	860.0		-10000 = Short Circuit 10000 = Open Circuit
27	Raw Analog Input 18	x.x	DegF	-58.0	860.0		-10000 = Short Circuit 10000 = Open Circuit
28	Raw Analog Input 19	x.x	DegF	-58.0	860.0		-10000 = Short Circuit 10000 = Open Circuit
29	Raw Analog Input 20	x.x	DegF	-58.0	860.0		-10000 = Short Circuit 10000 = Open Circuit
30	Raw Analog Input 21	x.x	DegF	-58.0	860.0		-10000 = Short Circuit 10000 = Open Circuit
31	Raw Analog Input 22	x.x	DegF	-58.0	860.0		-10000 = Short Circuit 10000 = Open Circuit
32	Raw Analog Input 23	x.x	DegF	-58.0	860.0		-10000 = Short Circuit 10000 = Open Circuit
33	Raw (AO1) Pressure Control Valve Position	x	N/A	0	4095		
34	Raw (AO2) Multipurpose	x	N/A	0	4095		
35	Scaled Analog Input 1	x					
36	Scaled Analog Input 2	x					
37	Scaled Analog Input 3	x.x					
38	Scaled Analog Input 3	x.x	PSI				
39	Scaled Analog Input 4	x					
40	Scaled Analog Input 5	x					
41	Scaled Analog Input 6	x.xx					
42	Scaled Analog Input 7	x.x	kBPD				
43	Scaled Analog Input 8	x.x					
44	Scaled Analog Input 9	x.x	%				
45	Scaled Analog Input 10	x.x	DegF	-328.0	1400.0		
46	Scaled Analog Input 11	x.xx					
47	Scaled Analog Input 12	x.xx					
48	Scaled Analog Input 13	x.xx					
49	Scaled Analog Input 14	x.x					
50	Scaled Analog Input 15	x.x					
51	Scaled Analog Input 16	x.x	DegF	-58.0	860.0		
52	Scaled Analog Input 17	x.x	DegF	-58.0	860.0		
53	Scaled Analog Input 18	x.x	DegF	-58.0	860.0		
54	Scaled Analog Input 19	x.x	DegF	-58.0	860.0		
55	Scaled Analog Input 20	x.x	DegF	-58.0	860.0		
56	Scaled Analog Input 21	x.x	DegF	-58.0	860.0		
57	Scaled Analog Input 22	x.x	DegF	-58.0	860.0		
58	Scaled Analog Input 23	x.x	DegF	-58.0	860.0		
59	Scaled Filter Differential Pressure	x.x	PSI				
60	Scaled (AO1) Pressure Control Valve Position	x.x	%				
61	Scaled (AO2) Multipurpose	x.x	%				
62	V/mA Analog Input 1	x.xx	mA				
63	V/mA Analog Input 2	x.xx	mA				
64	V/mA Analog Input 3	x.xx	mA				
65	V/mA Analog Input 4	x.xx	mA				

66	V/mA Analog Input 5	x.xx	mA				
67	V/mA Analog Input 6	x.xx	mA				
68	V/mA Analog Input 7	x.xx	mA				
69	V/mA Analog Input 8	x.xx	mA				
70	V/mA Analog Input 9	x.xx	mA				
71	V/mA Analog Input 10	N/A	N/A				Temperature input. Always 0.
72	V/mA Analog Input 11	x.xx	mA				
73	V/mA Analog Input 12	x.xx	mA				
74	V/mA Analog Input 13	x.xx	mA				
75	V/mA Analog Input 14	x.xx	mA				
76	V/mA Analog Input 15	x.xx	mA				
77	V/mA Analog Input 16	N/A	N/A				Temperature input. Always 0.
78	V/mA Analog Input 17	N/A	N/A				Temperature input. Always 0.
79	V/mA Analog Input 18	N/A	N/A				Temperature input. Always 0.
80	V/mA Analog Input 19	N/A	N/A				Temperature input. Always 0.
81	V/mA Analog Input 20	N/A	N/A				Temperature input. Always 0.
82	V/mA Analog Input 21	N/A	N/A				Temperature input. Always 0.
83	V/mA Analog Input 22	N/A	N/A				Temperature input. Always 0.
84	V/mA Analog Input 23	N/A	N/A				Temperature input. Always 0.
85	V/mA (AO1) Pressure Control Valve Position	x.xx	mA				
86	V/mA (AO2) Multipurpose	x.xx	mA				
142	Status	x	N/A			0 = Off 1 = Ready 2 = Pre-Run 3 = Run 4 = Post-Run 5 = Alarm 6 = Shutdown 7 = Fault 8 = Restart	
143	Alarm	x	N/A				See Alarm list for values.
144	Shutdown	x	N/A				See Shutdown list for values.
145	Fault	x	N/A				See Fault list for values.
146	Fault VFD	x	N/A				See Fault VFD list for values.
147	Shutdown Restart Type	x	N/A			1 = Manual 2 = Timed	
148	Shutdown Restart Time	x	Minutes				
149	Shutdown Restart Countdown	x	Minutes				
150	Fault Restart Type	x				1 = Manual 2 = Timed	
151	Fault Restart Time	x	Minutes				
152	Fault Restart Countdown	x	Minutes				
153	Capacity	x.x	HP				
154	Rated Current	x.x	A				
155	Reference Frequency	x.xx	Hz				
156	Output Frequency	x.xx	Hz				
157	Motor Voltage	x.x	VAC				
158	Motor Current	x.x	A				

159	Motor Torque	x	LbFt				
160	DC Bus	x	VDC				
161	Motor Speed	x	RPM				
164	Pre-Run State	x				0 = Waiting 1 = Thrust Chamber Oil Pump Run 2 = Block Valve Open 3 = Pressure Control Valve Position 4 = Charge Pump Run 5 = Done	
165	Post-Run State FUTURE USE	x					
166	Motor Horsepower	x.x	HP				
167	Motor Synchronous Speed	x	RPM				
168	Motor Poles	x	N/A				
200	Motor Rated Torque	x	LbFt				
201	Fault Reference Frequency	x.xx	Hz				
202	Fault Output Frequency	x.xx	Hz				
203	Fault Output Voltage	x.x	VAC				
204	Fault Output Current	x.x	A				
205	Fault Output Torque	x	LbFt				
206	Fault DC Bus	x	VDC				
207	Fault Motor Horsepower	x.x	HP				
208	Fault Motor Speed	x	RPM				
209	Fault Internal Temp	x	DegC				
210	Fault Heatsink Temp	x	DegC				
211	Fault Internal Temp	x	DegF				
212	Fault Heatsink Temp	x	DegF				
213	Internal Temp	x	DegF				
214	Heatsink Temp	x	DegF				
215	Pressure Control Valve Commanded Position	x.x	%				
228	Auto Pump Curve Discharge Pressure Target	x	PSI				
229	Discharge Pressure Target	x	PSI				
230	SD Card Status	x				0 = No SD Card 1 = Present - Read-Only 2 = Present - OK	
231	SD Logging Status	x				0 = Stopped 1 = Active	
232	Access Level	x				1 = View-Only 2 = Limited Operator 3 = Full Supervisor 4 = Factory	
233	Pressure Control Valve Position Error	x.x	%				
242	Speed Error	x.xx	Hz				
243	Discharge Pressure Error	x	PSI				
244	Discharge Error Lower Limit	x	PSI				
245	Discharge Error Upper Limit	x	PSI				
251	Thrust Chamber Oil Temperature	x.x	DegF			Works with either AI10 or AI16.	
252	Input Power	x.x	kW				
254	Curve Area Lower Bounds	x.xx	Hz				

255	Curve Area Upper Bounds	x.xx	Hz				
256	Pressure Control Valve Control Mode	x				0 = Auto Pump Curve 1 = Manual Pressure 2 = Manual Position	
257	Block Valve Status	x				0 = Disabled 1 = Command Open 2 = Command Close 3 = Opening 4 = Closing 5 = Open 6 = Closed 7 = Open and Closed	
258	Block Valve Commanded Position	x.x	%				
259	Last Version Software/Firmware/Program	x.xx					
260	Pump Curve Generation State	x		0	4	0 = Idle 1 = Initialization 2 = Min/Max 3 = Points 4 = Reset, Go Idle	
261	Pump Curve Generation Progress	x	%				
262	Pump Curve Generation Steps	x					
263	Screensaver Picture Index						
264	Maintenance Reminder 1 Frequency	x		0	2	0 = Disabled 1 = Run-Time 2 = Monthly	
265	Maintenance Reminder 1 Run-Time Source	x		0	3	0 = Panel 1 = Main Pump 2 = Charge Pump 3 = Thrust Chamber Oil Pump	
266	Maintenance Reminder 1 Time Remaining	x	Hrs				
267	Maintenance Reminder 1 Status	x		0	2	0 = Disabled 1 = OK 2 = Attention	
268	Maintenance Reminder 2 Frequency	x		0	2	0 = Disabled 1 = Run-Time 2 = Monthly	
269	Maintenance Reminder 2 Run-Time Source	x		0	3	0 = Panel 1 = Main Pump 2 = Charge Pump 3 = Thrust Chamber Oil Pump	
270	Maintenance Reminder 2 Time Remaining	x	Hrs				
271	Maintenance Reminder 2 Status	x		0	2	0 = Disabled 1 = OK 2 = Attention	
272	Maintenance Reminder 3 Frequency	x		0	2	0 = Disabled 1 = Run-Time 2 = Monthly	
273	Maintenance Reminder 3 Run-Time Source	x		0	3	0 = Panel 1 = Main Pump	

						2 = Charge Pump 3 = Thrust Chamber Oil Pump	
274	Maintenance Reminder 3 Time Remaining	x	Hrs				
275	Maintenance Reminder 3 Status	x		0	2	0 = Disabled 1 = OK 2 = Attention	
276	Maintenance Reminder 4 Frequency	x		0	2	0 = Disabled 1 = Run-Time 2 = Monthly	
277	Maintenance Reminder 4 Run-Time Source	x		0	3	0 = Panel 1 = Main Pump 2 = Charge Pump 3 = Thrust Chamber Oil Pump	
278	Maintenance Reminder 4 Time Remaining	x	Hrs				
279	Maintenance Reminder 4 Status	x		0	2	0 = Disabled 1 = OK 2 = Attention	
280	Maintenance Reminder 5 Frequency	x		0	2	0 = Disabled 1 = Run-Time 2 = Monthly	
281	Maintenance Reminder 5 Run-Time Source	x		0	3	0 = Panel 1 = Main Pump 2 = Charge Pump 3 = Thrust Chamber Oil Pump	
282	Maintenance Reminder 5 Time Remaining	x	Hrs				
283	Maintenance Reminder 5 Status	x		0	2	0 = Disabled 1 = OK 2 = Attention	
284	Maintenance Reminder 6 Frequency	x		0	2	0 = Disabled 1 = Run-Time 2 = Monthly	
285	Maintenance Reminder 6 Run-Time Source	x		0	3	0 = Panel 1 = Main Pump 2 = Charge Pump 3 = Thrust Chamber Oil Pump	
286	Maintenance Reminder 6 Time Remaining	x	Hrs				
287	Maintenance Reminder 6 Status	x		0	2	0 = Disabled 1 = OK 2 = Attention	
288	Maintenance Reminder 7 Frequency	x		0	2	0 = Disabled 1 = Run-Time 2 = Monthly	
289	Maintenance Reminder 7 Run-Time Source	x		0	3	0 = Panel 1 = Main Pump 2 = Charge Pump 3 = Thrust Chamber Oil Pump	
290	Maintenance Reminder 7 Time Remaining	x	Hrs				
291	Maintenance Reminder 7 Status	x		0	2	0 = Disabled 1 = OK	

						2 = Attention	
292	Maintenance Reminder 8 Frequency	x		0	2	0 = Disabled 1 = Run-Time 2 = Monthly	
293	Maintenance Reminder 8 Run-Time Source	x		0	3	0 = Panel 1 = Main Pump 2 = Charge Pump 3 = Thrust Chamber Oil Pump	
294	Maintenance Reminder 8 Time Remaining	x	Hrs				
295	Maintenance Reminder 8 Status	x		0	2	0 = Disabled 1 = OK 2 = Attention	
296	Maintenance Reminder 9 Frequency	x		0	2	0 = Disabled 1 = Run-Time 2 = Monthly	
297	Maintenance Reminder 9 Run-Time Source	x		0	3	0 = Panel 1 = Main Pump 2 = Charge Pump 3 = Thrust Chamber Oil Pump	
298	Maintenance Reminder 9 Time Remaining	x	Hrs				
299	Maintenance Reminder 9 Status	x		0	2	0 = Disabled 1 = OK 2 = Attention	
300	Maintenance Reminder 10 Frequency	x		0	2	0 = Disabled 1 = Run-Time 2 = Monthly	
301	Maintenance Reminder 10 Run-Time Source	x		0	3	0 = Panel 1 = Main Pump 2 = Charge Pump 3 = Thrust Chamber Oil Pump	
302	Maintenance Reminder 10 Time Remaining	x	Hrs				
303	Maintenance Reminder 10 Status	x		0	2	0 = Disabled 1 = OK 2 = Attention	
304	RESERVED						
305	Tank Screen Tank 1 Level	x.x					
306	Tank Screen Tank 1 Scale Minimum	x.x					
307	Tank Screen Tank 1 Scale Maximum	x.x					
308	Tank Screen Tank 2 Level	x.x					
309	Tank Screen Tank 2 Scale Minimum	x.x					
310	Tank Screen Tank 2 Scale Maximum	x.x					
311	Tank Screen Tank 3 Level	x.x					
312	Tank Screen Tank 3 Scale Minimum	x.x					
313	Tank Screen Tank 3 Scale Maximum	x.x					
314	Tank Screen Tank 4 Level	x.x					
315	Tank Screen Tank 4 Scale Minimum	x.x					
316	Tank Screen Tank 4 Scale Maximum	x.x					
317	Tank Screen Tank 5 Level	x.x					
318	Tank Screen Tank 5 Scale Minimum	x.x					

319	Tank Screen Tank 5 Scale Maximum	x.x					
320	Tank Screen Tank 6 Level	x.x					
321	Tank Screen Tank 6 Scale Minimum	x.x					
322	Tank Screen Tank 6 Scale Maximum	x.x					
323	VFD Heatsink Rated Overtemperature Threshold	x	DegC				
324	VFD Thermal Warning Threshold	x	DegC				

Monitors (32-Bit Holding Registers) – Read-Only (0x03)

Address	Description	Scaling	Units	Minimum	Maximum	Values	Notes
28672	Scaled Analog Input 7	x	BPD				
28673	Scaled Analog Input 8	x					
28692	Accumulated/Totalized Analog Input 7 Today	x	Brrls				
28693	Accumulated/Totalized Analog Input 7 Previous Day	x	Brrls				
28694	Accumulated/Totalized Analog Input 8 Today	x	Brrls				
28695	Accumulated/Totalized Analog Input 8 Previous Day	x	Brrls				
28694	Main Pump Run Time	x	Secs				
28695	Thrust Chamber Oil Pump Run Time	x	Secs				
28696	Charge Pump Run Time	x	Secs				
28697	Main Pump Run Time	x.x	Hrs				
28698	Thrust Chamber Oil Pump Run Time	x.x	Hrs				
28699	Charge Pump Run Time	x.x	Hrs				
28700	Power-Loss RTC Date	x					MMDDYY
28701	Power-Loss RTC Time	x					HHMMSS
28702	Panel Run Time	x	Secs				
28703	Panel Run Time	x.x	Hrs				
28704	Maintenance Reminder 1 Time Remaining	x	Secs				
28705	Maintenance Reminder 2 Time Remaining	x	Secs				
28706	Maintenance Reminder 3 Time Remaining	x	Secs				
28707	Maintenance Reminder 4 Time Remaining	x	Secs				
28708	Maintenance Reminder 5 Time Remaining	x	Secs				
28709	Maintenance Reminder 6 Time Remaining	x	Secs				
28710	Maintenance Reminder 7 Time Remaining	x	Secs				
28711	Maintenance Reminder 8 Time Remaining	x	Secs				
28712	Maintenance Reminder 9 Time Remaining	x	Secs				
28713	Maintenance Reminder 10 Time Remaining	x	Secs				

Monitors (Bits/Coils) – Read-Only (0x01)

