ALiEn²

ALiEn² Expert

Installation and Operations Manual

EXTREME TELEMATICS CORP.

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ALiEn^2/ALiEn^2 Expert Installation and Operations Manual

Revision History

Doc Rev	Rev	Date	Author	Changes
1	1.x.x	17/12/2010	Mark Scantlebury	Initial Version
	1.4.x	27/04/2012	Mark Scantlebury	Update to match simpler menus. Use new pictures and part numbers.
	1.6.x	19/09/2013	Mark Scantlebury	Add in vent time tracking, total stats and plunger stats. Add in Valve B Purge Add Digital Output Pulse
1.7	1.7.x	28/01/2014	Mark Scantlebury	Add in Tubing Pressure Add in Device Logging Add in screens to enable/disable pressure sensor modes. Add in Manual Valve and Valve Hold Operations Revise Valve B Tank Options
	2.0.x	08/02/2016	Mark Blackburn	Add in Velocity Optimization Update CP Rate Optimization
2	2.1.x	16/01/2017 31/01/2017	Mark Blackburn	Updated Pacesetter keypad image Changed IPS logo to Superior Energy
3	2.1.x	21/07/2017	Paolo Marrero	Add Model 550 and Pacesetter Basic. Replaced Gas and Oil Optimization with Afterflow and Close Optimization.
4	2.1.x	02/10/2017	Mark Blackburn	Added references to virtual pressure in pressure optimization sections. Add section for SW variants

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1 Introduction

1.1 Purpose

This manual is intended to provide all of the information required to set up and operate the ALiEn^2/ALiEn^2 Expert Plunger Lift Controllers. As well, it covers basic troubleshooting techniques and support information.

1.2 Overview

The ALiEn^2/ALiEn^2 Expert 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 time/velocity. 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 or installed simulator is available as a reference while reading this manual.

2 Installation

2.1 Mounting

Each controller is supplied with a universal mounting bracket. This bracket is designed to keep the controller away from other surfaces so that the vent can be properly routed. As well, it provides a number of different mounting configurations to meet any application.

Simply mount the bracket to the desired surface securely and then attach the controller to the bracket. Studs have been pre-pressed into the four corners to make attaching the controller simple.

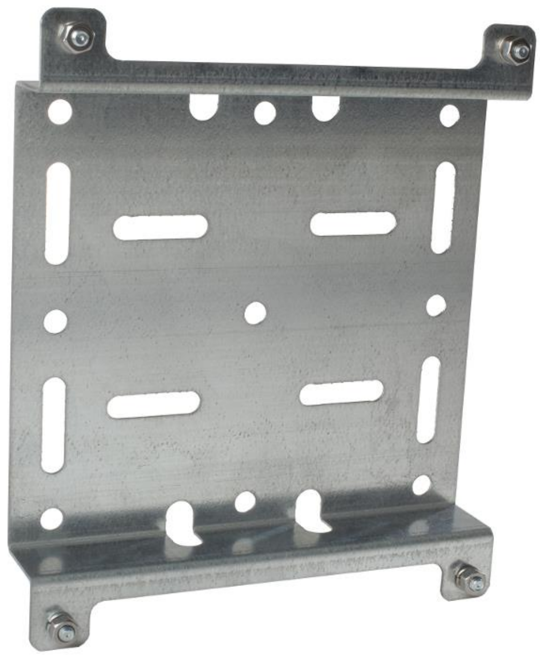

Figure 1 - Universal Mounting Bracket

2.1.1 Wall/Stud Mount

The universal mounting bracket includes nine holes that can be used for mounting to a wall or stud. To mount to a vertical stud, simply use three of the vertically aligned holes. For mounting to a horizontal stud, use one of the three horizontally aligned holes.

2.1.2 Pipe Mount

The long slots that run horizontally are intended for mounting to a vertical pipe, while the vertical slots are intended for mounting to a horizontal pipe. Use the appropriate set of slots to secure the mounting bracket with U-bolts/pipe clamps.

2.1.3 Valve Mount

Wider, shorter slots are provided along the bend to allow the bracket to be secured to a pneumatic valve. Simply remove 2 adjacent bolts from the top of the valve. Place the bracket over the holes and push the bolts through the bracket and valve, fastening them again.

2.2 Gas Connections

Each solenoid has 3 different connections which must be connected properly in order for the controller to operate the valve.

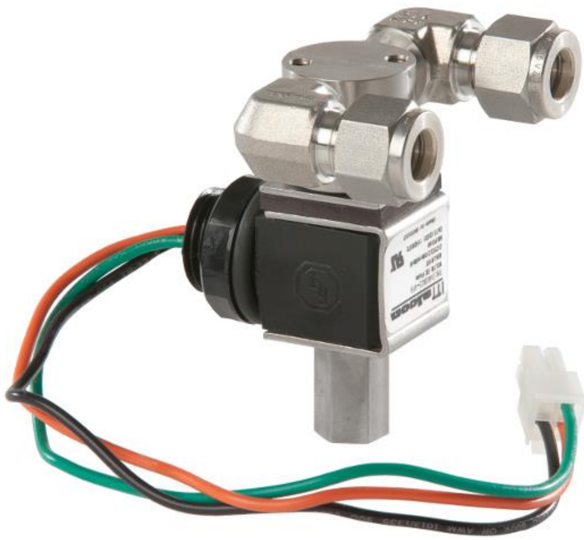

Figure 2 - Valve Solenoid

2.2.1 Supply

The supply side of the solenoid can be identified by the "IN" marking that is stamped on the body. A 90-degree elbow has been pre-installed to make it easier to terminate in the field.

Clean supply gas must be supplied in order to operate the valve. The solenoid is designed to work up to 60 psi, but will operate at lower pressures.

Dual valve assemblies are constructed so that the supply ports of the two solenoids are facing towards each other and are attached with a tee. Although two separate solenoids will perform the same function, a single supply connection makes installation simpler.

2.2.2 Valve

The valve side of the solenoid can be identified by the "CYL" marking that is stamped on the body. A 90-degree elbow has been pre-installed to make it easier to terminate in the field.

2.2.3 Vent

The vent faces towards the back of the enclosure and is threaded so that the appropriate fittings can be attached. The vent should be routed according to the appropriate local regulations.

2.3 Grounding

The controller is designed so that the circuit board is isolated from the enclosure and mounting hardware. This allows stray voltages to be routed away from the electronics through a ground point. If connected correctly, there is less chance of damage to the controller in the event of an electrical disruption.

A ground lug is provided on the bottom left corner of the enclosure. It is designed to fit up to 4 AWG wire. The enclosure should be grounded according to the appropriate local regulations.

2.4 Electrical Connections

The following is an outline of the locations that devices can be wired to. All connected devices must meet the entity parameters found in the ET-12001-1012-0000 Control Drawing.

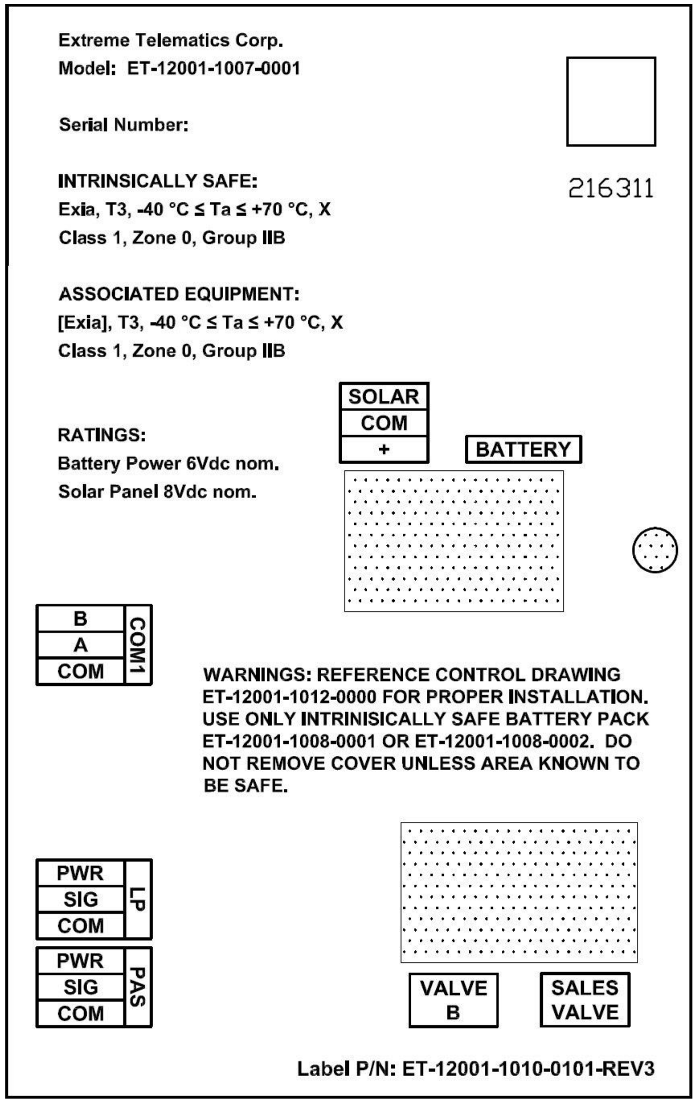

Figure 3 - ALiEn² Physical Connections

The ALiEn² model is limited to a maximum of 2 solenoids and has support for a Plunger Arrival Sensor (PAS), Line Pressure (LP), and Modbus Communications (COM1).

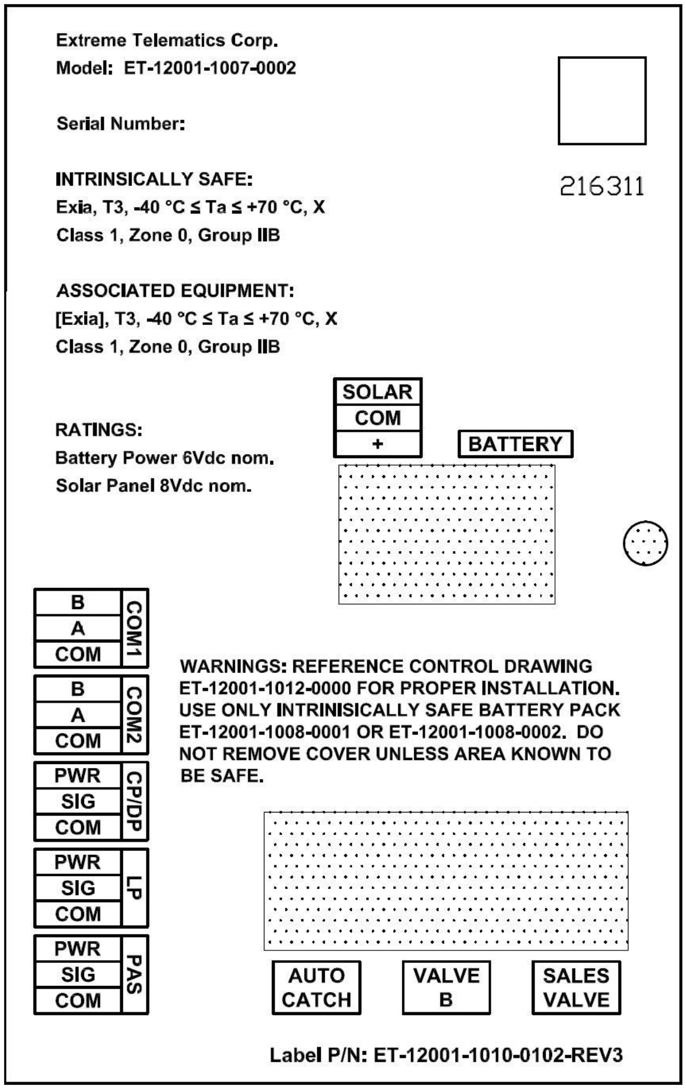

Figure 4 - ALiEn² Expert Physical Connections

The ALiEn² Expert has all of the same features, but includes support for an additional solenoid (AUTO CATCH), Casing Pressure or Differential Pressure (CP/DP) and additional Modbus Communication features (COM2).

The following table outlines all of the available connections for both models of controllers.

Table 1 - Electrical Connections Summary

Location	Devices To Connect	Description
Solar	Solar Panel	Use only an approved 1.1 W Solar Panel

Location	Devices To Connect	Description
Battery	6 V Battery	Use only an approved 6 V intrinsically safe battery.
Sales Valve	Sales Valve Solenoid	Use only an approved intrinsically safe solenoid.
Valve B	Valve B Solenoid	Use only an approved intrinsically safe solenoid.
Auto Catch	Auto Catch Solenoid	Use only an approved intrinsically safe solenoid.
PAS	Plunger Arrival Sensor	Connect signal and ground of a 2 or 3 wire plunger arrival sensor.
LP	Line Pressure Switch/Sensor	Connect a 2 wire switch to COM/SIG or a 3 wire sensor to all three connections to use line pressure features.
CP/DP	Casing Pressure/ Differential Pressure Switch/Sensor	Connect a 2 wire switch to COM/SIG or a 3 wire sensor to all three connections to use EITHER casing pressure OR differential pressure features.
COM 1	Differential RS485 device	Modbus slave connection Upgrade Port
COM 2	Differential RS485 device	Modbus master connection Plunger velocity sensor port

2.4.1 Solar Panel

The solar panel is optional, but will ensure that the battery is topped up and that operation of the controller is not interrupted due to a low battery condition.

1. Install the solar panel in a location where it will face the sun throughout the day.
2. Connect a pair of wires to the terminals on the solar panel.

3. Connect the other end of the pair so that the minus (-) terminal on the solar panel is connected to the SOLAR COM input on the controller. Likewise, the plus (+) terminal on the solar panel must be connected to the SOLAR + input on the controller.

Figure 5 - Solar Panel

Warning: Only approved solar panels can be used with this controller. Panels that operate at higher voltages or current are unsafe and cannot be used. Please refer to section 8.2 Replacement Parts and Accessories for a full list of approved parts.

2.4.2 Battery

Each controller is shipped with the battery disconnected to save the life of the battery and ensure that the product has enough energy to operate before requiring solar charge. Simply plug the pre-installed battery connector into the spot marked BATTERY. The connector is not field replaceable as it requires a special tool.

Warning: Only approved batteries can be used with this controller. Protective components must never be bypassed as it is unsafe to do so. Please refer to section 8.2 Replacement Parts and Accessories for a full list of approved parts.

