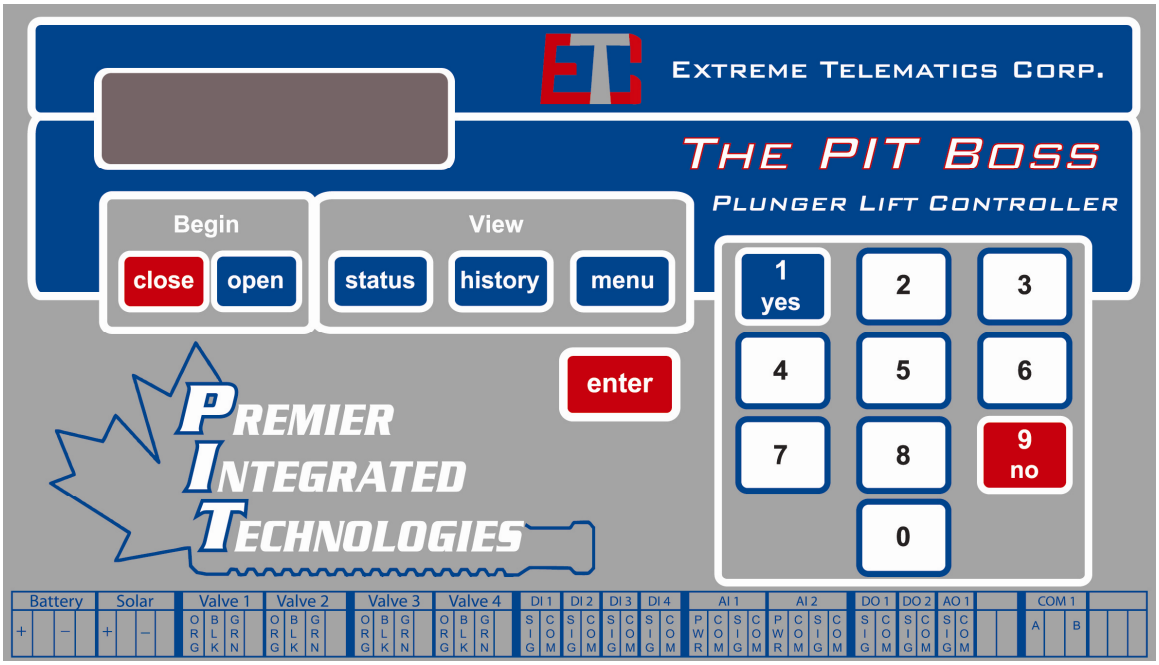
The PIT Boss Plunger Lift Controller

Installation and Operations Manual

Software Revision 5.x.x

27/02/2008



Extreme Telematics Corp.

Revision History

Revision	Date	Author	Changes
5.x.x	27/02/2009	Mark Scantlebury	Initial Version

Acronyms

ADC	**Analog-to-Digital Converter**
AI	**Analog Input**
CVC	**Configurable Valve Controller**
DAC	**Digital-to-Analog Converter**
DI	**Digital Input**
DO	**Digital Output**
ESD	**Emergency Shut Down**
N/C	**Normally Closed**
N/O	**Normally Open**
PIT	**Premier Integrated Technologies**
PSI	**Pounds per Square Inch**
R	**Read Permission**
RTU	**Remote Terminal Unit**
R/W	**Read/Write Permission**
SCADA	**Supervisory Control And Data Acquisition**
V	**Volts**
VFD	**Vacuum Fluorescent Display**
VI	**Virtual Input**

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1 Introduction

1.1 Purpose

This manual is intended to provide all of the information required to setup and operate the PIT Boss Plunger Lift Controller. As well, it covers basic troubleshooting techniques and support information.

1.2 Overview

The PIT Boss Plunger Lift Controller is a versatile gas well controller that can be used in a number of different configurations. It can function as a simple intermitter or with a plunger and can optimize a well based on pressures or plunger arrival times. In addition, the controller can be accessed remotely using the provided Modbus compatible RS485 communications port.

1.3 Assumptions

The following assumptions have been made when writing this manual:

- The reader has some knowledge of the operation of a gas well.
- A controller is available as a reference while reading this manual.

2 Installation

2.1 Physical Connections

The following is an outline of the locations that input devices can be wired to:

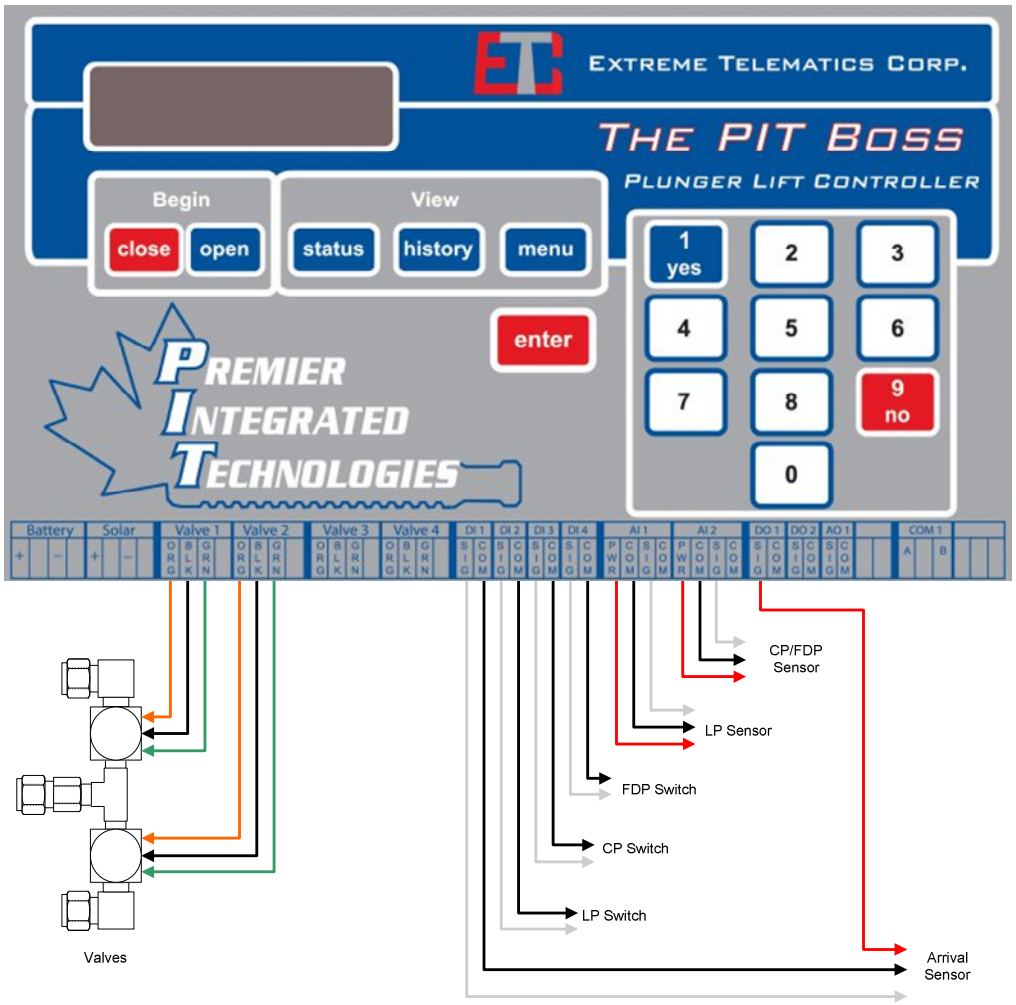


Figure 1 - PIT Boss Wiring Diagram

Location	Devices To Connect	Description
Battery	6V Battery	Only use a 6V intrinsically safe ETC battery.
Solar	Solar Panel	Use a 3W ETC Solar Panel
Valve 1	Valve A Solenoid	Only use an intrinsically safe ETC approved valve solenoid.
Valve 2	Valve B Solenoid	Only use an intrinsically safe ETC approved valve solenoid.
Valve 3	Valve C Solenoid	Only use an intrinsically safe ETC approved valve solenoid.
Valve 4	Valve D Solenoid (Autocatcher Valve)	Only use an intrinsically safe ETC approved valve solenoid.
DI 1	Arrival Sensor	Connect signal and ground of a 2 or 3 wire plunger arrival sensor.

Location	Devices To Connect	Description
DI 2	Line Pressure Switch	Switch contacts that can be configured to cause a trip on a switch closing or opening.
DI 3	Casing Pressure Switch	Switch contacts that can be configured to cause a trip on a switch closing or opening.
DI 4	Flow/Flow DP Switch	Switch contacts that can be configured to cause a trip on a switch closing or opening.
AI 1	Line Pressure Sensor	Use AST intrinsically safe, low power pressure transducer provided by ETC
AI 2	Casing Pressure	Use AST intrinsically safe, low power pressure transducer provided by ETC
	Flow Differential Pressure	Use low power Rosemount 1151 differential pressure transmitter unless the device is powered by another source.
	Flow Sensor	This feature is currently not fully implemented and requires customer input.
DO 1	Arrival Sensor Power or Field Connectable	Configure this output to power the arrival sensor or to mimic a valve. This is field connectable, but must meet the entity parameters found in the ETC Gas Valve Controller Installation Manual.
DO 2	Arrival Sensor Power or Field Connectable	Configure this output to power the arrival sensor or to mimic a valve. This is field connectable, but must meet the entity parameters found in the ETC Gas Valve Controller Installation Manual.
AO 1	Arrival Sensor Power or Field Connectable	Provides a 4 – 20 mA output signal. Configure this output to power the arrival sensor or to mimic a valve. This is field connectable, but must meet the entity parameters found in the ETC Gas Valve Controller Installation Manual.

Location	Devices To Connect	Description
COM 1	Differential RS485 device	Field connectable to a 2 wire RS485 interface. The connected device must meet the entity parameters found in the ETC Gas Valve Controller Installation Manual.

Note: support for a 3 wire arrival sensor has been included but must be configured through the Outputs menu. By default, the power for the 3 wire sensor is provided through the DO1>SIG connection.

2.2 Connecting Power

The following steps must be performed in the specified order to ensure that the battery properly charges:

1. Connect the Battery to the +/- Battery terminals on the left hand side of the controller
2. Connect the solar panel to the +/- Solar terminals

Note: If the controller is not hooked up to power in this order, the battery will not charge.

3 Controller Overview

3.1 Startup

On power up, the controller is initialized by performing the following operations:

- Set the outputs to a known state
- Close all valves
- Load all previously saved values
- Turn on the display
- Set the display to show the current controller state.

The controller automatically enters the Close state when powering up.

3.2 Battery Monitor

The controller samples the battery every 10 minutes, monitoring the voltage in order to prevent unpredictable valve operation. The battery voltage is reported as one of the following:

- *Normal*: The controller behaves normally. If 6 successive battery samples are below 5.5 Volts, the controller closes all valves and enters the *Low* state. A low battery alarm condition is recorded, which is reported in the history.
- *Low*: If 6 successive samples are above 6.0 Volts, the controller enters the *Normal* state. When entering the *Normal* state, the controller will restart to the *Close* state for a duration specified by the *Close Time* parameter.

During power on or reset, and before any valves are opened, the battery voltage is sampled. The *Normal* or *Low* state is entered based upon this sample.

4 User Interface

4.1 Display

A Vacuum Fluorescent Display (VFD) is provided which consists of 2 lines x 16 characters. Each character is a 5x7 dot matrix with a full underline bar. The display is used to show the current state of the controller as well as a menu that allows for the controller settings to be modified.

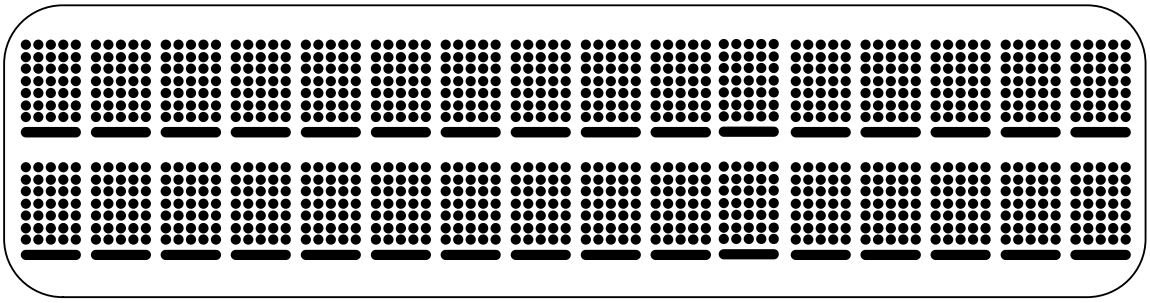


Figure 2 - Screen Layout

4.1.1 Automatic Shut Off

The controller is constantly monitoring the input from the operator. If no keys have been pressed in the last 5 minutes, the controller will turn off the display in order to conserve battery power.

4.1.2 Automatic Log Out

After no keys have been pressed for 8 minutes, the controller will automatically log out the active user to prevent unauthorized access to the controller setup.

4.2 Keypad

An integrated keypad is included which allows the user to change settings, navigate through statistics, and control the well. The following sections discuss the various keys that are available.

4.2.1 Numeric/Navigation Keys

The numeric keys as well as the enter key are used to navigate through the menus and to enter values.

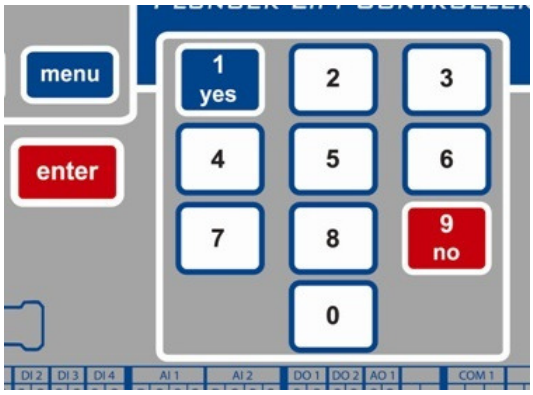


Figure 3 – Numeric/Navigation Keys

4.2.1.1 Yes/No

The *yes/no* keys are used to answer yes or no to a given configuration question. As well, the *yes* key is used to start editing a value. For example, if the user is currently in the Adjust Settings Menu and is viewing the *Close Time*, pressing *yes* will start editing the *Close Time*.

4.2.1.2 Numeric Keys

While in a menu (which is achieved by pressing *menu*), the numeric keys are used to select the sub menu to enter. As well, the numeric keys are used to enter values for timers and other numeric settings. If the user starts editing (by pressing *1*) a numeric value, the value will be blanked and the new value can be entered. Be aware that all blank spaces must be filled in. This means that any leading zeros must be entered.

4.2.1.3 Enter

The *enter* key is used to move downward through the menus. If the user is viewing a timer in the Adjust Settings menu, pressing *enter* will advance them to the next timer. If the desired setting is passed, re-enter the menu and press *enter* multiple times until the desired setting is displayed.

4.2.2 Hot Keys

The hot keys are provided to take the user to special menus or provide instant action.

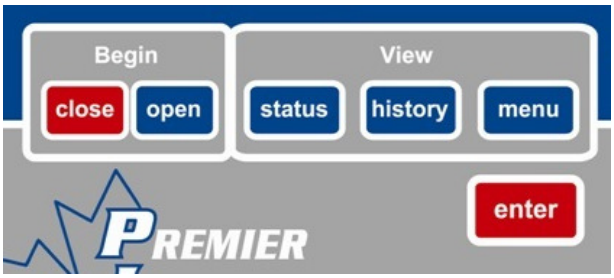


Figure 4 - Hot Keys

4.2.2.1 Close

Pressing c*lose* will send the controller to the close state, closing all valves.

4.2.2.2 Open

Pressing o*pen* will send the controller to the open portion of the cycle. The action that is taken depends on the number of valves configured, how they are set to operate, and if there are any special checks required, such as casing and/or line pressure. The normal mode of operation is to go to Wait Arrival, which opens Valve A and waits for a plunger arrival to occur.