Address	Description	Notes
10	Command Hand	
11	Command Auto	
12	Command Run	
13	Command Forward	
14	Command Reverse	
15	Command Reset Shutdown/Fault	
16	Command Motor Auto-Tune	
17	Command Reset SD Log	
18	Command Reset Manual	
19	Command PID1 Pressure Control Valve Auto-Tune	
20	Command PID2 Speed Auto-Tune	
21	Command 7-Point Auto Bounds	
22	Command Clear Events	
23	Command Reset kWh	
24	Command Reset SCADA	
25	Command Bit 15	
28	Status 1 Forward	
29	Status 1 Reverse	
30	Status 1 Pre-Run	
31	Status 1 Run	
32	Status 1 Post Run	
33	Status 1 Alarm	
34	Status 1 Shutdown	
35	Status 1 Fault	
36	Status 1 Fault VFD	
37	Status 1 Restart	
38	Status 1 Current Limiting	
39	Status 1 Torque Limiting	
40	Status 1 Accelerating	
41	Status 1 Decelerating	
42	Status 1 OptiMode	
43	Status 1 Maintenance Required	
46	Status 2 Master Enable	
47	Status 2 Bit 1	
48	Status 2 Bit 2	
49	Status 2 Bit 3	
50	Status 2 Bit 4	
51	Status 2 Bit 5	
52	Status 2 Bit 6	
53	Status 2 Bit 7	
54	Status 2 Bit 8	
55	Status 2 Bit 10	
56	Status 2 Bit 11	

57	Status 2 Bit 12	
58	Status 2 Bit 13	
59	Status 2 Bit 14	
60	Status 2 Bit 15	
61	Status 2 Bit 16	
100	Active Digital Input 1	
101	Active Digital Input 2	
102	Active Digital Input 3	
103	Active Digital Input 4	
104	Active Digital Input 5	
105	Active Digital Input 6	
106	Active Digital Input 7	
107	Active Digital Input 8	
108	Active Digital Input 9	
109	Active Digital Input 10	
110	Active Digital Input 11	
111	Active Digital Input 12	
112	Active Digital Input 13	
113	Active Digital Input 14	
114	Active Digital Input 15	
115	Active Digital Input 16	
116	Active (DO01) Charge Pump Run	
117	Active (DO02) Thrust Chamber Oil Pump Run	
118	Active (DO03) Block Valve Open	
119	Active (DO04) Heat Trace On	
120	Active (DO05) Hand Active	
121	Active (DO06) Run	
122	Active (DO07) Alarm	
123	Active (DO08) Shutdown	
124	Active (DO09) Fault	
125	Active (DO10) Status Ready (Yellow)	
126	Active (DO11) Status Run (Green)	
127	Active (DO12) Status Problem (Red)	
128	Active (DO13) Spare 1	
129	Active (DO14) Spare 2	
130	Active (DO15) Spare 3	
131	Active (DO16) Spare 4	
200	Alarm Active None	
201	Alarm Active Multiple	
202	Alarm Active Analog Input 1 High-High	
203	Alarm Active Analog Input 1 High	
204	Alarm Active Analog Input 1 Low	
205	Alarm Active Analog Input 1 Low-Low	
206	Alarm Active Analog Input 2 High-High	
207	Alarm Active Analog Input 2 High	
208	Alarm Active Analog Input 2 Low	
209	Alarm Active Analog Input 2 Low-Low	
210	Alarm Active Analog Input 3 High-High	

211	Alarm Active Analog Input 3 High	
212	Alarm Active Analog Input 3 Low	
213	Alarm Active Analog Input 3 Low-Low	
214	Alarm Active Analog Input 4 High-High	
215	Alarm Active Analog Input 4 High	
216	Alarm Active Analog Input 4 Low	
217	Alarm Active Analog Input 4 Low-Low	
218	Alarm Active Analog Input 5 High-High	
219	Alarm Active Analog Input 5 High	
220	Alarm Active Analog Input 5 Low	
221	Alarm Active Analog Input 5 Low-Low	
222	Alarm Active Analog Input 6 High-High	
223	Alarm Active Analog Input 6 High	
224	Alarm Active Analog Input 6 Low	
225	Alarm Active Analog Input 6 Low-Low	
226	Alarm Active Analog Input 7 High-High	
227	Alarm Active Analog Input 7 High	
228	Alarm Active Analog Input 7 Low	
229	Alarm Active Analog Input 7 Low-Low	
230	Alarm Active Analog Input 8 High-High	
231	Alarm Active Analog Input 8 High	
232	Alarm Active Analog Input 8 Low	
233	Alarm Active Analog Input 8 Low-Low	
234	Alarm Active Analog Input 9 High-High	
235	Alarm Active Analog Input 9 High	
236	Alarm Active Analog Input 9 Low	
237	Alarm Active Analog Input 9 Low-Low	
238	Alarm Active Analog Input 10 High-High	
239	Alarm Active Analog Input 10 High	
240	Alarm Active Analog Input 10 Low	
241	Alarm Active Analog Input 10 Low-Low	
242	Alarm Active Analog Input 11 High-High	
243	Alarm Active Analog Input 11 High	
244	Alarm Active Analog Input 11 Low	
245	Alarm Active Analog Input 11 Low-Low	
246	Alarm Active Analog Input 12 High-High	
247	Alarm Active Analog Input 12 High	
248	Alarm Active Analog Input 12 Low	
249	Alarm Active Analog Input 12 Low-Low	
250	Alarm Active Analog Input 13 High-High	
251	Alarm Active Analog Input 13 High	
252	Alarm Active Analog Input 13 Low	
253	Alarm Active Analog Input 13 Low-Low	
254	Alarm Active Analog Input 14 High-High	
255	Alarm Active Analog Input 14 High	
256	Alarm Active Analog Input 14 Low	
257	Alarm Active Analog Input 14 Low-Low	
258	Alarm Active Analog Input 15 High-High	

259	Alarm Active Analog Input 15 High	
260	Alarm Active Analog Input 15 Low	
261	Alarm Active Analog Input 15 Low-Low	
262	Alarm Active Analog Input 16 High-High	
263	Alarm Active Analog Input 16 High	
264	Alarm Active Analog Input 16 Low	
265	Alarm Active Analog Input 16 Low-Low	
266	Alarm Active Analog Input 17 High-High	
267	Alarm Active Analog Input 17 High	
268	Alarm Active Analog Input 17 Low	
269	Alarm Active Analog Input 17 Low-Low	
270	Alarm Active Analog Input 18 High-High	
271	Alarm Active Analog Input 18 High	
272	Alarm Active Analog Input 18 Low	
273	Alarm Active Analog Input 18 Low-Low	
274	Alarm Active Analog Input 19 High-High	
275	Alarm Active Analog Input 19 High	
276	Alarm Active Analog Input 19 Low	
277	Alarm Active Analog Input 19 Low-Low	
278	Alarm Active Analog Input 20 High-High	
279	Alarm Active Analog Input 20 High	
280	Alarm Active Analog Input 20 Low	
281	Alarm Active Analog Input 20 Low-Low	
282	Alarm Active Analog Input 21 High-High	
283	Alarm Active Analog Input 21 High	
284	Alarm Active Analog Input 21 Low	
285	Alarm Active Analog Input 21 Low-Low	
286	Alarm Active Analog Input 22 High-High	
287	Alarm Active Analog Input 22 High	
288	Alarm Active Analog Input 22 Low	
289	Alarm Active Analog Input 22 Low-Low	
290	Alarm Active Analog Input 23 High-High	
291	Alarm Active Analog Input 23 High	
292	Alarm Active Analog Input 23 Low	
293	Alarm Active Analog Input 23 Low-Low	
294	Alarm Active Filter Differential Pressure High-High	
295	Alarm Active Filter Differential Pressure High	
296	Alarm Active Digital Input 1	
297	Alarm Active Digital Input 2	
298	Alarm Active Digital Input 3	
299	Alarm Active Digital Input 4	
300	Alarm Active Digital Input 5	
301	Alarm Active Digital Input 6	
302	Alarm Active Digital Input 7	
303	Alarm Active Digital Input 8	
304	Alarm Active Digital Input 9	
305	Alarm Active Digital Input 10	
306	Alarm Active Digital Input 11	

307	Alarm Active Digital Input 12	
308	Alarm Active Digital Input 13	
309	Alarm Active Digital Input 14	
310	Alarm Active Digital Input 15	
311	Alarm Active Digital Input 16	
312	Alarm Active Main Pump Speed Mismatch	
313	Alarm Active Main Pump Out of Curve	
314	Alarm Active Pressure Control Valve Failed to Control Pressure	
315	Alarm Active Block Valve Open	
316	Alarm Active Block Valve Closed	
317	Alarm Active VFD Heatsink Thermal Warning	
400	Alarm Active Analog Input 1 Any	Set when ANY alarm is active for Analog Input 1 (High-High, High, Low, Low-Low).
401	Alarm Active Analog Input 2 Any	Set when ANY alarm is active for Analog Input 2 (High-High, High, Low, Low-Low).
402	Alarm Active Analog Input 3 Any	Set when ANY alarm is active for Analog Input 3 (High-High, High, Low, Low-Low).
403	Alarm Active Analog Input 4 Any	Set when ANY alarm is active for Analog Input 4 (High-High, High, Low, Low-Low).
404	Alarm Active Analog Input 5 Any	Set when ANY alarm is active for Analog Input 5 (High-High, High, Low, Low-Low).
405	Alarm Active Analog Input 6 Any	Set when ANY alarm is active for Analog Input 6 (High-High, High, Low, Low-Low).
406	Alarm Active Analog Input 7 Any	Set when ANY alarm is active for Analog Input 7 (High-High, High, Low, Low-Low).
407	Alarm Active Analog Input 8 Any	Set when ANY alarm is active for Analog Input 8 (High-High, High, Low, Low-Low).
408	Alarm Active Analog Input 9 Any	Set when ANY alarm is active for Analog Input 9 (High-High, High, Low, Low-Low).
409	Alarm Active Analog Input 10 Any	Set when ANY alarm is active for Analog Input 10 (High-High, High, Low, Low-Low).
410	Alarm Active Analog Input 11 Any	Set when ANY alarm is active for Analog Input 11 (High-High, High, Low, Low-Low).
411	Alarm Active Analog Input 12 Any	Set when ANY alarm is active for Analog Input 12 (High-High, High, Low, Low-Low).
412	Alarm Active Analog Input 13 Any	Set when ANY alarm is active for Analog Input 13 (High-High, High, Low, Low-Low).
413	Alarm Active Analog Input 14 Any	Set when ANY alarm is active for Analog Input 14 (High-High, High, Low, Low-Low).
414	Alarm Active Analog Input 15 Any	Set when ANY alarm is active for Analog Input 15 (High-High, High, Low, Low-Low).
415	Alarm Active Analog Input 16 Any	Set when ANY alarm is active for Analog Input 16 (High-High, High, Low, Low-Low).
416	Alarm Active Analog Input 17 Any	Set when ANY alarm is active for Analog Input 17 (High-High, High, Low, Low-Low).
417	Alarm Active Analog Input 18 Any	Set when ANY alarm is active for Analog Input 18 (High-High, High, Low, Low-Low).
418	Alarm Active Analog Input 19 Any	Set when ANY alarm is active for Analog Input 19 (High-High, High, Low, Low-Low).
419	Alarm Active Analog Input 20 Any	Set when ANY alarm is active for Analog Input 20 (High-High, High, Low, Low-Low).
420	Alarm Active Analog Input 21 Any	Set when ANY alarm is active for Analog Input 21 (High-High, High, Low, Low-Low).
421	Alarm Active Analog Input 22 Any	Set when ANY alarm is active for Analog Input 22 (High-High, High, Low, Low-Low).
422	Alarm Active Analog Input 23 Any	Set when ANY alarm is active for Analog Input 23 (High-High, High, Low, Low-Low).
423	Alarm Active Filter Differential Pressure Any	Set when ANY alarm is active for Filter Differential Pressure (High-High, High).
440	Maintenance Reminder Maintenance Required Any	Set when ANY maintenance reminder is active.
441	Maintenance Reminder 1 Maintenance Required	
442	Maintenance Reminder 2 Maintenance Required	
443	Maintenance Reminder 3 Maintenance Required	
444	Maintenance Reminder 4 Maintenance Required	
445	Maintenance Reminder 5 Maintenance Required	
446	Maintenance Reminder 6 Maintenance Required	
447	Maintenance Reminder 7 Maintenance Required	
448	Maintenance Reminder 8 Maintenance Required	
449	Maintenance Reminder 9 Maintenance Required	
450	Maintenance Reminder 10 Maintenance Required	

Alarm Codes (Register 143)

Code	Description	Notes
0	None	
1	Multiple	
2	Analog Input 1 High-High	
3	Analog Input 1 High	
4	Analog Input 1 Low	
5	Analog Input 1 Low-Low	
6	Analog Input 2 High-High	
7	Analog Input 2 High	
8	Analog Input 2 Low	
9	Analog Input 2 Low-Low	
10	Analog Input 3 High-High	
11	Analog Input 3 High	
12	Analog Input 3 Low	
13	Analog Input 3 Low-Low	
14	Analog Input 4 High-High	
15	Analog Input 4 High	
16	Analog Input 4 Low	
17	Analog Input 4 Low-Low	
18	Analog Input 5 High-High	
19	Analog Input 5 High	
20	Analog Input 5 Low	
21	Analog Input 5 Low-Low	
22	Analog Input 6 High-High	
23	Analog Input 6 High	
24	Analog Input 6 Low	
25	Analog Input 6 Low-Low	
26	Analog Input 7 High-High	
27	Analog Input 7 High	
28	Analog Input 7 Low	
29	Analog Input 7 Low-Low	
30	Analog Input 8 High-High	
31	Analog Input 8 High	
32	Analog Input 8 Low	
33	Analog Input 8 Low-Low	
34	Analog Input 9 High-High	
35	Analog Input 9 High	
36	Analog Input 9 Low	
37	Analog Input 9 Low-Low	
38	Analog Input 10 High-High	
39	Analog Input 10 High	
40	Analog Input 10 Low	
41	Analog Input 10 Low-Low	
42	Analog Input 11 High-High	

43	Analog Input 11 High	
44	Analog Input 11 Low	
45	Analog Input 11 Low-Low	
46	Analog Input 12 High-High	
47	Analog Input 12 High	
48	Analog Input 12 Low	
49	Analog Input 12 Low-Low	
50	Analog Input 13 High-High	
51	Analog Input 13 High	
52	Analog Input 13 Low	
53	Analog Input 13 Low-Low	
54	Analog Input 14 High-High	
55	Analog Input 14 High	
56	Analog Input 14 Low	
57	Analog Input 14 Low-Low	
58	Analog Input 15 High-High	
59	Analog Input 15 High	
60	Analog Input 15 Low	
61	Analog Input 15 Low-Low	
62	Analog Input 16 High-High	
63	Analog Input 16 High	
64	Analog Input 16 Low	
65	Analog Input 16 Low-Low	
66	Analog Input 17 High-High	
67	Analog Input 17 High	
68	Analog Input 17 Low	
69	Analog Input 17 Low-Low	
70	Analog Input 18 High-High	
71	Analog Input 18 High	
72	Analog Input 18 Low	
73	Analog Input 18 Low-Low	
74	Analog Input 19 High-High	
75	Analog Input 19 High	
76	Analog Input 19 Low	
77	Analog Input 19 Low-Low	
78	Analog Input 20 High-High	
79	Analog Input 20 High	
80	Analog Input 20 Low	
81	Analog Input 20 Low-Low	
82	Analog Input 21 High-High	
83	Analog Input 21 High	
84	Analog Input 21 Low	
85	Analog Input 21 Low-Low	
86	Analog Input 22 High-High	
87	Analog Input 22 High	
88	Analog Input 22 Low	
89	Analog Input 22 Low-Low	
90	Analog Input 23 High-High	

91	Analog Input 23 High	
92	Analog Input 23 Low	
93	Analog Input 23 Low-Low	
94	Filter Differential Pressure High-High	
95	Filter Differential Pressure High	
96	Digital Input 1	
97	Digital Input 2	
98	Digital Input 3	
99	Digital Input 4	
100	Digital Input 5	
101	Digital Input 6	
102	Digital Input 7	
103	Digital Input 8	
104	Digital Input 9	
105	Digital Input 10	
106	Digital Input 11	
107	Digital Input 12	
108	Digital Input 13	
109	Digital Input 14	
110	Digital Input 15	
111	Digital Input 16	
112	Main Pump Speed Mismatch	
113	Main Pump Out of Curve	
114	Pressure Control Valve Failed to Control Pressure	
115	Block Valve Open	
116	Block Valve Closed	
117	VFD Heatsink Thermal Warning	

Shutdown Codes (Register 144)

Code	Description	Notes
0	None	
1	RESERVED	
2	Analog Input 1 High-High	
3	Analog Input 1 High	
4	Analog Input 1 Low	
5	Analog Input 1 Low-Low	
6	Analog Input 2 High-High	
7	Analog Input 2 High	
8	Analog Input 2 Low	
9	Analog Input 2 Low-Low	
10	Analog Input 3 High-High	
11	Analog Input 3 High	
12	Analog Input 3 Low	
13	Analog Input 3 Low-Low	
14	Analog Input 4 High-High	
15	Analog Input 4 High	
16	Analog Input 4 Low	
17	Analog Input 4 Low-Low	
18	Analog Input 5 High-High	
19	Analog Input 5 High	
20	Analog Input 5 Low	
21	Analog Input 5 Low-Low	
22	Analog Input 6 High-High	
23	Analog Input 6 High	
24	Analog Input 6 Low	
25	Analog Input 6 Low-Low	
26	Analog Input 7 High-High	
27	Analog Input 7 High	
28	Analog Input 7 Low	
29	Analog Input 7 Low-Low	
30	Analog Input 8 High-High	
31	Analog Input 8 High	
32	Analog Input 8 Low	
33	Analog Input 8 Low-Low	
34	Analog Input 9 High-High	
35	Analog Input 9 High	
36	Analog Input 9 Low	
37	Analog Input 9 Low-Low	
38	Analog Input 10 High-High	
39	Analog Input 10 High	
40	Analog Input 10 Low	
41	Analog Input 10 Low-Low	
42	Analog Input 11 High-High	