2.4.3 Solenoids

Each solenoid is supplied with a pre-installed connector. The connector is not field replaceable as it requires a special tool.

Press each solenoid connector into one of Sales Valve, Valve B, or Auto Catch until you hear it click. Every solenoid is the same, so it does not matter which one is plugged into a particular socket.

Warning: Only approved solenoids can be used with this controller. Using any other solenoid or extending the solenoid wires is unsafe. Please refer to section 8.2 Replacement Parts and Accessories for a full list of approved parts.

2.4.4 Plunger Arrival Sensor

The plunger arrival sensor connection has an unregulated power output that will be related to the battery voltage. As such, it cannot be used with any device that requires exactly 5V. It is recommended that Cyclops™ IS is used, but most 2 and 3 wire plunger arrival sensors are supported.

Figure 6 - ETC Cyclops™ IS

If using a 3 wire plunger arrival sensor, connect power, signal and common to the appropriate connections on the terminal block. If using a 2 wire sensor, the power connection is omitted.

2.4.5 Pressure Inputs

Depending on the model, the controller comes with either one (Line) or two (Line and Casing /Differential) pressure inputs. These inputs are physically the same and support either two or three wire devices. Two wire devices only use the COM and SIG inputs, while three wire devices make use of the PWR output as well.

The PWR output will provide a regulated 5 V output that is used to power the attached device. This output is only turned on for a short duration while the sensor is being sampled, so measuring the power is not possible.

When configured as a sensor, the SIG input is expecting to see an input of 0.5 – 4.5 V, which is translated to the appropriate value by the controller.

When configured as a switch, the SIG input is expecting to see an open or closed signal – 0V or 5V approximately.

The pressure inputs can also be configured as a virtual sensor, which requires the pressure value to be written to the controller via Modbus. When sensors are configured as virtual, this is functionally equivalent to being configured as a sensor.

2.4.6 Digital Outputs

The digital output functionality is overlayed on the pressure inputs. To use the digital outputs, simply use the PWR and COM connections of a pressure input block when not in use by another device. The output must be enabled in the outputs menu in the controller and the software will determine when to set the output to 5V or ground.

2.4.7 COM Ports

Each controller is equipped with at least one communications (COM) port. Both COM ports are designed to communicate with Modbus devices.

COM1 is disabled by default, but operates as a Modbus Slave when enabled. When enabled, all of the communication settings for this port are made visible and can be configured by the installer. In general, the communication settings must be configured to match the settings of the Modbus Master. This will allow the master to poll the controller as a slave to retrieve operational data. As well, the master may also write data to the controller to change settings or to change the controller's state.

COM2 functions as a Modbus Master and communicates with downstream devices. It can be used to retrieve pressure or flow readings, communicate with Modbus enabled plunger arrival sensors, or pass data through to a downstream controller.

Please refer to your local regulations to determine if an intrinsic safety barrier is required. This typically is the case if the communications modem is located in a less hazardous area.

2.4.8 Plunger Velocity Sensor

A plunger velocity sensor can be used in place of a plunger arrival sensor with the added feature of having the Surface Velocity available to the controller for safety and optimization purposes. All the features that require a plunger arrival sensor will continue to work with a plunger velocity sensor. Currently, only the Sasquatch™ is supported as a plunger velocity sensor.

The plunger velocity sensor has 2 connections: to the conventional PAS port and to the COM2 port. The PAS port connection reports the arrival to the controller, whereas the COM2 port connection reports the Surface Velocity to the controller. Connect the power, signal and common signals from the velocity sensor to the appropriate connections on the PAS port terminal block. Connect the common and RS485 signals from the velocity sensor to the appropriate connections on the COM2 port terminal block.

A plunger velocity sensor can only be used with the ALiEn^2 Expert model due to the requirement for the COM2 port.

Figure 7 - ETC Sasquatch™ Plunger Velocity Sensor

3 Controller Overview

3.1 Start Up

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

- Load all previously saved values
- Close all valves
- Turn on the display
- Set the display to show the current controller state as the latest device status information.

The controller automatically enters the Close state when powering up and begins counting down.

3.2 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 partitioned into 2 areas with an unused column between them for spacing.

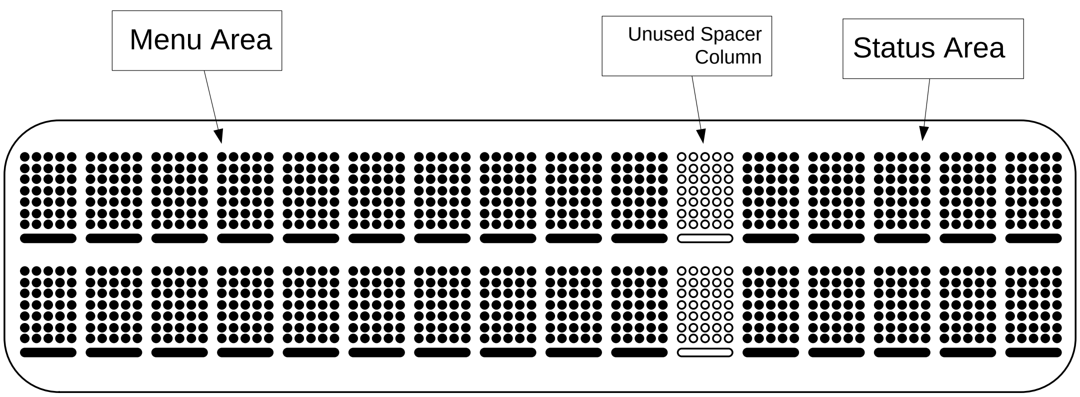

Figure 8 - Screen Layout

3.2.1 Menu Area

The content of the *Menu Area* (2 x 10 characters) shows the current state of the controller on start up. This area will change based on user keypad interaction. The current state information as well as the setup menu is available in this area.

3.2.2 Status Area

The *Status Area* (2 x 5 characters) constantly rotates through all enabled inputs and outputs. By default, this includes the battery voltage as well as the state of The Sales Valve. As other options are enabled on the controller, additional information becomes available in this same

For example, Valve B will be displayed if it has been enabled. If pressure devices such as line pressure and casing pressure are enabled, their current value will also be displayed.

3.2.3 Automatic Shut Off

To conserve power, the display will automatically go to sleep if a key press has not been detected in the previous 30 seconds. This time can be modified by the user.

3.2.4 Automatic Log Out

If security is enabled, the active user will be automatically logged out if a key press has not been detected in the previous 10 minutes. This time can be modified by the user.

3.3 Keypad

An integrated keypad is included which allows the user to change settings, navigate through history, and control the well. Both models utilize the same keypad layout and functionality. The following sections discuss the various keys that are available.

The navigation and numeric keys are overlapped to provide both sets of functionality on fewer keys. The controller automatically knows what function to use based on the current controller display. When in the menus, the arrow keys are used. When editing a numeric screen, the same keys are interpreted as their numerical equivalent.

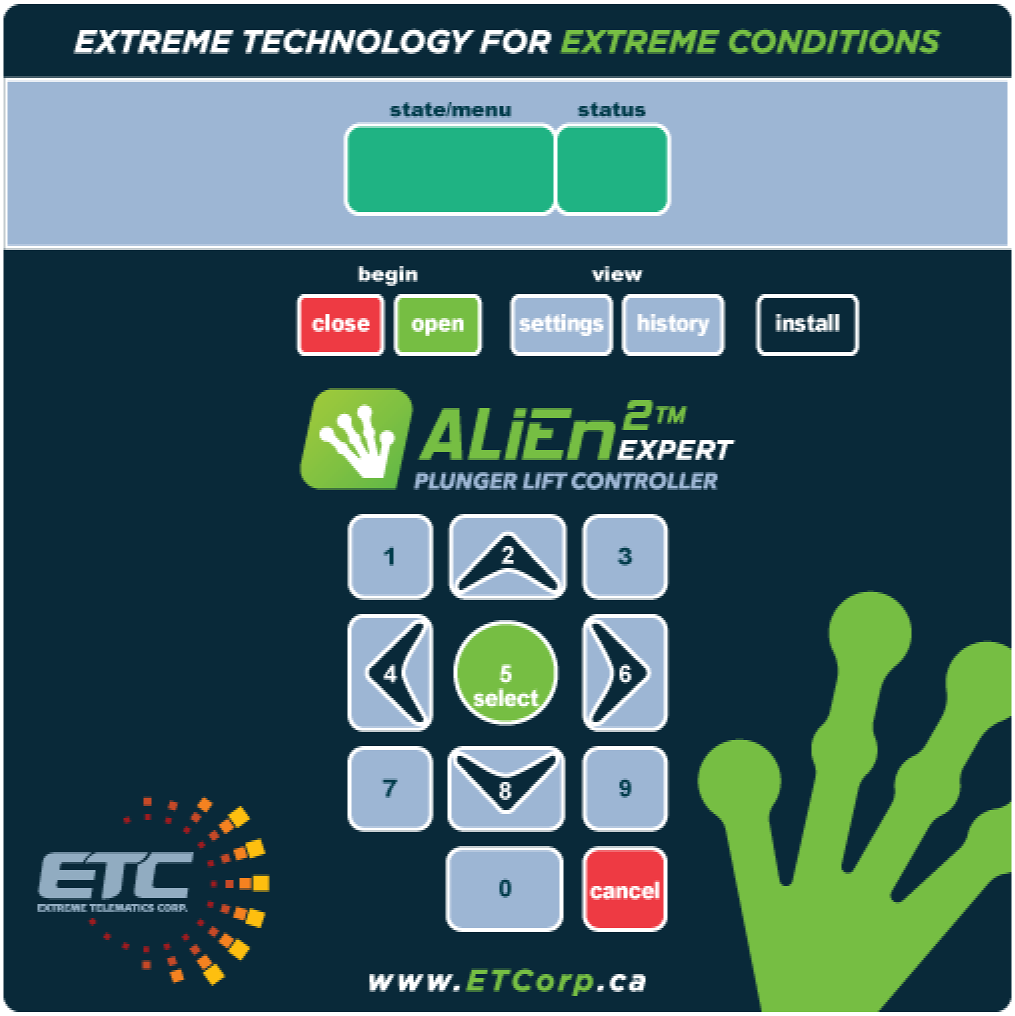

Figure 9 – Keypad Layout

3.3.1 Navigation Keys

The navigation keys are used to move through the menus in the controller and select items from lists.

3.3.1.1 Select

Select is used to enter a sub-menu, select a field to be edited, or save changes made while editing a field.

3.3.1.2 Cancel

Cancel is used to back up through the menu levels or to cancel editing a value.

3.3.1.3 Arrow Keys

The arrow keys allow the user to move up/down and left/rightin the menu. If the display is on a line that has a sub menu associated with it, pressing "Right" will enter the sub menu. Conversely, pressing the "Left" arrow will go back one level of menu depth. If a field can be edited the "Right" arrow will put the controller into edit mode.

If a numeric value is being edited, the arrow keys will act as their numeric value instead.

3.3.2 Numeric Keys

The numeric keys are used to input new values for numeric fields. Examples include entering new times and or setting numeric values such as Fast Trip Count. If a numeric field is not currently being edited, then the number keys are ignored.

3.3.3 Hot Keys

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

3.3.3.1 Close

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

Holding close down for 3 seconds will send the controller to the stop state and will keep the valves held perpetually closed.

3.3.3.2 Open

Pressing *open* 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 Rise, which opens The Sales Valve and waits for a plunger arrival to occur.

Holding open down for 3 seconds will send the controller to the stop state and will keep the valves perpetually in the position they would start Rise. This normally means that the Sales valve is held open perpetually.

3.3.3.3 Settings

The *settings* key navigates to a special menu that contains all of the timers that are used by the controller as well as the set points for pressure devices.

More details can be seen about the settings menu, which is detailed below.

3.3.3.4 History

The *history* key navigates to a special menu that shows information about the recent operation of the well. The available menus include:

- Rise Time – A short summary of the last 25 plunger arrivals
- Cycle Log – More detail about the last 25 plunger cycles
- Daily – Summary of the current day and previous 14 days
- Total – Lifetime summary information
- Plunger – Number of plunger arrivals and distance travelled.
- Device Log – Historical sensor readings.

More details can be seen about the history menu in section 6.1.2 History Menu

3.3.3.5 Install

The *install* key navigates to the install menu. The user may be required to login if that option has been enabled. The default login is 000-0000. Once logged in, a number of sub menus are available.

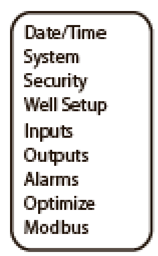

Figure 10 -Install Menu

More details are available in section 6.2 Install Menu.

3.4 Home Screen

As soon as the controller powers on, if the user presses close/open, or if the user presses cancel to back out of the menus, the home screen will appear on the display. By default, this shows the current state of the controller and the time remaining until it switches state. As well, there are a number of screens available at this same level that show more detailed information

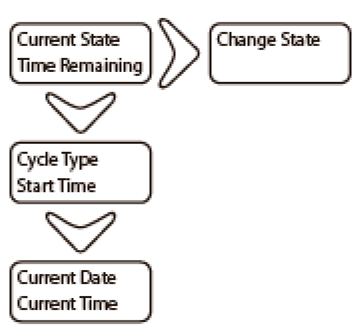

Figure 11 – Home Screen Structure

Scrolling down from the home screen will take you through a number of other screens. Information such as the cycle type, start time, and the current date/time are displayed here. Pressing select or the right arrow will take you to a screen that allows you to force the controller to change states.

3.4.1 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 and a timer that indicates when the state will change.

3.4.2 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.

3.4.3 Current Date/Time

This screen simply shows the current date and time. If this information is incorrect, the user must login and 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.

3.4.4 Change State

The controller can be manually forced into the Afterflow, Rise, or Close states by performing a manual state change. The controller will enter the selected state for a length of time set by the user in this screen.

3.5 Status Screens

When active, the display will automatically update the status area on the right hand side of the display. The information shown is a summary of the current operation of the controller.

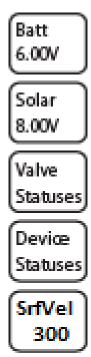

Figure 12 - Status Screens

3.5.1 Battery Status

This screen shows the current battery voltage with the solar charger disconnected so that it does not influence the reading. A battery level indicator is also shown in the top right hand corner to show how full the battery is. If the battery is currently being charged, a lightning bolt is shown instead of the battery indicator.