4.2.2.3 Status

The *status* key sends the display back to the main status screen. This shows the current controller state as well as the time remaining in the current state.

4.2.2.4 History

The *history* key provides access to the history menu. This contains information about the number and type of cycles, production information and plunger statistics.

4.2.2.4.1 Daily Production

The controller maintains production statistics which are written to persistent memory when the current time-of-day passes the *Day Start* parameter. A total of 8 daily production logs can be

stored. This consists of the current day, plus the previous 7 days. When the day crosses over, a new day starts, all days are shifted by one location, and the oldest day is removed. The following information is available in the Daily Production menu:

Table 1 – Daily Production Screens

Screen	Description
Date and Total Cycles	Shows the date for the given history record as well as the total number of cycles that occurred during that day.
Volume	This shows the total volume for the given day. This is represented as e^3m^3. This screen is only available when flow is being measured.
Open/Close Time	Displays the total time that the well has been open and the total time the well has been closed for the day.
Cycle Counts	There are a number of screens that are used to display all of the cycle types for the current day.
End of Log	This screen is a read only screen that signifies the end of the log.
Reset Time	This indicates the last time that the log was reset.
Reset Log	This resets the Daily Production History.
Day Start	This defines the gas day cut off. When the controller passes this time each day, the history for the current day will stop and a new day will start.

4.2.2.4.2 Cycle Log

One cycle log entry is a history of a given cycle that the plunger went through. A cycle log entry is written at the end of a cycle, which is defined as the point when the controller finishes the *Close Time*. Therefore, the controller will write the first cycle log entry after the controller starts and the initial *Close Time* expires. Each log entry is stored in persistent memory so that it is maintained through any power disruptions. A maximum of 25 log entries will be saved. Once this limit is reached, new entries are written over top of the oldest entry.

The following information is saved in the cycle log:

Table 2 - Cycle Log Screens

Screen	Description
Cycles in Log	This indicates the number of cycles that exist in the log.
Cycle Type and Start Time	This screen shows the type of cycle that occurred as well as the date and time that the cycle started. The cycle type will be one of: o Normal o Fast-trip o Non-Arrival o Max Open o Line Pressure Shut-In o Low Battery Shutdown o Operator Change o Startup
Rise Duration	This value shows the time that it took the plunger to come to surface once the well was opened. This screen is not displayed if the arrival sensor has been disabled.

Afterflow Duration	This is the total *Afterflow Time* for this cycle. It is the total of *Afterflow* and *Extended Afterflow Time*.
Close Duration	This is the amount of *Close Time* for the given cycle. It may be longer than the specified *Close Time* if the well is held in close by devices such as line pressure or casing pressure.
Minimum Afterflow Casing Pressure	This is the value of casing pressure that caused the well to go from open to close. This screen is only displayed if Pressure Based Optimization is being used and the Casing Pressure device is configured as a sensor.
End of Log	This screen is a read only screen that signifies the end of the log.
Reset Time	This indicates the last time that the log was reset.
Reset Log	This resets the Cycle Log.

4.2.2.4.3 Total Production

The Total Production History provides a summary of the total production of the well. The total production is saved to persistent memory at the end of each cycle and is restored when the controller restarts after a power loss.

The following screens are available in the Total Production History:

Table 3 – Total Production Screens

Screen	Description
Volume	This shows the total volume produced. This is represented as e^3m^3.
Open/Close Time	Displays the total time that the well has been open and the total time the well has been.
Cycle Counts	There are a number of screens that are used to display all of the cycle types.
Reset Time	This indicates the last time that the log was reset.
Reset Log	This resets the Total Production History.

4.2.2.4.4 Plunger Statistics

The Plunger Statistics Log shows a number of key pieces of information about the plunger. This can be used to determine plunger wear and help the user to schedule maintenance.

The items available in this log are:

Table 4 – Plunger Statistics Log

Screen	Description
Distance Travelled	Indicates the distance in km that the plunger has travelled.
Arrivals	Displays the number of plunger arrivals since the last reset.
Reset Log	This resets the Plunger Statistics back to 0.

4.3 Top Level Menu

A menu is provided that allows the user to view current controller information.

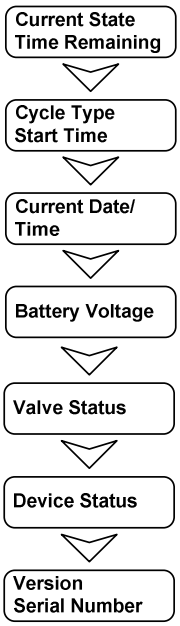


Figure 5 – Top Level Menu Structure

Scrolling down (pressing enter) from the status screen that appears on startup will take you through the top level menu. Information such as the cycle type, start time, and the current date/time are displayed here.

4.3.1 Current State

This screen is shown by default when the controller is powered up. It shows the current part of the cycle that the controller is in and a timer that indicates when the state will change.

4.3.2 Cycle Information

This screen shows the information for the last cycle. This includes the type of cycle (Ok, Fast Trip, Non Arrival, etc…) as well as the time that the cycle started.

4.3.3 Current Date/Time

This screen simply shows the current date and time. If this information is incorrect, the user may change the date and time in the Date/Time menu. The date and time is reset back to January 1, 2000 when the battery is disconnected.

4.3.4 Battery Voltage

Initially, this screen shows “Checking Battery”. Once the battery check is complete, the current battery voltage is displayed. To give a more accurate reading of the battery voltage, the screen is turned off. This will cause a brief flash.

4.3.5 Valve Status

The valve status screens will show whether a given valve is open or closed. Information for each valve is only shown if that valve has been enabled.

4.3.6 Device Status

There are several device screens, one for each input device. Each screen will show the name of the device and its current reading. Please be aware that this may not be updated as soon as a

change is made. Enabling some devices may not take effect until the next cycle starts. This can be achieved by pressing open or repowering the controller.

4.3.7 Version/Serial Number

This screen shows controller information. The top line shows the firmware version running on the controller. The bottom line shows the serial number of the controller. This information is required to enable product features or to obtain support.

4.4 Settings Menu

By pressing menu on the keypad, the user will see a list of available menu items, which will automatically scroll. Each item is prefaced with a number. Press the number for the desired menu. Once a menu has been selected, pressing *enter* will scroll down through the available settings. The top level settings menu is shown below.

1. Adjust Settings
2. Set Date/Time
3. Alarms
4. Install Setup
5. Device Setup
6. Outputs
7. System
8. Modbus Setup
9. Hold Valves

Figure 6 - Settings Menu

Please note that some menu items do not appear by default. Some are dependent on an operator/installer being logged in. Other menu items will not appear unless a particular feature has been enabled.

4.4.1 Adjust Settings Menu (Menu 1)

The Adjust Settings menu contains a list of timers and basic settings that control how long the well is open/closed, what constitutes a fast trip, and how long the controller waits for an arrival. The following is a list of the settings that are available in this menu:

Table 5 - Adjust Settings Menu Screens

Screen	Description	Default Value
Fast Trip Time	This time is used to indicate that the plunger did not likely fall to the bottom of the well, is hanging up on wax/hydrates, or that insufficient fluid is being brought up. The default value is based on a 730 m/minute travel speed. The well will be shut-in if a set number of consecutive fast trips have occurred. Not used if the *Arrival Sensor* is disabled.	0h01m22s

Screen	Description	Default Value
Target Rise Time	This is the time that the plunger is expected to arrive after the well has been opened. It is only used when running Timer Based Optimization. The controller will increase or decrease the *Afterflow Time* or *Close Time* in order to try and cause the plunger to arrive at the *Target Rise Time*. Not used if the *Arrival Sensor* or Timer Based Optimization is disabled.	0h04m41s
Wait Arrival Time	This time indicates the maximum amount of time that the controller should wait for the plunger to arrive. If the plunger does not arrive, the controller will go to either Close, Backup Close, or shut in the well. The action taken depends on the number of non-arrivals or backups that have previously occurred. The intent is to allow extra pressure to build in order to lift the plunger on the next cycle. The Wait Arrival Time may not be set to zero. Not used if the *Arrival Sensor* or Timer Based Optimization is disabled.	0h14m03s
Afterflow Time	The *Afterflow Time* defines the amount of flow time after the plunger arrives. This portion of the cycle is terminated when *Afterflow Time* expires. When "extended-afterflow"[1] devices are enabled, the controller will advance to Extended-Afterflow instead of Close if none of the devices have already tripped.	1h00m00s
Max Open Time	This is the maximum time that a valve will remain open in a given cycle. If non-zero, must be greater than the Wait Arrival time. Not used if set to zero or if the *Arrival Sensor* is disabled or extended flow devices are not enabled.	999h59m59s
Close Time	This determines the normal duration of the Close portion of the cycle.	0h21m52s
Backup Close Time	This is an Extended period of close time that is used to create an additional build-up prior to opening the well. The *Backup Close Time* will only run after the set amount of non-arrivals. Not used if the *Arrival Sensor* is disabled.	0h54m41s

[1] The "Extended-Afterflow" devices are:
- Casing Pressure Switch/Sensor
- Flow Differential Pressure Switch/Sensor
- Flow Switch/Sensor/Virtual

Screen	Description	Default Value
Fast Trip Count	The controller will shut in the well after "Fast Trip Count" consecutive fast trips. Not used if this parameter is set to zero, the *Fast Trip Time* is set to 0 or if the Arrival Sensor is disabled.	3
Non-Arrival Count	The controller will move to Backup Close after "Non-Arrival Count" consecutive plunger non-arrivals. Not used if set to zero or if the Arrival Sensor is disabled.	3
Backup Fail Count	After the "Backup Fail Count" of consecutive backups is reached, the well will be shut in. Not used if set to zero or if the Arrival Sensor is disabled.	3
Display Level	Sets the screen brightness. Can be used to save power or adapt to different lighting conditions.	50%
Tank Delay Time	When Valve B is configured as a Tank Valve, this timer delays the opening of Valve B to allow the initial "gas cap" or "buildup" to go down the flow line prior to opening to tank. It must be less than the Wait Arrival Time. Not used if set to zero or if Valve B is disabled.	0h00m05s
Afterflow Delay Time	This timer delays the opening of Valve A after the plunger arrives to ensure that the plunger is fully in the lubricator and to allow fluids to flush through the system. Not used unless Valve B is set as "line: open A" or "line: open A&B" and this time is set to non-zero	0h01m00s
Autocatcher Hold Time	This timer allows the installer to specify a set amount of time to hold the plunger in the Autocatcher once the well is closed. When this timer expires, the plunger will be released. This timer is only used if the Autocatcher has been enabled and the value is non-zero.	disabled

4.4.2 Set Date/Time Menu (Menu 2)

This menu allows the date and time to be configured. There is also a screen that allows daylight savings time to be enabled. The following is list of all of the available screens:

Table 6 - Date/Time Menu Screens

Screen	Description	Default
Date	Allows the user to set the current date.	Jan 1, 2000
Day Confirm	This confirms the current day of the week when the date is set.	N/A
Time	Allows the user to set the current time. Please note that this is in 24 hr time (i.e. 1:00 pm is entered as 13:00)	00:00

Screen	Description	Default
DST Enable	If enabled, the controller will automatically adjust 2 times a year for daylight savings. The PIT Boss has 2 different DST formats as the daylight savings time recently changed. The options are: 1. disabled 2. pre 2006 dst 3. post 2007 dst	disabled

4.4.3 Alarms Menu (Menu 3)

The alarms menu allows parameters such as the number of Fast Trips or Non-Arrivals that can occur before the controller shuts the well in. There are also settings that determine if the well is shut in or opened when an alarm condition occurs.

Table 7 - Alarms Menu Screens

Screen	Description	Default
Fast Trip Count	The number of Fast Trips that occurred since the last alarm reset. This screen will not be displayed if there have been no fast trips.	0
Non-Arrival Count	The number of Non-Arrivals that occurred since the last alarm reset. This screen will not be displayed if there have been no non-arrivals.	0
Controller Reset	The number of controller resets that have occurred since the last alarm reset.	0
Reset Time	The time of the last alarm reset	N/A
Reset Alarms	Reset all current alarm counts.	N/A

4.4.4 Install Setup Menu (Menu 4)

The Install Setup Menu contains all of the settings that should be configured for a new controller install. All of the screens from the Adjust Settings Menu (Menu 1) and the Device Setup Menu (Menu 5) are available in this menu. This provides a convenient way of setting up the controller in a single pass.

Table 8 - Install Setup Menu Screens

Screen	Description	Default Value
New Install?	This allows the installer to reset the controller back to factory defaults and start from scratch. All statistics, logs, and alarms are cleared.	N/A
Stop Controller?	This allows the user to stop the controller and hold it in a known state while the controller is setup. This provides access to a number of screens that would not normally be available.	N/A
Stop Time	This is the time that the controller will be held in a stopped state. When this timer expires, the controller will resume normal operation.	20m00s

Screen	**Description**	**Default Value**
Plunger Depth	The depth that the plunger will have to fall once the well is closed. This is used to calculate the *Target Rise Time*.	1000 m
Optimization Mode	This is the type of optimization scheme that the controller will use: 1. manual – No optimization is performed (i.e. entered times are not modified) 2. gas – Change the *Afterflow Time* only 3. oil – Change the *Close Time* only 4. oil then gas – Change the *Close Time*, then change the *Afterflow Time*. 5. pressure – Use Line Pressure, Casing Pressure, Differential Pressure or Flow to optimize the well.	manual
Plunger Type	Specifies the plunger that is installed in the well. 1. conventional 2. freecycle 3. pacemaker	conventional
Optimization Adjustment Type	The aggressiveness of the timer optimization modes. 1. escalate – The amount of the adjustments is proportional to the amount of *Afterflow Time*. The larger the afterflow, the larger the adjustments. 2. 1:1 – For every minute the averaged[2] arrival time is faster/slower than the *Target Time*, the controller will add/subtract 1 minute of *Afterflow/Close Time*. 3. 2:1 – For every minute the averaged arrival time is faster/slower than the *Target Time*, the controller will add/subtract 2 minutes of *Afterflow/Close Time*. 4. 3:1 – For every minute the averaged arrival time is faster/slower than the *Target Time*, the controller will add/subtract 3 minutes of *Afterflow/Close Time*.	1:1

[2] The PIT Boss controller calculates a weighted average that consists of the last 3 arrival times (with the most recent time given double the weight) to obtain the arrival time used for optimization.