43	Analog Input 11 High	
44	Analog Input 11 Low	
45	Analog Input 11 Low-Low	
46	Analog Input 12 High-High	
47	Analog Input 12 High	
48	Analog Input 12 Low	
49	Analog Input 12 Low-Low	
50	Analog Input 13 High-High	
51	Analog Input 13 High	
52	Analog Input 13 Low	
53	Analog Input 13 Low-Low	
54	Analog Input 14 High-High	
55	Analog Input 14 High	
56	Analog Input 14 Low	
57	Analog Input 14 Low-Low	
58	Analog Input 15 High-High	
59	Analog Input 15 High	
60	Analog Input 15 Low	
61	Analog Input 15 Low-Low	
62	Analog Input 16 High-High	
63	Analog Input 16 High	
64	Analog Input 16 Low	
65	Analog Input 16 Low-Low	
66	Analog Input 17 High-High	
67	Analog Input 17 High	
68	Analog Input 17 Low	
69	Analog Input 17 Low-Low	
70	Analog Input 18 High-High	
71	Analog Input 18 High	
72	Analog Input 18 Low	
73	Analog Input 18 Low-Low	
74	Analog Input 19 High-High	
75	Analog Input 19 High	
76	Analog Input 19 Low	
77	Analog Input 19 Low-Low	
78	Analog Input 20 High-High	
79	Analog Input 20 High	
80	Analog Input 20 Low	
81	Analog Input 20 Low-Low	
82	Analog Input 21 High-High	
83	Analog Input 21 High	
84	Analog Input 21 Low	
85	Analog Input 21 Low-Low	
86	Analog Input 22 High-High	
87	Analog Input 22 High	
88	Analog Input 22 Low	
89	Analog Input 22 Low-Low	
90	Analog Input 23 High-High	

91	Analog Input 23 High	
92	Analog Input 23 Low	
93	Analog Input 23 Low-Low	
94	Filter Differential Pressure High-High	
95	Filter Differential Pressure High	
96	Digital Input 1	
97	Digital Input 2	
98	Digital Input 3	
99	Digital Input 4	
100	Digital Input 5	
101	Digital Input 6	
102	Digital Input 7	
103	Digital Input 8	
104	Digital Input 9	
105	Digital Input 10	
106	Digital Input 11	
107	Digital Input 12	
108	Digital Input 13	
109	Digital Input 14	
110	Digital Input 15	
111	Digital Input 16	
112	Main Pump Speed Mismatch	
113	Main Pump Out of Curve	
114	Pressure Control Valve Failed to Control Pressure	

Fault Codes (Register 145)

Code	Description	Notes
0	None	
1	VFD Fault	
2	Analog Input 1 Signal-Loss	
3	Analog Input 2 Signal-Loss	
4	Analog Input 3 Signal-Loss	
5	Analog Input 4 Signal-Loss	
6	Analog Input 5 Signal-Loss	
7	Analog Input 6 Signal-Loss	
8	Analog Input 7 Signal-Loss	
9	Analog Input 8 Signal-Loss	
10	Analog Input 9 Signal-Loss	
11	Analog Input 10 Signal-Loss	
12	Analog Input 11 Signal-Loss	
13	Analog Input 12 Signal-Loss	
14	Analog Input 13 Signal-Loss	
15	Analog Input 14 Signal-Loss	
16	Analog Input 15 Signal-Loss	
17	Analog Input 16 Signal-Loss	
18	Analog Input 17 Signal-Loss	
19	Analog Input 18 Signal-Loss	
20	Analog Input 19 Signal-Loss	
21	Analog Input 20 Signal-Loss	
22	Analog Input 21 Signal-Loss	
23	Analog Input 22 Signal-Loss	
24	Analog Input 23 Signal-Loss	
25	Block Valve Failed to Open	
26	Pressure Control Valve Failed to Position	
27	Thrust Chamber Oil Pump Failed to Run	
28	Charge Pump Failed to Run	
29	Main Pump Failed to Run	
30	VFD Communications Failed	
31	VFD Failed to Stop at Start-up	
32	Battery Failure	
33	Hand and Auto Both Active	
34	Block Valve Failed to Close	
35	Block Valve Open and Close Both Active	

VFD Fault Codes (Register 146)

Code	Description	Notes
0	None	
1	(OC1) Overcurrent During Accel	
2	(OC2) Overcurrent During Decel	
3	(OC3) Overcurrent At Set Speed	
4	Undefined VFD Fault 4	
5	EF Ground Fault	
6	(OU1) Overvoltage During Accel	
7	(OU2) Overvoltage During Decel	
8	(OU3) Overvoltage At Set Speed	
9	Undefined VFD Fault 9	
10	(LU) Undervoltage	
11	(Lin) Input Phase Loss	
12	Undefined VFD Fault 12	
13	Undefined VFD Fault 13	
14	(FUS) DC Bus Fuse Blown	
15	Undefined VFD Fault 15	
16	(PbF) Charging Circuit Fault	
17	(OH1) Heatsink Overheat	
18	(OH2) External Shutdown	
19	(OH3) Internal Overheat	
20	(OH4) Motor PTC/NTC Overheat	
21	Undefined VFD Fault 21	
22	(dbH) Braking Resistor Overheat	
23	(OL1) Motor Overload	
24	(OL2) Motor 2 Overload	
25	(OLU) VFD Overload	
26	Undefined VFD Fault 26	
27	(OS) Overspeed Protection	
28	(PG) PG Disconnected	
29	(nrb) NTC Disconnected	
30	Undefined VFD Fault 30	
31	(Er1) Memory Error	
32	(Er2) Keypad Comm Error	
33	(Er3) CPU Error	
34	(Er4) Option Card Comm Error	
35	(Er5) Option Card Error	
36	(Er6) Stop Key Error	
37	(Er7) Auto-Tuning Error	
38	(Er8) RS485 Comm Port 1 Error	
39	Undefined VFD Fault 39	
40	Undefined VFD Fault 40	
41	Undefined VFD Fault 41	
42	Undefined VFD Fault 42	

43	Undefined VFD Fault 43	
44	(OL3) Motor 3 Overload	
45	(OL4) Motor 4 Overload	
46	(OPL) Output Phase Loss	
47	(ErE) Excessive Speed Deviation	
48	Undefined VFD Fault 48	
49	Undefined VFD Fault 49	
50	Undefined VFD Fault 50	
51	(ErF) Data Save Error	
52	Undefined VFD Fault 52	
53	(ErP) RS485 Comm Port 2 Error	
54	(ErH) Hardware Error	
55	Undefined VFD Fault 55	
56	Undefined VFD Fault 56	
57	(ECN) Enabled EN1/EN2 Lost	
58	(CoF) PID Fdbck Disconnected	
59	(dbA) Dynamic Braking Transistor	
60	Undefined VFD Fault 60	
61	Undefined VFD Fault 61	
62	Undefined VFD Fault 62	
63	Undefined VFD Fault 63	
64	Undefined VFD Fault 64	
65	Undefined VFD Fault 65	
66	Undefined VFD Fault 66	
67	Undefined VFD Fault 67	
68	Undefined VFD Fault 68	
69	Undefined VFD Fault 69	
70	Undefined VFD Fault 70	
71	Undefined VFD Fault 71	
72	Undefined VFD Fault 72	
73	Undefined VFD Fault 73	
74	Undefined VFD Fault 74	
75	Undefined VFD Fault 75	
76	Undefined VFD Fault 76	
77	Undefined VFD Fault 77	
78	Undefined VFD Fault 78	
79	Undefined VFD Fault 79	
80	Undefined VFD Fault 80	
81	Undefined VFD Fault 81	
82	Undefined VFD Fault 82	
83	Undefined VFD Fault 83	
84	Undefined VFD Fault 84	
85	Undefined VFD Fault 85	
86	Undefined VFD Fault 86	
87	Undefined VFD Fault 87	
88	Undefined VFD Fault 88	
89	Undefined VFD Fault 89	
90	Undefined VFD Fault 90	

91	Undefined VFD Fault 91	
92	Undefined VFD Fault 92	
93	Undefined VFD Fault 93	
94	Undefined VFD Fault 94	
95	Undefined VFD Fault 95	
96	Undefined VFD Fault 96	
97	Undefined VFD Fault 97	
98	Undefined VFD Fault 98	
99	Undefined VFD Fault 99	
100	(FAL) Internal DC Fan Failure	
101	(OL) Motor Overload Warn	
102	(OH) Cooling Fin Overheat Warn	
103	(LiF) Component Life Warn	
104	(rEF) Command Loss	
105	(Pid) PID Output Warn	
106	(UTL) Low Torque Detected	
107	(PTC) Thermistor Loss	
108	(rTE) Machine Life Accum Hours	
109	(CnT) Machine Life Start Count	
110	Undefined VFD Fault 110	
111	Undefined VFD Fault 111	
112	Undefined VFD Fault 112	
113	Undefined VFD Fault 113	
114	Undefined VFD Fault 114	
115	Undefined VFD Fault 115	
116	Undefined VFD Fault 116	
117	Undefined VFD Fault 117	
118	Undefined VFD Fault 118	
119	Undefined VFD Fault 119	
120	Undefined VFD Fault 120	
121	Undefined VFD Fault 121	
122	Undefined VFD Fault 122	
123	Undefined VFD Fault 123	
124	Undefined VFD Fault 124	
125	Undefined VFD Fault 125	
126	Undefined VFD Fault 126	
127	Undefined VFD Fault 127	
128	Undefined VFD Fault 128	
129	Undefined VFD Fault 129	
130	Undefined VFD Fault 130	
131	Undefined VFD Fault 131	
132	Undefined VFD Fault 132	
133	Undefined VFD Fault 133	
134	Undefined VFD Fault 134	
135	Undefined VFD Fault 135	
136	Undefined VFD Fault 136	
137	Undefined VFD Fault 137	
138	Undefined VFD Fault 138	

139	Undefined VFD Fault 139	
140	Undefined VFD Fault 140	
141	Undefined VFD Fault 141	
142	Undefined VFD Fault 142	
143	Undefined VFD Fault 143	
144	Undefined VFD Fault 144	
145	Undefined VFD Fault 145	
146	Undefined VFD Fault 146	
147	Undefined VFD Fault 147	
148	Undefined VFD Fault 148	
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213	Undefined VFD Fault 213	
214	Undefined VFD Fault 214	
215	Undefined VFD Fault 215	
216	Undefined VFD Fault 216	
217	Undefined VFD Fault 217	
218	Undefined VFD Fault 218	
219	Undefined VFD Fault 219	
220	Undefined VFD Fault 220	
221	Undefined VFD Fault 221	
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225	Undefined VFD Fault 225	
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227	Undefined VFD Fault 227	
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249	Undefined VFD Fault 249	
250	Undefined VFD Fault 250	
251	Undefined VFD Fault 251	
252	Undefined VFD Fault 252	
253	Undefined VFD Fault 253	
254	(Err) Simulated Fault	

Parameters (16-Bit Holding Registers) – Read/Write

Address	Description	Scaling	Units	Minimum	Maximum	Values	Notes
3	SCADA Shutdown/Fault Reset	x		0	1	0 = Idle 1 = Reset	
4	RESERVED						
5	SCADA Pump Curve Generate Table	x		0	1	0 = Idle 1 = Generate Table	
500	Serial Port 1 SCADA Type	x		1	2	1 = RS-232 2 = RS-485	
501	Serial Port 1 SCADA Baud Rate	x	bps	1	5	1 = 9600 2 = 19200 3 = 38400 4 = 57800 5 = 115200	
502	Serial Port 1 SCADA Slave Address	x		1	255		
503	Serial Port 2 VFD Baud Rate	x	bps	1	3	1 = 9600 2 = 19200 3 = 38400	
504	Serial Port 2 VFD Slave Address	x		1	255		
505	Screensaver	x		1	3	1 = Disabled 2 = Blank 3 = Pictures	
506	Screensaver Timeout	x	Minutes	1	60		
507	Analog Input 1 Scale Minimum	x		-32768	32767		
508	Analog Input 1 Scale Maximum	x		-32768	32767		
509	Analog Input 1 Signal-Loss/Broken Fault	x		1	2	1 = Disabled 2 = Enabled	
510	Analog Input 1 High-High Reaction	x		1	3	1 = Disabled 2 = Alarm 3 = Shutdown	
511	Analog Input 1 High Reaction	x		1	3	1 = Disabled 2 = Alarm 3 = Shutdown	
512	Analog Input 1 Low Reaction	x		1	3	1 = Disabled 2 = Alarm 3 = Shutdown	
513	Analog Input 1 Low-Low Reaction	x		1	3	1 = Disabled 2 = Alarm 3 = Shutdown	
514	Analog Input 1 High-High Setpoint	x		-32768	32767		
515	Analog Input 1 High Setpoint	x		-32768	32767		
516	Analog Input 1 Low Setpoint	x		-32768	32767		
517	Analog Input 1 Low-Low Setpoint	x		-32768	32767		
518	Analog Input 1 Start Delay	x	Seconds	1	32767		
519	Analog Input 1 Detection Delay	x	Seconds	1	32767		

520	Analog Input 1 Restart Type	x		1	2	1 = Manual 2 = Timed	
521	Analog Input 1 Restart Delay	x	Minutes	1	32767		
522	RESERVED						
523	RESERVED						
524	Analog Input 2 Scale Minimum	x	PSI	-32768	32767		
525	Analog Input 2 Scale Maximum	x	PSI	-32768	32767		
526	Analog Input 2 Signal-Loss Broken Fault	x		1	2	1 = Disabled 2 = Enabled	
527	Analog Input 2 High-High Reaction	x		1	3	1 = Disabled 2 = Alarm 3 = Shutdown	
528	Analog Input 2 High Reaction	x		1	3	1 = Disabled 2 = Alarm 3 = Shutdown	
529	Analog Input 2 Low Reaction	x		1	3	1 = Disabled 2 = Alarm 3 = Shutdown	
530	Analog Input 2 Low-Low Reaction	x		1	3	1 = Disabled 2 = Alarm 3 = Shutdown	
531	Analog Input 2 High-High Setpoint	x	PSI	-32768	32767		
532	Analog Input 2 High Setpoint	x	PSI	-32768	32767		
533	Analog Input 2 Low Setpoint	x	PSI	-32768	32767		
534	Analog Input 2 Low-Low Setpoint	x	PSI	-32768	32767		
535	Analog Input 2 Start Delay	x	Seconds	1	32767		
536	Analog Input 2 Detection Delay	x	Seconds	1	32767		
537	Analog Input 2 Restart Type	x		1	2	1 = Manual 2 = Timed	
538	Analog Input 2 Restart Delay	x	Minutes	1	32767		
539	RESERVED						
540	RESERVED						
541	Analog Input 3 Scale Minimum	x.x		-3276.8	3276.7		
542	Analog Input 3 Maximum	x.x		-3276.8	3276.7		
543	Analog Input 3 Signal-Loss/Broken Fault	x		1	2	1 = Disabled 2 = Enabled	
544	Analog Input 3 High-High Reaction	x		1	3	1 = Disabled 2 = Alarm 3 = Shutdown	
545	Analog Input 3 High Reaction	x		1	3	1 = Disabled 2 = Alarm 3 = Shutdown	
546	Analog Input 3 Low Reaction	x		1	3	1 = Disabled 2 = Alarm 3 = Shutdown	
547	Analog Input 3 Low-Low Reaction	x		1	3	1 = Disabled 2 = Alarm 3 = Shutdown	