3.5.2 Solar Status

This shows the current voltage as seen on the solar panel input. The charger is disconnected during this reading so that it in not influenced by the battery/

3.5.3 Valve Status

Each enabled valve is shown on these screens. The screen shows whether the valve is currently open or closed.

3.5.4 Device Status

Each enabled device such as Line Pressure, Casing Pressure, etc… is shown on its own screen. The current value of the last reading is displayed. 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.

3.5.5 Surface Velocity Status

If enabled, the Surface Velocity status screen will display the last reported surface velocity measured by the plunger velocity sensor. The displayed value will only get updated when a plunger arrival occurs.

4 Controller Operation

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.

The ALiEn^2/ALiEn^2 Expert Modbus Communications User's Guide discusses everything from physical connection to data format and access. As such, the Modbus communications interface will not be discussed further in this manual.

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.

4.1 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 V, 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 V, 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.

4.1.1 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 go into the 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.

4.2 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.

4.2.1 Stopping the Controller

If you wish to stop the controller and hold the valves in a specific configuration for maintenance, during installation, or at any other time, pressing and holding either the Open or Close button for 3 consecutive seconds will send the controller to stop.

While stopped, the controller will count up to show how long the controller has been stopped for. Whenever stopped, only a single valve will be held open or closed. If another configuration is required, each enabled valve can be toggled in the Install>Outputs menu.

When you are ready to go back to normal operation, press the close button. This will ensure that all valves are closed and the controller returns to normal operation. As the controller operates, valves will be opened or closed as needed.

NOTE: If you press open or manually change state, valves that had their state changed manually may not be in the right position since a valve is expected to be in a certain position when Rise or Afterflow starts.

4.2.1.1 Stop Hold Closed

When entering the Stop Hold Closed state, all valves will be held in the closed position perpetually.

4.2.1.2 Stop Hold Open

When entering the Stop Hold Open state, the valve that is configured to open at the start of Rise will be held open perpetually. In most configurations, this will be the Sales Valve. If the controller is configured to operate Valve B in a line configuration, it will be held open instead.

If the Auto Catch is enabled, it will be engaged and held along with the Sales Valve.

4.2.2 Intermitting

The controller is designed to act as a well intermitter in the most basic configuration. In this case, a plunger is not present in the well.

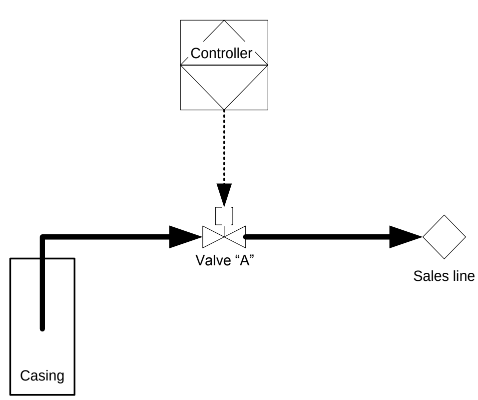

Figure 13 - Well Intermitting

In this configuration, Valve A is opened and closed based on a simple timer setup. The *Close Time* and *Afterflow Time* 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.

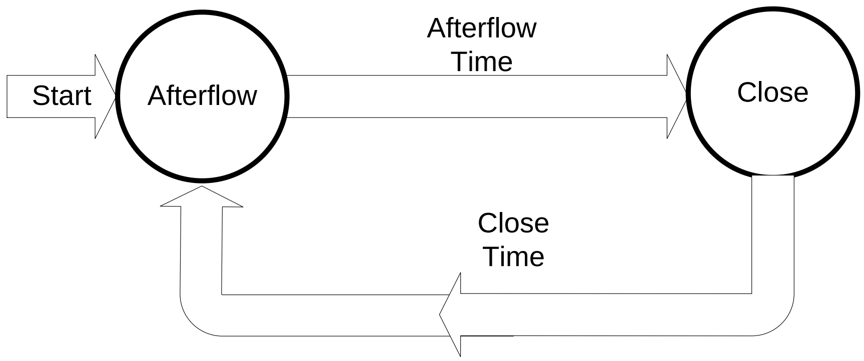

Figure 14 - Basic Controller States

4.2.3 Plunger Arrival Sensor (PAS)

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

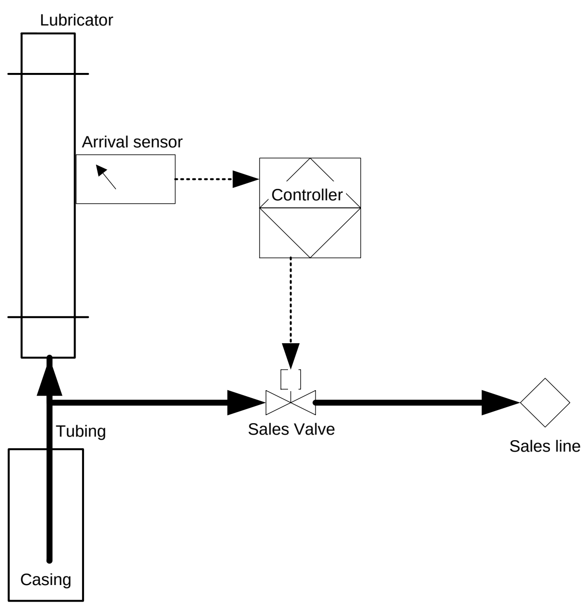

Figure 15 – Plunger Arrival Sensor Operation

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 a *Plunger Arrival Sensor*. The *Arrival Sensor* acts as a switch, closing its contacts as the plunger arrives.

When the valve is closed, the plunger falls to the bottom of the well tubing. After the expiry of the *Close Time*, the Sales Valve is opened, and the pressure in the gas formation drives the plunger and any accumulated fluids to the top of the well tubing. As the plunger arrives, the controller transitions to Afterflow. On expiry of the *Afterflow Time*, the Sales Valve is closed and the cycle repeats.

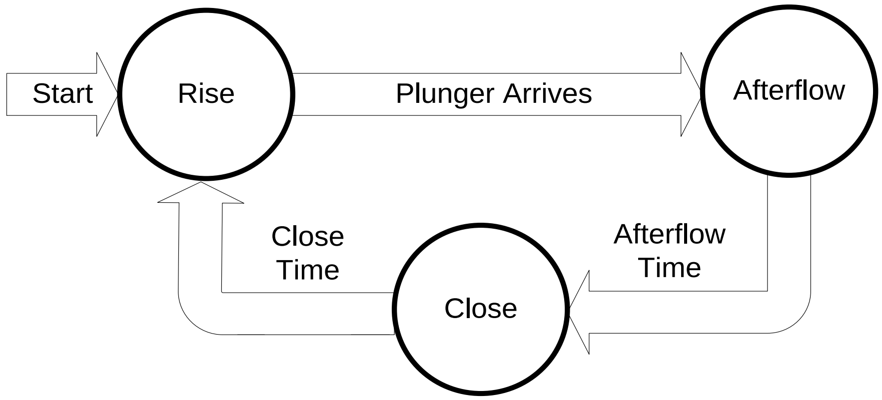

Figure 16 - Controller Operation with Plunger Arrival Sensor (PAS)

4.2.3.1 Non-Arrival

If the plunger fails to arrive within the *Rise Time*, a non-arrival cycle is recorded. In this case, The Sales Valve is closed for an extended amount of time (*Non-Arrival Close Time*). After a pre-determined number of *Non-Arrivals,* defined in the Alarms menu, the controller will move to the Stopped state and wait for operator intervention.

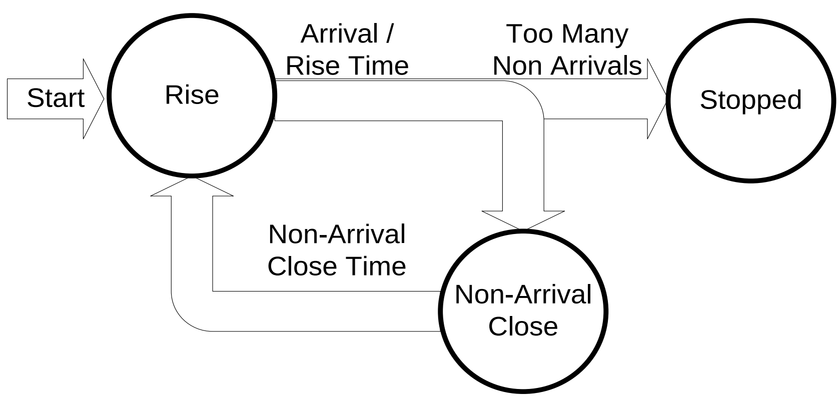

Figure 17 - Non-Arrival

4.2.3.2 Fast-Trip

A Fast-Trip cycle is when the plunger's velocity, average or surface, exceeds the Fast-Trip Velocity setting. 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 wait for operator intervention to protect the well.

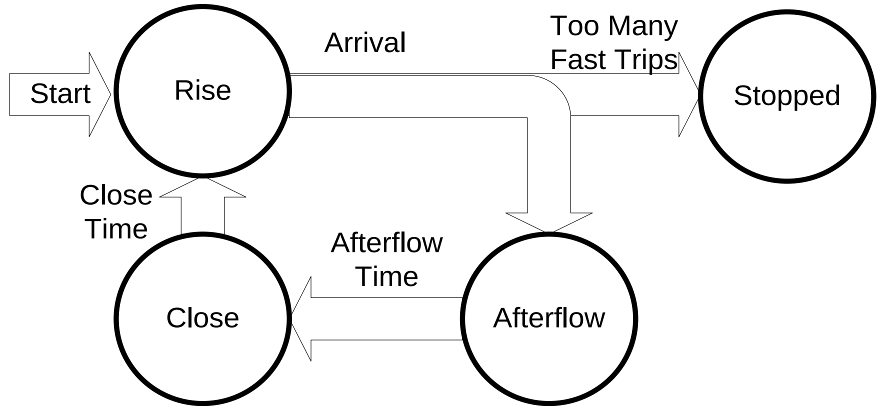

Figure 18 - Fast Trip

4.2.3.3 Danger Trip

A Danger Trip cycle is when the plunger's velocity, average or surface, exceeds the Danger Velocity setting. 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. Danger Velocity differs from Fast-Trip Velocity in that one impact from a plunger traveling in excess of the Danger Velocity would cause significant damage to the lubricator and springs. When a dangerous trip occurs, the controller proceeds immediately to the Stopped state and waits for operator intervention to protect the well.

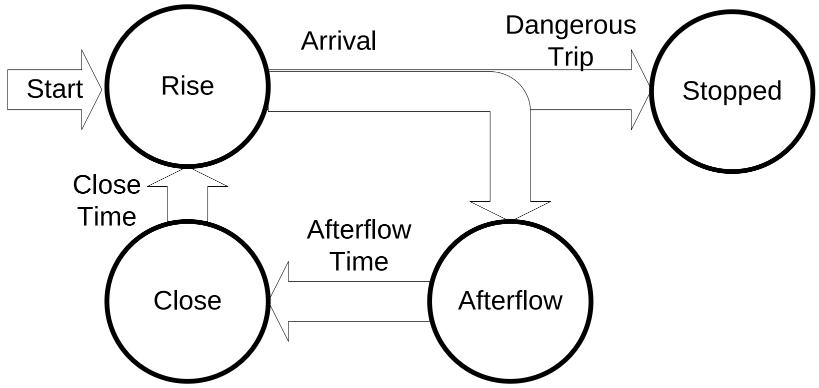

Figure 19 - Dangerous Trip

4.2.3.4 PAS Delay

Some manufacturers of plunger arrival sensors will close their switch contacts on power up. Setting a *PAS Delay Time* allows the controller to ignore this glitch.

This may also be used when the *Close Time* is short when using a continuous or free cycle plunger. This allows time for the plunger to leave the lubricator and the movement of the internal parts to settle before looking at the plunger arrival sensor output.

4.2.4 Valve B

The well may also be equipped with a second valve (Valve B). This valve may be installed in one of 5 configurations. These configurations are illustrated and described below.

4.2.4.1 Top Valve

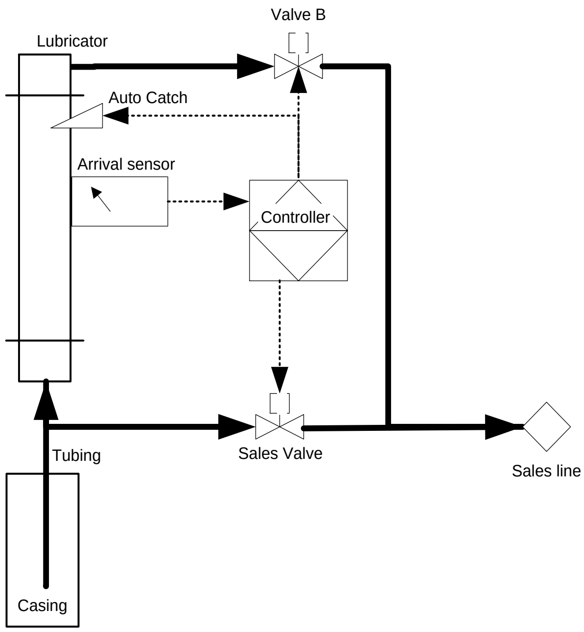

Figure 20 - Top Valve Well Configuration

The *Valve B Type* must be set to line and the *Afterflow Valve Configuration* must be set to Sales in order to operate the controller in a Top Valve configuration.

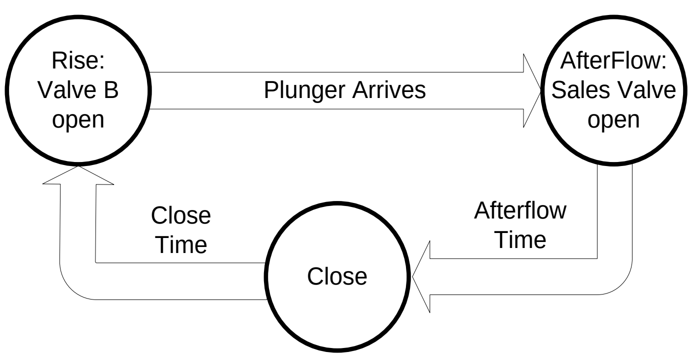

Figure 21 - Top Valve Operation

During the Rise portion of the cycle, Valve B is open and The Sales Valve 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 after the plunger arrival, The Sales

Valve is opened and Valve B is closed. The location of The Sales Valve 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 auto catch which is driven from the Valve B gas supply line.