Screen	Description	Default Value
Arrival Sensor	Specifies the type of arrival sensor that is connected to the controller. 1. disabled 2. 2-wire 3. 3-wire	3-wire
Arrival Sensor Location	This screen shows the location that the arrival sensor needs to be connected to in order to function correctly. This is a read only screen.	DI1/DO1
Sensor Delay Time	The delay time to wait after the well opens (Wait Arrival) to start accepting arrival signals. This setting is used with a pacemaker or freecycle plunger only.	disabled
Fast Trip Time	This time is used to indicate that the Plunger did not likely fall to the bottom of the well, is hanging up on wax/hydrates, or that insufficient fluid is being brought up. The default value is based on a 730 m/minute travel speed. The well will be shut-in if a set number of consecutive fast trips have occurred. Not used if the *Arrival Sensor* is disabled.	0h01m22s
Target Rise Time	This is the time that the plunger is expected to arrive after the well has been opened. It is only used when running Timer Based Optimization. The controller will increase or decrease the *Afterflow Time* or *Close Time* in order to try and cause the plunger to arrive at the *Target Rise Time*. Not used if the *Arrival Sensor* or Timer Based Optimization is disabled.	0h04m41s
Wait Arrival Time	This time indicates the maximum amount of time that the controller should wait for the plunger to arrive. If the plunger does not arrive, the controller will go to either Close, Backup Close, or shut in the well. The action taken depends on the number of non-arrivals or backups that have previously occurred. The intent is to allow extra pressure to build in order to lift the plunger on the next cycle. The Wait Arrival Time may not be set to zero. Not used if the *Arrival Sensor* or Timer Based Optimization is *disabled*.	0h14m03s
Min Afterflow Time	Defines the minimum allowable *Afterflow Time*. When using Timer Based Optimization, the *Afterflow Time* will never be allowed to drop below this time.	1h00m00s

Screen	Description	Default Value
Max Afterflow Time	Defines the maximum allowable *Afterflow Time*. When using Timer Based Optimization, the *Afterflow Time* will never be allowed to exceed this time.	24h00m00s
Afterflow Time	This defines the amount of flow time after the plunger arrives. This portion of the cycle is terminated when *Afterflow Time* expires. When "extended-afterflow"[3] devices are enabled, the controller will advance to Extended-Afterflow instead of Close if none of the devices have already tripped.	1h00m00s
Max Open Time	This is the maximum time that the well will remain open in a given cycle. If non-zero, must be greater than the *Wait Arrival Time*. The *Afterflow Time* or *Extended Afterflow Time* will be truncated if the *Max Open Time* expires. Not used if set to zero or if the *Arrival Sensor* is *disabled* or extended flow devices are not enabled.	999h59m59s
Min Close Time	Defines the minimum allowable *Close Time*. When using Timer Based Optimization, the *Close Time* will never be allowed to drop below this time.	0h21m52s
Max Close Time	Defines the maximum allowable *Close Time*. When using Timer Based Optimization, the *Close Time* will never be allowed to exceed this time.	2h00m00s
Close Time	This determines the normal duration of the Close portion of the cycle.	0h21m52s
Backup Close Time	This is an Extended period of *Close Time* that is used to create an additional build-up prior to opening the well. The *Backup Close Time* will only run after the set amount of non-arrivals. Not used if the *Arrival Sensor* is *disabled*.	0h54m41s
Fast Trip Count	The controller will shut in the well after *Fast Trip Count* consecutive fast trips. Not used if this parameter is set to zero, the *Fast Trip Time* is set to 0 or if the *Arrival Sensor* is *disabled*.	3
Non-Arrival Count	The controller will move to Backup Close after *Non-Arrival Count* consecutive plunger non-arrivals. Not used if set to zero or if the *Arrival Sensor* is *disabled*.	3

[3] The "Extended-Afterflow" devices are:
- Casing Pressure Switch/Sensor
- Flow Differential Pressure Switch/Sensor
- Flow Switch/Sensor/Virtual

Screen	Description	Default Value
Backup Fail Count	After the *Backup Fail Count* of consecutive backups is reached, the well will be shut in. Not used if set to zero or if the *Arrival Sensor* is *disabled*.	3
Backup To Afterflow Screen	This determines how the *Afterflow Time* is adjusted when the controller goes to Backup Close. The options are: 1. Min Afterflow – The *Afterflow Time* is set to the *Minimum Afterflow Time*. 2. 25% - The *Afterflow Time* is reduced by 25% of the difference between the *Afterflow Time* and the *Minimum Afterflow Time*. 3. 50% - The *Afterflow Time* is reduced by 50% of the difference between the *Afterflow Time* and the *Minimum Afterflow Time*. 4. 75% - The *Afterflow Time* is reduced by 75% of the difference between the *Afterflow Time* and the *Minimum Afterflow Time*. 5. No Change – The Afterflow time is not adjusted.	Min Afterflow
Display Level	Sets the screen brightness. Can be used to save power or adapt to different lighting conditions.	50%
Valve A Test	This screen allows the installer to manually test Valve A. The valve is toggled without changing the state of the controller. The controller must be stopped to test the valve in this manner.	N/A
Valve A Location	This is a read only screen that shows where to connect Valve A.	Valve 1
Valve B	Selects how to use Valve B. 1. disabled 2. line: open A 3. line: open A&B 4. tank See the 5.1.6 Dual Valve for more information on these configurations.	disabled
Valve B Test	This screen allows the installer to manually test Valve B. The valve is toggled without changing the state of the controller. The controller must be stopped to test the valve in this manner.	N/A
Valve B Location	This is a read only screen that shows where to connect Valve B.	Valve 2

Screen	**Description**	**Default Value**
Tank Delay Time	When *Valve B* is configured as *tank*, this timer delays the opening of *Valve B* to allow the initial "gas cap" or "buildup" to go down the flow line prior to opening to tank. It must be less than the *Wait Arrival Time*. Not used if set to zero or if *Valve B* is *disabled*.	0h00m05s
Afterflow Delay Time	This timer delays the opening of Valve A after the plunger arrives to ensure that the plunger is fully in the lubricator and to allow fluids to flush through the system. Not used unless Valve B is set as "line: open A" or "line: open A&B" and this time is set to non-zero	0h01m00s
Autocatcher	Specifies when to activate the Autocatcher Valve. 1. disabled – Do not use the Autocatcher Valve 2. on wait arrival – Activate the Autocatcher Valve at the start of the *Wait Arrival Time*. 3. on arrival – Activate the Autocatcher after the plunger arrival has been detected.	disabled
Autocatcher Hold Time	This timer allows the installer to specify a set amount of time to hold the plunger in the Autocatcher once the well is closed. When this timer expires, the plunger will be released. This timer is only used if the Autocatcher has been enabled and the value is non-zero.	disabled
Autocatcher Location	This is a read only screen that shows where to connect the Autocatcher valve.	Valve 4
Line Pressure Device Type	Enables the use of a Line Pressure Switch or Sensor. 1. disabled – Device not installed or unused. 2. switch – Discrete Input Switch installed and enabled. 3. sensor – An analog Line Pressure Sensor is installed.	*disabled*
Line Pressure Range	When the *Line Pressure Device Type* is Analog, defines the range of the sensor.	500.0 psi
Line Pressure Location	This is a read only screen that shows where to connect a Line Pressure Device.	DI2/AI1
Line Pressure Value	This displays the current value of an attached line pressure device.	N/A
Wait Arrival Line Pressure	Determines if the Line Pressure is checked during the Wait Arrival portion of the cycle.	disabled
Wait Arrival Line Pressure Trip Point	When the *Line Pressure Device Type* is *Analog*, defines the pressure, above which, the well will be shut-in.	90.0 psi

Screen	**Description**	**Default Value**
Wait Arrival Line Pressure Reset Point	When the *Line Pressure Device Type* is *Analog*, defines the pressure, below which, a Line Pressure trip condition will be cleared.	85.0 psi
Wait Arrival Line Pressure Stable Time	When the *Line Pressure Device Type* is enabled, defines the time required for the line pressure to stabilize above the *Line Pressure Trip Point*, or below the *Line Pressure Reset Point*, in order to declare a trip or reset condition.	0h00m05s
Afterflow Line Pressure	Determines if the Line Pressure is checked during the Afterflow portion of the cycle.	disabled
Afterflow Line Pressure Trip Point	When the *Line Pressure Device Type* is *Analog*, defines the pressure, above which, the well will be shut-in.	90.0 psi
Afterflow Line Pressure Reset Point	When the *Line Pressure Device Type* is *Analog*, defines the pressure, below which, a Line Pressure trip condition will be cleared.	85.0 psi
Afterflow Line Pressure Stable Time	When the *Line Pressure Device Type* is enabled, defines the time required for the line pressure to stabilize above the *Line Pressure Trip Point*, or below the *Line Pressure Reset Point*, in order to declare a trip or reset condition.	0h00m05s
Close Line Pressure	Determines if the Line Pressure is checked at the end of the Close portion of the cycle before allowing the well to open.	disabled
Close Line Pressure Trip Point	When the *Line Pressure Device Type* is *Analog*, defines the pressure, above which, the well will remain shut-in.	90.0 psi
Close Line Pressure Reset Point	When the *Line Pressure Device Type* is *Analog*, defines the pressure, below which, a Line Pressure trip condition will be cleared.	85.0 psi
Close Line Pressure Stable Time	When the *Line Pressure Device Type* is enabled, defines the time required for the line pressure to stabilize above the *Line Pressure Trip Point*, or below the *Line Pressure Reset Point*, in order to declare a trip or reset condition.	0h00m05s
Flow Differential Pressure Device Type	Enables the use of a Flow Differential Pressure Switch or Sensor. 1. disabled – Device not installed or unused. 2. switch – Discrete Input Switch installed and enabled. 3. sensor – An analog Flow Differential Pressure Sensor is installed. (Use low power Rosemount 1151 differential pressure transmitter unless the device is powered by another source.)	*disabled*

Screen	Description	Default Value
Flow Differential Pressure Range	When the *Flow Differential Pressure Device Type* is Analog, defines the range of sensor.	750.0 “WC
Flow Differential Pressure Voltage	Defines the interface that is supported by the Flow Differential Pressure Device. 1. 0.8V – 3.2V 2. 1.0V – 5.0V	0.8V – 3.2V
Flow Differential Pressure Value	This displays the current value of an attached Flow Differential Pressure device. This screen is not available if the *Flow DP Device Type* is disabled.	N/A
Flow Differential Pressure Trip Point	When the *Flow DP Device Type* is *Analog*, this defines the pressure which will cause a trip condition to be reset. This screen is not available if the *Flow DP Device Type* is disabled or if *Flow DP Device Type* is set to *sensor* and the *Line Pressure Device Type* is also set to *sensor*.	20.0 “WC
Flow Differential Pressure Reset Point	When the *Flow DP Device Type* is *Analog*, this defines the pressure which will cause a trip condition to be reset. This screen is not available if the *Flow DP Device Type* is disabled or if *Flow DP Device Type* is set to *sensor* and the *Line Pressure Device Type* is also set to *sensor*.	22.0 “WC
Flow Differential Pressure Stable Time	When the *Flow DP Device Type* is enabled, this defines the time required for the pressure to stabilize below the *Flow Differential Pressure Trip Point*, or above the *Flow Differential Pressure Reset Point*, in order to declare a trip or reset condition. This screen is not available if the *Flow DP Device Type* is disabled or if *Flow DP Device Type* is set to *sensor* and the *Line Pressure Device Type* is also set to *sensor*.	0h00m05s
Flow Rate Value	This displays the current value for Flow Rate. This screen is only available if the *Line Pressure Device Type* is set to *sensor* and the *Flow DP Device Type* is set to *sensor*.	N/A
Flow Rate Trip Point	This defines the rate above which the well will stay flowing. This screen is only available if the *Line Pressure Device Type* is set to *sensor* and the *Flow DP Device Type* is set to *sensor*.	18.0 e3m3/d

Screen	Description	Default Value
Flow Rate Reset Point	This defines the rate which will cause a trip condition to be reset. This screen is only available if the *Line Pressure Device Type* is set to *sensor* and the *Flow DP Device Type* is set to *sensor*.	19.0 e3m3/d
Flow Rate Stable Time	This defines the time required for the rate to stabilize below the trip point, or above the reset point, in order to declare a trip or reset condition. This screen is only available if the *Line Pressure Device Type* is set to *sensor* and the *Flow DP Device Type* is set to *sensor*.	0h00m05s
Gas Temperature	When the *Flow Differential Pressure Device Type* and the *Line Pressure Device Type* are both *Sensor*, defines the gas temperature used for flow rate calculations. This screen is only available if the *Line Pressure Device Type* is set to *sensor* and the *Flow DP Device Type* is set to *sensor*.	60 °F
Gas Specific Gravity	When *Flow Differential Pressure Device Type* and the *Line Pressure Device Type* are both *Sensor*, defines the specific gravity (relative to air) used for flow rate calculations. This screen is only available if the *Line Pressure Device Type* is set to *sensor* and the *Flow DP Device Type* is set to *sensor*.	0.60
Meter Run Size	When the *Flow Differential Pressure Device Type* and the *Line Pressure Device Type* are both *Sensor*, defines the meter run diameter used for flow rate calculations. Valid values are 2”, 3”, 4” This screen is only available if the *Line Pressure Device Type* is set to *sensor* and the *Flow DP Device Type* is set to *sensor*.	2”
Orifice Size	When *Flow Differential Pressure Device Type* and the *Line Pressure Device Type* are both *Sensor*, defines the orifice diameter used for flow rate calculations. Valid Orifice Sizes are from 0.125” to 3.000”. The maximum for 3” Meter Run is 2.250” and the maximum for a 2” Meter Run is 1.375”. This screen is only available if the *Line Pressure Device Type* is set to *sensor* and the *Flow DP Device Type* is set to *sensor*.	1.000”

Screen	**Description**	**Default Value**
Casing Pressure Device Type	Enables the use of a Casing Pressure Switch or Sensor. 1. disabled – Device not installed or unused. 2. switch – Discrete Input Switch installed and enabled. 3. sensor – An analog Casing Pressure Sensor is installed.	*disabled*
Casing Pressure Range	When the *Casing Pressure Device Type* is *sensor*, defines the range of sensor.	500.0 psi
Casing Pressure Location	This is a read only screen that shows where to connect a Casing Pressure Device. This screen is only available if the *Casing Pressure Device Type* is enabled.	DI3/AI2
Casing Pressure Value	This displays the current value of the Casing Pressure. This screen is only available if the *Casing Pressure Device Type* is enabled.	N/A
Afterflow Casing Pressure	This determines which algorithm to use for closing the well when the *Casing Pressure Device Type* is *enabled*. The options are: *1. Disabled* *2. Low Rise (Not valid for casing pressure switch)* *3. Absolute* These optimization algorithms are discussed further in the 5.1.4.1 Casing Pressure section. This screen is only available if the *Casing Pressure Device Type* is not *disabled*. This screen is also not available if both the *Line Pressure Device Type* and the *Casing Pressure Device Type* are *sensor*.	disabled
Afterflow Casing Pressure Trip Point	When using the Low Rise method, this screen is used to define the amount that the casing pressure has to rise above the minimum point before declaring a trip condition. When using the Absolute method, this screen is used to define the casing pressure that has to be reached before a trip condition is declared. This screen is only visible when the *Casing Pressure Device Type* is *sensor*. This screen is also not available if both the *Line Pressure Device Type* and the *Casing Pressure Device Type* are *sensor*.	Low Rise 55.0 psi Absolute 150.0 psi

Screen	**Description**	**Default Value**
Afterflow Casing Pressure Reset Point	When using the Low Rise method, this screen is used to define the amount that the casing pressure has to be above the minimum point before declaring a reset condition. When using the Absolute method, this screen is used to define the casing pressure that has to be reached before a reset condition is declared. This screen is only visible when the *Casing Pressure Device Type* is *sensor*. This screen is also not available if both the *Line Pressure Device Type* and the *Casing Pressure Device Type* are *sensor*.	Low Rise 50.0 psi Absolute 155.0 psi
Afterflow Casing Pressure Stable Time	This defines the time required for the casing pressure to stabilize before a trip or reset condition is declared. This screen is only visible when the *Casing Pressure Device Type* is <u>not</u> *disabled*. This screen is also not available if both the *Line Pressure Device Type* and the *Casing Pressure Device Type* are *sensor*.	0h00m05s
Close Casing Pressure	This screen defines whether the casing pressure is to be checked at the end of the Close cycle. If this is enabled, a low casing pressure will prevent the well from being opened. This screen is only visible when the *Casing Pressure Device Type* is <u>not</u> *disabled*. This screen is also not available if both the *Line Pressure Device Type* and the *Casing Pressure Device Type* are *sensor*.	disabled
Close Casing Pressure Trip Point	When the *Casing Pressure Device Type* is *sensor*, this defines the pressure below which the well will remain closed. This screen is only visible if the *Casing Pressure Device Type* is set as *sensor* and the *Close Casing Pressure* is *enabled*. This screen is also not available if both the *Line Pressure Device Type* and the *Casing Pressure Device Type* are *sensor*.	85.0 psi
Close Casing Pressure Reset Point	When the *Casing Pressure Device Type* is *sensor*, defines the above which the well will be opened. This screen is only visible if the *Close Casing Pressure Device Type* is set as *Absolute*. This screen is also not available if both the *Line Pressure Device Type* and the *Casing Pressure Device Type* are *sensor*.	90.0 psi

Screen	Description	Default Value
Close Casing Pressure Stable Time	When the *Casing Pressure Device Type* is *sensor*, this defines the time required for the pressure to stabilize below the *Close Casing Pressure Trip Point*, or above the *Close Casing Pressure Reset Point*, in order to declare a trip or reset condition. This screen is only visible if the *Close Casing Pressure Device Type* is set as *Absolute*. This screen is also not available if both the *Line Pressure Device Type* and the *Casing Pressure Device Type* are *sensor*.	0h00m05s
Close Casing/Line Differential Pressure Trip Point	When the *Casing* and *Line Pressure Device Types* are both *sensor*, defines the pressure difference, below which the well will stay shut-in. This screen is only available if both the *Line Pressure Device Type* and the *Casing Pressure Device Type* are *sensor*.	25.0 psi
Close Casing/Line Differential Pressure Reset Point	When the *Casing* and *Line Pressure Device Types* are both *sensor*, defines the pressure difference, above which the well will open. This screen is only available if both the *Line Pressure Device Type* and the *Casing Pressure Device Type* are *sensor*.	30.0 psi
Close Casing/Line Differential Pressure Stable Time	When the *Casing* and *Line Pressure Device Types* are both *sensor*, defines the time required for the pressure difference to stabilize above the reset point, or below the trip point, in order to declare a trip or reset condition. This screen is only available if both the *Line Pressure Device Type* and the *Casing Pressure Device Type* are *sensor*.	0h00m05s

4.4.5 Device Setup Menu (Menu 5)

The Device Setup Menu is a subset of the Install Setup Menu. The difference is that this menu shows only the screens that are specific to devices. The following are the available screens.