548	Analog Input 3 High-High Setpoint	x.x		-3276.8	3276.7		
549	Analog Input 3 High Setpoint	x.x		-3276.8	3276.7		
550	Analog Input 3 Low Setpoint	x.x		-3276.8	3276.7		
551	Analog Input 3 Low-Low Setpoint	x.x		-3276.8	3276.7		
552	Analog Input 3 Start Delay	x	Seconds	1	32767		
553	Analog Input 3 Detection Delay	x	Seconds	1	32767		
554	Analog Input 3 Restart Type	x		1	2	1 = Manual 2 = Timed	
555	Analog Input 3 Restart Delay	x	Minutes	1	32767		
556	RESERVED						
557	RESERVED						
558	Analog Input 4 Scale Minimum	x		-32768	32767		
559	Analog Input 4 Scale Maximum	x		-32768	32767		
560	Analog Input 4 Signal-Loss/Broken Fault	x		1	2	1 = Disabled 2 = Enabled	
561	Analog Input 4 High-High Reaction	x		1	3	1 = Disabled 2 = Alarm 3 = Shutdown	
562	Analog Input 4 High Reaction	x		1	3	1 = Disabled 2 = Alarm 3 = Shutdown	
563	Analog Input 4 Low Reaction	x		1	3	1 = Disabled 2 = Alarm 3 = Shutdown	
564	Analog Input 4 Low-Low Reaction	x		1	3	1 = Disabled 2 = Alarm 3 = Shutdown	
565	Analog Input 4 High-High Setpoint	x		-32768	32767		
566	Analog Input 4 High Setpoint	x		-32768	32767		
567	Analog Input 4 Low Setpoint	x		-32768	32767		
568	Analog Input 4 Low-Low Setpoint	x		-32768	32767		
569	Analog Input 4 Start Delay	x	Seconds	1	32767		
570	Analog Input 4 Detection Delay	x	Seconds	1	32767		
571	Analog Input 4 Restart Type	x		1	2	1 = Manual 2 = Timed	
572	Analog Input 4 Restart Delay	x	Minutes	1	32767		
573	RESERVED						
574	RESERVED						
575	Analog Input 5 Scale Minimum	x		-32768	32767		
576	Analog Input 5 Scale Maximum	x		-32768	32767		
577	Analog Input 5 Signal-Loss/Broken Fault	x		1	2	1 = Disabled 2 = Enabled	
578	Analog Input 5 High-High Reaction	x		1	3	1 = Disabled 2 = Alarm 3 = Shutdown	
579	Analog Input 5 High Reaction	x		1	3	1 = Disabled 2 = Alarm 3 = Shutdown	

580	Analog Input 5 Low Reaction	x		1	3	1 = Disabled 2 = Alarm 3 = Shutdown	
581	Analog Input 5 Low-Low Reaction	x		1	3	1 = Disabled 2 = Alarm 3 = Shutdown	
582	Analog Input 5 High-High Setpoint	x		-32768	32767		
583	Analog Input 5 High Setpoint	x		-32768	32767		
584	Analog Input 5 Low Setpoint	x		-32768	32767		
585	Analog Input 5 Low-Low Setpoint	x		-32768	32767		
586	Analog Input 5 Start Delay	x	Seconds	1	32767		
587	Analog Input 5 Detection Delay	x	Seconds	1	32767		
588	Analog Input 5 Restart Type	x		1	2	1 = Manual 2 = Timed	
589	Analog Input 5 Restart Delay	x	Minutes	1	32767		
590	RESERVED						
591	RESERVED						
592	Analog Input 6 Scale Minimum	x.xx		-327.68	327.67		
593	Analog Input 6 Scale Maximum	x.xx		-327.68	327.67		
594	Analog Input 6 Signal-Loss/Broken Fault	x		1	2	1 = Disabled 2 = Enabled	
595	Analog Input 6 High-High Reaction	x		1	3	1 = Disabled 2 = Alarm 3 = Shutdown	
596	Analog Input 6 High Reaction	x		1	3	1 = Disabled 2 = Alarm 3 = Shutdown	
597	Analog Input 6 Low Reaction	x		1	3	1 = Disabled 2 = Alarm 3 = Shutdown	
598	Analog Input 6 Low-Low Reaction	x		1	3	1 = Disabled 2 = Alarm 3 = Shutdown	
599	Analog Input 6 High-High Setpoint	x.xx		-327.68	327.67		
600	Analog Input 6 High Setpoint	x.xx		-327.68	327.67		
601	Analog Input 6 Low Setpoint	x.xx		-327.68	327.67		
602	Analog Input 6 Low-Low Setpoint	x.xx		-327.68	327.67		
603	Analog Input 6 Start Delay	x	Seconds	1	32767		
604	Analog Input 6 Detection Delay	x	Seconds	1	32767		
605	Analog Input 6 Restart Type	x		1	2	1 = Manual 2 = Timed	
606	Analog Input 6 Restart Delay	x	Minutes	1	32767		
607	RESERVED						
608	RESERVED						
609	RESERVED						
610	RESERVED						
611	Analog Input 7 Flow Signal-Loss/Broken Fault	x		1	2	1 = Disabled 2 = Enabled	

612	Analog Input 7 High-High Reaction	x		1	3	1 = Disabled 2 = Alarm 3 = Shutdown	
613	Analog Input 7 High Reaction	x		1	3	1 = Disabled 2 = Alarm 3 = Shutdown	
614	Analog Input 7 Low Reaction	x		1	3	1 = Disabled 2 = Alarm 3 = Shutdown	
615	Analog Input 7 Low-Low Reaction	x		1	3	1 = Disabled 2 = Alarm 3 = Shutdown	
616	RESERVED						
617	RESERVED						
618	RESERVED						
619	RESERVED						
620	Analog Input 7 Start Delay	x	Seconds	1	32767		
621	Analog Input 7 Detection Delay	x	Seconds	1	32767		
622	Analog Input 7 Restart Type	x		1	2	1 = Manual 2 = Timed	
623	Analog Input 7 Restart Delay	x	Minutes	1	32767		
624	RESERVED						
625	RESERVED						
626	RESERVED						
627	RESERVED						
628	Analog Input 8 Signal-Loss/Broken Fault	x		1	2	1 = Disabled 2 = Enabled	
629	Analog Input 8 High-High Reaction	x		1	3	1 = Disabled 2 = Alarm 3 = Shutdown	
630	Analog Input 8 High Reaction	x		1	3	1 = Disabled 2 = Alarm 3 = Shutdown	
631	Analog Input 8 Low Reaction	x		1	3	1 = Disabled 2 = Alarm 3 = Shutdown	
632	Analog Input 8 Low-Low Reaction	x		1	3	1 = Disabled 2 = Alarm 3 = Shutdown	
633	RESERVED						
634	RESERVED						
635	RESERVED						
636	RESERVED						
637	Analog Input 8 Start Delay	x	Seconds	1	32767		
638	Analog Input 8 Detection Delay	x	Seconds	1	32767		
639	Analog Input 8 Restart Type	x		1	2	1 = Manual 2 = Timed	
640	Analog Input 8 Restart Delay	x	Minutes	1	32767		

641	RESERVED						
642	RESERVED						
643	Analog Input 9 Scale Minimum	x.x	%	-3276.8	3276.7		
644	Analog Input 9 Scale Maximum	x.x	%	-3276.8	3276.7		
645	Analog Input 9 Signal-Loss/Broken Fault	x		1	2	1 = Disabled 2 = Enabled	
646	Analog Input 9 High-High Reaction	x		1	3	1 = Disabled 2 = Alarm 3 = Shutdown	
647	Analog Input 9 High Reaction	x		1	3	1 = Disabled 2 = Alarm 3 = Shutdown	
648	Analog Input 9 Low Reaction	x		1	3	1 = Disabled 2 = Alarm 3 = Shutdown	
649	Analog Input 9 Low-Low Reaction	x		1	3	1 = Disabled 2 = Alarm 3 = Shutdown	
650	Analog Input 9 High-High Setpoint	x.x	%	-3276.8	3276.7		
651	Analog Input 9 High Setpoint	x.x	%	-3276.8	3276.7		
652	Analog Input 9 Low Setpoint	x.x	%	-3276.8	3276.7		
653	Analog Input 9 Low-Low Setpoint	x.x	%	-3276.8	3276.7		
654	Analog Input 9 Start Delay	x	Seconds	1	32767		
655	Analog Input 9 Detection Delay	x	Seconds	1	32767		
656	Analog Input 9 Restart Type	x		1	2	1 = Manual 2 = Timed	
657	Analog Input 9 Restart Delay	x	Minutes	1	32767		
658	RESERVED						
659	RESERVED						
660	RESERVED						
661	RESERVED						
662	Analog Input 10/16 Signal-Loss/Broken Fault	x		1	2	1 = Disabled 2 = Enabled	
663	Analog Input 10/16 High-High Reaction	x		1	3	1 = Disabled 2 = Alarm 3 = Shutdown	
664	Analog Input 10/16 High Reaction	x		1	3	1 = Disabled 2 = Alarm 3 = Shutdown	
665	Analog Input 10/16 Low Reaction	x		1	3	1 = Disabled 2 = Alarm 3 = Shutdown	
666	Analog Input 10/16 Low-Low Reaction	x		1	3	1 = Disabled 2 = Alarm 3 = Shutdown	
667	Analog Input 10/16 High-High Setpoint	x.x	DegF	-3276.8	3276.7		
668	Analog Input 10/16 High Setpoint	x.x	DegF	-3276.8	3276.7		
669	Analog Input 10/16 Low Setpoint	x.x	DegF	-3276.8	3276.7		

670	Analog Input 10/16 Low-Low Setpoint	x.x	DegF	-3276.8	3276.7		
671	Analog Input 10/16 Start Delay	x	Seconds	1	32767		
672	Analog Input 10/16 Detection Delay	x	Seconds	1	32767		
673	Analog Input 10/16 Restart Type	x		1	2	1 = Manual 2 = Timed	
674	Analog Input 10/16 Restart Delay	x	Minutes	1	32767		
675	RESERVED						
676	RESERVED						
677	Analog Input 11 Scale Minimum	x.xx		-327.68	327.67		
678	Analog Input 11 Scale Maximum	x.xx		-327.68	327.67		
679	Analog Input 11 Signal-Loss/Broken Fault	x		1	2	1 = Disabled 2 = Enabled	
680	Analog Input 11 High-High Reaction	x		1	3	1 = Disabled 2 = Alarm 3 = Shutdown	
681	Analog Input 11 High Reaction	x		1	3	1 = Disabled 2 = Alarm 3 = Shutdown	
682	Analog Input 11 Low Reaction	x		1	3	1 = Disabled 2 = Alarm 3 = Shutdown	
683	Analog Input 11 Low-Low Reaction	x		1	3	1 = Disabled 2 = Alarm 3 = Shutdown	
684	Analog Input 11 High-High Setpoint	x.xx		-327.68	327.67		
685	Analog Input 11 High Setpoint	x.xx		-327.68	327.67		
686	Analog Input 11 Low Setpoint	x.xx		-327.68	327.67		
687	Analog Input 11 Low-Low Setpoint	x.xx		-327.68	327.67		
688	Analog Input 11 Start Delay	x	Seconds	1	32767		
689	Analog Input 11 Detection Delay	x	Seconds	1	32767		
690	Analog Input 11 Restart Type	x		1	2	1 = Manual 2 = Timed	
691	Analog Input 11 Restart Delay	x	Minutes	1	32767		
692	RESERVED						
693	RESERVED						
694	Analog Input 12 Scale Minimum	x.xx		-327.68	327.67		
695	Analog Input 12 Scale Maximum	x.xx		-327.68	327.67		
696	Analog Input 12 Signal-Loss/Broken Fault	x		1	2	1 = Disabled 2 = Enabled	
697	Analog Input 12 High-High Reaction	x		1	3	1 = Disabled 2 = Alarm 3 = Shutdown	
698	Analog Input 12 High Reaction	x		1	3	1 = Disabled 2 = Alarm 3 = Shutdown	
699	Analog Input 12 Low Reaction	x		1	3	1 = Disabled 2 = Alarm 3 = Shutdown	

700	Analog Input 12 Low-Low Reaction	x		1	3	1 = Disabled 2 = Alarm 3 = Shutdown	
701	Analog Input 12 High-High Setpoint	x.xx		-327.68	327.67		
702	Analog Input 12 High Setpoint	x.xx		-327.68	327.67		
703	Analog Input 12 Low Setpoint	x.xx		-327.68	327.67		
704	Analog Input 12 Low-Low Setpoint	x.xx		-327.68	327.67		
705	Analog Input 12 Start Delay	x	Seconds	1	32767		
706	Analog Input 12 Detection Delay	x	Seconds	1	32767		
707	Analog Input 12 Restart Type	x		1	2	1 = Manual 2 = Timed	
708	Analog Input 12 Restart Delay	x	Minutes	1	32767		
709	RESERVED						
710	RESERVED						
711	Analog Input 13 Scale Minimum	x.xx		-327.68	327.67		
712	Analog Input 13 Scale Maximum	x.xx		-327.68	327.67		
713	Analog Input 13 Signal-Loss/Broken Fault	x		1	2	1 = Disabled 2 = Enabled	
714	Analog Input 13 High-High Reaction	x		1	3	1 = Disabled 2 = Alarm 3 = Shutdown	
715	Analog Input 13 High Reaction	x		1	3	1 = Disabled 2 = Alarm 3 = Shutdown	
716	Analog Input 13 Low Reaction	x		1	3	1 = Disabled 2 = Alarm 3 = Shutdown	
717	Analog Input 13 Low-Low Reaction	x		1	3	1 = Disabled 2 = Alarm 3 = Shutdown	
718	Analog Input 13 High-High Setpoint	x.xx		-327.68	327.67		
719	Analog Input 13 High Setpoint	x.xx		-327.68	327.67		
720	Analog Input 13 Low Setpoint	x.xx		-327.68	327.67		
721	Analog Input 13 Low-Low Setpoint	x.xx		-327.68	327.67		
722	Analog Input 13 Start Delay	x	Seconds	1	32767		
723	Analog Input 13 Detection Delay	x	Seconds	1	32767		
724	Analog Input 13 Restart Type	x		1	2	1 = Manual 2 = Timed	
725	Analog Input 13 Restart Delay	x	Minutes	1	32767		
726	RESERVED						
727	RESERVED						
728	Analog Input 14 Scale Minimum	x.x		-3276.8	3276.7		
729	Analog Input 14 Scale Maximum	x.x		-3276.8	3276.7		
730	Analog Input 14 Signal-Loss/Broken Fault	x		1	2	1 = Disabled 2 = Enabled	
731	Analog Input 14 High-High Reaction	x		1	3	1 = Disabled 2 = Alarm 3 = Shutdown	

732	Analog Input 14 High Reaction	x		1	3	1 = Disabled 2 = Alarm 3 = Shutdown	
733	Analog Input 14 Low Reaction	x		1	3	1 = Disabled 2 = Alarm 3 = Shutdown	
734	Analog Input 14 Low-Low Reaction	x		1	3	1 = Disabled 2 = Alarm 3 = Shutdown	
735	Analog Input 14 High-High Setpoint	x.x		-3276.8	3276.7		
736	Analog Input 14 High Setpoint	x.x		-3276.8	3276.7		
737	Analog Input 14 Low Setpoint	x.x		-3276.8	3276.7		
738	Analog Input 14 Low-Low Setpoint	x.x		-3276.8	3276.7		
739	Analog Input 14 Start Delay	x	Seconds	1	32767		
740	Analog Input 14 Detection Delay	x	Seconds	1	32767		
741	Analog Input 14 Restart Type	x		1	2	1 = Manual 2 = Timed	
742	Analog Input 14 Restart Delay	x	Minutes	1	32767		
743	RESERVED						
744	RESERVED						
745	Analog Input 15 Scale Minimum	x.x		-3276.8	3276.7		
746	Analog Input 15 Scale Maximum	x.x		-3276.8	3276.7		
747	Analog Input 15 Signal-Loss/Broken Fault	x		1	2	1 = Disabled 2 = Enabled	
748	Analog Input 15 High-High Reaction	x		1	3	1 = Disabled 2 = Alarm 3 = Shutdown	
749	Analog Input 15 High Reaction	x		1	3	1 = Disabled 2 = Alarm 3 = Shutdown	
750	Analog Input 15 Low Reaction	x		1	3	1 = Disabled 2 = Alarm 3 = Shutdown	
751	Analog Input 15 Low-Low Reaction	x		1	3	1 = Disabled 2 = Alarm 3 = Shutdown	
752	Analog Input 15 High-High Setpoint	x.x		-3276.8	3276.7		
753	Analog Input 15 High Setpoint	x.x		-3276.8	3276.7		
754	Analog Input 15 Low Setpoint	x.x		-3276.8	3276.7		
755	Analog Input 15 Low-Low Setpoint	x.x		-3276.8	3276.7		
756	Analog Input 15 Start Delay	x	Seconds	1	32767		
757	Analog Input 15 Detection Delay	x	Seconds	1	32767		
758	Analog Input 15 Restart Type	x		1	2	1 = Manual 2 = Timed	
759	Analog Input 15 Restart Delay	x	Minutes	1	32767		
760	RESERVED						
761	RESERVED						
762	RESERVED						