4.2.4.2 Flow Tee

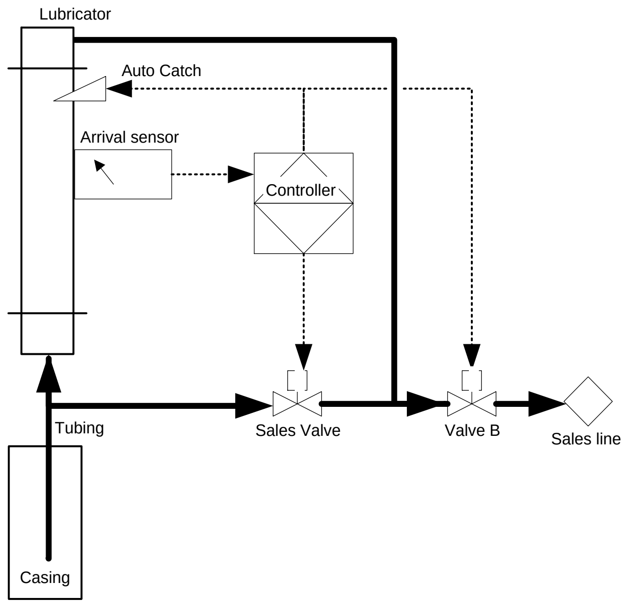

Figure 22 - Flow Tee Well Configuration

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.

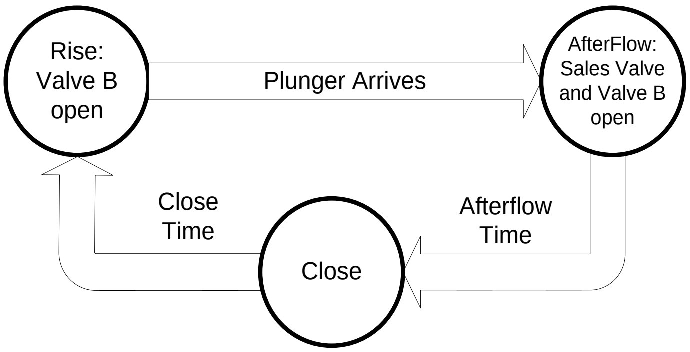

Figure 23 - Flow Tee Operation

To achieve this configuration, the *Valve B Type* must be set to line and the *Afterflow Valve Configuration* must be set to Sales/B.

4.2.4.3 Tank Valve

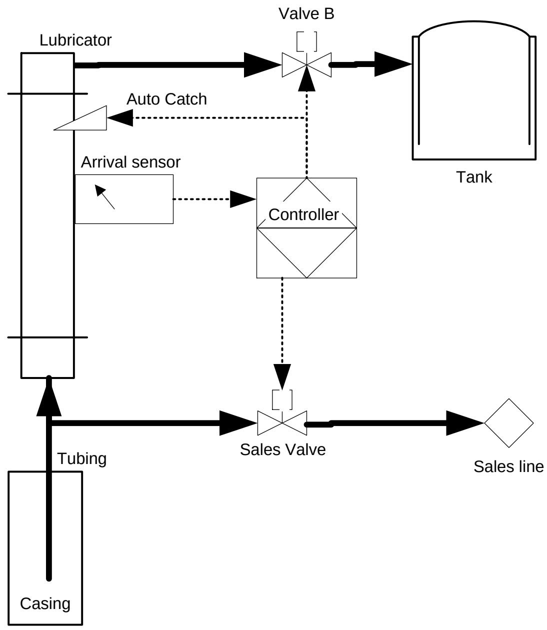

Figure 24 - Tank Valve Well Configuration

The purpose of the tank is to help the plunger to surface by exerting less back pressure on the well tubing than that exerted from the sales Line.

If Valve B is configured as Tank, The Sales Valve is opened at the start of the Rise portion of the cycle. If the plunger does not arrive within a specified time, Valve B is opened. By default, the Sales Valve is closed at this time, but can be configured to be left open. Once the plunger arrives, we move to Afterflow.

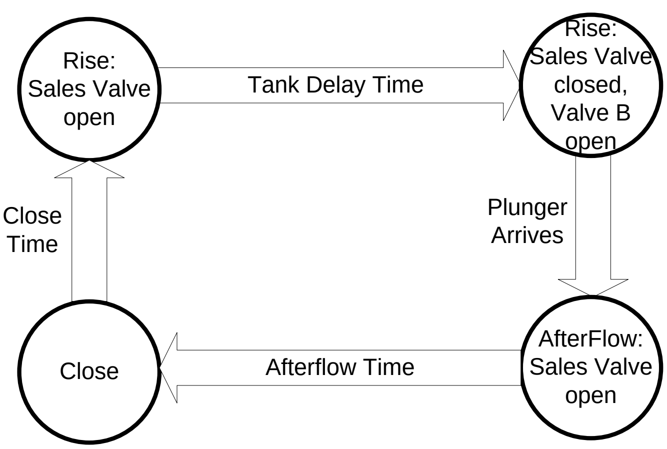

Figure 25 – Normal Tank Valve Operation

Alternatively, the system can be configured such that if the well is vented (Valve B opened), we skip Afterflow and go directly to Close once the plunger arrives. This essentially forces another trip to remove the fluids that rushed into the well bore while venting.

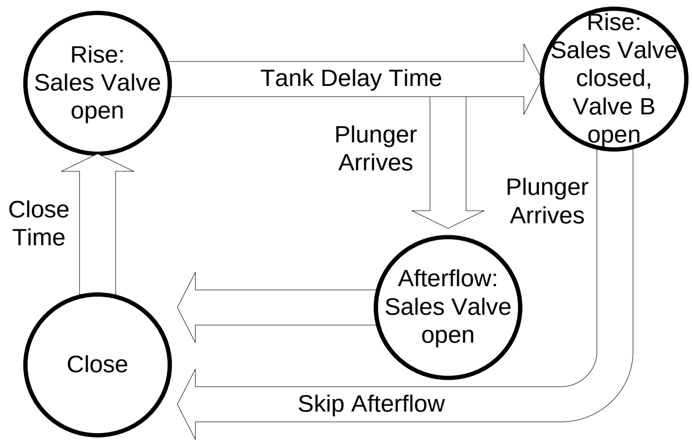

Figure 26 – Valve B Go to Close after Vent

4.2.4.4 Flow Control Valve

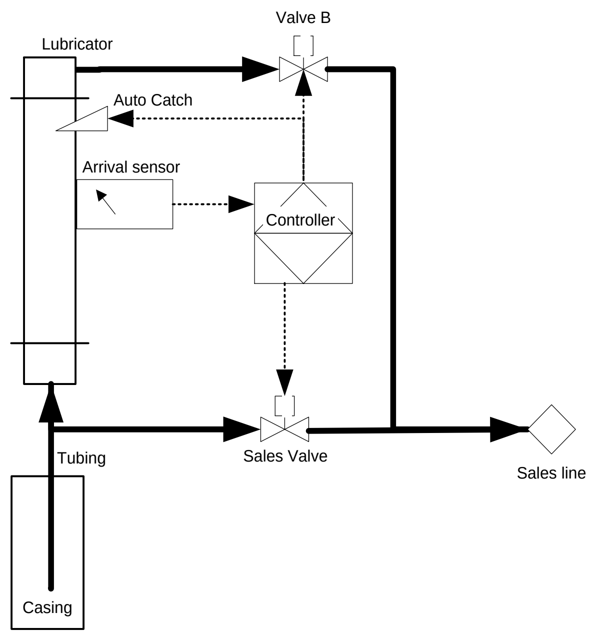

Figure 27 – Flow Control Valve Well Configuration

This mode of operation allows the well to flow through 2 ports of the lubricator during the Rise portion of the cycle. Once the plunger has arrived, Valve B is closed and the well continues to flow through the sales valve.

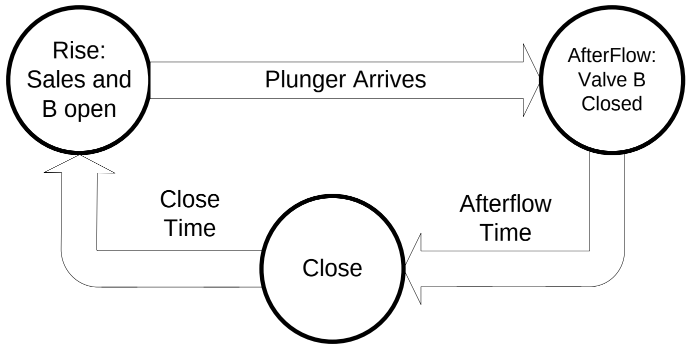

Figure 28 – Flow Control Valve Operation

4.2.4.5 Purge Valve

The purge valve option allows the well to be purged through Valve B just prior to the opening of the Sales Valve and the start of Rise. A configurable Purge Time sets how long before the start of Rise that Valve B is opened.

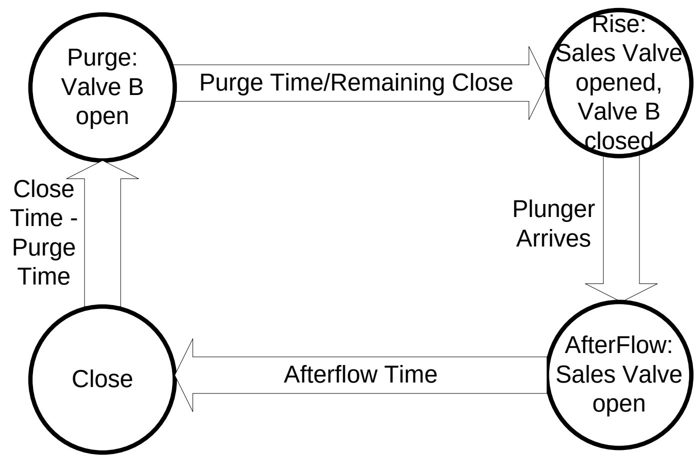

Figure 29 - Purge Valve Operation

4.2.5 Auto Catcher

The lubricator may be fitted with an auto catcher that allows the plunger to be held at surface during the Afterflow portion of the cycle. The auto catcher can be engaged either at the start of Rise or once the plunger arrival is detected to prevent the damage caused by repeated impacts from the plunger. Also, the auto catcher may be released sometime after the well is closed by setting the Auto Catcher Hold Time.

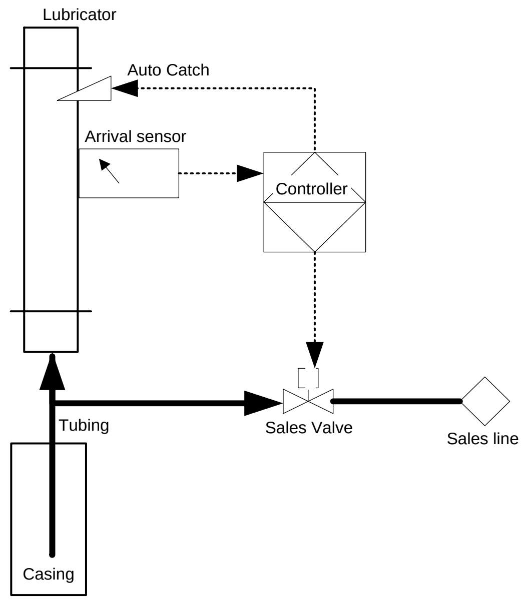

Figure 30 – Auto Catcher Configuration

4.2.6 Line Pressure

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

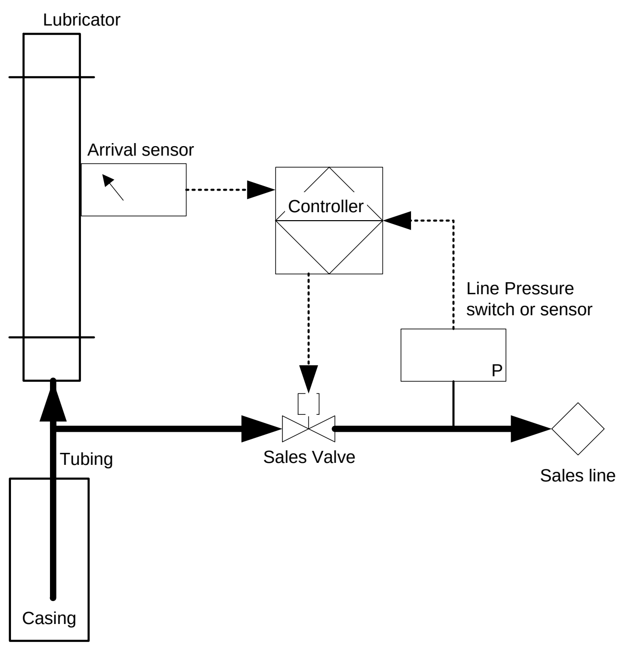

Figure 31 - Using Line Pressure

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

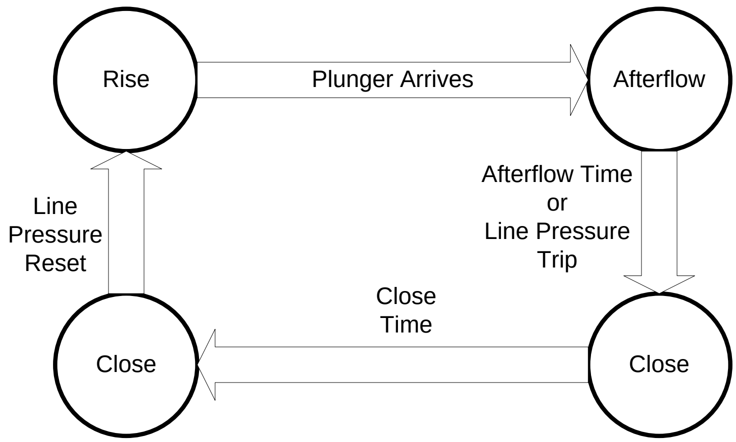

Figure 32 - Line Pressure Cycle

4.2.7 Velocity Optimization

The goal of velocity based optimization is to get the plunger to arrive at a Target Average or Surface Velocity. Adjustments are made to either the *Afterflow Time* or *Close Time* on each arrival at the plunger. The algorithm is proportional meaning that a small miss will result in a small change or no change at all, while a large miss will result in a much larger change.