Table 9 - Device Setup Menu Screens

Screen	Description	Default Value
Stop Controller?	This allows the user to stop the controller and hold it in a known state while the controller is setup. This provides access to a number of screens that would not normally be available.	N/A
Stop Time	This is the time that the controller will be held in a stopped state. When this timer expires, the controller will resume normal operation.	20m00s

Screen	Description	Default Value
Arrival Sensor	Specifies the type of arrival sensor that is connected to the controller. 1. disabled 2. 2-wire 3. 3-wire	3-wire
Arrival Sensor Location	This screen shows the location that the arrival sensor needs to be connected to in order to function correctly. This is a read only screen.	DI1/DO1
Valve A Test	This screen allows the installer to test Valve A. The valve is toggled without changing the state of the controller. The controller must be stopped to test the valve in this manner.	N/A
Valve A Location	This is a read only screen that shows where to connect Valve A.	Valve 1
Valve B	Selects how to use Valve B. 1. disabled 2. line: open A 3. line: open A&B 4. tank	disabled
Valve B Test	This screen allows the installer to test Valve B. The valve is toggled without changing the state of the controller. The controller must be stopped to test the valve in this manner.	N/A
Valve B Location	This is a read only screen that shows where to connect Valve B.	Valve 2
Tank Delay Time	When Valve B is configured as a Tank Valve, this timer delays the opening of Valve B to allow the initial “gas cap” or “buildup” to go down the flow line prior to opening to tank. It must be less than the Wait Arrival Time. Not used if set to zero or if Valve B is disabled.	0h00m05s
Afterflow Delay Time	This timer delays the opening of Valve A after the plunger arrives to ensure that the plunger is fully in the lubricator and to allow fluids to flush through the system. Not used unless Valve B is set as “line: open A” or “line: open A&B” and this time is set to non-zero	0h01m00s

Screen	**Description**	**Default Value**
Autocatcher	Specifies when to activate the Autocatcher valve. 1. disabled – Do not use the Autocatcher Valve 2. on wait arrival – Activate the Autocatcher Valve at the start of Wait Arrival. 3. on arrival – Activate the Autocatcher after the plunger arrival has been detected.	disabled
Autocatcher Hold Time	This timer allows the installer to specify a set amount of time to hold the plunger in the Autocatcher once the well is closed. When this timer expires, the plunger will be released. This timer is only used if the Autocatcher has been enabled and the value is non-zero.	disabled
Autocatcher Location	This is a read only screen that shows where to connect the Autocatcher valve.	Valve 4
Line Pressure Device Type	Enables the use of a Line Pressure Switch or Sensor. 1. disabled – Device not installed or unused. 2. switch – Discrete Input Switch installed and enabled. 3. sensor – An analog Line Pressure Sensor is installed.	*disabled*
Line Pressure Range	When the *Line Pressure Device Type* is Analog, defines the range of the sensor.	500.0 psi
Line Pressure Location	This is a read only screen that shows where to connect a Line Pressure Device.	DI2/AI1
Line Pressure Value	This displays the current value of an attached line pressure device.	N/A
Wait Arrival Line Pressure	Determines if the Line Pressure is checked during the Wait Arrival portion of the cycle.	disabled
Wait Arrival Line Pressure Trip Point	When the *Line Pressure Device Type* is *Analog*, defines the pressure, above which, the well will be shut-in.	90.0 psi
Wait Arrival Line Pressure Reset Point	When the *Line Pressure Device Type* is *Analog*, defines the pressure, below which, a Line Pressure trip condition will be cleared.	85.0 psi
Wait Arrival Line Pressure Stable Time	When the *Line Pressure Device Type* is enabled, defines the time required for the line pressure to stabilize above the *Line Pressure Trip Point*, or below the *Line Pressure Reset Point*, in order to declare a trip or reset condition.	0h00m05s
Afterflow Line Pressure	Determines if the Line Pressure is checked during the Afterflow portion of the cycle.	disabled

Screen	Description	Default Value
Afterflow Line Pressure Trip Point	When the *Line Pressure Device Type* is *Analog*, defines the pressure, above which, the well will be shut-in.	90.0 psi
Afterflow Line Pressure Reset Point	When the *Line Pressure Device Type* is *Analog*, defines the pressure, below which, a Line Pressure trip condition will be cleared.	85.0 psi
Afterflow Line Pressure Stable Time	When the *Line Pressure Device Type* is enabled, defines the time required for the line pressure to stabilize above the *Line Pressure Trip Point*, or below the *Line Pressure Reset Point*, in order to declare a trip or reset condition.	0h00m05s
Close Line Pressure	Determines if the Line Pressure is checked at the end of the Close portion of the cycle before allowing the well to open.	disabled
Close Line Pressure Trip Point	When the *Line Pressure Device Type* is *Analog*, defines the pressure, above which, the well will remain shut-in.	90.0 psi
Close Line Pressure Reset Point	When the *Line Pressure Device Type* is *Analog*, defines the pressure, below which, a Line Pressure trip condition will be cleared.	85.0 psi
Close Line Pressure Stable Time	When the *Line Pressure Device Type* is enabled, defines the time required for the line pressure to stabilize above the *Line Pressure Trip Point*, or below the *Line Pressure Reset Point*, in order to declare a trip or reset condition.	0h00m05s
Flow Differential Pressure Device Type	Enables the use of a Flow Differential Pressure Switch or Sensor. 1. disabled – Device not installed or unused. 2. switch – Discrete Input Switch installed and enabled. 3. sensor – An analog Flow Differential Pressure Sensor is installed. (Use low power Rosemount 1151 differential pressure transmitter unless the device is powered by another source.)	*disabled*
Flow Differential Pressure Range	When the *Flow Differential Pressure Device Type* is Analog, defines the range of sensor.	750.0 “WC
Flow Differential Pressure Voltage	Defines the interface that is supported by the Flow Differential Pressure Device. 1. 0.8V – 3.2V 2. 1.0V – 5.0V	0.8V – 3.2V

Screen	Description	Default Value
Flow Differential Pressure Value	This displays the current value of an attached Flow Differential Pressure device. This screen is not available if the *Flow DP Device Type* is disabled.	N/A
Flow Differential Pressure Trip Point	When the *Flow DP Device Type* is *Analog*, this defines the pressure which will cause a trip condition to be reset. This screen is not available if the *Flow DP Device Type* is disabled or if *Flow DP Device Type* is set to *sensor* and the *Line Pressure Device Type* is also set to *sensor*.	20.0 “WC
Flow Differential Pressure Reset Point	When the *Flow DP Device Type* is *Analog*, this defines the pressure which will cause a trip condition to be reset. This screen is not available if the *Flow DP Device Type* is disabled or if *Flow DP Device Type* is set to *sensor* and the *Line Pressure Device Type* is also set to *sensor*.	22.0 “WC
Flow Differential Pressure Stable Time	When the *Flow DP Device Type* is enabled, this defines the time required for the pressure to stabilize below the *Flow Differential Pressure Trip Point*, or above the *Flow Differential Pressure Reset Point*, in order to declare a trip or reset condition. This screen is not available if the *Flow DP Device Type* is disabled or if *Flow DP Device Type* is set to *sensor* and the *Line Pressure Device Type* is also set to *sensor*.	0h00m05s
Flow Rate Value	This displays the current value for Flow Rate. This screen is only available if the *Line Pressure Device Type* is set to *sensor* and the *Flow DP Device Type* is set to *sensor*.	N/A
Flow Rate Trip Point	This defines the rate above which the well will stay flowing. This screen is only available if the *Line Pressure Device Type* is set to *sensor* and the *Flow DP Device Type* is set to *sensor*.	18.0 e3m3/d
Flow Rate Reset Point	This defines the rate which will cause a trip condition to be reset. This screen is only available if the *Line Pressure Device Type* is set to *sensor* and the *Flow DP Device Type* is set to *sensor*.	19.0 e3m3/d
Flow Rate Stable Time	This defines the time required for the rate to stabilize below the trip point, or above the reset point, in order to declare a trip or reset condition. This screen is only available if the *Line Pressure Device Type* is set to *sensor* and the *Flow DP Device Type* is set to *sensor*.	0h00m05s

Screen	Description	Default Value
Gas Temperature	When the *Flow Differential Pressure Device Type* and the *Line Pressure Device Type* are both *Sensor*, defines the gas temperature used for flow rate calculations. This screen is only available if the *Line Pressure Device Type* is set to *sensor* and the *Flow DP Device Type* is set to *sensor*.	60 °F
Gas Specific Gravity	When *Flow Differential Pressure Device Type* and the *Line Pressure Device Type* are both *Sensor*, defines the specific gravity (relative to air) used for flow rate calculations. This screen is only available if the *Line Pressure Device Type* is set to *sensor* and the *Flow DP Device Type* is set to *sensor*.	0.60
Meter Run Size	When the *Flow Differential Pressure Device Type* and the *Line Pressure Device Type* are both *Sensor*, defines the meter run diameter used for flow rate calculations. Valid values are 2”, 3”, 4” This screen is only available if the *Line Pressure Device Type* is set to *sensor* and the *Flow DP Device Type* is set to *sensor*.	2”
Orifice Size	When *Flow Differential Pressure Device Type* and the *Line Pressure Device Type* are both *Sensor*, defines the orifice diameter used for flow rate calculations. Valid Orifice Sizes are from 0.125” to 3.000”. The maximum for 3” Meter Run is 2.250” and the maximum for a 2” Meter Run is 1.375”. This screen is only available if the *Line Pressure Device Type* is set to *sensor* and the *Flow DP Device Type* is set to *sensor*.	1.000”
Casing Pressure Device Type	Enables the use of a Casing Pressure Switch or Sensor. 1. disabled – Device not installed or unused. 2. switch – Discrete Input Switch installed and enabled. 3. sensor – An analog Casing Pressure Sensor is installed.	*disabled*
Casing Pressure Range	When the *Casing Pressure Device Type* is *sensor*, defines the range of sensor.	500.0 psi
Casing Pressure Location	This is a read only screen that shows where to connect a Casing Pressure Device. This screen is only available if the *Casing Pressure Device Type* is enabled.	DI3/AI2

Screen	**Description**	**Default Value**
Casing Pressure Value	This displays the current value of the Casing Pressure. This screen is only available if the *Casing Pressure Device Type* is enabled.	N/A
Afterflow Casing Pressure	This determines which algorithm to use for closing the well when the *Casing Pressure Device Type* is *enabled*. The options are: 1. *Disabled* 2. *Low Rise (Not valid for casing pressure switch)* 3. *Absolute* These optimization algorithms are discussed further in the 5.1.4.1 Casing Pressure section. This screen is only available if the *Casing Pressure Device Type* is not *disabled*. This screen is also not available if both the *Line Pressure Device Type* and the *Casing Pressure Device Type* are *sensor*.	disabled
Afterflow Casing Pressure Trip Point	When using the Low Rise method, this screen is used to define the amount that the casing pressure has to rise above the minimum point before declaring a trip condition. When using the Absolute method, this screen is used to define the casing pressure that has to be reached before a trip condition is declared. This screen is only visible when the *Casing Pressure Device Type* is *sensor*. This screen is also not available if both the *Line Pressure Device Type* and the *Casing Pressure Device Type* are *sensor*.	Low Rise 55.0 psi Absolute 150.0 psi
Afterflow Casing Pressure Reset Point	When using the Low Rise method, this screen is used to define the amount that the casing pressure has to be above the minimum point before declaring a reset condition. When using the Absolute method, this screen is used to define the casing pressure that has to be reached before a reset condition is declared. This screen is only visible when the *Casing Pressure Device Type* is *sensor*. This screen is also not available if both the *Line Pressure Device Type* and the *Casing Pressure Device Type* are *sensor*.	Low Rise 50.0 psi Absolute 155.0 psi

Screen	**Description**	**Default Value**
Afterflow Casing Pressure Stable Time	This defines the time required for the casing pressure to stabilize before a trip or reset condition is declared. This screen is only visible when the *Casing Pressure Device Type* is <u>not</u> *disabled*. This screen is also not available if both the *Line Pressure Device Type* and the *Casing Pressure Device Type* are *sensor*.	0h00m05s
Close Casing Pressure	This screen defines whether the casing pressure is to be checked at the end of the Close cycle. If this is enabled, a low casing pressure will prevent the well from being opened. This screen is only visible when the *Casing Pressure Device Type* is <u>not</u> *disabled*. This screen is also not available if both the *Line Pressure Device Type* and the *Casing Pressure Device Type* are *sensor*.	disabled
Close Casing Pressure Trip Point	When the *Casing Pressure Device Type* is *sensor*, this defines the pressure below which the well will remain closed. This screen is only visible if the *Casing Pressure Device Type* is set as *sensor* and the *Close Casing Pressure* is *enabled*. This screen is also not available if both the *Line Pressure Device Type* and the *Casing Pressure Device Type* are *sensor*.	85.0 psi
Close Casing Pressure Reset Point	When the *Casing Pressure Device Type* is *sensor*, defines the above which the well will be opened. This screen is only visible if the *Close Casing Pressure Device Type* is set as *Absolute*. This screen is also not available if both the *Line Pressure Device Type* and the *Casing Pressure Device Type* are *sensor*.	90.0 psi
Close Casing Pressure Stable Time	When the *Casing Pressure Device Type* is *sensor*, this defines the time required for the pressure to stabilize below the *Close Casing Pressure Trip Point*, or above the *Close Casing Pressure Reset Point*, in order to declare a trip or reset condition. This screen is only visible if the *Close Casing Pressure Device Type* is set as *Absolute*. This screen is also not available if both the *Line Pressure Device Type* and the *Casing Pressure Device Type* are *sensor*.	0h00m05s

Screen	Description	Default Value
Close Casing/Line Differential Pressure Trip Point	When the *Casing* and *Line Pressure Device Types* are both *sensor*, defines the pressure difference, below which the well will stay shut-in. This screen is only available if both the *Line Pressure Device Type* and the *Casing Pressure Device Type* are *sensor*.	25.0 psi
Close Casing/Line Differential Pressure Reset Point	When the *Casing* and *Line Pressure Device Types* are both *sensor*, defines the pressure difference, above which the well will open. This screen is only available if both the *Line Pressure Device Type* and the *Casing Pressure Device Type* are *sensor*.	30.0 psi
Close Casing/Line Differential Pressure Stable Time	When the *Casing* and *Line Pressure Device Types* are both *sensor*, defines the time required for the pressure difference to stabilize above the reset point, or below the trip point, in order to declare a trip or reset condition. This screen is only available if both the *Line Pressure Device Type* and the *Casing Pressure Device Type* are *sensor*.	0h00m05s

4.4.6 Outputs Menu (Menu 6)

The Outputs menu allows the installer to configure the behaviour of the Autocatcher valve and the Digital Outputs (DOs). The Autocatcher may be enabled or disabled. The DOs can be used to provide power for a 3 Wire Arrival Sensor, mimic a valve operation, operate an Autocatcher, or signal an alarm condition.