763	RESERVED						
764	RESERVED						
765	RESERVED						
766	RESERVED						
767	RESERVED						
768	RESERVED						
769	RESERVED						
770	RESERVED						
771	RESERVED						
772	RESERVED						
773	RESERVED						
774	RESERVED						
775	RESERVED						
776	RESERVED						
777	RESERVED						
778	RESERVED						
779	RESERVED						
780	RESERVED						
781	Analog Input 17 Signal-Loss/Broken Fault	x		1	2	1 = Disabled 2 = Enabled	
782	Analog Input 17 High-High Reaction	x		1	3	1 = Disabled 2 = Alarm 3 = Shutdown	
783	Analog Input 17 High Reaction	x		1	3	1 = Disabled 2 = Alarm 3 = Shutdown	
784	Analog Input 17 Low Reaction	x		1	3	1 = Disabled 2 = Alarm 3 = Shutdown	
785	Analog Input 17 Low-Low Reaction	x		1	3	1 = Disabled 2 = Alarm 3 = Shutdown	
786	Analog Input 17 High-High Setpoint	x.x	DegF	-3276.8	3276.7		
787	Analog Input 17 High Setpoint	x.x	DegF	-3276.8	3276.7		
788	Analog Input 17 Low Setpoint	x.x	DegF	-3276.8	3276.7		
789	Analog Input 17 Low-Low Setpoint	x.x	DegF	-3276.8	3276.7		
790	Analog Input 17 Start Delay	x	Seconds	1	32767		
791	Analog Input 17 Detection Delay	x	Seconds	1	32767		
792	Analog Input 17 Restart Type	x		1	2	1 = Manual 2 = Timed	
793	Analog Input 17 Restart Delay	x	Minutes	1	32767		
794	RESERVED						
795	RESERVED						
796	RESERVED						
797	RESERVED						
798	Analog Input 18 Signal-Loss/Broken Fault	x		1	2	1 = Disabled 2 = Enabled	

799	Analog Input 18 High-High Reaction	x		1	3	1 = Disabled 2 = Alarm 3 = Shutdown	
800	Analog Input 18 High Reaction	x		1	3	1 = Disabled 2 = Alarm 3 = Shutdown	
801	Analog Input 18 Low Reaction	x		1	3	1 = Disabled 2 = Alarm 3 = Shutdown	
802	Analog Input 18 Low-Low Reaction	x		1	3	1 = Disabled 2 = Alarm 3 = Shutdown	
803	Analog Input 18 High-High Setpoint	x.x	DegF	-3276.8	3276.7		
804	Analog Input 18 High Setpoint	x.x	DegF	-3276.8	3276.7		
805	Analog Input 18 Low Setpoint	x.x	DegF	-3276.8	3276.7		
806	Analog Input 18 Low-Low Setpoint	x.x	DegF	-3276.8	3276.7		
807	Analog Input 18 Start Delay	x	Seconds	1	32767		
808	Analog Input 18 Detection Delay	x	Seconds	1	32767		
809	Analog Input 18 Restart Type	x		1	2	1 = Manual 2 = Timed	
810	Analog Input 18 Restart Delay	x	Minutes	1	32767		
811	RESERVED						
812	RESERVED						
813	RESERVED						
814	RESERVED						
815	Analog Input 19 Signal-Loss/Broken Fault	x		1	2	1 = Disabled 2 = Enabled	
816	Analog Input 19 High-High Reaction	x		1	3	1 = Disabled 2 = Alarm 3 = Shutdown	
817	Analog Input 19 High Reaction	x		1	3	1 = Disabled 2 = Alarm 3 = Shutdown	
818	Analog Input 19 Low Reaction	x		1	3	1 = Disabled 2 = Alarm 3 = Shutdown	
819	Analog Input 19 Low-Low Reaction	x		1	3	1 = Disabled 2 = Alarm 3 = Shutdown	
820	Analog Input 19 High-High Setpoint	x.x	DegF	-3276.8	3276.7		
821	Analog Input 19 High Setpoint	x.x	DegF	-3276.8	3276.7		
822	Analog Input 19 Low Setpoint	x.x	DegF	-3276.8	3276.7		
823	Analog Input 19 Low-Low Setpoint	x.x	DegF	-3276.8	3276.7		
824	Analog Input 19 Start Delay	x	Seconds	1	32767		
825	Analog Input 19 Detection Delay	x	Seconds	1	32767		
826	Analog Input 19 Restart Type	x		1	2	1 = Manual 2 = Timed	
827	Analog Input 19 Restart Delay	x	Minutes	1	32767		

828	RESERVED						
829	RESERVED						
830	RESERVED						
831	RESERVED						
832	Analog Input 20 Signal-Loss/Broken Fault	x		1	2	1 = Disabled 2 = Enabled	
833	Analog Input 20 High-High Reaction	x		1	3	1 = Disabled 2 = Alarm 3 = Shutdown	
834	Analog Input 20 High Reaction	x		1	3	1 = Disabled 2 = Alarm 3 = Shutdown	
835	Analog Input 20 Low Reaction	x		1	3	1 = Disabled 2 = Alarm 3 = Shutdown	
836	Analog Input 20 Low-Low Reaction	x		1	3	1 = Disabled 2 = Alarm 3 = Shutdown	
837	Analog Input 20 High-High Setpoint	x.x	DegF	-3276.8	3276.7		
838	Analog Input 20 High Setpoint	x.x	DegF	-3276.8	3276.7		
839	Analog Input 20 Low Setpoint	x.x	DegF	-3276.8	3276.7		
840	Analog Input 20 Low-Low Setpoint	x.x	DegF	-3276.8	3276.7		
841	Analog Input 20 Start Delay	x	Seconds	1	32767		
842	Analog Input 20 Detection Delay	x	Seconds	1	32767		
843	Analog Input 20 Restart Type	x		1	2	1 = Manual 2 = Timed	
844	Analog Input 20 Restart Delay	x	Minutes	1	32767		
845	RESERVED						
846	RESERVED						
847	RESERVED						
848	RESERVED						
849	Analog Input 21 Signal-Loss/Broken Fault	x		1	2	1 = Disabled 2 = Enabled	
850	Analog Input 21 High-High Reaction	x		1	3	1 = Disabled 2 = Alarm 3 = Shutdown	
851	Analog Input 21 High Reaction	x		1	3	1 = Disabled 2 = Alarm 3 = Shutdown	
852	Analog Input 21 Low Reaction	x		1	3	1 = Disabled 2 = Alarm 3 = Shutdown	
853	Analog Input 21 Low-Low Reaction	x		1	3	1 = Disabled 2 = Alarm 3 = Shutdown	
854	Analog Input 21 High-High Setpoint	x.x	DegF	-3276.8	3276.7		
855	Analog Input 21 High Setpoint	x.x	DegF	-3276.8	3276.7		
856	Analog Input 21 Low Setpoint	x.x	DegF	-3276.8	3276.7		

857	Analog Input 21 Low-Low Setpoint	x.x	DegF	-3276.8	3276.7		
858	Analog Input 21 Start Delay	x	Seconds	1	32767		
859	Analog Input 21 Detection Delay	x	Seconds	1	32767		
860	Analog Input 21 Restart Type	x		1	2	1 = Manual 2 = Timed	
861	Analog Input 21 Restart Delay	x	Minutes	1	32767		
862	RESERVED						
863	RESERVED						
864	RESERVED						
865	RESERVED						
866	Analog Input 22 Signal-Loss/Broken Fault	x		1	2	1 = Disabled 2 = Enabled	
867	Analog Input 22 High-High Reaction	x		1	3	1 = Disabled 2 = Alarm 3 = Shutdown	
868	Analog Input 22 High Reaction	x		1	3	1 = Disabled 2 = Alarm 3 = Shutdown	
869	Analog Input 22 Low Reaction	x		1	3	1 = Disabled 2 = Alarm 3 = Shutdown	
870	Analog Input 22 Low-Low Reaction	x		1	3	1 = Disabled 2 = Alarm 3 = Shutdown	
871	Analog Input 22 High-High Setpoint	x.x	DegF	-3276.8	3276.7		
872	Analog Input 22 High Setpoint	x.x	DegF	-3276.8	3276.7		
873	Analog Input 22 Low Setpoint	x.x	DegF	-3276.8	3276.7		
874	Analog Input 22 Low-Low Setpoint	x.x	DegF	-3276.8	3276.7		
875	Analog Input 22 Start Delay	x	Seconds	1	32767		
876	Analog Input 22 Detection Delay	x	Seconds	1	32767		
877	Analog Input 22 Restart Type	x		1	2	1 = Manual 2 = Timed	
878	Analog Input 22 Restart Delay	x	Minutes	1	32767		
879	RESERVED						
880	RESERVED						
881	RESERVED						
882	RESERVED						
883	Analog Input 23 Signal-Loss/Broken Fault	x		1	2	1 = Disabled 2 = Enabled	
884	Analog Input 23 High-High Reaction	x		1	3	1 = Disabled 2 = Alarm 3 = Shutdown	
885	Analog Input 23 High Reaction	x		1	3	1 = Disabled 2 = Alarm 3 = Shutdown	
886	Analog Input 23 Low Reaction	x		1	3	1 = Disabled 2 = Alarm 3 = Shutdown	

887	Analog Input 23 Low-Low Reaction	x		1	3	1 = Disabled 2 = Alarm 3 = Shutdown	
888	Analog Input 23 High-High Setpoint	x.x	DegF	-3276.8	3276.7		
889	Analog Input 23 High Setpoint	x.x	DegF	-3276.8	3276.7		
890	Analog Input 23 Low Setpoint	x.x	DegF	-3276.8	3276.7		
891	Analog Input 23 Low-Low Setpoint	x.x	DegF	-3276.8	3276.7		
892	Analog Input 23 Start Delay	x	Seconds	1	32767		
893	Analog Input 23 Detection Delay	x	Seconds	1	32767		
894	Analog Input 23 Restart Type	x		1	2	1 = Manual 2 = Timed	
895	Analog Input 23 Restart Delay	x	Minutes	1	32767		
896	RESERVED						
897	RESERVED						
898	Thrust Chamber Oil Temperature Source	x		1	2	1 = J-Type Thermocouple (AI10) 2 = RTD (AI16)	
899	Flow Source	x		1	2	1 = Analog (AI7) 2 = Calculated	
900	Filter Differential Pressure AI3 Rescale Minimum	x.x	PSI	-3276.8	3276.7		
901	Filter Differential Pressure AI3 Rescale Maximum	x.x	PSI	-3276.8	3276.7		
902	Filter Differential Pressure High-High Reaction	x		1	3	1 = Disabled 2 = Alarm 3 = Shutdown	
903	Filter Differential Pressure High Reaction	x		1	3	1 = Disabled 2 = Alarm 3 = Shutdown	
904	Filter Differential Pressure High-High Setpoint	x.x	PSI	-3276.8	3276.7		
905	Filter Differential Pressure High Setpoint	x.x	PSI	-3276.8	3276.7		
906	Filter Differential Pressure Start Delay	x	Seconds	1	32767		
907	Filter Differential Pressure Detection Delay	x	Seconds	1	32767		
908	Filter Differential Pressure Restart Type	x		1	2	1 = Manual 2 = Timed	
909	Filter Differential Pressure Restart Delay	x	Minutes	1	32767		
910	RESERVED						
911	RESERVED						
912	Filter Differential Pressure Inlet Analog Input	x		1	5	1 = Analog Input 1 2 = Analog Input 3 3 = Analog Input 11 4 = Analog Input 12 5 = Analog Input 13 6 = Analog Input 14 7 = Analog Input 15	
913	Filter Differential Pressure Outlet Analog Input	x		1	5	1 = Analog Input 1 2 = Analog Input 3 3 = Analog Input 11 4 = Analog Input 12 5 = Analog Input 13 6 = Analog Input 14 7 = Analog Input 15	

914	Unlock Advanced Parameters Analog Inputs	x		1	2	1 = Disabled 2 = Enabled	Feature disabled.
915	Unlock Advanced Parameters Digital Inputs	x		1	2	1 = Disabled 2 = Enabled	Feature disabled.
916	Controller Ethernet IP Address 1	x		0	255		1st octet.
917	Controller Ethernet IP Address 2	x		0	255		2nd octet.
918	Controller Ethernet IP Address 3	x		0	255		3rd octet.
919	Controller Ethernet IP Address 4	x		0	255		4th octet.
920	Controller Ethernet Subnet Mask 1	x		0	255		1st octet.
921	Controller Ethernet Subnet Mask 2	x		0	255		2nd octet.
922	Controller Ethernet Subnet Mask 3	x		0	255		3rd octet.
923	Controller Ethernet Subnet Mask 4	x		0	255		4th octet.
924	Controller Ethernet Default Gateway 1	x		0	255		1st octet.
925	Controller Ethernet Default Gateway 2	x		0	255		2nd octet.
926	Controller Ethernet Default Gateway 3	x		0	255		3rd octet.
927	Controller Ethernet Default Gateway 4	x		0	255		4th octet.
928	Digital Input 1 Active When	x		1	2	1 = Contact Open 2 = Contact Closed	
929	Digital Input 1 Active Delay	x	Seconds	0	32767		
930	RESERVED						
931	RESERVED						
932	RESERVED						
933	RESERVED						
934	RESERVED						
935	RESERVED						
936	RESERVED						
937	Digital Input 2 Active When	x		1	2	1 = Contact Open 2 = Contact Closed	
938	Digital Input 2 Active Delay	x	Seconds	0	32767		
939	RESERVED						
940	RESERVED						
941	RESERVED						
942	RESERVED						
943	RESERVED						
944	RESERVED						
945	RESERVED						
946	Digital Input 3 Active When	x		1	2	1 = Contact Open 2 = Contact Closed	
947	Digital Input 3 Active Delay	x	Seconds	0	32767		
948	RESERVED						
949	RESERVED						
950	RESERVED						
951	RESERVED						
952	RESERVED						
953	RESERVED						
954	RESERVED						
955	Digital Input 4 Active When	x		1	2	1 = Contact Open 2 = Contact Closed	

956	Digital Input 4 Active Delay	x	Seconds	0	32767		
957	RESERVED						
958	RESERVED						
959	RESERVED						
960	RESERVED						
961	RESERVED						
962	RESERVED						
963	RESERVED						
964	Digital Input 5 Active When	x		1	2	1 = Contact Open 2 = Contact Closed	
965	Digital Input 5 Active Delay	x	Seconds	0	32767		
966	RESERVED						
967	RESERVED						
968	RESERVED						
969	RESERVED						
970	RESERVED						
971	RESERVED						
972	RESERVED						
973	Digital Input 6 Confirm When	x		1	2	1 = Contact Open 2 = Contact Closed	
974	Digital Input 6 Confirm Delay	x	Seconds	0	32767		
975	RESERVED						
976	RESERVED						
977	RESERVED						
978	RESERVED						
979	RESERVED						
980	RESERVED						
981	RESERVED						
982	Digital Input 7 Confirm When	x		1	2	1 = Contact Open 2 = Contact Closed	
983	Digital Input 7 Confirm Delay	x	Seconds	0	32767		
984	RESERVED						
985	RESERVED						
986	RESERVED						
987	RESERVED						
988	RESERVED						
989	RESERVED						
990	RESERVED						
991	Digital Input 8 Confirm When	x		1	2	1 = Contact Open 2 = Contact Closed	
992	Digital Input 8 Confirm Delay	x	Seconds	0	32767		
993	RESERVED						
994	RESERVED						
995	RESERVED						
996	RESERVED						
997	RESERVED						
998	RESERVED						
999	RESERVED						

1000	Digital Input 9 Confirm When	x		1	2	1 = Contact Open 2 = Contact Closed	
1001	Digital Input 9 Confirm Delay	x	Seconds	0	32767		
1002	RESERVED						
1003	RESERVED						
1004	RESERVED						
1005	RESERVED						
1006	RESERVED						
1007	RESERVED						
1008	RESERVED						
1009	Digital Input 10 Confirm When	x		1	2	1 = Contact Open 2 = Contact Closed	
1010	Digital Input 10 Confirm Delay	x	Seconds	0	32767		
1011	RESERVED						
1012	RESERVED						
1013	RESERVED						
1014	RESERVED						
1015	RESERVED						
1016	RESERVED						
1017	RESERVED						
1018	Digital Input 11 Active When	x		1	2	1 = Contact Open 2 = Contact Closed	
1019	Digital Input 11 Active Delay	x	Seconds	0	32767		
1020	Digital Input 11 Reaction	x		1	3	1 = Disabled 2 = Alarm 3 = Shutdown	
1021	Digital Input 11 Start Delay	x	Seconds	1	32767		
1022	Digital Input 11 Detection Delay	x	Seconds	1	32767		
1023	Digital Input 11 Restart Type	x		1	2	1 = Manual 2 = Timed	
1024	Digital Input 11 Restart Delay	x	Minutes	1	32767		
1025	RESERVED						
1026	RESERVED						
1027	Digital Input 12 Active When	x		1	2	1 = Contact Open 2 = Contact Closed	
1028	Digital Input 12 Active Delay	x	Seconds	0	32767		
1029	Digital Input 12 Reaction	x		1	3	1 = Disabled 2 = Alarm 3 = Shutdown	
1030	Digital Input 12 Start Delay	x	Seconds	1	32767		
1031	Digital Input 12 Detection Delay	x	Seconds	1	32767		
1032	Digital Input 12 Restart Type	x		1	2	1 = Manual 2 = Timed	
1033	Digital Input 12 Restart Delay	x	Minutes	1	32767		
1034	RESERVED						
1035	RESERVED						
1036	Digital Input 13 Active When	x		1	2	1 = Contact Open 2 = Contact Closed	