4.2.7.1 Principle of Operation

There are two input sources for optimizing:

- Average Velocity: The average plunger velocity, calculated from the time it takes the plunger to come to the surface, is compared to the Target Rise Velocity and used to calculate an adjustment.
- Surface Velocity: The velocity at the wellhead, measured using a velocity sensor, is compared to the Target Velocity and used to calculate an adjustment.

When using Surface Velocity optimization, it is possible for the velocity sensor to fail to measure a velocity and report an error code. If this occurs, the algorithm will fall back on optimizing using Average Velocity for the current cycle.

The aggressiveness of the algorithm can be controlled by changing the Scale Factor. There are two different algorithms that allow the operator to select what Timer settings the adjustments are based on, either the difference between the minimum and maximum Timer settings or the current Timer settings.

Whether the plunger arrives faster or slower than the Target Rise Velocity, they are treated in the same manner and the same calculation is used.

4.2.7.2 Optimization Types

The following sections outline the different optimization types that make use of the above Velocity Optimization.

4.2.7.2.1 Afterflow Optimization

The goal of Afterflow Optimization is to fix the *Close Time* and automatically find a stable *Afterflow Time* that ensures the plunger travels fast enough to bring up the fluids yet travels at a safe speed.

The *Afterflow Time* increases or decreases to vary the time the plunger is held at surface, thus varying the amount of accumulated liquids between plunger cycles.

When using Afterflow Optimization, the well will shut-in earlier when the measured velocity is less than the target. It will flow longer when measured velocity is greater than the target velocity.

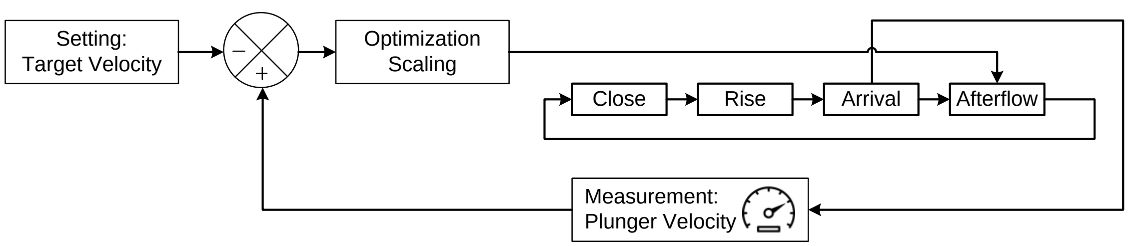

Figure 33 – Afterflow Optimization Using Velocity

4.2.7.2.2 Close Optimization

The goal of Close Optimization is to fix the *Afterflow Time* and automatically find a stable *Close Time* that ensures the plunger travels fast enough to bring up the fluids yet travels at a safe speed.

The *Close Time* increases or decreases to vary the time the plunger is left at bottom, thus varying the amount of accumulated liquids between plunger cycles.

When using Close Optimization and the measured velocity is greater than the target velocity, time is subtracted from *Close Time*. When the measured velocity is less, time is added to the *Close Time*.

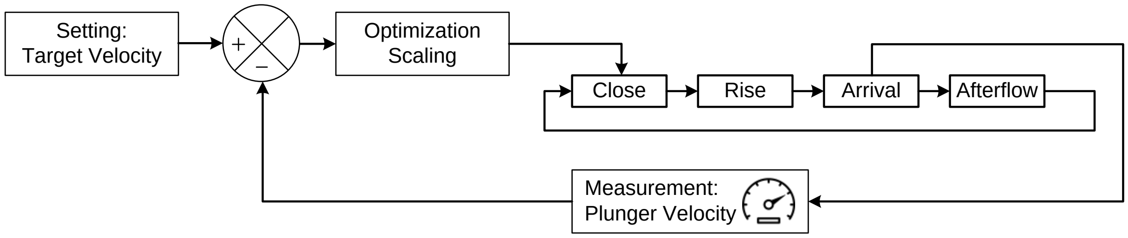

Figure 34 – Close Optimization Using Velocity

4.2.7.2.3 Close Then Afterflow Optimization

This optimization scheme works the same as the previous two sections, but the algorithm first adjusts the *Close Time.* The goal is to minimize the *Close Time* and then maximize the *Afterflow Time*.

For Average Velocity optimization, each fast arrival of the plunger results in a reduction of the *Close Time*. When the *Close Time* reaches the minimum, the *Afterflow Time* is increased until it reaches the maximum. If the plunger arrives at a slower velocity, we first reduce Afterflow Optimization the *Afterflow Time*. If the *Afterflow Time* is at the minimum, we add to the *Close Time* until it reaches the maximum.

4.2.7.3 Optimization Scaling

4.2.7.3.1 Current Time Optimization

This optimization is selected by default. Current Time Optimization uses the current timer value to scale the adjustments. It does not use the minimum and maximum parameters except as boundaries, meaning they can be set to appropriate long term values and will not need to be changed regularly.

In this case, the magnitude of the change is dictated by the current *Afterflow Time* or *Close Time*, meaning that the operator does not have to be as concerned that large changes will be made to a time that is currently very small. For this reason, the default Scale Factor is 10% and is allowed to be set up to a maximum of 100%.

When using Velocity optimization, the following formula is used:

$$\Delta Afterflow = \frac{\Delta Velocity}{TargetVelocity} \times ScaleFactor_{AF} \times Afterflow$$

The same formula is used for close, but the Close Scale Factor and *Close Time* are used instead.

The difference between the measured Velocity and the Target Velocity sets the magnitude of the response.

If the current time is short, then small changes will be made. If the current time is longer, then larger changes will be made.

NOTE: If the initial time or minimum time is very small (less than 1 minute) or the Scale Factor is set to 0%, the calculation will result in a very small or zero result, leading to no change, regardless of when the plunger arrives.

A fast plunger velocity will result in a reduction of the *Close Time*. When the *Close Time* reaches the minimum, the *Afterflow Time* is increased until it reaches maximum. If the plunger arrives with a slow velocity, the *Afterflow Time* is reduced first. If the *Afterflow Time* is at the minimum, the *Close Time* is increased until it reaches the maximum.

4.2.7.3.2 Max – Min Optimization

Max-Min Optimization uses the difference between the minimum and maximum parameters to determine the size of the changes that will be applied. The drawback to this algorithm is that if the difference between the minimum and maximum is large, the changes can be quite large. To protect against very large changes, the default Scale Factor is set to 1% and is limited to a maximum of 15%. The minimum and maximum parameters may need to be modified as well conditions change to ensure that the changes are not too large.

When using Velocity optimization, the following formula is used to calculate the change to Afterflow Time:

$$\Delta Afterflow = \frac{\Delta Velocity}{Target\,Velocity} \times ScaleFactor_{AF} \times [Max_{AF} - Min_{AF}]$$

The same formula is used for *Close Time*, but the Close Scale Factor, Minimum Close Time and Maximum Close Time are used instead.

The larger the difference between the Actual and Target Velocity, the larger the response will be. The Scale Factor reduces the magnitude of the change. Finally, the result is multiplied by the difference in the maximum and minimum times.

4.2.8 Pressure Based Optimization

Pressure based optimization is available on some models of controller. Additional devices may be added and used on their own or in conjunction with line pressure to help optimize the production of the well. The following diagram shows an overview of the devices that may be attached.

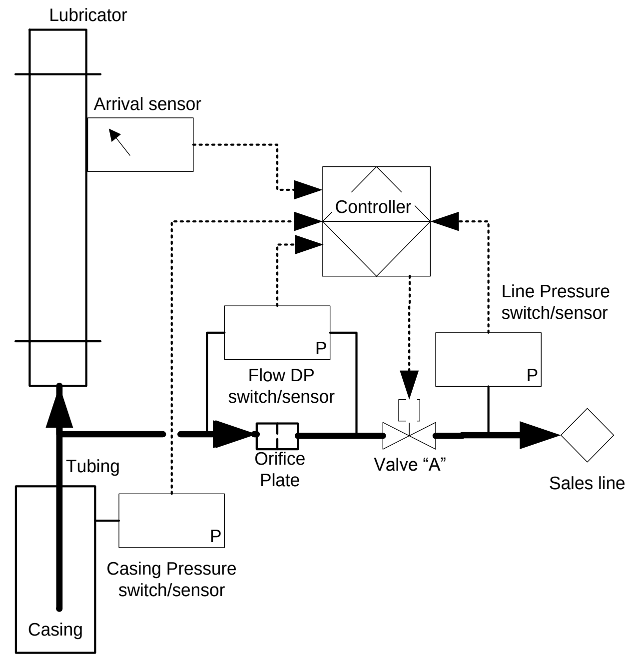

Figure 35 - Pressure Based Optimization

Several different optimization techniques can be used depending on the device or devices that are attached. Some devices are checked prior to leaving the close portion of the cycle. Others are used to extend the Afterflow time beyond the minimum.

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

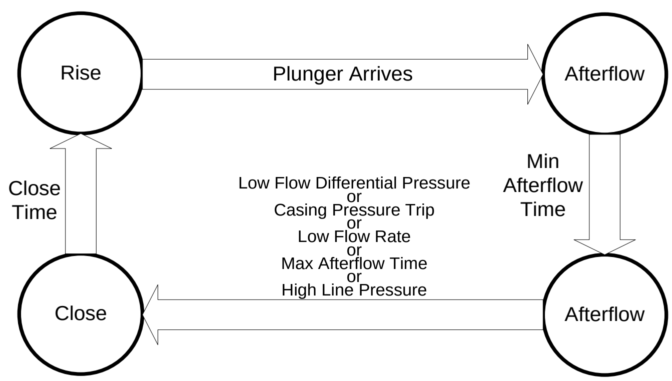

Figure 36 - Extended Afterflow Optimization

In order to use pressure based optimization, the relevant sensor needs to be configured in either the switch, sensor or virtual sensor setting.

The following sections describe what can be accomplished with each device or combination of devices.

4.2.8.1 Tubing Pressure

Tubing pressure can be enabled in place of Line Pressure. Currently, Tubing Pressure is only available at the end of the Close portion of the cycle.

4.2.8.1.1 Open Tubing Pressure

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

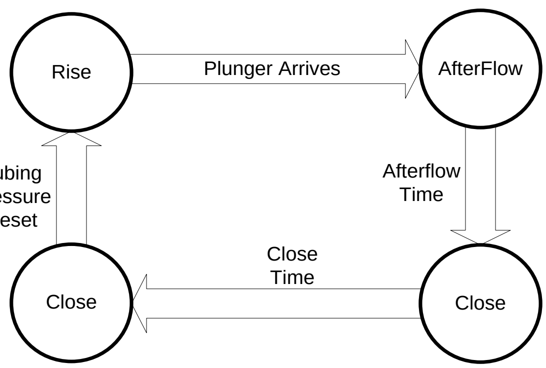

Figure 37 - Tubing Pressure Close Cycle

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

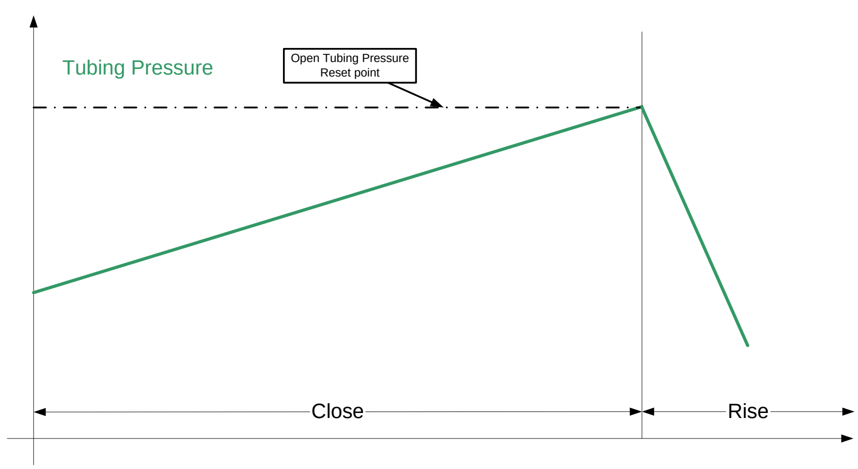

Figure 38 - Open Tubing Pressure Reset Point

4.2.8.2 Casing Pressure

Casing pressure can be used to prevent the well from opening (entering the Rise portion of the cycle) or can be used to close the well from Afterflow. If enabled as a sensor or virtual sensor with a line pressure sensor, casing line differential pressure is monitored at the end of Close instead. This is discussed in a later section.

4.2.8.2.1 Open Casing Pressure

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

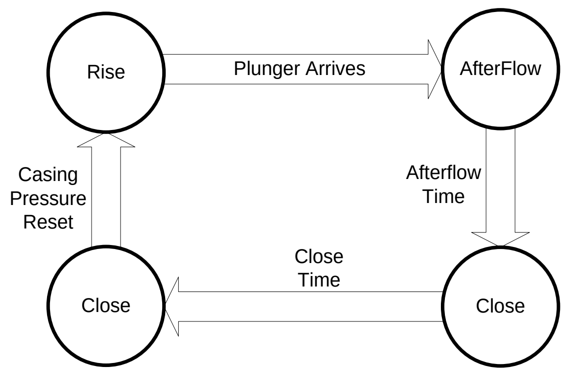

Figure 39 - Casing Pressure Close Cycle

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 or virtual sensor, then the sensor value must exceed the *Open Casing Pressure Reset Point* and stay there for at least the *Open Casing Pressure Stable Time*.