Table 10 - Outputs Menu Screens

Screen	Description	Default
Digital Output 1	Setup the digital output to do one of the following operations: 1. disabled – Not used 2. 3-Wire - Provide power for a 3 wire arrival sensor 3. Valve A – Mimic Valve A 4. Valve B – Mimic Valve B 5. Valve C – Mimic Valve C (Not Currently Supported) 6. Autocatcher – Mimic the Autocatcher 7. On Alarm – Toggle when the controller shuts the well in due to an alarm condition.	*3 Wire*
Digital Output 2	Same as above, but for DO2.	*Disabled*
Analog Output 1	Same as above, but for AO1.	*Disabled*

4.4.7 System Menu (Menu 7)

The System menu provides information specific to the given controller. This includes information such as the serial number and firmware version. Features can be enabled, the display brightness can be adjusted, and the controller settings can be reset to factory defaults. If any errors have been reported by the controller, they can be found at the end of this menu. The following is a list of the available screens:

Table 11 - System Menu Screens

Screen	Description	Default
Display Level	Sets the screen brightness. Can be used to save power or adapt to different lighting conditions.	50%
Reset All Data	This will reset all controller settings back to the factory defaults. The user will be prompted to confirm this action before the settings are restored.	N/A
Serial Number	The serial number of the controller. This is required if features need to be enabled on the controller or it is to be returned for repair.	N/A
Firmware Version	This identifies the specific firmware version that is currently running on the controller. This is required if issues are reported to ETC. Please refer to the release notes for this version to see a list of known issues.	N/A
Pressure Optimization Option	This feature allows the controller to optimize on one or more pressure devices. These devices include casing pressure, casing line differential pressure, flow differential pressure, or flow.	Disabled
Modbus Option	This feature allows the controller to communicate with a Modbus master. This feature is typically used as part of a Modbus network that is controlled by a central SCADA host.	Disabled
Operator ID	This screen allows the Installer to set an *Operator ID*. This allows another user to have limited access to the Setup menu. This screen is only visible to a logged in Installer.	000-0000
Installer ID	This screen allows the Installer to change the current Installer ID. This screen is only visible to a logged in Installer. Note: If the Installer and Operator IDs are configured to be the same number, the user will be logged in as the Installer when using this code.	000-0000
Logout	This screen forces a log out. The screen will move back to the main status screen when the operator has logged out. The operator will be required to enter a password to regain entry to the Setup menu.	N/A
Error Log	This screen will only appear if a detectable error has occurred. Some errors will result in the controller restarting. This is the first place that should be checked if the controller is restarting itself.	N/A

Screen	Description	Default
Reset Error Log	If there are entries in the error log this screen will appear. It allows you to clear the error log. You will be prompted to confirm this action.	No

4.4.8 Modbus Menu (Menu 8)

The Modbus menu will only appear if the Modbus feature has been enabled on the controller. This feature allows data to be retrieved by a SCADA host remotely. This menu contains all of the settings that are available for Modbus communications. These settings must match the settings that are used in the SCADA host.

Table 12 - Modbus Menu Screens

Screen	Description	Default
Station Address	Defines the Modbus station. Valid values are 1 to 247. This setting must match the settings on your Modbus master.	1
Protocol	The specific Modbus protocol that is use. This can be set to either RTU or ASCII. This setting must match the settings on your Modbus master.	RTU
Baud Rate	The speed of the serial port. This setting must match the settings on your Modbus master.	9600
Character Format	This setting defines the character format used for the serial port. The number of data bits, the parity, and the stop bits are all defined within one selection. This setting must match the settings on your Modbus master.	8N1

4.4.9 Hold Valves (Menu 9)

This item is different from all other menu items. Instead of loading a sub menu, it changes the state of the controller. It will hold the controller in a stopped state with the valve either being held open or closed. The valve position is determined by the current valve state when this menu item is selected. For example, if the controller is currently open and Hold Valves is selected, the controller will be stopped with the valve open.

5 Controller

The controller configuration can be accessed in two different ways:

- Through the menu using the display and keypad
- Using Modbus over the RS485 communications port.

When the controller starts up, all valves are closed and the controller is put into the Close state. The close timer starts decrementing. Once this timer has expired, the controller decides what action to take based on the controller configuration.

5.1 Controller Configurations

The following sections describe the various ways that the controller can be configured. The configuration may be changed by modifying the parameters that are available through the user interface screens outlined in the preceding sections.

5.1.1 Intermitting

The plunger lift controller is designed to act as a well intermitter in the most basic configuration.

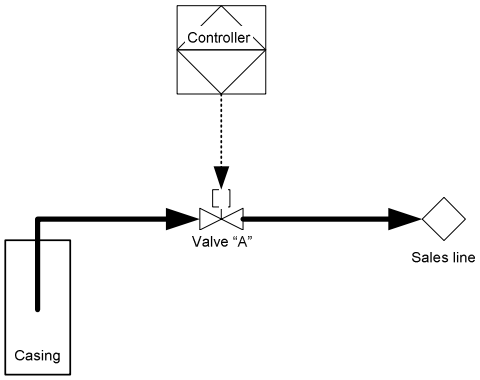


Figure 7 - Well Intermitting

In this configuration, Valve A is opened and closed based on a simple timer setup. The *Close,* and *Afterflow Times* are used to determine when to open and close the well. The *Arrival Sensor Device Type* must be *Disabled* for the controller to act as a simple well intermitter.

At the start of the cycle, Valve A is closed and the *Close Time* is started. When the *Close Time* expires the controller moves to Afterflow and the *Afterflow Time* is started. Once this timer expires, the controller moves back to Close and the valve is closed, restarting the cycle.

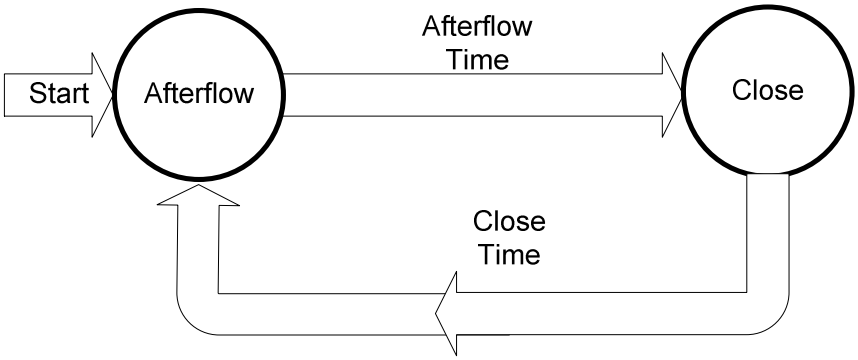


Figure 8 - Basic Controller States

5.1.2 Arrival Sensor Operation

The plunger lift controller is designed to operate primarily in the following plunger lift configuration:

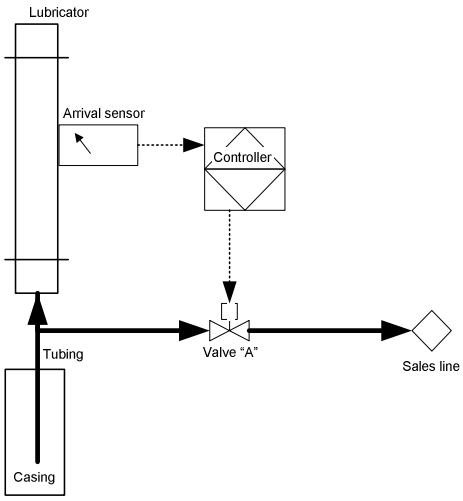


Figure 9 - Arrival Sensor Operation

In this application, a plunger travels between the bottom of the well tubing and the lubricator. The purpose of the plunger is to lift fluids which accumulate at the bottom of the well tubing. The lubricator acts as a trap for the plunger when it arrives at the surface and is fitted with an *Arrival Sensor*. The *Arrival Sensor* provides a pulse to the controller as the plunger moves past it in either direction.

When the valve is closed, the plunger falls to the bottom of the well tubing. At an appropriate time, Valve A is opened, and the pressure in the gas formation drives the plunger and any accumulated fluids to the top of the well tubing. A short time after plunger arrival, Valve A is closed and the cycle repeats.

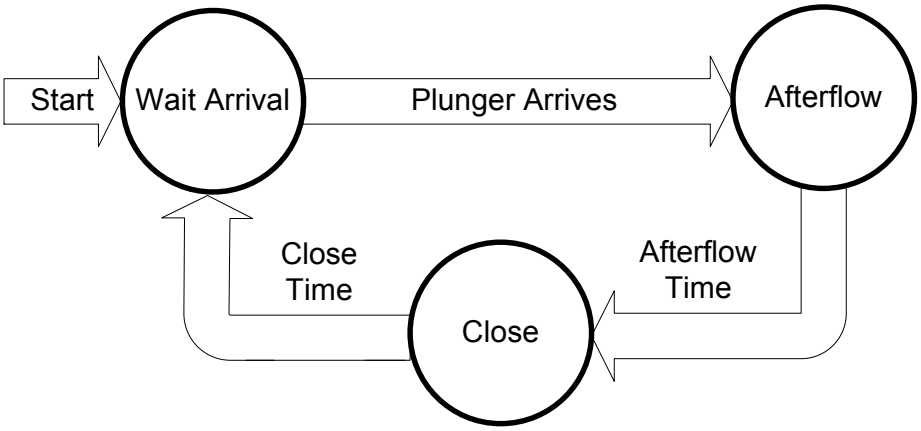


Figure 10 - Controller Operation with Arrival Sensor

5.1.2.1 Non-Arrival

If the plunger fails to arrive within the *Wait Arrival Time*, a non-arrival cycle is declared. In this case, the controller returns to the Close portion of the cycle without executing the Afterflow portion of the cycle. After a pre-determined number of *Non-Arrivals*, the controller will move into a Backup Close state, which will close the well for an extended period of time.

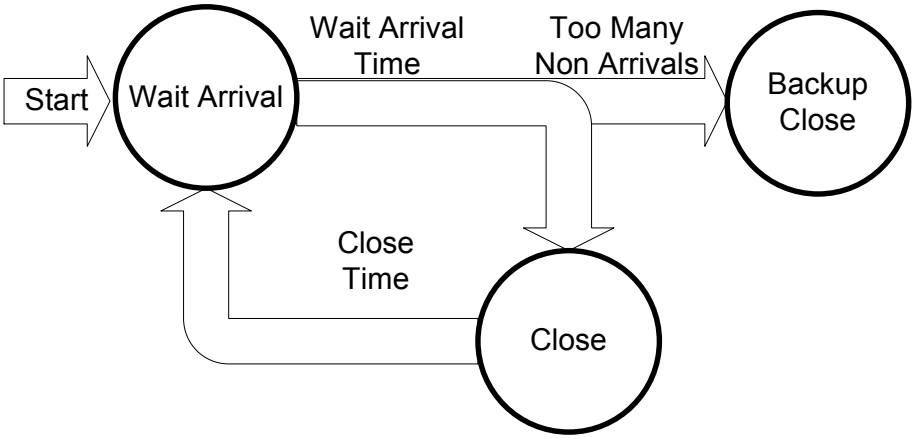


Figure 11 - Non-Arrival

5.1.2.2 Backup Close

If the specified number of consecutive non-arrivals is reached, the controller will move into Backup Close and the *Backup Close Time* will be started. The Backup Close Time is an extended period of close time that is used to create additional build-up prior to opening the well. If the plunger continues to not arrive within the *Wait Arrival Time*, the backup close will be executed each cycle. Once the Backup Fail Count is reached, the controller will shut in the well and wait for operator intervention.

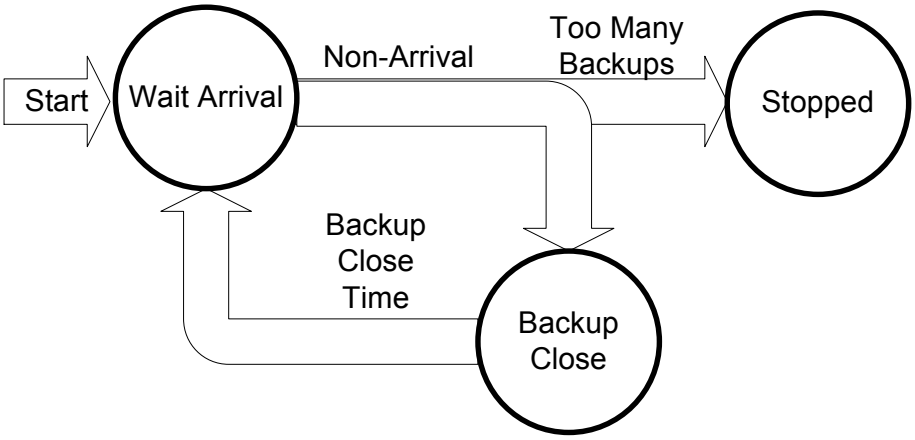


Figure 12 - Backup Close

5.1.2.3 Fast-Trip

If the plunger arrives within the *Fast-Trip Time*, a fast-trip cycle is declared. This may occur if the plunger did not fall to the bottom of the well during the Close portion of the last cycle and the plunger returns to the surface dry. When a fast trip occurs, the controller proceeds to the Afterflow portion of the cycle. After a predetermined number of fast trip occurrences, the controller will move to the Stopped state and waits for operator intervention to protect the well.

Any arrivals in the first 10 seconds of the *Wait Arrival Time* are ignored. This delay helps to avoid a glitch from some arrival sensors that send out a signal when they are powered up. The controller only powers on the arrival sensor when expecting an arrival, which helps to reduce power consumption.

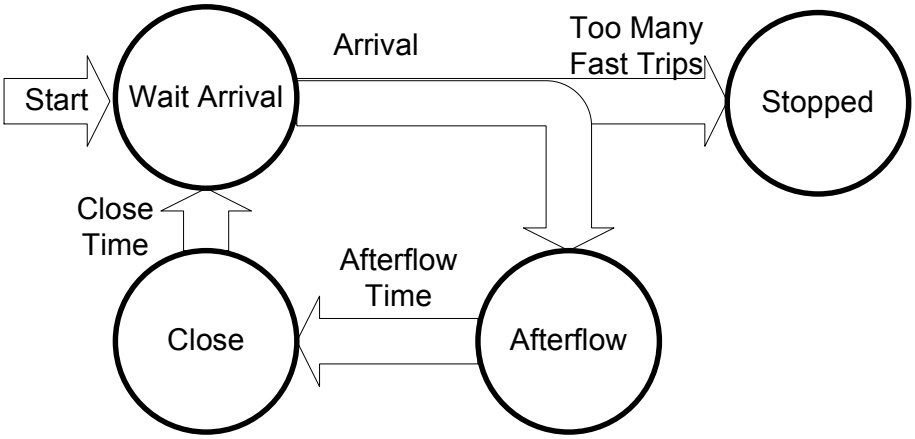


Figure 13 - Fast Trip

5.1.3 Line Pressure

The well may be equipped with a line pressure switch or sensor. This device is configured to be "tripped" when the pressure in the sales line exceeds a pre-determined threshold.