1037	Digital Input 13 Active Delay	x	Seconds	0	32767		
1038	Digital Input 13 Reaction	x		1	3	1 = Disabled 2 = Alarm 3 = Shutdown	
1039	Digital Input 13 Start Delay	x	Seconds	1	32767		
1040	Digital Input 13 Detection Delay	x	Seconds	1	32767		
1041	Digital Input 13 Restart Type	x		1	2	1 = Manual 2 = Timed	
1042	Digital Input 13 Restart Delay	x	Minutes	1	32767		
1043	RESERVED						
1044	RESERVED						
1045	Digital Input 14 Active When	x		1	2	1 = Contact Open 2 = Contact Closed	
1046	Digital Input 14 Active Delay	x	Seconds	0	32767		
1047	Digital Input 14 Reaction	x		1	3	1 = Disabled 2 = Alarm 3 = Shutdown	
1048	Digital Input 14 Start Delay	x	Seconds	1	32767		
1049	Digital Input 14 Detection Delay	x	Seconds	1	32767		
1050	Digital Input 14 Restart Type	x		1	2	1 = Manual 2 = Timed	
1051	Digital Input 14 Restart Delay	x	Minutes	1	32767		
1052	RESERVED						
1053	RESERVED						
1054	Digital Input 15 Active When	x		1	2	1 = Contact Open 2 = Contact Closed	
1055	Digital Input 15 Active Delay	x	Seconds	0	32767		
1056	Digital Input 15 Reaction	x		1	3	1 = Disabled 2 = Alarm 3 = Shutdown	
1057	Digital Input 15 Start Delay	x	Seconds	1	32767		
1058	Digital Input 15 Detection Delay	x	Seconds	1	32767		
1059	Digital Input 15 Restart Type	x		1	2	1 = Manual 2 = Timed	
1060	Digital Input 15 Restart Delay	x	Minutes	1	32767		
1061	RESERVED						
1062	RESERVED						
1063	Digital Input 16 Active When	x		1	2	1 = Contact Open 2 = Contact Closed	
1064	Digital Input 16 Active Delay	x	Seconds	0	32767		
1065	Digital Input 16 Reaction	x		1	3	1 = Disabled 2 = Alarm 3 = Shutdown	
1066	Digital Input 16 Start Delay	x	Seconds	1	32767		
1067	Digital Input 16 Detection Delay	x	Seconds	1	32767		
1068	Digital Input 16 Restart Type	x		1	2	1 = Manual 2 = Timed	
1069	Digital Input 16 Restart Delay	x	Minutes	1	32767		

1070	RESERVED						
1071	RESERVED						
1072	Variable Frequency Drive Maximum Speed	x.xx	Hz	25.00	120.00		
1073	Variable Frequency Drive Base Frequency	x.x	Hz	25.0	120.0		
1074	Variable Frequency Drive Maximum Voltage	x	Volts	160	500		
1075	Variable Frequency Drive Acceleration Time	x.x	Seconds	0	3000.0		
1076	Variable Frequency Drive Deceleration Time	x.x	Seconds	0	3000.0		
1077	Variable Frequency Drive Torque Boost	x.x	%	0	20.0		
1078	Variable Frequency Drive Overload	x.x	Amps	1.0	3000.0		
1079	Variable Frequency Drive Minimum Speed	x.xx	Hz	0.00	120.00		
1080	Variable Frequency Drive Carrier Frequency	x	kHz	1	10		
1081	Variable Frequency Drive Control Mode	x		1	2	1 = V/Hz 2 = Torque Vector	
1082	Variable Frequency Drive Current Limit	x		1	2	1 = Disabled 2 = Enabled	
1083	Variable Frequency Drive Current Limit Setpoint	x	Amps	1	3000		
1084	Variable Frequency Drive Stop Mode	x		1	2	1 = Decelerate 2 = Coast to Stop	
1085	Variable Frequency Drive Regen Mode	x		1	3	1 = Brake/Disabled 2 = Control by Torque 3 = Control by DC Bus	
1086	Variable Frequency Drive Regen Frequency	x.x	Hz	0	120.0		
1087	Motor Rated Speed	x	RPM	1	4	1 = 900 2 = 1200 3 = 1800 4 = 3600	
1088	Motor Rated Horsepower	x	HP	1	1000		
1089	Motor Full-Load Amps	x.x	Amps	1.0	3000.0		
1090	Pressure Control Valve Control Mode	x		1	2	1 = Manual Setpoint 2 = Auto Pump Curve	
1091	Pressure Control Valve Manual Setpoint	x	PSI	-32768	32767		
1092	Serial Port 2 VFD Ignore Communication Faults	x		1	2	1 = Disabled 2 = Enabled	
1093	Access Control Operator Password	x		0	9999		
1094	Access Control Supervisor Password	x		0	9999		
1095	Main Pump Start/Stop Source	x		1	6	1 = Analog Suction Pressure (AI1) 2 = Analog Discharge Pressure (AI2) 3 = Analog Tank Level (AI3) 4 = Maintained Contact Tank Level (DI4) 5 = Momentary Contact Tank Level (DI4/DI5)	
1096	Main Pump Speed Source	x		1	4	1 = Analog Suction Pressure (AI1) 2 = Analog Discharge Pressure (AI2) 3 = Analog Tank Level (AI3) 4 = User Manual Entry/Fixed Speed	
1097	Pump Curve Number of Stages	x		1	1000		
1098	Pump Curve Specific Gravity	x		0.001	2.000		
1099	Pump Curve 7-Point Point 1 Speed	x.xx	Hz	0.00	120.00		

1100	Pump Curve 7-Point Point 1 Discharge Pressure	x	PSI	0	32767		
1101	Pump Curve 7-Point Point 2 Speed	x.xx	Hz	0.00	120.00		
1102	Pump Curve 7-Point Point 2 Discharge Pressure	x	PSI	0	32767		
1103	Pump Curve 7-Point Point 3 Speed	x.xx	Hz	0.00	120.00		
1104	Pump Curve 7-Point Point 3 Discharge Pressure	x	PSI	0	32767		
1105	Pump Curve 7-Point Point 4 Speed	x.xx	Hz	0.00	120.00		
1106	Pump Curve 7-Point Point 4 Discharge Pressure	x	PSI	0	32767		
1107	Pump Curve 7-Point Point 5 Speed	x.xx	Hz	0.00	120.00		
1108	Pump Curve 7-Point Point 5 Discharge Pressure	x	PSI	0	32767		
1109	Pump Curve 7-Point Point 6 Speed	x.xx	Hz	0.00	120.00		
1110	Pump Curve 7-Point Point 6 Discharge Pressure	x	PSI	0	32767		
1111	Pump Curve 7-Point Point 7 Speed	x.xx	Hz	0.00	120.00		
1112	Pump Curve 7-Point Point 7 Discharge Pressure	x	PSI	0	32767		
1113	Pump Curve 7-Point Point 1 Tornado Plot Bounds Lower Pressure	x	PSI	0	32767		
1114	Pump Curve 7-Point Point 1 Tornado Plot Bounds Upper Pressure	x	PSI	0	32767		
1115	Pump Curve 7-Point Point 2 Tornado Plot Bounds Lower Pressure	x	PSI	0	32767		
1116	Pump Curve 7-Point Point 2 Tornado Plot Bounds Upper Pressure	x	PSI	0	32767		
1117	Pump Curve 7-Point Point 3 Tornado Plot Bounds Lower Pressure	x	PSI	0	32767		
1118	Pump Curve 7-Point Point 3 Tornado Plot Bounds Upper Pressure	x	PSI	0	32767		
1119	Pump Curve 7-Point Point 4 Tornado Plot Bounds Lower Pressure	x	PSI	0	32767		
1120	Pump Curve 7-Point Point 4 Tornado Plot Bounds Upper Pressure	x	PSI	0	32767		
1121	Pump Curve 7-Point Point 5 Tornado Plot Bounds Lower Pressure	x	PSI	0	32767		
1122	Pump Curve 7-Point Point 5 Tornado Plot Bounds Upper Pressure	x	PSI	0	32767		
1123	Pump Curve 7-Point Point 6 Tornado Plot Bounds Lower Pressure	x	PSI	0	32767		
1124	Pump Curve 7-Point Point 6 Tornado Plot Bounds Upper Pressure	x	PSI	0	32767		
1125	Pump Curve 7-Point Point 7 Tornado Plot Bounds Lower Pressure	x	PSI	0	32767		
1126	Pump Curve 7-Point Point 7 Tornado Plot Bounds Upper Pressure	x	PSI	0	32767		
1127	Support Pumps Charge Pump	x		1	2	1 = Disabled 2 = Enabled	
1128	Support Pumps Charge Pump Pre-Run Time	x	Seconds	30	32767		
1129	Support Pumps Thrust Chamber Oil Pump	x		1	2	1 = Disabled 2 = Enabled	
1130	Support Pumps Thrust Chamber Oil Pump Pre-Run Time	x	Seconds	30	32767		
1131	Support Pumps Thrust Chamber Oil Pump Post-Run Time	x	Seconds	30	32767		

1132	Main Pump Speed (AIx) Proportional Band	x.x	%	-3276.8	3276.7		
1133	Main Pump Speed (Aix) Integral Time	x	Seconds	-32768	32767		
1134	Main Pump Speed (Aix) Derivative Time	x	Seconds	-32768	32767		
1135	Pressure Control Valve Auto Proportional Band	x.x	%	-3276.8	3276.7		
1136	Pressure Control Valve Auto Integral Time	x	Seconds	-32768	32767		
1137	Pressure Control Valve Auto Derivative Time	x	Seconds	-32768	32767		
1138	Pressure Control Valve Travel Time	x	Seconds	1	30000		
1139	Pressure Control Valve Stabilization Time	x	Seconds	1	30000		
1140	Pressure Control Valve Start Position	x.x	%	0.0	100.0		
1141	SD Card Logging Log When	x		1	2	1 = Always 2 = Running Only	
1142	SD Card Logging Logging Interval	x	Seconds	1	3600		
1143	Main Pump User Start	x		1	2	1 = Disabled 2 = Enabled	
1144	Block Valve Control Mode	x		1	2	1 = Disabled 2 = Run Sequence 3 = Independent	
1145	Block Valve Travel Time	x	Seconds	1	30000		
1146	(AO1) Pressure Control Valve Position Full Open (100%)	x		1	2	1 = 4 mA 2 = 20 mA	
1147	Main Pump Speed Mismatch Reaction	x		1	3	1 = Disabled 2 = Alarm 3 = Shutdown	
1148	Pressure Control Valve Out of Curve Reaction	x		1	3	1 = Disabled 2 = Alarm 3 = Shutdown	
1149	Pressure Control Valve Failed to Control Pressure Reaction	x		1	3	1 = Disabled 2 = Alarm 3 = Shutdown	
1150	RESERVED						
1151	Main Pump Speed OptiMode	x		1	2	1 = Disabled 2 = Enabled	
1152	Pressure Control Valve Position Feedback	x		1	4	1 = Disabled 2 = Analog (AI9) 3 = Digital (DI8) 4 = Both (AI9/DI8)	
1153	Pump Curve 7-Point Auto-Bounds Range	x	%	1	100		
1154	Pump Curve Upper Tolerance	x	%	0.1	100.0		
1155	Pump Curve Lower Tolerance	x	%	0.1	100.0		
1156	Digital Input 16 Function	x		1	2	1 = General Purpose 2 = Reset	
1157	Home Screen	x		1	2	1 = Tank 2 = Booster	
1158	Pressure Control Valve Manual Position Setpoint	x.x	%	0.0	100.0		
1159	Variable Frequency Drive Ethernet IP Address 1	x		0	255		1st octet.
1160	Variable Frequency Drive Ethernet IP Address 2	x		0	255		2nd octet.
1161	Variable Frequency Drive Ethernet IP Address 3	x		0	255		3rd octet.
1162	Variable Frequency Drive Ethernet IP Address 4	x		0	255		4th octet.

1163	Block Valve Operate When HOA	x		1	2	1 = Hand/Auto 2 = Hand/Off/Auto	
1164	Block Valve Operate During Shutdown/Fault	x		1	2	1 = Disabled 2 = Enabled	
1165	Block Valve Open Conditions	x		1	2	1 = All Met 2 = Any Met	
1166	Block Valve Opened Reaction	x		1	2	1 = Disabled 2 = Alarm	
1167	Block Valve Open Source 1	x		1	10	1 = None 2 = Analog Input 1 3 = Analog Input 2 4 = Analog Input 3 5 = Analog Input 4 6 = Analog Input 5 7 = Analog Input 11 8 = Analog Input 12 9 = Analog Input 13 10 = Analog Input 14 11 = Analog Input 15 12 = Digital Input 13 13 = Digital Input 14 14 = Digital Input 15 15 = Digital Input 16	
1168	Block Valve When To Open 1	x		1	2	1 = Equal or Greater 2 = Equal or Less	
1169	Block Valve Open Source 2	x		1	10	1 = None 2 = Analog Input 1 3 = Analog Input 2 4 = Analog Input 3 5 = Analog Input 4 6 = Analog Input 5 7 = Analog Input 11 8 = Analog Input 12 9 = Analog Input 13 10 = Analog Input 14 11 = Analog Input 15 12 = Digital Input 13 13 = Digital Input 14 14 = Digital Input 15 15 = Digital Input 16	
1170	Block Valve When To Open 2	x		1	2	1 = Equal or Greater 2 = Equal or Less	

1171	Block Valve Open Source 3	x		1	10	1 = None 2 = Analog Input 1 3 = Analog Input 2 4 = Analog Input 3 5 = Analog Input 4 6 = Analog Input 5 7 = Analog Input 11 8 = Analog Input 12 9 = Analog Input 13 10 = Analog Input 14 11 = Analog Input 15 12 = Digital Input 13 13 = Digital Input 14 14 = Digital Input 15 15 = Digital Input 16	
1172	Block Valve When To Open 3	x		1	2	1 = Equal or Greater 2 = Equal or Less	
1173	Block Valve Open Source 4	x		1	10	1 = None 2 = Analog Input 1 3 = Analog Input 2 4 = Analog Input 3 5 = Analog Input 4 6 = Analog Input 5 7 = Analog Input 11 8 = Analog Input 12 9 = Analog Input 13 10 = Analog Input 14 11 = Analog Input 15 12 = Digital Input 13 13 = Digital Input 14 14 = Digital Input 15 15 = Digital Input 16	
1174	Block Valve When To Open 4	x		1	2	1 = Equal or Greater 2 = Equal or Less	
1175	Block Valve Close Conditions	x		1	2	1 = All Met 2 = Any Met	
1176	Block Valve Closed Reaction	x		1	2	1 = Disabled 2 = Alarm	

1177	Block Valve Close Source 1	x		1	10	1 = None 2 = Analog Input 1 3 = Analog Input 2 4 = Analog Input 3 5 = Analog Input 4 6 = Analog Input 5 7 = Analog Input 11 8 = Analog Input 12 9 = Analog Input 13 10 = Analog Input 14 11 = Analog Input 15 12 = Digital Input 13 13 = Digital Input 14 14 = Digital Input 15 15 = Digital Input 16	
1178	Block Valve When To Close 1	x		1	2	1 = Equal or Greater 2 = Equal or Less	
1179	Block Valve Close Source 2	x		1	10	1 = None 2 = Analog Input 1 3 = Analog Input 2 4 = Analog Input 3 5 = Analog Input 4 6 = Analog Input 5 7 = Analog Input 11 8 = Analog Input 12 9 = Analog Input 13 10 = Analog Input 14 11 = Analog Input 15 12 = Digital Input 13 13 = Digital Input 14 14 = Digital Input 15 15 = Digital Input 16	
1180	Block Valve When To Close 2	x		1	2	1 = Equal or Greater 2 = Equal or Less	
1181	Block Valve Close Source 3	x		1	10	1 = None 2 = Analog Input 1 3 = Analog Input 2 4 = Analog Input 3 5 = Analog Input 4 6 = Analog Input 5 7 = Analog Input 11 8 = Analog Input 12 9 = Analog Input 13 10 = Analog Input 14 11 = Analog Input 15 12 = Digital Input 13 13 = Digital Input 14 14 = Digital Input 15 15 = Digital Input 16	