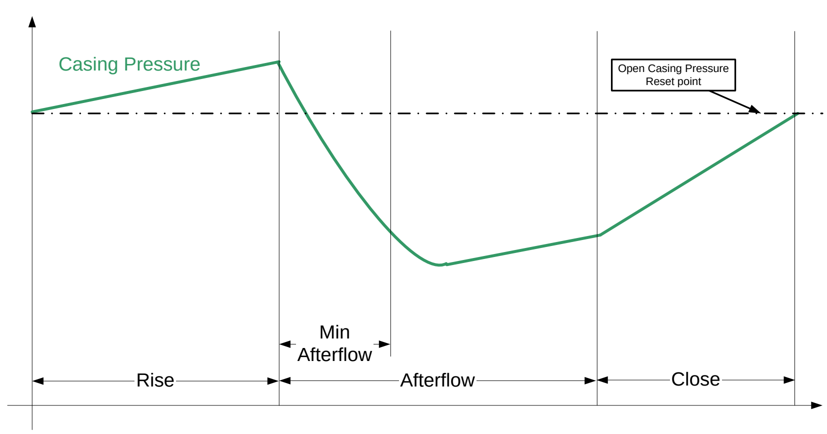

Figure 40 - Open Casing Pressure Reset Point

4.2.8.2.2 Close Casing Pressure

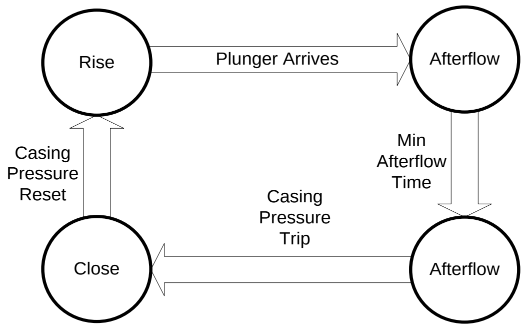

Figure 41 - Afterflow Casing Pressure

During the Afterflow portion of the cycle, the Casing Pressure is monitored one of three different ways if the *Casing Pressure Device Type* has been configured as a sensor or virtual 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 portion of Afterflow. A trip during this time 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.

4.2.8.2.2.1 Absolute

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

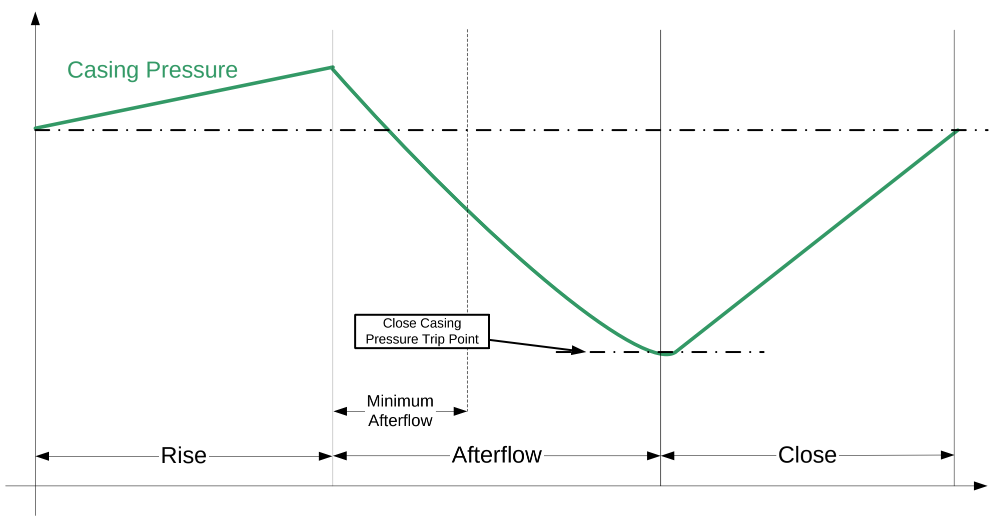

Figure 42 - Casing Pressure Absolute Method

4.2.8.2.2.2 Rate Drop

The Rate Drop method monitors the change in the Casing Pressure over time. As the rate of change slows and becomes lower than the *Casing Pressure Rate Threshold*, the *Trip Delay Time* is started. When this timer expires the well will be shut-in. This timer is adjusted similar to the Velocity Optimization algorithms described earlier. This mode is currently not available in conjunction with casing pressure configured as a virtual senor.

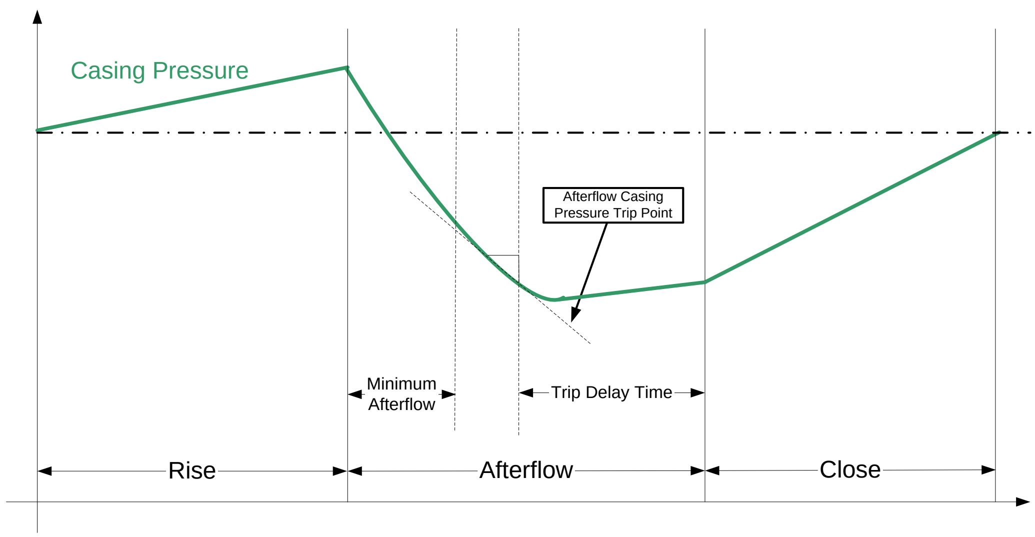

Figure 43 - Casing Pressure Rate Drop Method

All the previously described optimization options are available: Average Velocity/Surface Velocity, Current Time/Min-Max. The control drawing for CP Rate optimization is show below:

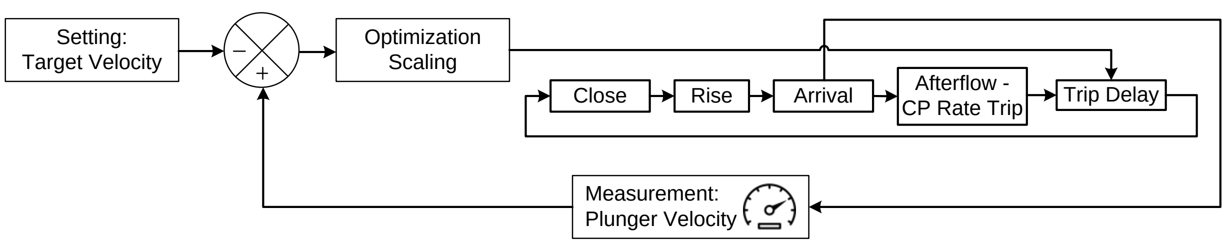

Figure 44 – Casing Pressure Rate Drop Optimization Using Velocity

4.2.8.3 *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 *Open Casing Line Differential Pressure Reset Point*. Once the differential exceeds the reset point and stays above it for at least the *Open 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.

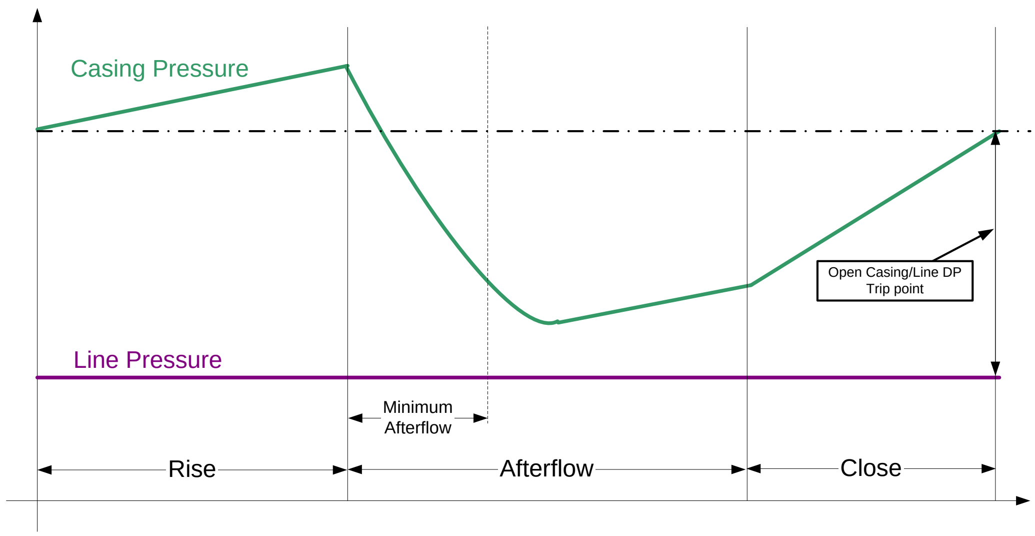

Figure 45 - Open Casing Line Differential Trip

4.2.8.4 *Differential Pressure*

The *Differential Pressure Device Type* can be configured as either a switch, sensor or virtual sensor. When it is configured as a switch, it will automatically drop out of 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 *Differential Pressure Device Type* is enabled as sensor or virtual, the controller will behave in the same manner. The difference is that the *Flow Differential Pressure Trip Point* and *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 Differential Pressure Sensor, then a flow rate can be estimated. Please refer to the Flow Rate section below.

4.2.8.5 *Flow Rate*

There are several ways to obtain a Flow Rate for optimization. They are discussed in detail in the sections below.

When the Flow Rate is available, the *Afterflow Time* of the controller is optimized. If the Flow Rate is a numerical value, 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.

4.2.8.5.1 Calculated

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 entered in the Inputs menu. 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.

4.2.8.5.2 Switch

The *Flow Rate Device Type* can also be configured as a switch. This allows the well to be shut in when the switch trips. Since there is no value associated with the Flow Rate, production numbers will not be provided.

4.2.8.5.3 Virtual

This configuration for Flow Rate allows the well to be optimized based on a Flow Rate from another system. This mode of operation requires a Flow Rate to be written to a Modbus register. This incoming value is then compared against the *Flow Rate Trip Point* to determine when to shut-in the well. Since a value is available for Flow Rate, the production numbers are calculated and displayed in the daily logs.

4.2.8.5.4 Sensor

The *Flow Rate Device Type* can also be set to sensor which uses an analog input. This input value is scaled to provide a flow value. This option is currently available, but has not been tailored to match any specific flow sensor at this point. Development would be required to fully implement this solution.

4.3 Digital Outputs

The controller is equipped with 1 or 2 digital outputs based on the model that is being used. There are a number of different functions that can be achieved depending on how the outputs are configured. The following sections show some of the common configurations.

4.3.1 Mimic Valve

The digital outputs can mimic any valve that is enabled on the controller. If there is a valve, such as an auto catch that you would like to mimic that is not available; first ensure that the auto catch is enabled.

4.3.1.1 Level

By default, the output is turned ON (5 V) when a given valve is opened. The output is turned OFF (0 V) as soon as the valve is closed. This is useful when connecting to a relay. The relay is energized when the valve is open, allowing devices such as en electric valve to be powered. When the valve is closed, the power to the relay is removed, cutting power to the electric valve.

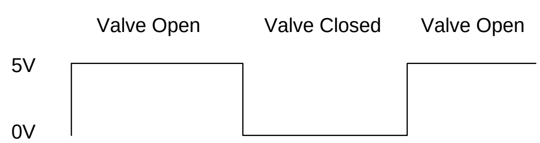

Figure 46 - Level Based Valve Output

4.3.1.2 Pulse

Alternatively, the output can be set to pulse. In this instance, we can set the output to pulse on open or pulse on close. When the desired valve operation occurs, the output is turned ON (5 V) for a specified amount of time (in milliseconds). After this time has lapsed, the output is turned OFF (0V).

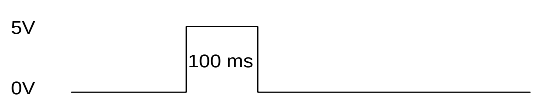

Figure 47 - Pulse to Open or Close Valve Output

This is useful for communicating with interfaces that require a short duration pulse instead of level that is held until the valve state changes. One example is the Kimray Electro Hydraulic Valve. This valve requires 2 signals, one which pulses when the valve is expected to open and another that is expected to pulse when the valve is closed.

4.3.2 On Alarm

This feature is used to communicate with other systems when the controller has gone into an alarm state. If the controller stops operating because it has a low battery or another alarm condition has caused the internal state machine to shut the well in, the output will be turned ON

(5 V). When the alarm condition is cleared and normal operation resumes, the output will be turned OFF (0 V).

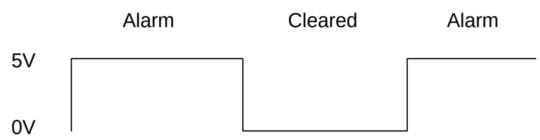

Figure 48 - Level Based Alarm Output

5 Modbus Communications

Each controller is equipped with at least one RS-485 port. COM 1 is designed primarily to provide communications to a SCADA system and acts as a Modbus Slave. This port provides access to most of the functions and parameters that are available from the front panel user interface. The ALiEn²/ALiEn² Expert Modbus Communications User's Guide discusses the physical connections, communications settings, and the available registers.

6 Menu Reference

6.1 Hot Key Menus

The following menus are available to the operator without logging in. Simply press the corresponding hot key to access the menus.