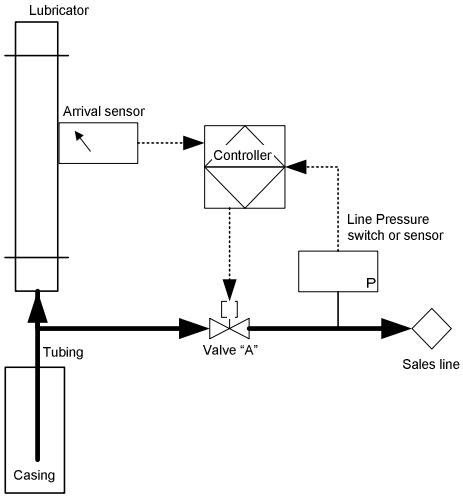


Figure 14 - Using Line Pressure

The controller monitors the state of the switch just before the Wait Arrival portion of the cycle. The cycle is delayed if the pressure is too high. It is also monitored during the Afterflow portion of the cycle. The well is shut-in if the pressure is high.

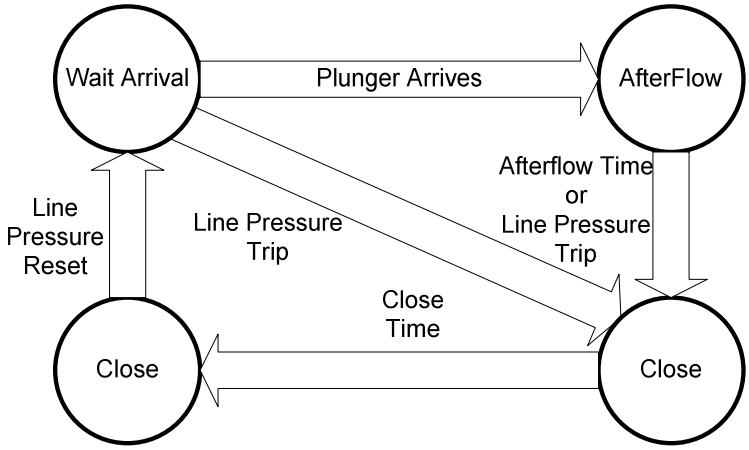


Figure 15 - Line Pressure Cycle

5.1.4 Pressure Optimization

In addition to the line pressure switch/sensor, the well may be equipped with a casing pressure switch/sensor and/or a flow differential pressure switch/sensor.

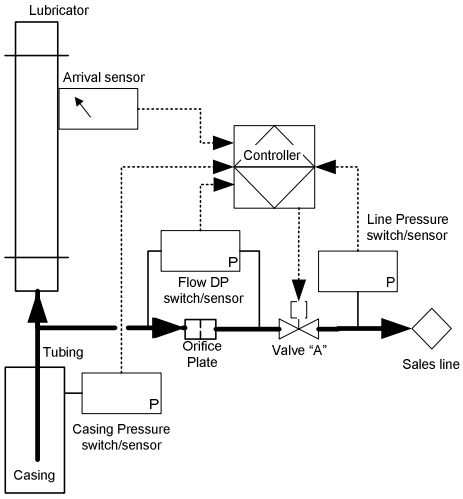


Figure 16 - Pressure Based Optimization

The following table describes the different optimization schemes that are used depending on the devices that are enabled.

Table 13 - Pressure Optimization Modes

Ref	Line Pressure	Casing Pressure	Flow DP	Optimization
1	disabled	disabled	disabled	none
2	disabled	disabled	switch	1
3	disabled	disabled	sensor	2
4	disabled	switch	disabled	3
5	disabled	switch	switch	1, 3
6	disabled	switch	sensor	2, 3

Ref	Line Pressure	Casing Pressure	Flow DP	Optimization
7	disabled	sensor	disabled	4
8	disabled	sensor	switch	1, 4
9	disabled	sensor	sensor	2, 4
10	switch	disabled	disabled	none
11	switch	disabled	switch	1
12	switch	disabled	sensor	2
13	switch	switch	disabled	3
14	switch	switch	switch	1, 3
15	switch	switch	sensor	2, 3
16	switch	sensor	disabled	4, 6
17	switch	sensor	switch	1, 4, 6
18	switch	sensor	sensor	2, 4, 6
19	sensor	disabled	disabled	none
20	sensor	disabled	switch	1
21	sensor	disabled	sensor	2, 5
22	sensor	switch	disabled	3
23	sensor	switch	switch	1, 3
24	sensor	switch	sensor	3, 5
25	sensor	sensor	disabled	6, 7
26	sensor	sensor	switch	1, 6, 7
27	sensor	sensor	sensor	5, 6, 7

1. Stay in Afterflow until the *Afterflow Time* expires AND: the *Max Open Time* expires or the Flow DP switch trips.
2. Stay in Afterflow until the *Afterflow Time* expires and: the *Max Open Time* expires or the Flow DP drops below an operator-entered threshold.
3. Monitor the Casing Pressure switch after the *Close Time* expires. Stay shut-in while the Casing Pressure switch is tripped.
4. Monitor the Casing Pressure sensor after the *Close Time* expires. Stay shut-in while the Casing Pressure is below an operator-entered set-point.
5. During Wait Arrival, Afterflow: Calculate the Flow Rate using a simplified orifice meter formula. Stay in Afterflow until the *Afterflow Time* expires. Stay in Afterflow until the *Max Open Time* expires or the Flow Rate drops below an operator-entered threshold. Calculate and save daily production volumes based on the calculated flow rate.

6. During Afterflow: Monitor the Casing Pressure to find its “minimum value”.[4] Keep the well flowing until the *Afterflow Time* expires AND: the *Max Open Time* expires or the Casing Pressure exceeds the “minimum value” by an operator-entered set-point. See diagram below. Other algorithms are also available to monitor Casing Pressure in the Afterflow portion of the cycle.
7. During Close: After the *Close* or *Backup Close Time* expires, monitor the Casing/Line differential pressure. Start a new cycle when the Casing/Line pressure difference exceeds an operator-entered threshold.

The following diagram illustrates the controller behaviour when using various extended flow devices.

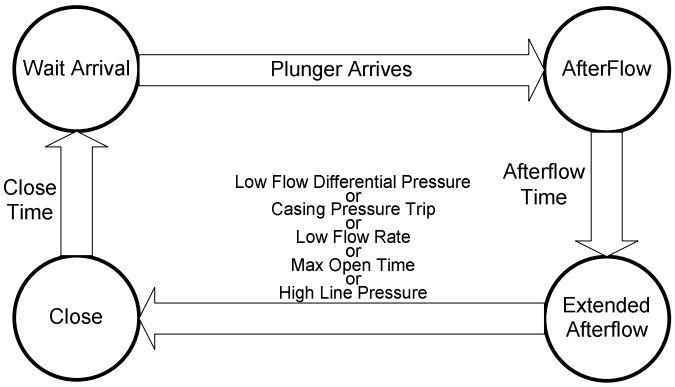


Figure 17 - Extended Afterflow Optimization

5.1.4.1 Casing Pressure

Casing Pressure can be used on its own or in combination with Line Pressure. This section discusses how Casing Pressure can be used on its own. Some of the optimization schemes behave the same when line pressure is turned on, while others will cause the controller to switch to using Casing Line Differential Pressure. The following controller actions will only take place if a Casing Pressure device has been enabled.

5.1.4.1.1 Close

The Casing Pressure is not monitored until the end of the Close portion of the cycle. Once the *Close Time* or *Backup Close Time* has expired, the well will be held closed until the Casing Pressure device has been reset.

[4] Do not monitor Casing and Line pressure sensors within the *Arrival Guard* time of plunger arrival.

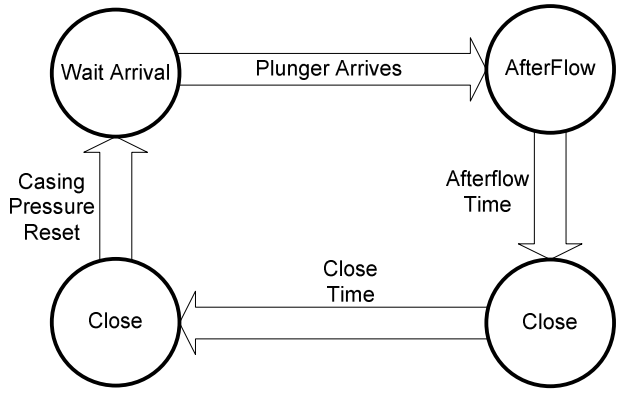


Figure 18 - Casing Pressure Close Cycle

If a switch is used, it must be in the reset position and must stay there for at least the stable time. If the *Casing Pressure Device Type* is configured as a *sensor*, then the sensor value must exceed the *Close Casing Pressure Reset Point* and stay there for at least the *Close Casing Pressure Stable Time*.

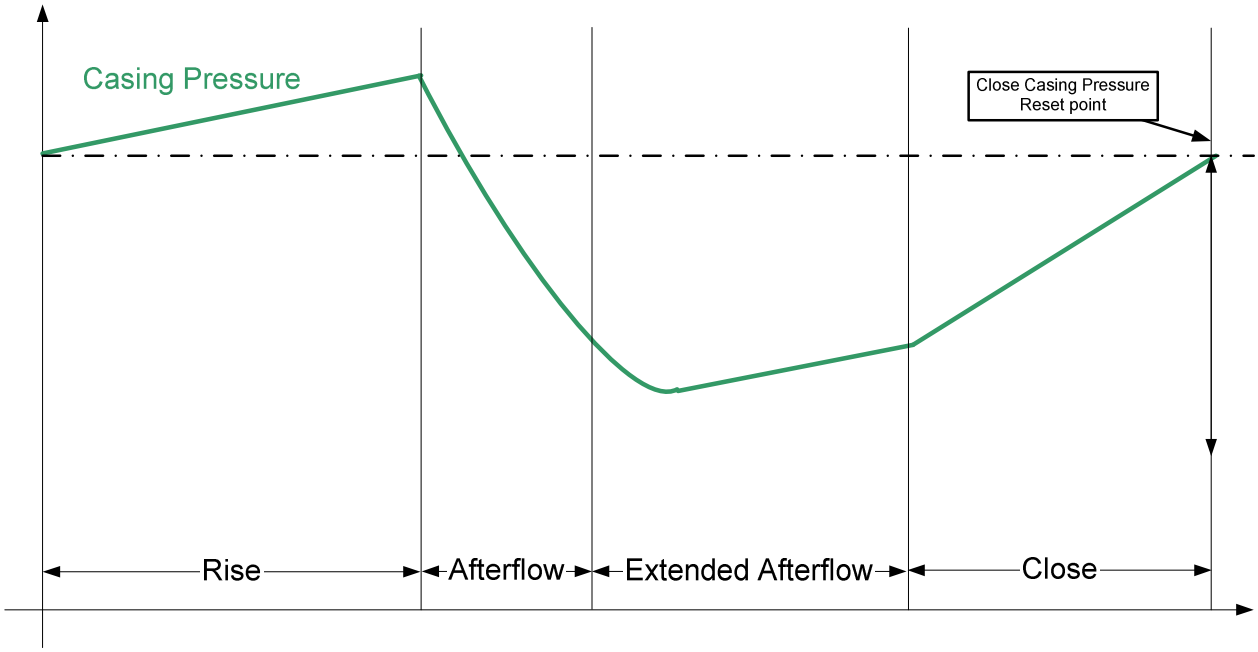


Figure 19 - Close Casing Pressure Reset Point

5.1.4.1.2 Afterflow/ Extended Afterflow

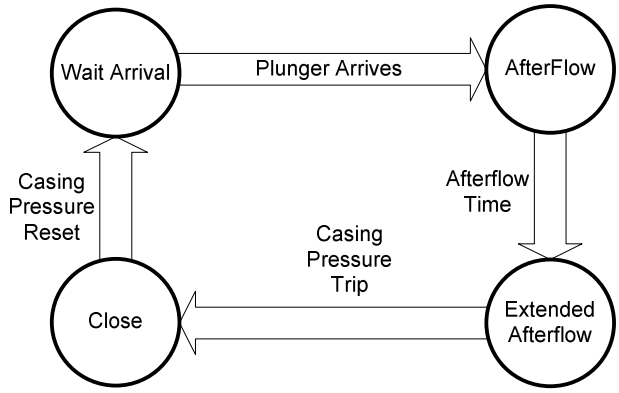


Figure 20 - Afterflow/Extended Afterflow Casing Pressure

During the Afterflow portion of the cycle, the Casing Pressure is monitored one of two different ways if the *Casing Pressure Device Type* has been configured as a *sensor*. If the Casing Pressure trips during Afterflow, the well is closed as soon as the *Afterflow Time* expires. If the Casing Pressure has not tripped by the end of the *Afterflow Time*, then the Casing Pressure will continue to be monitored during the Extended Afterflow portion of the cycle. A trip during the Extended Afterflow portion of the cycle will cause the well to be closed once the applicable *Stable Time* has been met. The following sections describe the different Casing Pressure monitors that can be configured.

5.1.4.1.2.1 Low Rise

The Low Rise method monitors the down slope of the Casing Pressure. Once the Casing Pressure stops decreasing, the current value is saved. This is used to determine how much the Casing Pressure has risen when the well begins to water in. Once the Casing Pressure has risen greater than the *Afterflow Casing Pressure Trip Point* and stays there for at least the time defined by the *Afterflow Casing Pressure Stable Time*, the well will be shut-in.

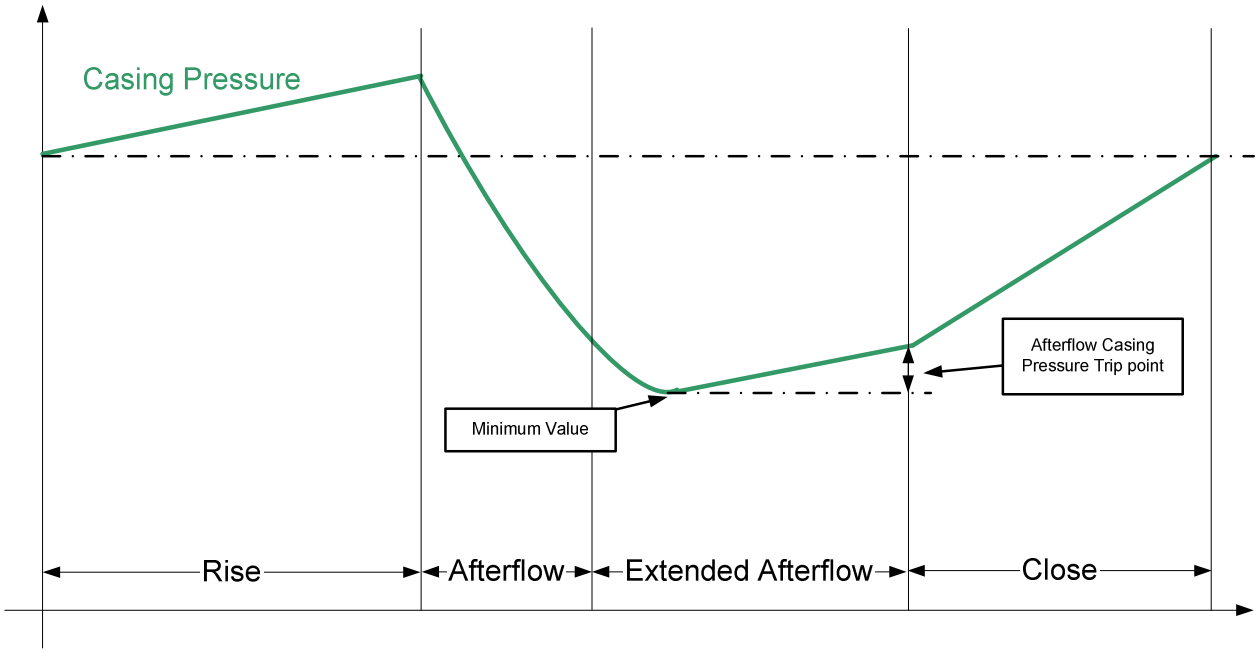


Figure 21 - Casing Pressure Low Rise Method

5.1.4.1.2.2 Absolute

This method simply looks for a drop in the Casing Pressure. Once the Casing Pressure drops below the *Afterflow Casing Pressure Trip Point* and stays there for at least the time defined by the *Afterflow Casing Pressure Stable Time*, the well will be shut in.