1182	Block Valve When To Close 3	x		1	2	1 = Equal or Greater 2 = Equal or Less	
1183	Block Valve Close Source 4	x		1	10	1 = None 2 = Analog Input 1 3 = Analog Input 2 4 = Analog Input 3 5 = Analog Input 4 6 = Analog Input 5 7 = Analog Input 11 8 = Analog Input 12 9 = Analog Input 13 10 = Analog Input 14 11 = Analog Input 15 12 = Digital Input 13 13 = Digital Input 14 14 = Digital Input 15 15 = Digital Input 16	
1184	Block Valve When To Close 4	x		1	2	1 = Equal or Greater 2 = Equal or Less	
1185	(AO2) Multipurpose Block Valve Position Full Open (100%)	x		1	2	1 = 4 mA 2 = 20 mA	
1186	Equipment Stabilization Time	x	Secs	1	60		
1187	(AO2) Multipurpose Function	x		1	2	1 = Block Valve Position 2 = Retransmit Analog Input	
1188	(AO2) Retransmit Analog Input	x		1	23	1 = Analog Input 1 2 = Analog Input 2 3 = Analog Input 3 4 = Analog Input 4 5 = Analog Input 5 6 = Analog Input 6 7 = Analog Input 7 8 = Analog Input 8 9 = Analog Input 9 10 = Analog Input 10 11 = Analog Input 11 12 = Analog Input 12 13 = Analog Input 13 14 = Analog Input 14 15 = Analog Input 15 16 = Analog Input 16 17 = Analog Input 17 18 = Analog Input 18 19 = Analog Input 19 20 = Analog Input 20 21 = Analog Input 21 22 = Analog Input 22 23 = Analog Input 23	
1189	Maintenance Reminder 1 Run-Time Hours	x	Hrs	1	32767		
1190	Maintenance Reminder 1 Day of Month	x		1	31		

1191	Maintenance Reminder 2 Run-Time Hours	x	Hrs	1	32767		
1192	Maintenance Reminder 2 Day of Month	x		1	31		
1193	Maintenance Reminder 3 Run-Time Hours	x	Hrs	1	32767		
1194	Maintenance Reminder 3 Day of Month	x		1	31		
1195	Maintenance Reminder 4 Run-Time Hours	x	Hrs	1	32767		
1196	Maintenance Reminder 4 Day of Month	x		1	31		
1197	Maintenance Reminder 5 Run-Time Hours	x	Hrs	1	32767		
1198	Maintenance Reminder 5 Day of Month	x		1	31		
1199	Maintenance Reminder 6 Run-Time Hours	x	Hrs	1	32767		
1200	Maintenance Reminder 6 Day of Month	x		1	31		
1201	Maintenance Reminder 7 Run-Time Hours	x	Hrs	1	32767		
1202	Maintenance Reminder 7 Day of Month	x		1	31		
1203	Maintenance Reminder 8 Run-Time Hours	x	Hrs	1	32767		
1204	Maintenance Reminder 8 Day of Month	x		1	31		
1205	Maintenance Reminder 9 Run-Time Hours	x	Hrs	1	32767		
1206	Maintenance Reminder 9 Day of Month	x		1	31		
1207	Maintenance Reminder 10 Run-Time Hours	x	Hrs	1	32767		
1208	Maintenance Reminder 10 Day of Month	x		1	31		
1209	RESERVED						
1210	RESERVED						
1211	Analog Input 3 Tank Status	x		0	7	1 = Disabled 2 = Tank 1 3 = Tank 2 4 = Tank 3 5 = Tank 4 6 = Tank 5 7 = Tank 6	
1212	Analog Input 4 Tank Status	x		0	7	1 = Disabled 2 = Tank 1 3 = Tank 2 4 = Tank 3 5 = Tank 4 6 = Tank 5 7 = Tank 6	
1213	Analog Input 5 Tank Status	x		0	7	1 = Disabled 2 = Tank 1 3 = Tank 2 4 = Tank 3 5 = Tank 4 6 = Tank 5 7 = Tank 6	
1214	RESERVED						
1215	RESERVED						
1216	RESERVED						
1217	RESERVED						
1218	RESERVED						

1219	Analog Input 11 Tank Status	x		0	7	1 = Disabled 2 = Tank 1 3 = Tank 2 4 = Tank 3 5 = Tank 4 6 = Tank 5 7 = Tank 6	
1220	Analog Input 12 Tank Status	x		0	7	1 = Disabled 2 = Tank 1 3 = Tank 2 4 = Tank 3 5 = Tank 4 6 = Tank 5 7 = Tank 6	
1221	Analog Input 13 Tank Status	x		0	7	1 = Disabled 2 = Tank 1 3 = Tank 2 4 = Tank 3 5 = Tank 4 6 = Tank 5 7 = Tank 6	
1222	Analog Input 14 Tank Status	x		0	7	1 = Disabled 2 = Tank 1 3 = Tank 2 4 = Tank 3 5 = Tank 4 6 = Tank 5 7 = Tank 6	
1223	Analog Input 15 Tank Status	x		0	7	1 = Disabled 2 = Tank 1 3 = Tank 2 4 = Tank 3 5 = Tank 4 6 = Tank 5 7 = Tank 6	
1224	RESERVED						
1225	RESERVED						
1226	RESERVED						
1227	RESERVED						
1228	RESERVED						
1229	RESERVED						
1230	RESERVED						
1231	RESERVED						
1232	Support Pumps Charge Pump Post-Run Time	x	Seconds	30	32767		
1233	VFD Thermal Warning	x		1	3	1 = Disabled 2 = Alarm 3 = Alarm & Message	
1234	VFD Thermal Warning Threshold	x	%	1	100		

1235	Analog Input 8 Flow Totalizer	x		1	2	1 = Disabled 2 = Enabled	
1250	Site Name	x	Chars		20		Up to 20 ASCII characters. 2 characters per 16-bit register. Be sure to include null terminator.
1261	Analog Input 1 Name	x	Chars		20		Up to 20 ASCII characters. 2 characters per 16-bit register. Be sure to include null terminator.
1272	Analog Input 1 Units	x	Chars		5		Up to 5 ASCII characters. 2 characters per 16-bit register. Be sure to include null terminator.
1276	Analog Input 2 Name	x	Chars		20		Up to 20 ASCII characters. 2 characters per 16-bit register. Be sure to include null terminator.
1287	Analog Input 2 Units	x	Chars		5		Up to 5 ASCII characters. 2 characters per 16-bit register. Be sure to include null terminator.
1291	Analog Input 3 Name	x	Chars		20		Up to 20 ASCII characters. 2 characters per 16-bit register. Be sure to include null terminator.
1302	Analog Input 3 Units	x	Chars		5		Up to 5 ASCII characters. 2 characters per 16-bit register. Be sure to include null terminator.
1306	Analog Input 4 Name	x	Chars		20		Up to 20 ASCII characters. 2 characters per 16-bit register. Be sure to include null terminator.
1317	Analog Input 4 Units	x	Chars		5		Up to 5 ASCII characters. 2 characters per 16-bit register. Be sure to include null terminator.
1321	Analog Input 5 Name	x	Chars		20		Up to 20 ASCII characters. 2 characters per 16-bit register. Be sure to include null terminator.
1332	Analog Input 5 Units	x	Chars		5		Up to 5 ASCII characters. 2 characters per 16-bit register. Be sure to include null terminator.
1336	Analog Input 6 Name	x	Chars		20		Up to 20 ASCII characters. 2 characters per 16-bit register. Be sure to include null terminator.
1347	Analog Input 6 Units	x	Chars		5		Up to 5 ASCII characters. 2 characters per 16-bit register. Be sure to include null terminator.
1351	Analog Input 7 Name	x	Chars		20		Up to 20 ASCII characters. 2 characters per 16-bit register. Be sure to include null terminator.
1362	Analog Input 7 Units	x	Chars		5		Up to 5 ASCII characters. 2 characters per 16-bit register. Be sure to include null terminator.

1366	Analog Input 8 Name	x	Chars		20		Up to 20 ASCII characters. 2 characters per 16-bit register. Be sure to include null terminator.
1377	Analog Input 8 Units	x	Chars		5		Up to 5 ASCII characters. 2 characters per 16-bit register. Be sure to include null terminator.
1381	Analog Input 9 Name	x	Chars		20		Up to 20 ASCII characters. 2 characters per 16-bit register. Be sure to include null terminator.
1392	Analog Input 9 Units	x	Chars		5		Up to 5 ASCII characters. 2 characters per 16-bit register. Be sure to include null terminator.
1396	Analog Input 10/16 Name	x	Chars		20		Up to 20 ASCII characters. 2 characters per 16-bit register. Be sure to include null terminator.
1407	Analog Input 10/16 Units	x	Chars		5		Up to 5 ASCII characters. 2 characters per 16-bit register. Be sure to include null terminator.
1411	Analog Input 11 Name	x	Chars		20		Up to 20 ASCII characters. 2 characters per 16-bit register. Be sure to include null terminator.
1422	Analog Input 11 Units	x	Chars		5		Up to 5 ASCII characters. 2 characters per 16-bit register. Be sure to include null terminator.
1426	Analog Input 12 Name	x	Chars		20		Up to 20 ASCII characters. 2 characters per 16-bit register. Be sure to include null terminator.
1437	Analog Input 12 Units	x	Chars		5		Up to 5 ASCII characters. 2 characters per 16-bit register. Be sure to include null terminator.
1441	Analog Input 13 Name	x	Chars		20		Up to 20 ASCII characters. 2 characters per 16-bit register. Be sure to include null terminator.
1452	Analog Input 13 Units	x	Chars		5		Up to 5 ASCII characters. 2 characters per 16-bit register. Be sure to include null terminator.
1456	Analog Input 14 Name	x	Chars		20		Up to 20 ASCII characters. 2 characters per 16-bit register. Be sure to include null terminator.
1467	Analog Input 14 Units	x	Chars		5		Up to 5 ASCII characters. 2 characters per 16-bit register. Be sure to include null terminator.
1471	Analog Input 15 Name	x	Chars		20		Up to 20 ASCII characters. 2 characters per 16-bit register. Be sure to include null terminator.
1482	Analog Input 15 Units	x	Chars		5		Up to 5 ASCII characters. 2 characters per 16-bit register. Be sure to include null terminator.

1501	Analog Input 17 Name	x	Chars		20		Up to 20 ASCII characters. 2 characters per 16-bit register. Be sure to include null terminator.
1512	Analog Input 17 Units	x	Chars		5		Up to 5 ASCII characters. 2 characters per 16-bit register. Be sure to include null terminator.
1516	Analog Input 18 Name	x	Chars		20		Up to 20 ASCII characters. 2 characters per 16-bit register. Be sure to include null terminator.
1527	Analog Input 18 Units	x	Chars		5		Up to 5 ASCII characters. 2 characters per 16-bit register. Be sure to include null terminator.
1531	Analog Input 19 Name	x	Chars		20		Up to 20 ASCII characters. 2 characters per 16-bit register. Be sure to include null terminator.
1542	Analog Input 19 Units	x	Chars		5		Up to 5 ASCII characters. 2 characters per 16-bit register. Be sure to include null terminator.
1546	Analog Input 20 Name	x	Chars		20		Up to 20 ASCII characters. 2 characters per 16-bit register. Be sure to include null terminator.
1557	Analog Input 20 Units	x	Chars		5		Up to 5 ASCII characters. 2 characters per 16-bit register. Be sure to include null terminator.
1561	Analog Input 21 Name	x	Chars		20		Up to 20 ASCII characters. 2 characters per 16-bit register. Be sure to include null terminator.
1572	Analog Input 21 Units	x	Chars		5		Up to 5 ASCII characters. 2 characters per 16-bit register. Be sure to include null terminator.
1576	Analog Input 22 Name	x	Chars		20		Up to 20 ASCII characters. 2 characters per 16-bit register. Be sure to include null terminator.
1587	Analog Input 22 Units	x	Chars		5		Up to 5 ASCII characters. 2 characters per 16-bit register. Be sure to include null terminator.
1591	Analog Input 23 Name	x	Chars		20		Up to 20 ASCII characters. 2 characters per 16-bit register. Be sure to include null terminator.
1602	Analog Input 23 Units	x	Chars		5		Up to 5 ASCII characters. 2 characters per 16-bit register. Be sure to include null terminator.
1606	Digital Input 1 Name	x	Chars		20		Up to 20 ASCII characters. 2 characters per 16-bit register. Be sure to include null terminator.
1617	Digital Input 2 Name	x	Chars		20		Up to 20 ASCII characters. 2 characters per 16-bit register. Be sure to include null terminator.

1628	Digital Input 3 Name	x	Chars		20		Up to 20 ASCII characters. 2 characters per 16-bit register. Be sure to include null terminator.
1639	Digital Input 4 Name	x	Chars		20		Up to 20 ASCII characters. 2 characters per 16-bit register. Be sure to include null terminator.
1650	Digital Input 5 Name	x	Chars		20		Up to 20 ASCII characters. 2 characters per 16-bit register. Be sure to include null terminator.
1661	Digital Input 6 Name	x	Chars		20		Up to 20 ASCII characters. 2 characters per 16-bit register. Be sure to include null terminator.
1672	Digital Input 7 Name	x	Chars		20		Up to 20 ASCII characters. 2 characters per 16-bit register. Be sure to include null terminator.
1683	Digital Input 8 Name	x	Chars		20		Up to 20 ASCII characters. 2 characters per 16-bit register. Be sure to include null terminator.
1694	Digital Input 9 Name	x	Chars		20		Up to 20 ASCII characters. 2 characters per 16-bit register. Be sure to include null terminator.
1705	Digital Input 10 Name	x	Chars		20		Up to 20 ASCII characters. 2 characters per 16-bit register. Be sure to include null terminator.
1716	Digital Input 11 Name	x	Chars		20		Up to 20 ASCII characters. 2 characters per 16-bit register. Be sure to include null terminator.
1727	Digital Input 12 Name	x	Chars		20		Up to 20 ASCII characters. 2 characters per 16-bit register. Be sure to include null terminator.
1738	Digital Input 13 Name	x	Chars		20		Up to 20 ASCII characters. 2 characters per 16-bit register. Be sure to include null terminator.
1749	Digital Input 14 Name	x	Chars		20		Up to 20 ASCII characters. 2 characters per 16-bit register. Be sure to include null terminator.
1760	Digital Input 15 Name	x	Chars		20		Up to 20 ASCII characters. 2 characters per 16-bit register. Be sure to include null terminator.
1771	Digital Input 16 Name	x	Chars		20		Up to 20 ASCII characters. 2 characters per 16-bit register. Be sure to include null terminator.

Parameters (32-Bit Holding Registers) – Read/Write

Address	Description	Scaling	Units	Minimum	Maximum	Values	Notes
28722	Analog Input 7 Scale Minimum	x	BPD	-999999	999999		
28723	Analog Input 7 Scale Maximum	x	BPD	-999999	999999		
28724	Analog Input 7 High-High Setpoint	x	BPD	-999999	999999		
28725	Analog Input 7 High Setpoint	x	BPD	-999999	999999		
28726	Analog Input 7 Low Setpoint	x	BPD	-999999	999999		
28727	Analog Input 7 Low-Low Setpoint	x	BPD	-999999	999999		
28728	Analog Input 8 Scale Minimum	x		-999999	999999		
28729	Analog Input 8 Scale Maximum	x		-999999	999999		
28730	Analog Input 8 High-High Setpoint	x		-999999	999999		
28731	Analog Input 8 High Setpoint	x		-999999	999999		
28732	Analog Input 8 Low Setpoint	x		-999999	999999		
28733	Analog Input 8 Low-Low Setpoint	x		-999999	999999		
28734	Main Pump Start/Stop Start Setpoint	x.x		-214748364.8	214748364.8		
28735	Main Pump Start/Stop Stop Setpoint	x.x		-214748364.8	214748364.8		
28736	Main Pump Speed Maintain Setpoint	x.x		-214748364.8	214748364.8		
28737	Main Pump Speed Fixed Speed	x.xx	Hz	0.00	120.00		
28738	Pump Curve 7-Point Point 1 Flow	x	BPD	0	999999		
28739	Pump Curve 7-Point Point 2 Flow	x	BPD	0	999999		
28740	Pump Curve 7-Point Point 3 Flow	x	BPD	0	999999		
28741	Pump Curve 7-Point Point 4 Flow	x	BPD	0	999999		
28742	Pump Curve 7-Point Point 5 Flow	x	BPD	0	999999		
28743	Pump Curve 7-Point Point 6 Flow	x	BPD	0	999999		
28744	Pump Curve 7-Point Point 7 Flow	x	BPD	0	999999		
28745	Pump Curve 7-Point Point 1 Tornado Plot Bounds Lower Flow	x	BPD	0	999999		
28746	Pump Curve 7-Point Point 1 Tornado Plot Bounds Upper Flow	x	BPD	0	999999		
28747	Pump Curve 7-Point Point 2 Tornado Plot Bounds Lower Flow	x	BPD	0	999999		
28748	Pump Curve 7-Point Point 2 Tornado Plot Bounds Upper Flow	x	BPD	0	999999		
28749	Pump Curve 7-Point Point 3 Tornado Plot Bounds Lower Flow	x	BPD	0	999999		
28750	Pump Curve 7-Point Point 3 Tornado Plot Bounds Upper Flow	x	BPD	0	999999		
28751	Pump Curve 7-Point Point 4 Tornado Plot Bounds Lower Flow	x	BPD	0	999999		
28752	Pump Curve 7-Point Point 4 Tornado Plot Bounds Upper Flow	x	BPD	0	999999		
28753	Pump Curve 7-Point Point 5 Tornado Plot Bounds Lower Flow	x	BPD	0	999999		
28754	Pump Curve 7-Point Point 5 Tornado Plot Bounds Upper Flow	x	BPD	0	999999		
28755	Pump Curve 7-Point Point 6 Tornado Plot Bounds Lower Flow	x	BPD	0	999999		
28756	Pump Curve 7-Point Point 6 Tornado Plot Bounds Upper Flow	x	BPD	0	999999		
28757	Pump Curve 7-Point Point 7 Tornado Plot Bounds Lower Flow	x	BPD	0	999999		
28758	Pump Curve 7-Point Point 7 Tornado Plot Bounds Upper Flow	x	BPD	0	999999		
28759	Block Valve Open Setpoint 1	x.x		-214748364.8	214748364.8		
28760	Block Valve Open Setpoint 2	x.x		-214748364.8	214748364.8		
28761	Block Valve Open Setpoint 3	x.x		-214748364.8	214748364.8		
28762	Block Valve Open Setpoint 4	x.x		-214748364.8	214748364.8		
28763	Block Valve Close Setpoint 1	x.x		-214748364.8	214748364.8		
28764	Block Valve Close Setpoint 2	x.x		-214748364.8	214748364.8		