6.1.1 Settings Menu

The *settings* hot key navigates to a special menu that contains all of the timers that are used by the controller as well as the set points for pressure devices. The timers control how long the controller leaves the well open, waits for an arrival, closes the well in, and more. These settings give the installer/operator control over how the well behaves. The following is a list of the timers and settings that are available in this menu:

Table 2 - Settings Screens

Screen	**Description**	**Default Value**
Close Time	This determines the duration of the Close portion of the cycle.	0h18m11s
Non-Arrival Close Time	This determines the duration of the Close portion of the cycle following a non-arrival. Not used if the *Arrival Sensor* is disabled.	0h36m22s

Screen	Description	Default Value
Rise Time	This time is used to indicate that the plunger is not likely to arrive at the surface unless special action is taken. If this time expires before the plunger arrives, the controller will bypass the Afterflow portion of the cycle and close the valves for the Non-Arival Close Time, or possibly shutdown the well. The intent is to allow extra pressure to build in order to lift the plunger on the next cycle. The Rise Time may not be set to zero. If the *Arrival Sensor* is disabled, this defines the time spent in the Rise portion of the cycle. That is, the controller will advance to Afterflow when this time expires.	0h6m40s
Fast Trip Time	This time is used to indicate that the Plunger did not likely fall to the bottom of the well. The well will be shut-in if a number of consecutive fast trips have occurred. Not used if the *Arrival Sensor* is disabled.	0h03m10s
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 or Close Time* in order to try and cause the plunger to arrive at this time. Not used if the *Plunger Arrival Sensor* or Timer Based Optimization is disabled.	0h04m00s

Screen	Description	Default Value
Afterflow Time	The Afterflow portion of the cycle is terminated when this time expires. When "extended-afterflow"[2] devices are enabled, the controller will extend the Afterflow time instead of advancing to Close if none of the devices have already tripped.	1h00m00s
Line Pressure Trip Point	When the *Line Pressure Device Type* is *Sensor*, defines the pressure, above which, the well will be shut-in.	90.0 psi
Open Tubing Pressure Trip Point	When the *Tubing Pressure Device Type* is *Sensor*, defines the pressure, below which, the well will stay closed.	90.0 psi
Open Casing Pressure Trip Point	When the *Casing Pressure Device Type* is *Sensor*, and the *Line Pressure Device Type* is not Sensor, defines the casing pressure, below which, the well will stay shut-in.	90.0 psi
Open Casing Line Differential 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.	50.0 psi
Close Casing Pressure Rate Threshold	When the *Casing Pressure Device Type* is *Sensor*, defines the rate at which the casing pressure is falling that causes an event. It is used for Casing Pressure Rate of Change optimization and is the point at which the Trip Delay Timer is started, after which the well is shut. This screen is only visible if the *Close Casing Pressure Type* is set as *Rate Drop*.	1.0 psi/min

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

Screen	Description	Default Value
Close Casing Pressure Trip Point	When the *Casing Pressure Device Type* is *Sensor*, this defines the pressure above which the well will stay flowing. This screen is only visible if the *Casing Pressure Device Type* is set as *Absolute*.	150.0 psi
Close Differential Pressure Trip Point	When the *Differential Pressure Device Type* is *Sensor*, this defines the differential pressure which will cause a trip condition to be reset.	20.0 “WC
Flow Rate Trip Point	When the *Differential Pressure and Line Pressure Device Types* are both *Sensor OR Flow is Sensor/Virtual*, this defines the rate above which the well will stay flowing.	18.0 e3m3/d

6.1.2 History Menu

6.1.2.1 Rise Time Log

The rise time log is a shortened version of the cycle log. It's primary purpose is to provide a quick reference to the most recent rise times for the last 25 cycles.

The following information is saved for each cycle:

Table 3 – Rise Time Log Screens

Screen	Description
Cycle Type and Rise Duration	This screen shows the type of cycle that occurred as well as the Rise Time of the plunger. The cycle type will be one of: Waiting Normal Fast-trip Non-Arrival Maximum Afterflow

	Line Pressure Shut-In Low Battery Shutdown Operator Change Startup
Reset Log?	This clears all of the cycle log data.

6.1.2.2 Cycle Log

The cycle log is a history of each cycle that the controller goes through. A 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 for each cycle:

Table 4 - Cycle Log Screens

Screen	**Description**
Number of Cycles	The total number of plunger cycles currently stored in the Cycle 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: Waiting Normal Fast-trip Non-Arrival Maximum Afterflow Line Pressure Shut-In Low Battery Shutdown Operator Change

	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.
Vent Duration	Shows the amount of vent time during this cycle.
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.
Reset Log?	This clears all of the cycle log data.

6.1.2.3 Daily

The controller maintains daily production statistics which are written to persistent memory when the current time-of-day passes the *Day Start* parameter. The following information is available in the Daily History menu:

Table 5 – Daily History 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.
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.
Vent Time	Displays the total amount of vent time for the day.
Volume	This shows the total volume for the given day. This is represented as e^3m^3.
Cycle Counts	There are a number of screens that are used to display all of the cycle types for the current day.

Reset Log?	This clears all of the daily log data.
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.

6.1.2.4 Total

The controller maintains total production statistics which continually increases until the log is reset. The following information is available in the Total History menu:

Table 6 – Total Statistics Screens

Screen	**Description**
Open/Close Time	Displays the total time that the well has been open and the total time the well has been closed.
Vent Time	Displays the total amount of vent time.
Volume	This shows the total volume. This is represented as e^3m^3.
Cycle Counts	There are a number of screens that are used to display all of the cycle types.
Reset Time	Shows the time that the total statistics were last reset.
Reset Log?	This clears all of the total statistics data.

6.1.2.5 Plunger

The controller maintains total plunger statistics which continually increases until the log is reset. The following information is available in the Daily History menu:

Table 7 – Plunger Statistics Screens

Screen	**Description**
Travel Distance	Total distance that the plunger has travelled since the last reset.
Plunger Arrivals	Total number of plunger arrivals since the last reset.
Reset Time	Shows the time that the plunger statistics were last reset.
Reset Log?	This clears all of the plunger log data.

6.1.2.6 Device Log

The controller can store up to 500 historical values for up to 2 sensors. The historical values are available in this log. The following information is available in each of the Device Log History menu:

Table 8 – Device Log Screens

Screen	Description
Log Type	The type of device values stored in this log.
Number of Values	Total number of values that is available in the log.
Reset Log?	This clears all of the device log data.
Log Value(s)	Shows the time that the sensor was read and the value at the time.

6.2 Install Menu

If security has been enabled, users must log in here in order to see the menus below. The install menu is entered by pressing the *install* hot key. The default login is 000-0000, which can be changed in the security menu.

6.2.1 Date/Time

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 9 - Date/Time 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
DST Enable	If enabled, the controller will automatically adjust 2 times a year for daylight savings.	disabled

6.2.2 System

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 10 - System Screens

Screen	Description	Default
Display Level	Sets the screen brightness. Can be used to save power or adapt to different lighting conditions.	50%
Display Auto Off	This sets the amount of time after the last key press that the display will stay on.	0m30s
Units	Set the controller to use imperial or metric units.	Imperial
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
Software Version	This identifies the specific firmware version that is currently running on the controller. This is required if issues are reported. Please refer to the release notes for this version to see a list of known issues.	N/A
Software Variant	This identifies the specific Software Build/Variant that is currently running on the controller. This is required if issues are reported.	N/A
Hardware Version	Shows the current version of hardware. This is used to manage different generations of hardware. It also helps troubleshoot any future issues that may be linked to a specific version of hardware.	N/A
Timer Optimization Option	This feature allows the controller to optimize the well based on plunger arrival time. The *Afterflow or Close Time* is manipulated in order to change the next arrival time of the plunger. This screen does not appear in the ALiEn^2 Expert as this feature is always available.	Disabled
	ALiEn^{2}ALiEn^2 Expert	
	ALiEn^{2}ALiEn^2 Expert	

Screen	Description	Default
Restore Defaults	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.	No
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
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

6.2.3 Security

The Security menu allows the currently logged in user to logout. Installers are able to view and change both the Operator and Installer login IDs.

Table 11 - Security Screens

Screen	Description	Default
Secure Login	Allows the installer to add security to the menu. If this is disabled, no login is requested and none of the following screens are displayed.	disabled
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
Auto Logout Time	The amount of time after the last key press that the user will remain logged in.	10m00s
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

Screen	Description	Default
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

6.2.4 Well Setup

The well setup menu allows the installer to define some basic parameters of the well such as the depth, the plunger type, and the desired velocities. The depth and velocities can be set to auto calculate the various timer values.

Table 12 – Well Setup Screens

Screen	Description	Default
Plunger Type	Identifies the type of plunger currently in the well. This allows the controller to modify some of the default settings that are related to the plunger type.	Conventional
Well Depth	Specifies the depth of the well in meters. This is used in conjunction with the velocities specified below to automatically populate values for the timers. This can be specified as any integer value between 1 and 50,000 m	1000 m
Danger/Fast Source	Configures the source used to test for danger velocity and fast trip velocity. Options are: • Average velocity: Calculated by dividing the well depth by the rise time. • Instantaneous Velocity: Acquired using a velocity sensor (Sasquatch).	Average Velocity

Screen	Description	Default
Danger Velocity	This is the average velocity at which the plunger is moving at a dangerous velocity. A single run at this velocity is likely to damage the well head. When entered, the *Fast Trip Time* will be re-calculated based on this parameter and the well depth. Enter Zero to disable the Danger Trip feature.	640 m/min
Danger Time	This time is used to indicate that the Plunger did not likely fall to the bottom of the well. The well will be shut-in immediately if a dangerous trip has occurred. Not used if the Arrival Sensor is disabled. Enter Zero to disable the Danger Trip feature.	0h01m34s
Fast Trip Velocity	This is the average velocity at which the plunger is moving much faster than expected. Repetitive runs at this velocity may damage the well head. When entered, the *Fast Trip Time* will be re-calculated based on this parameter and the well depth. Enter Zero to disable the Fast Trip feature.	250 m/min
Fast Trip Time	This time is used to indicate that the Plunger did not likely fall to the bottom of the well. The well will be shut-in if a number of consecutive fast trips have occurred. Not used if the Arrival Sensor is disabled. Enter Zero to disable the Fast Trip feature.	0h03m10s
Rise Velocity	This is the average velocity at which the plunger is moving much slower than expected and is unlikely to arrive. When entered, the *Rise Time* will be re-calculated based on this parameter and the well depth.	150 m/min

Screen	**Description**	**Default**
Rise Time	This time is used to indicate that the plunger is not likely to arrive at the surface unless special action is taken. If this time expires before the plunger arrives, the controller will bypass the Afterflow portion of the cycle and close the valves for the Non-Arrival Close Time, or possibly shutdown the well. The intent is to allow extra pressure to build in order to lift the plunger on the next cycle. The Rise Time may not be set to zero. If the Arrival Sensor is disabled, this defines the time spent in the Rise portion of the cycle. That is, the controller will advance to Afterflow when this time expires.	0h6m40s
Target Instantaneous Rise Velocity	This is the Instantaneous Velocity (measure using a velocity sensor) at which the plunger should travel in order to operate the well the most efficiently. This screen is available when Instantaneous Velocity is selected as the source to use for optimization in the Optimize menu.	250 m/min
Target Average Rise Velocity	This is the average velocity (well depth divided by rise time) at which the plunger should travel in order to operate the well the most efficiently. When entered, the *Target Rise Time* will be re-calculated based on this parameter and the well depth. This screen is available when average velocity is selected as the source to use for optimization in the Optimize menu.	250 m/min

Screen	Description	Default
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 or Close Time in order to try and cause the plunger to arrive at this time. Not used if the Plunger Arrival Sensor or Timer Based Optimization is disabled. This screen is available when average velocity is selected as the source to use for optimization in the Optimize menu.	0h04m00s
Close Velocity	This is the average velocity at which the plunger is expected to fall in the well, including travelling through the water that is at the bottom of the well.. When entered, the *Rise Time* will be re-calculated based on this parameter and the well depth.	55 m/min
Minimum Close Time	This determines the minimum time for of the Close portion of the cycle. This value prevents the operator from setting the Close Time outside of acceptable parameters. It also used for time based optimization.	0h18m11s
Maximum Close Time	This determines the maximum time of the Close portion of the cycle. This value prevents the operator from setting the Close Time outside of acceptable parameters. It also used for time based optimization.	8h00m00s
Close Time	This determines the duration of the Close portion of the cycle.	0h18m11s
Non-Arrival Close Time	This determines the duration of the Close portion of the cycle following a non-arrival. Not used if the Arrival Sensor is disabled.	0h36m22s

Screen	Description	Default
Minimum Afterflow Time	This sets the minimum amount of time for Afterflow. This value prevents the operator from setting the Afterflow Time outside of acceptable parameters. It also used for both pressure and time based optimization. In pressure based optimization, it ensures that pressure devices cannot terminate the Afterflow Time too early.	1h00m00s
Maximum Afterflow Time	This sets the maximum amount of time for Afterflow. This value prevents the operator from setting the Afterflow Time outside of acceptable parameters. It also used for both pressure and time based optimization. In pressure based optimization, it ensures that pressure devices do not hold the well open for an extraordinarily long time.	8h00m00s
Afterflow Time	The Afterflow portion of the cycle is terminated when this time expires. When "extended-afterflow"[3] devices are enabled, the controller will extend the Afterflow time instead of advancing to Close if none of the devices have already tripped.	1h00m00s

6.2.5 Inputs

The Inputs menu lists all of the available inputs, such as arrival sensor and line pressure sensor. Other input devices will be available when the Pressure Optimization feature has been enabled. These devices include casing pressure, flow differential pressure, and flow.