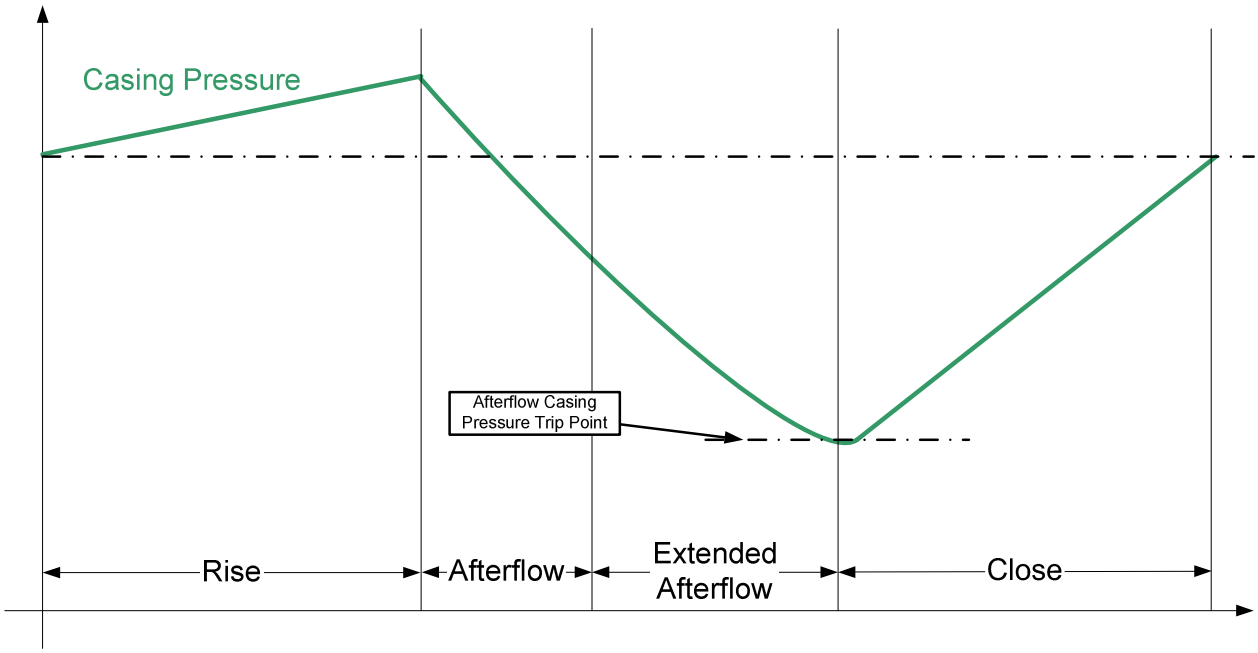


Figure 22 - Casing Pressure Absolute Method

5.1.4.2 Casing Line Differential Pressure

If a Casing Pressure Sensor and a Line Pressure Sensor are both enabled, Casing Line Differential Pressure will be used to determine when the controller can move from Close to Open. The difference will be taken between these two values and then compared to the *Close Casing Line Differential Pressure Reset Point*. Once the differential exceeds the reset point and stays above it for at least the *Close Casing Line Differential Pressure Stable Time*, the well will open. Please note that casing pressure alone is used when determining when to go from open to close.

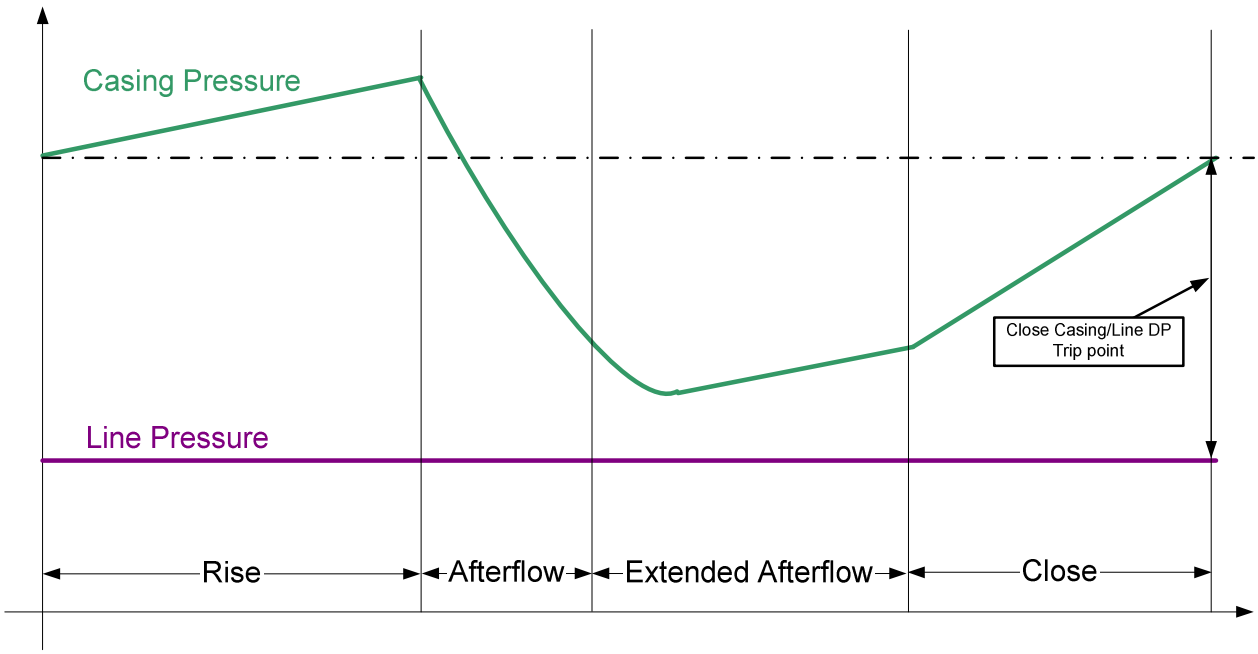


Figure 23 - Close Casing Line Differential Trip

5.1.4.3 Flow Differential Pressure

Flow Differential Pressure Device Type can be configured as either a switch or sensor. When it is configured as a switch, it will automatically drop out of Extended Afterflow when the switch trips. A trip indicates that the differential is below a trip point set externally. The differential is proportional to the flow. A drop in flow is represented as a drop in differential. As the well begins to water in, the differential will decrease.

When the *Flow Differential Pressure Device Type* is enabled as sensor, the controller will behave in the same manner. The difference is that the *Flow Differential Pressure Trip Point* and *Flow Differential Pressure Reset Point* must be configured to tell the controller when to shut in the well. If a Line Pressure sensor is used in conjunction with a Flow Differential Pressure Sensor, then a flow rate can be estimated. Please refer to the Flow Rate section below.

5.1.4.4 Flow Rate

When the Flow Rate is available, the *Extended Afterflow Time* of the controller is optimized. The well is shut-in when the Flow Rate drops below the *Flow Rate Trip Point* and remains there for at least the *Flow Rate Stable Time*.

The Flow Rate value is also used to provide an estimated daily production. The flow is summed over time and the resultant production numbers are shown in the daily logs, which can be viewed by pressing the History hot key and selecting the daily or total production menu.

The flow rate can be calculated if a Line Pressure sensor and a Flow Differential Pressure Sensor are used. This method will require a set of orifice plate parameters to be. A Meter Factor is derived from a look up table using the *Meter Run Size* and *Orifice Plate Size*. The *Gas Temperature* and *Gas Specific Gravity* are entered by the installer and are NOT updated real time. This calculation will provide an estimated flow that can be used for optimization. Please note that the production values that are derived from the calculation are not suitable for custody transfer.

5.1.5 Timer Optimization

Timer Optimization allows the well to be optimized based on the arrival time of the plunger, which is derived from the plunger velocity. The average[5] plunger arrival time is compared to a *Target Rise Time* and adjustments are made to the flow time or shut in time of the well in order to optimize the performance of the well. The objective of this optimization is to cause the plunger to arrive at the *Target Rise Time*.

Adjustments are made directly to the *Afterflow Time* and/or the *Close Time*. Each of these times are bounded by a minimum and maximum time to prevent the timers from going to zero or escalating beyond reasonable limits.

5.1.5.1 Optimization Modes

There are 3 different time optimization modes in the PIT Boss. Each mode specifies whether the *Afterflow Time*, *Close Time*, or both times are manipulated.

5.1.5.1.1 Gas

This optimization mode will manipulate the *Afterflow Time* only. If the plunger arrives too soon (fast), the *Afterflow Time* is increased, allowing more production and additional water to accumulate. If the plunger arrives too late (slow), the *Afterflow time* is decreased, causing the plunger to make more frequent trips to remove water from the well.

5.1.5.1.2 Oil

This optimization mode will manipulate the *Close Time* only. If the plunger arrives too soon (fast), the *Close Time* is increased, reducing production while allowing additional water to accumulate. If the plunger arrives too late (slow), the *Close time* is decreased, causing the plunger to make more frequent trips to remove water from the well.

5.1.5.1.3 Oil Then Gas

This optimization mode will manipulate the *Close Time* first. Once there is no more room for the *Close Time* to adjust (i.e. We have reached the *Minimum Close Time* or *Maximum Close Time*), then the *Afterflow Time* is adjusted.

5.1.5.2 Optimization Adjustment Type

The aggressiveness of the adjustments is controlled by the *Optimization Adjustment Type*. This setting directly controls the magnitude of the adjustments that are made. Each adjustment type is described below.

5.1.5.2.1 Escalate

The amount of the adjustments is proportional to the amount of *Afterflow Time*. The larger the afterflow, the larger the adjustments.

5.1.5.2.2 1:1

For every minute the averaged arrival time is faster/slower than the *Target Time*, the controller add/subtract 1 minute of afterflow/close time.

5.1.5.2.3 2:1

[5] The PIT Boss controller calculates a weighted average that consists of the last 3 arrival times (with the most recent time given double the weight) to obtain the arrival time used for optimization.

For every minute the averaged arrival time is faster/slower than the *Target Time*, the controller add/subtract 2 minutes of afterflow/close time.

5.1.5.2.4 3:1

For every minute the averaged arrival time is faster/slower than the *Target Time*, the controller add/subtract 3 minutes of afterflow/close time.

5.1.5.3 Backup to Afterflow

The Backup to Afterflow feature allows the Installer to specify how a Backup event impacts the *Afterflow Time* when using time optimization. On a backup, the *Afterflow Time* can be left at its current value, reduced to the *Minimum Afterflow Time*, or reduced by a percentage of the difference between the *Afterflow Time* and the *Minimum Afterflow Time*.

5.1.5.3.1 Min Afterflow

The *Afterflow Time* is set to the *Minimum Afterflow Time*.

5.1.5.3.2 25%

The *Afterflow Time* is reduced by 25% of the difference between the *Afterflow Time* and the *Minimum Afterflow Time*.

5.1.5.3.3 50%

The *Afterflow Time* is reduced by 50% of the difference between the *Afterflow Time* and the *Minimum Afterflow Time*.

5.1.5.3.4 75%

The *Afterflow Time* is reduced by 75% of the difference between the *Afterflow Time* and the *Minimum Afterflow Time*.

5.1.5.3.5 No Change

The Afterflow time is not adjusted.

5.1.6 Dual Valve

The well may also be equipped with a second valve (Valve B). This valve may be installed in one of 3 configurations. These configurations are illustrated and described below.

5.1.6.1 Top Valve

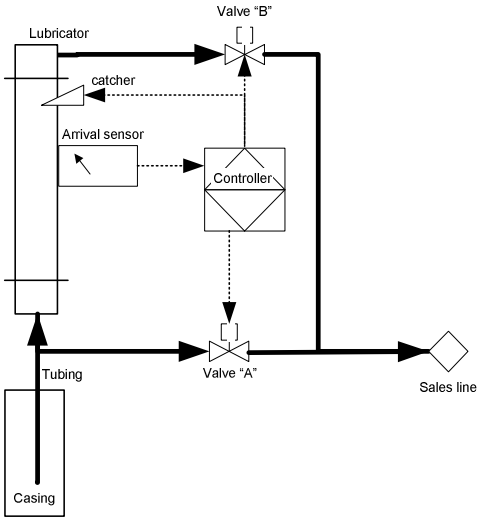


Figure 24 - Top Valve Well Configuration

Valve B must be set to *line: open A* in order to operate the controller in a Top Valve configuration.

During the Wait Arrival portion of the cycle, Valve B is open and Valve A is closed. The location of Valve B is such that the plunger will be driven fully into the lubricator upon arrival without requiring excessive (i.e. sub-optimal) velocity. A short time (*Afterflow Delay Time*) after the plunger arrival, Valve A is opened and Valve B is closed. The location of Valve A causes the Plunger to be held within the Lubricator while gas is flowing with sufficient pressure. In this configuration, the well may be equipped with an Autocatcher which is driven from the Valve B gas supply line.

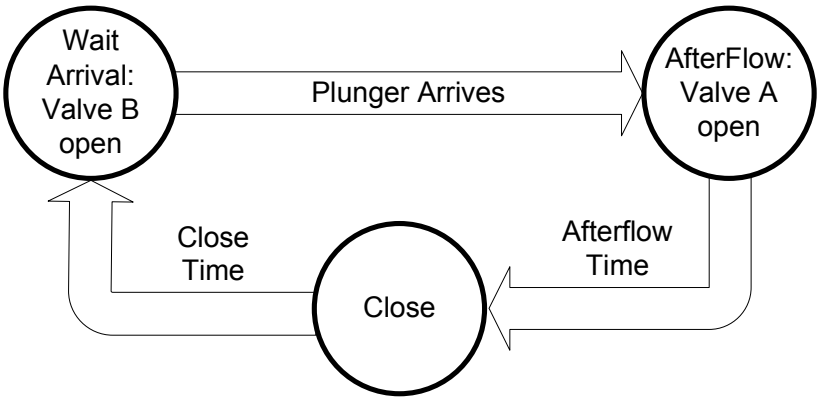


Figure 25 - Top Valve Operation

5.1.6.2 Flow Tee

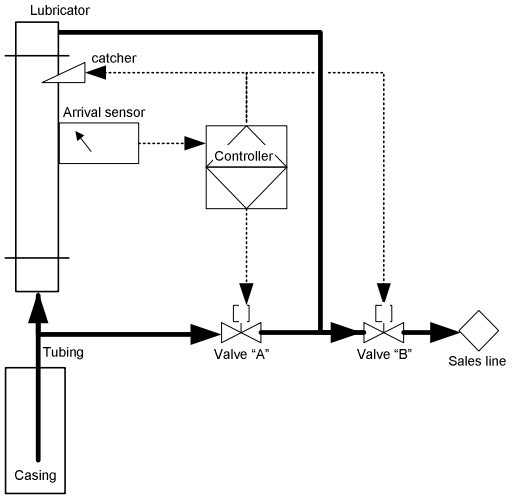


Figure 26 - Flow Tee Well Configuration

The Top Valve configuration has the disadvantage of requiring that a valve gas control line be installed between the separator shack and well-head. To avoid this, a Flow Tee configuration is often used. Operation is the same as for the *Top* valve except that, in the Afterflow portion of the cycle, both valves are left open.