28765	Block Valve Close Setpoint 3	x.x		-214748364.8	214748364.8		
28766	Block Valve Close Setpoint 4	x.x		-214748364.8	214748364.8		

Parameters (Bits/Coils) – Read/Write

Address	Description	Notes
160	Maintenance Reminder 1 Reset	Resets Maintenance Reminder 1. If Maintenance Reminder 1 Frequency set to Run-Time, will reset the countdown Timer, even if the reminder is not active.
161	Maintenance Reminder 2 Reset	Resets Maintenance Reminder 2. If Maintenance Reminder 1 Frequency set to Run-Time, will reset the countdown Timer, even if the reminder is not active.
162	Maintenance Reminder 3 Reset	Resets Maintenance Reminder 3. If Maintenance Reminder 1 Frequency set to Run-Time, will reset the countdown Timer, even if the reminder is not active.
163	Maintenance Reminder 4 Reset	Resets Maintenance Reminder 4. If Maintenance Reminder 1 Frequency set to Run-Time, will reset the countdown Timer, even if the reminder is not active.
164	Maintenance Reminder 5 Reset	Resets Maintenance Reminder 5. If Maintenance Reminder 1 Frequency set to Run-Time, will reset the countdown Timer, even if the reminder is not active.
165	Maintenance Reminder 6 Reset	Resets Maintenance Reminder 6. If Maintenance Reminder 1 Frequency set to Run-Time, will reset the countdown Timer, even if the reminder is not active.
166	Maintenance Reminder 7 Reset	Resets Maintenance Reminder 7. If Maintenance Reminder 1 Frequency set to Run-Time, will reset the countdown Timer, even if the reminder is not active.
167	Maintenance Reminder 8 Reset	Resets Maintenance Reminder 8. If Maintenance Reminder 1 Frequency set to Run-Time, will reset the countdown Timer, even if the reminder is not active.
168	Maintenance Reminder 9 Reset	Resets Maintenance Reminder 9. If Maintenance Reminder 1 Frequency set to Run-Time, will reset the countdown Timer, even if the reminder is not active.
169	Maintenance Reminder 10 Reset	Resets Maintenance Reminder 10. If Maintenance Reminder 1 Frequency set to Run-Time, will reset the countdown Timer, even if the reminder is not active.
500	Trends Plot Curve 1 None	Selects data for plotting as Curve 1 on Trends screen. Only one bit may be Set at a time. Setting a bit will Reset any other Set bit.
501	Trends Plot Curve 1 Speed	
502	Trends Plot Curve 1 Voltage	
503	Trends Plot Curve 1 Current	
504	Trends Plot Curve 1 Torque	
505	Trends Plot Curve 1 Horsepower	
506	Trends Plot Curve 1 Analog Input 1	
507	Trends Plot Curve 1 Analog Input 2	
508	Trends Plot Curve 1 Analog Input 4	
509	Trends Plot Curve 1 Analog Input 5	
510	Trends Plot Curve 2 None	Selects data for plotting as Curve 2 on Trends screen. Only one bit may be Set at a time. Setting a bit will Reset any other Set bit.
511	Trends Plot Curve 2 Speed	
512	Trends Plot Curve 2 Voltage	
513	Trends Plot Curve 2 Current	
514	Trends Plot Curve 2 Torque	
515	Trends Plot Curve 2 Horsepower	
516	Trends Plot Curve 2 Analog Input 1	
517	Trends Plot Curve 2 Analog Input 2	
518	Trends Plot Curve 2 Analog Input 4	
519	Trends Plot Curve 2 Analog Input 5	
520	Trends Plot Curve 3 None	Selects data for plotting as Curve 3 on Trends screen. Only one bit may be Set at a time. Setting a bit will Reset any other Set bit.
521	Trends Plot Curve 3 Analog Input 3	
522	Trends Plot Curve 3 Analog Input 7	

523	Trends Plot Curve 3 Analog Input 8	
524	Trends Plot Curve 3 Analog Input 9	
525	Trends Plot Curve 3 Analog Input 10/16	
526	Trends Plot Curve 3 Analog Input 14	
527	Trends Plot Curve 3 Analog Input 15	
528	Trends Plot Curve 3 Analog Input 17	
529	Trends Plot Curve 3 Analog Input 18	
530	Trends Plot Curve 3 Analog Input 19	
531	Trends Plot Curve 3 Analog Input 20	
532	Trends Plot Curve 3 Analog Input 21	
533	Trends Plot Curve 3 Analog Input 22	
534	Trends Plot Curve 3 Analog Input 23	
535	RESERVED	
536	Trends Plot Curve 4 None	Selects data for plotting as Curve 4 on Trends screen. Only one bit may be Set at a time. Setting a bit will Reset any other Set bit.
537	Trends Plot Curve 4 Analog Input 3	
538	Trends Plot Curve 4 Analog Input 7	
539	Trends Plot Curve 4 Analog Input 8	
540	Trends Plot Curve 4 Analog Input 9	
541	Trends Plot Curve 4 Analog Input 10/16	
542	Trends Plot Curve 4 Analog Input 14	
543	Trends Plot Curve 4 Analog Input 15	
544	Trends Plot Curve 4 Analog Input 17	
545	Trends Plot Curve 4 Analog Input 18	
546	Trends Plot Curve 4 Analog Input 19	
547	Trends Plot Curve 4 Analog Input 20	
548	Trends Plot Curve 4 Analog Input 21	
549	Trends Plot Curve 4 Analog Input 22	
550	Trends Plot Curve 4 Analog Input 23	
551	RESERVED	
552	Trends Plot Curve 5 None	Selects data for plotting as Curve 5 on Trends screen. Only one bit may be Set at a time. Setting a bit will Reset any other Set bit.
553	Trends Plot Curve 5 Analog Input 6	
554	Trends Plot Curve 5 Analog Input 11	
555	Trends Plot Curve 5 Analog Input 12	
556	Trends Plot Curve 5 Analog Input 13	
557	RESERVED	
558	RESERVED	
559	RESERVED	
560	RESERVED	
561	RESERVED	
562	RESERVED	
563	RESERVED	
564	RESERVED	
565	RESERVED	
566	RESERVED	
567	RESERVED	
568	Trends Plot Curve 6 None	Selects data for plotting as Curve 6 on Trends screen. Only one bit may be Set at a time. Setting a bit will Reset any other Set bit.
569	Trends Plot Curve 6 Analog Input 6	
570	Trends Plot Curve 6 Analog Input 11	

571	Trends Plot Curve 6 Analog Input 12	
572	Trends Plot Curve 6 Analog Input 13	
573	RESERVED	Selects the pump curve profile type. Only one bit may be Set at a time. Setting a bit will Reset any other Set bit.
574	Pump Curve Profile Type Custom Coefficients	
575	Pump Curve Profile Type Custom 7-Point	
576	RESERVED	RESERVED. Only one bit may be Set at a time. Setting a bit will Reset any other Set bit.
577	RESERVED	
578	RESERVED	
579	RESERVED	
580	RESERVED	
581	RESERVED	
582	RESERVED	
583	RESERVED	
584	RESERVED	
585	RESERVED	
586	RESERVED	
587	RESERVED	
588	RESERVED	
589	RESERVED	
590	RESERVED	
591	RESERVED	
592	RESERVED	
600	Pressure Control Valve Control Mode Auto Pump Curve	Selects the pressure control valve control mode. Only one bit may be Set at a time. Setting a bit will Reset any other Set bit.
601	Pressure Control Valve Control Mode Manual Pressure	
602	Pressure Control Valve Control Mode Manual Position	
610	Maintenance Reminder 1 Frequency Disabled	Selects the maintenance reminder frequency. Only one bit may be Set at a time. Setting a bit will Reset any other Set bit.
611	Maintenance Reminder 1 Frequency Run-Time	
612	Maintenance Reminder 1 Frequency Monthly	
613	Maintenance Reminder 1 Run-Time Source Panel	Selects the maintenance reminder run-time source. Only one bit may be Set at a time. Setting a bit will Reset any other Set bit.
614	Maintenance Reminder 1 Run-Time Source Main Pump	
615	Maintenance Reminder 1 Run-Time Source Charge Pump	
616	Maintenance Reminder 1 Run-Time Source Thrst Chmbr Oil Pump	
617	Maintenance Reminder 2 Frequency Disabled	Selects the maintenance reminder frequency. Only one bit may be Set at a time. Setting a bit will Reset any other Set bit.
618	Maintenance Reminder 2 Frequency Run-Time	
619	Maintenance Reminder 2 Frequency Monthly	
620	Maintenance Reminder 2 Run-Time Source Panel	Selects the maintenance reminder run-time source. Only one bit may be Set at a time. Setting a bit will Reset any other Set bit.
621	Maintenance Reminder 2 Run-Time Source Main Pump	
622	Maintenance Reminder 2 Run-Time Source Charge Pump	
623	Maintenance Reminder 2 Run-Time Source Thrst Chmbr Oil Pump	
624	Maintenance Reminder 3 Frequency Disabled	Selects the maintenance reminder frequency. Only one bit may be Set at a time. Setting a bit will Reset any other Set bit.
625	Maintenance Reminder 3 Frequency Run-Time	
626	Maintenance Reminder 3 Frequency Monthly	
627	Maintenance Reminder 3 Run-Time Source Panel	Selects the maintenance reminder run-time source. Only one bit may be Set at a time. Setting a bit will Reset any other Set bit.
628	Maintenance Reminder 3 Run-Time Source Main Pump	
629	Maintenance Reminder 3 Run-Time Source Charge Pump	
630	Maintenance Reminder 3 Run-Time Source Thrst Chmbr Oil Pump	
631	Maintenance Reminder 4 Frequency Disabled	Selects the maintenance reminder frequency. Only one bit may be Set at a time. Setting a bit will Reset any other Set bit.
632	Maintenance Reminder 4 Frequency Run-Time	

633	Maintenance Reminder 4 Frequency Monthly	
634	Maintenance Reminder 4 Run-Time Source Panel	Selects the maintenance reminder run-time source. Only one bit may be Set at a time. Setting a bit will Reset any other Set bit.
635	Maintenance Reminder 4 Run-Time Source Main Pump	
636	Maintenance Reminder 4 Run-Time Source Charge Pump	
637	Maintenance Reminder 4 Run-Time Source Thrst Chmbr Oil Pump	
638	Maintenance Reminder 5 Frequency Disabled	Selects the maintenance reminder frequency. Only one bit may be Set at a time. Setting a bit will Reset any other Set bit.
639	Maintenance Reminder 5 Frequency Run-Time	
640	Maintenance Reminder 5 Frequency Monthly	
641	Maintenance Reminder 5 Run-Time Source Panel	Selects the maintenance reminder run-time source. Only one bit may be Set at a time. Setting a bit will Reset any other Set bit.
642	Maintenance Reminder 5 Run-Time Source Main Pump	
643	Maintenance Reminder 5 Run-Time Source Charge Pump	
644	Maintenance Reminder 5 Run-Time Source Thrst Chmbr Oil Pump	
645	Maintenance Reminder 6 Frequency Disabled	Selects the maintenance reminder frequency. Only one bit may be Set at a time. Setting a bit will Reset any other Set bit.
646	Maintenance Reminder 6 Frequency Run-Time	
647	Maintenance Reminder 6 Frequency Monthly	
648	Maintenance Reminder 6 Run-Time Source Panel	Selects the maintenance reminder run-time source. Only one bit may be Set at a time. Setting a bit will Reset any other Set bit.
649	Maintenance Reminder 6 Run-Time Source Main Pump	
650	Maintenance Reminder 6 Run-Time Source Charge Pump	
651	Maintenance Reminder 6 Run-Time Source Thrst Chmbr Oil Pump	
652	Maintenance Reminder 7 Frequency Disabled	Selects the maintenance reminder frequency. Only one bit may be Set at a time. Setting a bit will Reset any other Set bit.
653	Maintenance Reminder 7 Frequency Run-Time	
654	Maintenance Reminder 7 Frequency Monthly	
655	Maintenance Reminder 7 Run-Time Source Panel	Selects the maintenance reminder run-time source. Only one bit may be Set at a time. Setting a bit will Reset any other Set bit.
656	Maintenance Reminder 7 Run-Time Source Main Pump	
657	Maintenance Reminder 7 Run-Time Source Charge Pump	
658	Maintenance Reminder 7 Run-Time Source Thrst Chmbr Oil Pump	
659	Maintenance Reminder 8 Frequency Disabled	Selects the maintenance reminder frequency. Only one bit may be Set at a time. Setting a bit will Reset any other Set bit.
660	Maintenance Reminder 8 Frequency Run-Time	
661	Maintenance Reminder 8 Frequency Monthly	
662	Maintenance Reminder 8 Run-Time Source Panel	Selects the maintenance reminder run-time source. Only one bit may be Set at a time. Setting a bit will Reset any other Set bit.
663	Maintenance Reminder 8 Run-Time Source Main Pump	
664	Maintenance Reminder 8 Run-Time Source Charge Pump	
665	Maintenance Reminder 8 Run-Time Source Thrst Chmbr Oil Pump	
666	Maintenance Reminder 9 Frequency Disabled	Selects the maintenance reminder frequency. Only one bit may be Set at a time. Setting a bit will Reset any other Set bit.
667	Maintenance Reminder 9 Frequency Run-Time	
668	Maintenance Reminder 9 Frequency Monthly	
669	Maintenance Reminder 9 Run-Time Source Panel	Selects the maintenance reminder run-time source. Only one bit may be Set at a time. Setting a bit will Reset any other Set bit.
670	Maintenance Reminder 9 Run-Time Source Main Pump	
671	Maintenance Reminder 9 Run-Time Source Charge Pump	
672	Maintenance Reminder 9 Run-Time Source Thrst Chmbr Oil Pump	
673	Maintenance Reminder 10 Frequency Disabled	Selects the maintenance reminder frequency. Only one bit may be Set at a time. Setting a bit will Reset any other Set bit.
674	Maintenance Reminder 10 Frequency Run-Time	
675	Maintenance Reminder 10 Frequency Monthly	
676	Maintenance Reminder 10 Run-Time Source Panel	Selects the maintenance reminder run-time source. Only one bit may be Set at a time. Setting a bit will Reset any other Set bit.
677	Maintenance Reminder 10 Run-Time Source Main Pump	
678	Maintenance Reminder 10 Run-Time Source Charge Pump	
679	Maintenance Reminder 10 Run-Time Source Thrst Chmbr Oil Pump	

Parameters (32-Bit Floating Point Holding Registers) – Read/Write

Address	Description	Units	Minimum	Maximum	Values	Notes
16434	Pump Curve Custom Coefficients Plot Minimum Flow	BPD				
16435	Pump Curve Custom Coefficients Plot Maximum Flow	BPD				
16436	Pump Curve Custom Coefficients BEP Flow @ 60 Hz	BPD				
16437	Pump Curve Custom Coefficients BEP Minimum Flow @ 60 Hz	BPD				
16438	Pump Curve Custom Coefficients BEP Maximum Flow @ 60 Hz	BPD				
16439	Pump Curve Custom Coefficients Coefficient X^5 (a)					
16440	Pump Curve Custom Coefficients Coefficient X^4 (b)					
16441	Pump Curve Custom Coefficients Coefficient X^3 (c)					
16442	Pump Curve Custom Coefficients Coefficient X^2 (d)					
16443	Pump Curve Custom Coefficients Coefficient X^1 (e)					
16444	Pump Curve Custom Coefficients Coefficient X^0 (f)					

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