To achieve this configuration, *Valve B* must be set to *line: open A&B*.

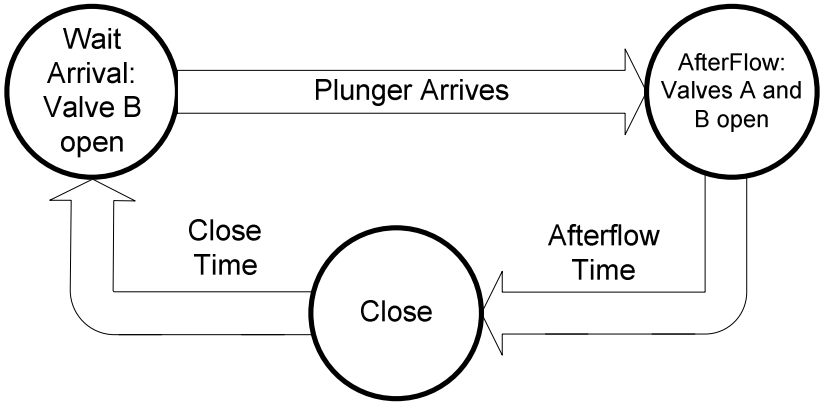


Figure 27 - Flow Tee Operation

5.1.6.3 Tank Valve

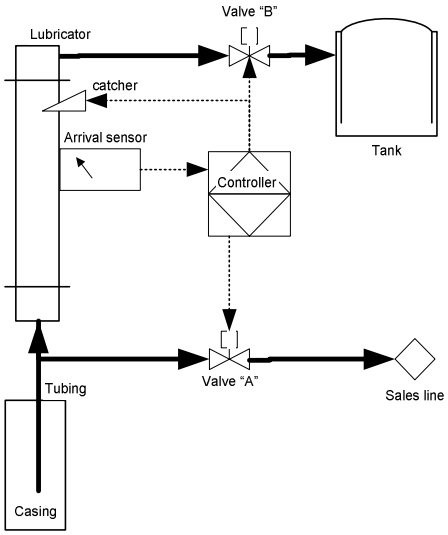
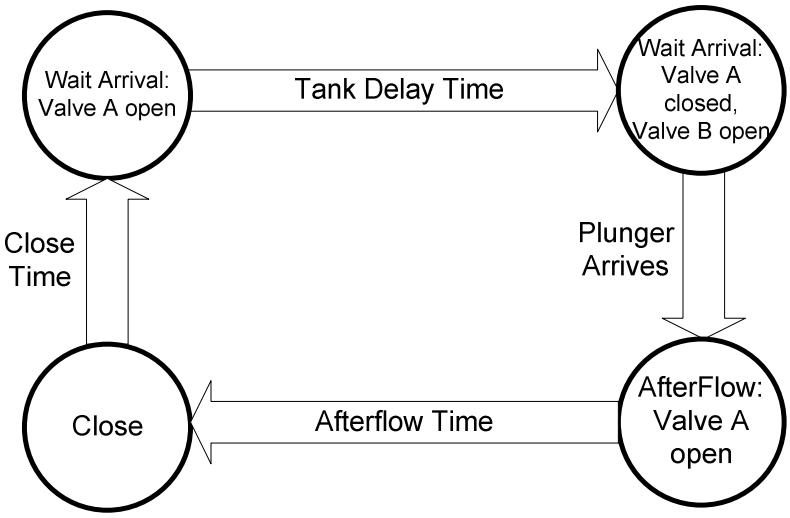


Figure 28 - Tank Valve Well Configuration

If Valve B is connected to a Tank, Valve A is opened at the start of the Wait Arrival portion of the cycle. If the plunger does not arrive within a specified time, then the valves are toggled (i.e. simultaneously open Valve B and close Valve A). When the plunger arrives, the valves may be toggled again. The purpose of the tank is to assist in plunger lift by exerting less back pressure on the well tubing than that exerted from the sales line.

To achieve this configuration, *Valve B* must be set to *tank*.



5.1.7 Autocatcher

The PIT Boss has the ability to run a pneumatic Autocatcher. Valve 4 is currently used for this purpose. By default, the Autocatcher is not used and a pulse will not be delived to Valve 4. If you wish to use the Autocatcher, it must first be enabled.

5.1.7.1 Autocatcher Modes of Operation

The Autocatcher can be enabled to perform two different ways.

5.1.7.1.1 On Wait Arrival

The Autocatcher will be engaged as soon as the *Wait Arrival Time* is started.

5.1.7.1.2 On Arrival

The Autocatcher will be engaged as soon as the plunger arrival has been detected.

5.1.7.2 Catch Hold Time

The Catch Hold Time parameter tells the controller how long to hold the plunger at surface after the sales line has been closed. This can be disabled by setting this parameter to zero. If the value of this timer is non-zero, then a timer is started as soon as the sales line is closed. Once the timer expires, the Autocatcher will be released, allowing the plunger to fall.

5.1.8 Outputs

There are 2 Digital Outputs and 1 Ananlog Output on the PIT Boss. These outputs can be configured in a number of different ways to power specific devices, interact with electric valves, or to communicate with other systems. The following is a description of each configuration that is available.

5.1.8.1 3-Wire

The outputs have historically been used to provide power to a 3 wire arrival sensor. The power lead of the arrival sensor is connected to the signal connection of the given output. The controller will provide power using this output when an arrival is expected, helping to reduce the power consumption of the system.

5.1.8.2 Valve A

The output will be set high when Valve A is open. Conversely, the output will be set low when Valve A is closed. This is typically used to drive an optically isolated relay which can be used to control an electric valve.

5.1.8.3 Valve B

The output will be set high when Valve B is open. Conversely, the output will be set low when Valve B is closed. This is typically used to drive an optically isolated relay which can be used to control an electric valve.

5.1.8.4 Valve C

Valve C is not currently supported by this controller.

5.1.8.5 Autocatcher

The output will be set high when the Autocatcher is engaged. Conversely, the output will be set low when Autocatcher is disengaged. This is typically used to drive an optically isolated relay which can be used to control an electric Autocatcher.

5.1.8.6 On Alarm

The output is set high when the controller enters a Stopped state. This happens when the an error condition exists such as low battery, too many fast trips, or too many backups. This feature is used typically to tie into another system so that the operator can be alerted that the well has been shut in.

5.1.9 Low Battery

The controller is designed to handle a number of failure conditions, most of which have already been discussed. If the controller senses that the battery is low, it will take action to ensure that the valve(s) are left in a known state. When a low battery condition has occurred, the controller will actuate the valve(s) and then go into a Stopped state. The controller will remain in this state until the battery has recovered or an operator has intervened.

The state that the valve is placed in when a low battery condition occurs is based on the *Low Battery Fail Mode* parameter that is found in the Alarms menu.

6 Modbus Communications

The controller is equipped with an RS-485 port which is designed primarily to provide communications to a SCADA system. This port provides most of the functions available from the front panel user interface using the Modbus protocol. The Modbus Communications User's Guide discusses the physical connections, communications settings, and the available registers.

7 Troubleshooting

The following outlines a number of common issues that may be encountered.

Table 14 - Troubleshooting Guide

Issue	Cause	Resolution
The display won't come on when the battery is plugged in.	The fuse is blown on the battery	Return to ETC to be repaired. To avoid this issue, make sure to avoid shorting the battery connections.
	Battery is unplugged or there is a loose connection	Plug in the battery and check all connections
	Battery is dead	Charge the battery as per the directions on the side of the battery. If it does not hold a charge, contact ETC to purchase a new battery.
	Software has been erased	Reprogram the software using the software upgrade procedure.
Pressing a button does not produce the desired response.	A key is stuck on the keypad	The keypad will need to be replaced. Please call ETC to arrange for the controller to be repaired.
	The main core of the controller has been shocked	The controller core must be replaced. Please call ETC to arrange for the controller to be repaired. To avoid this, always transport the controller board in a static protection bag and avoid touching any exposed connections along the back of the controller without appropriate grounding.

Issue	Cause	Resolution
Cannot log in to some of the menus	You have forgotten your operator/installer ID.	If the Operator ID has been forgotten, use the Installer ID. If the Installer ID has been forgotten, ETC can generate a new ID on a per controller basis.
Cannot access some of the devices (i.e. Flow DP, Casing Pressure, etc…)	Pressure Optimization is not enabled on this controller.	Contact ETC to purchase an optimization feature key.
	The *Optimization Mode* is not set to Pressure Optimization.	Change the Optimization Mode to Pressure Optimization.
Cannot see the Modbus menu item	Modbus communications has not been enabled on this controller	Contact ETC to purchase a Modbus communications feature key.
Timer Optimization adjustments are too large	The algorithm is setup to be too aggressive.	Try using a less aggressive *Optimization Adjustment Type.*
Timer Optimization takes too long to adjust to the right value	The algorithm is not setup to be aggressive enough.	Try using a more aggressive *Optimization Adjustment Type.*
Fast Trips do not shut in the well	Fast Trips are disabled	Set the Fast Trips in the Alarms menu to something other than disabled.
	The number of consecutive Fast Trips has not been reached.	The controller will continue in to Afterflow when a Fast Trip occurs. The well is only shut in after the number of consecutive Fast Trips has been reached. This is specified in the *Fast Trip Count* screen.
Non-Arrivals do not shut in the well	Non-Arrivals are disabled	Set the Non-Arrivals in the Alarms menu to something other than disabled.
Controller is sitting in the stopped state	The battery is low	Replace the battery and ensure that the solar panel is connected and positioned correctly.
	Too many fast trips have occurred	Correct the issue with the well and set the controller to resume normal operation.
	Too many backups have occurred	Correct the issue with the well and set the controller to resume normal operation.

8 Support

8.1 Software Upgrade

On occasion, software upgrades are made available. These releases will contain new features as well as resolutions to issues found in the product. The release notes describe the changes

that are available in each release. The new software can be downloaded through the communications port whether the Modbus option is enabled or not.

It is recommended that the controller be removed from the well before the upgrade is performed as the valve operation cannot be trusted during the upgrade.

8.1.1 Prerequisites

The following equipment is required to upgrade the controller:

- Battery
- Laptop with a USB port
- USB to RS485 converter
- Latest Firmware file from Extreme Telematics Corp.

8.1.2 Setup

1. Ensure that the USB to RS485 adapter is configured in 2 wire mode.
2. Wire the RDA(-) to COM1 B and RDB(+) to COM1 A. The GND can be wired to the unlabelled connection on COM1 between A and B, but is not necessary.
3. Plug adapter into an available USB port
4. Install the drivers that were provided with the USB to RS485 converter

8.1.3 Upgrade Procedure

1. Hold the ***Menu*** button down
2. Plug the battery into the controller
3. Release the ***Menu*** button
4. If the controller does not enter the upgrade program, the previous software that was installed may not include this program. Please contact ETC.
5. Follow the prompts on the screen to erase the current firmware. To abort the upgrade process at this point, unplug the battery.
6. When prompted to do so, download the firmware
    a. Open the ETC Upgrade Utility
    b. Browse to the latest ETC file that was provided by Extreme Telematics Corp.
    c. Select the appropriate COM port from the drop down list.
    d. Click the Connect button
    e. Select Download
7. The display on the controller should change to show the status of the download and a progress bar should appear on the screen, showing how much code has been downloaded.
8. When the download is complete, the controller should start normally.

8.1.4 Upgrade Errors

During the download of a firmware image, errors may occasionally occur. If this does happen, simply repeat the procedure again, making sure to erase the current firmware. If an error occurs multiple times in a row, contact Extreme Telematics Corp.

The following is a list of errors that may be seen:

- **Err 1 – Invalid file format.** The Bootloader found information in the serial stream that did not match the expected format. This could be a transmission error or an error with the file.
- **Err 2 – Dropped Characters.** While parsing the incoming stream, extra characters were detected. This typically means that some data was lost.
- **Err 3 – Character Buffer Overrun.** Incoming characters were lost because the controller was too busy processing to service the incoming data. Please contact ETC if this occurs.

- **Err 4 – Flash Buffer Overrun.** This means that there is a back log saving to the controller. Please contact ETC if this occurs.
- **Err 5 – Character Buffer Underrun.** The controller was expecting to parse more incoming characters, but there are none available. Please contact ETC if this occurs.

8.2 Replacement Parts and Accessories

Several replacement parts or accessories are available for purchase. These items are listed in the table below with their associated part numbers. Please contact sales for the current price list.

Table 15 - Available Replacement Parts and Accessories

Part Number	Name	Description
ET-10000-1007-0001	Single Valve Assembly	Includes a pneumatic valve solenoid, 2 3/8" NPT elbows, an O Ring, and Nylon Lock Nut
ET-10000-1007-0002	Dual Valve Assembly	Includes 2 pneumatic valve solenoids, 2 3/8" NPT elbows, a Tee, a 3/8" NPT connector, 2 O Rings, and 2 Nylon Lock Nuts
ET-10000-1007-0005	Dual Valve Upgrade Kit	Includes a pneumatic valve solenoid, a Tee, a 3/8" NPT connector, an O Ring, and Nylon Lock Nut
ET-00000-0000-0230	Valve Solenoid Core	Includes the plastic molded solenoid core and wires
ET-00000-0000-0231	Valve Piston and Spring	Includes the internal valve piston and attached spring assembly
ET-00000-0000-0225	Solar Panel	6V, 3W CSA Class 1 Div 1 Intrinsically safe solar panel
ET-10000-1011-0000	6V Battery	CSA approved replacement battery with intrinsically safe protection.
Coming Soon	Arrival Sensor	Use with the PIT Boss controller to detect a plunger arrival.
ET-00000-0000-0070	4 Pin Connector	4 Pin Weidmuller connector
ET-00000-0000-0009	8 Pin Connector	8 Pin Weidmuller connector
ET-00000-0000-0180	Captive Screw	Small screws that are used to attach the controller to the enclosure.
S0000002	Pressure Optimization License Key	Allows pressure devices to be used to optimize both the close and extended Afterflow portions of the cycle.
S0000003	Modbus Communications	Allows for remote

	License Key	communications via Modbus.

8.3 Technical Support

8.3.1 Contacting Support

Support is available through ***Premier Integrated Technologies (PIT)***. Authorized representatives from PIT can contact us in the following ways:

8.3.1.1 Web

Please visit our website at http://www.ETCorp.ca.

8.3.1.2 Phone

ETC support can be contacted via phone at our office in Calgary, AB at (403) 290-6300 Mon – Fri, 9:00 am to 5:00 pm MST. Authorized distributors will be provided information on how to contact someone outside the normal business hours listed above.

8.3.2 Identifying the Issue

Please take the time to identify the issue that is being experienced. Many issues can be resolved by simply upgrading the controller to the latest software. If the issue still persists, please try and determine if there is an issue with the software or hardware. Here are some common indications of each type of issue:

8.3.2.1 Hardware

- Battery is not charging
- Some display pixels do not power up
- The controller display does not come up and the controller does not draw any current
- A key is stuck

8.3.2.2 Firmware

- The controller restarts itself (goes back to close at an incorrect time)
- There are entries in the error log (Located in the System menu)
- Controller behaviour is erratic
- The same issue happens across multiple controllers

8.3.3 Reporting Software Issues

We strive to provide the best software possible that is free of defects. As with any controller, there may be issues. When issues do arise, please do the following:

- Copy down any errors that are found in the error log
- Note the controller configuration
- Note what was being done on the controller when the issue occurred
- Note the serial number and version number of the controller that experienced the issue
- Detail instructions on how to repeat the issue if possible

8.3.4 Repair Process

Repairs should be handled through ***Premier Integrated Technologies***. They will arrange to have the controller repaired. Please be ready to explain the issues that are being experienced. A detailed account of the problem will be required so that the issue can addressed in a timely fashion. Returned controllers will take approximately 4 – 6 weeks to be diagnosed and resolved.