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

Table 13 - Inputs Screens

Screen	**Description**	**Default**
Sensor	Configures the type of sensor that is being used. Options are: • Disabled: No sensor attached. • Plunger Arrival Sensor (PAS) • Velocity Sensor (Sasquatch)	PAS
PAS Power	The Plunger Arrival Sensor can be configured to be powered during rise only, open only, or always powered.	*Rise Only*
PAS Delay Time	This sets the amount of time to ignore plunger arrival signals at the start of the rise time. This is necessary for some manufacturer's sensors that send a signal as soon as they are powered up.	*Disabled*
PAS Switch Polarity	Allows the type of arrival sensor to be configured. The controller can detect an arrival on a close or open of a switch.	*Normally Open (Detects on a switch close)*
Line Pressure Device Type	Enables the use of a Line Pressure Switch or Sensor. Disabled = Device not installed or unused. Switch = Discrete Input Switch installed and enabled. Sensor = A Line Pressure Analog Sensor is installed.	*Disabled*
Line Pressure Range	When the Line Pressure Device Type is sensor, defines the range of the sensor.	*500.0 psi*
Line Pressure Switch Polarity	Configures the type of Line Pressure switch to use. The controller can detect a Line Pressure trip on a close or open of a switch.	*Normally Open (Detects on a switch close)*

Screen	**Description**	**Default**
Sensor	Configures the type of sensor that is being used. Options are: • Disabled: No sensor attached. • Plunger Arrival Sensor (PAS) • Velocity Sensor (Sasquatch)	PAS
Tubing Pressure Device Type	Enables the use of a Tubing Pressure Switch or Sensor. Disabled = Device not installed or unused. Switch = Discrete Input Switch installed and enabled. Sensor = A Tubing Pressure Analog Sensor is installed.	*Disabled*
Tubing Pressure Range	When the *Tubing Pressure Device Type* is *sensor*, defines the range of the sensor.	500.0 psi
Tubing Pressure Switch Polarity	Configures the type of Tubing Pressure switch to use. The controller can detect a Tubing Pressure trip on a close or open of a switch.	*Normally Open (Detects on a switch close)*
Casing Pressure Device Type	Enables the use of a Casing Pressure Switch or Sensor. Disabled = Device not installed or unused. Switch = Discrete Input Switch installed and enabled. Sensor = A Casing Pressure Analog Sensor is installed. This screen is only available on the ALiEn^2 Expert .	*Disabled*
Casing Pressure Range	When the *Casing Pressure Device Type* is Sensor, defines the range of sensor. This screen is only available on the ALiEn^2 Expert .	500.0 psi

Screen	Description	Default
Sensor	Configures the type of sensor that is being used. Options are: • Disabled: No sensor attached. • Plunger Arrival Sensor (PAS) • Velocity Sensor (Sasquatch)	PAS
Casing Pressure Switch Polarity	Configures the type of Casing Pressure switch to use. The controller can detect a Casing Pressure trip on a close or open of a switch. This screen is only available on the ALiEn^2 Expert .	*Normally Open (Detects on a switch close)*
Differential Pressure Device Type	Enables the use of a Differential Pressure Switch or Sensor. Disabled = Device not installed or unused. Switch = Discrete Input Switch installed and enabled. Sensor = A Pressure Analog Sensor is installed. This screen is only available on ALiEn^2 Expert .	*Disabled*
Differential Pressure Range	When the *Differential Pressure Device Type* is Sensor, defines the range of sensor. This screen is only available on the ALiEn^2 Expert .	150.0 “WC
Differential Pressure Switch Polarity	Configures the type of Differential Pressure switch to use. The controller can detect a Flow Differential Pressure trip on a close or open of a switch. This screen is only available on the ALiEn^2 Expert .	*Normally Open (Detects on a switch close)*

Screen	Description	Default
Sensor	Configures the type of sensor that is being used. Options are: • Disabled: No sensor attached. • Plunger Arrival Sensor (PAS) • Velocity Sensor (Sasquatch)	PAS
Flow Rate Device Type	Enables the use of a Flow Switch, Sensor, or Virtual. Disabled = Device not installed or unused. Switch = Discrete Input Switch installed and enabled. Sensor = A Pressure Analog Sensor is installed. This screen is disabled if the *Differential Pressure Device Type* and the *Line Pressure Device Type* are both configured as *Sensor*. This configuration causes the Flow Rate to be calculated automatically. This screen is only available on the ALiEn² Expert .	*Disabled*
Flow Rate Range	When the *Flow Rate Device Type* is *Sensor*, defines the range of sensor. This screen is only available on the ALiEn² Expert .	10.0 e3m3/d
Flow Rate Switch Polarity	Configures the type of Flow Rate switch to use. The controller can detect a Flow Rate trip on a close or open of a switch. This screen is only available on the ALiEn² Expert .	*Normally Open (Detects on a switch close)*
Pressure Sensor Scan Time	Defines the rate at which all pressure sensors are read.	00m01s
Pressure Switch Scan Time	Defines the rate at which all pressure switches are read.	00m01s
Log 1 Type	Selects an enabled sensor to be logged.	disabled

Screen	Description	Default
Sensor	Configures the type of sensor that is being used. Options are: • Disabled: No sensor attached. • Plunger Arrival Sensor (PAS) • Velocity Sensor (Sasquatch)	PAS
Log 1 Frequency	Configures the rate at which to log the value of the selected sensor. The log can store up to 500 values. The faster the frequency, the less time will be logged. At 30 s, just over 4 hours of samples will be saved.	30 s
Log 2 Type	Selects an enabled sensor to be logged.	disabled
Log 2 Frequency	Configures the rate at which to log the value of the selected sensor. The log can store up to 500 values. The faster the frequency, the less time will be logged. At 30 s, just over 4 hours of samples will be saved.	30 s
Meter Run Size	When the *Differential Pressure Device Type* and the *Line Pressure Device Type* are both *Sensor*, defines the meter run diameter used for flow rate calculations. This screen is only available on the ALiEn² Expert .	2 inches
Orifice Size	When *Differential Pressure Device Type* and the *Line Pressure Device Type* are both *Sensor*, defines the orifice diameter used for flow rate calculations. This screen is only available on ALiEn² Expert .	1.000 inches
Gas Temperature	When the *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 on the ALiEn² Expert .	60 °F

Screen	**Description**	**Default**
Sensor	Configures the type of sensor that is being used. Options are: • Disabled: No sensor attached. • Plunger Arrival Sensor (PAS) • Velocity Sensor (Sasquatch)	PAS
Gas Specific Gravity	When *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 on the ALiEn^2 Expert .	0.60

6.2.6 Outputs

The Outputs menu allows the installer to configure the behaviour of Valve B and the Auto Catch (only available on the ALiEn^2 Expert).

Table 14 - Outputs Screens

Screen	Description	Default
Sales Valve State	Shows the current state of the valve. The user can also manually override the valve position.	*N/A*
Valve B Type	Defines Valve B operation: *Disabled*: Valve B not present or unused. The controller will only assert control on the Sales Valve. *Line*: Valve B is connected to the Sales Line. It can be opened or closed during the Afterflow portion of the cycle based on the Afterflow Valve Configuration. *Tank*: Valve B is connected to a Tank. *Flow Control*: Valve B is opened during Rise and closed during Afterflow. *Purge*: Valve B is opened at the end of Close for a set duration of time.	*Disabled*
Valve B State	Shows the current state of the valve. The user can also manually override the valve position.	*N/A*
Tank Delay Time	When Valve B is configured as a Tank Valve, the flow is switched from The Sales Valve to Valve B during the Rise portion of the cycle if the Plunger does not arrive within this time. It must be less than the Rise Time. Not used if set to zero or if Valve B is disabled.	*0h05m00s*
Afterflow Delay Time	When Valve B is enabled, this defines the amount of time the controller will wait following a plunger arrival before opening The Sales Valve. This is done to ensure that the plunger has moved fully into the Lubricator following a plunger arrival sensor signal. It is also used to ensure that any liquids are flushed through the system. Not used if Valve B Is disabled or if set to zero.	*0h00m00s*

Purge Time	The amount of time that Valve B is purged before the opening of the Sales Valve.	*0h00m01s*
Afterflow Valve Configuration	This parameter allows the user to configure which valves should be open during the Afterflow portion of the cycle when operating in dual valve mode. Valve B is open during Afterflow to keep the Auto Catch activated. It can be left closed during the Afterflow portion of the cycle for configurations where an Auto Catch is not installed.	*Sales/B*
Tank Valve Configuration	Specifies what valves are open during the vent portion of the cycle. Normally just Valve B is opened, but Sales can be left open at the same time.	*Valve B*
Vent -> Close	Specifies whether the controller should skip Afterflow and go immediately to Close once the plunger arrives after venting.	*Disabled*
Auto Catch	The Auto Catch can be set to engage on the start of the Rise cycle when the Sales Valve is opened or on the arrival of the plunger. The Auto Catch is only available on the ALiEn² Expert .	*Disabled*
Auto Catch State	Shows the current state of the valve. The user can also manually override the valve position.	*N/A*
Auto Catch Hold Time	This parameter sets the amount of time to hold the plunger at surface after the Sales Valve has been closed. This parameter is not used if the Auto Catch is disabled.	*Disabled*
DO1-LP Power	Sets the operation to use the LP Power connection for.	Default (Power a LP sensor)

DO1 Signal	Sets what type of output signal is desired: Level – High signal when open and low when closed Pulse Open – Pulse high for a set time on open Pulse Close – Pulse high for a set time on close	Level
DO1 Time	Specify the time to pulse the output for.	1000 ms
DO2-CP/DP Power	Sets the operation to use the CP/DP Power connection for. This screen is only available on the ALiEn^2 Expert .	Default (Power a CP/DP Sensor)
DO2 Signal	Sets what type of output signal is desired: Level – High signal when open and low when closed Pulse Open – Pulse high for a set time on open Pulse Close – Pulse high for a set time on close	Level
DO2 Time	Specify the time to pulse the output for.	1000 ms

6.2.7 Alarms

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 15 - Alarms Screens

Screen	Description	Default
Non-Arrival Count	The controller will shut down the well after “Non-Arrival Count” consecutive plunger non-arrivals. Not used if set to zero. Not used if the Arrival Sensor is disabled.	Disabled

Screen	Description	Default
Pre Non-Arrival Count	If this value is set, the controller will initiate a normal close cycle rather than a non-arrival close cycle if the plunger does not arrive. If the number of consecutive non-arrivals reaches this count value, any further non-arrivals will result in the controller going to Non-Arrival close. In this case "Non-Arrival Count" will then apply, and the well will be shut down once the count has reached that number of consecutive non-arrivals. Not used if set to zero. Not used if the Arrival Sensor is disabled.	Disabled
Fast Trip Count	The controller will shut down the well after "Fast Trip Count" consecutive fast trips. Not used if set to zero. Not used if the *Fast Trip Time* is set to 0. Not used if the Arrival Sensor is disabled.	2
Low Battery Fail Mode	This screen allows the user to configure the behaviour of the controller for this type of failure. The user can decide to have the controller fail Closed or Open.	Closed
Fast Trip Fail Mode	This screen allows the user to configure the behaviour of the controller for this type of failure. The user can decide to have the controller fail Closed or Open.	Closed
Non Arrival Fail Mode	This screen allows the user to configure the behaviour of the controller for this type of failure. The user can decide to have the controller fail Closed or Open.	Closed

6.2.8 Optimize

The optimize menu allows the optimization mode such as Timer or Pressure to be selected. The available optimization schemes depend on the features that have been enabled for a particular controller. Depending on the optimization scheme chosen, a number of additional screens become available.

Table 16 - Optimize Screens

<table>
<tr><th>Screen</th><th>Description</th><th>Default</th></tr>
<tr><td>Optimization Type</td><td>This screen is used to select the type of optimization. The selections that are available depend on the model of controller. Possible choices include:
Disabled
Afterflow Time Optimization
Close Time Optimization,
Close Then Afterflow Time Optimization
Pressure Optimization
Pressure optimization only available on ALiEn^2 Expert .

Time Optimization only available on ALiEn^2 Expert when the Timer Optimization feature is unlocked.</td><td>Disabled</td></tr>
<tr><td>Optimize Velocity Source</td><td>Specifies the source to use when timer/velocity optimization is selected (afterflow, close, close then afterflow). Options are:
Average Velocity: Time optimization is calculated using the average velocity (measured rise time divided by the well depth).
Instantaneous Velocity: Time optimization is calculated using the Instantaneous Velocity measured using a velocity sensor (Sasquatch).</td><td>Average Velocity</td></tr>
<tr><td>Adjust Using</td><td>Specifies what key parameter to use in the proportional time based adjustments. Options are:

Max – Min: Take the max parameter (Afterflow or Close) minus the min parameter to determine how large of a response to generate.

Current Time: Take the current time parameter (Afterfflow or Close Time) to determine how large of a response to generate.</td><td>Max - Min</td></tr>
</table>

Screen	Description	Default
Afterflow Scale Factor	This scaling factor determines how aggressively the controller makes adjustments to the Afterflow Time during Timer Based Optimization. It effectively dampens the response. Maximum is 15% for Max – Min optimization.	1% for Max – Min 10% for Current
Close Scale Factor	This scaling factor determines how aggressively the controller makes adjustments to the Close Time during Timer Based Optimization. Maximum is 15% for Max – Min optimization.	1% for Max – Min 10% for Current
Close Line Pressure Enable	Specifies whether the controller should monitor Line Pressure in the Close portion of the cycle and stay shut in when it is too high.	Enabled
Rise Line Pressure Enable	Specifies whether the controller should monitor Line Pressure in the Rise portion of the cycle and shut in when it is too high.	Disabled
Afterflow Line Pressure Enable	Specifies whether the controller should monitor Line Pressure in the Afterflow portion of the cycle and shut in when it is too high.	Enabled
Line Pressure Trip Point	When the *Line Pressure Device Type* is *Sensor*, defines the pressure, above which, the well will be shut-in.	90.0 psi
Line Pressure Reset Point	When the *Line Pressure Device Type* is *Sensor*, defines the pressure, below which, a Line Pressure trip condition will be cleared.	85.0 psi
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
Open Tubing Pressure Enable	Specifies whether the controller should monitor Tubing Pressure at the end of Close before opening the valve.	Enabled

Screen	Description	Default
Open Tubing Pressure Trip Point	When the *Tubing Pressure Device Type* is *Sensor*, defines the pressure, below which, the well will stay closed.	90.0 psi
Open Tubing Pressure Reset Point	When the *Tubing Pressure Device Type* is *Sensor*, defines the pressure, above which, a Tubing Pressure trip condition will be cleared and the well will be allowed to open.	95.0 psi
Tubing Pressure Stable Time	When the *Tubing Pressure Device Type* is enabled, defines the time required for the tubing pressure to stabilize above the *Tubing Pressure Reset Point*, or below the *Tubing Pressure Trip Point*, in order to declare a trip or reset condition.	0h00m05s
Open Casing Pressure Enable	Specifies whether the controller should monitor Casing Pressure at the end of Close before opening the valve.	Enabled
Open Casing Pressure Trip Point	When the *Casing Pressure Device Type* is *Sensor*, and the *Line Pressure Device Type* is <u>not</u> Sensor, defines the casing pressure, below which, the well will stay shut-in.	90.0 psi
Open Casing Pressure Reset Point	When the *Casing Pressure Device Type* is *Sensor*, and the *Line Pressure Device Type* is <u>not</u> *Sensor*, defines the pressure, above which, the well will be opened.	95.0 psi
Open Casing Pressure Stable Time	When the *Casing Pressure Device Type* is enabled, and the *Line Pressure Device Type* is <u>not</u> *Sensor*, defines the time required for the line pressure to stabilize above the *Open Casing Pressure Reset Point*, or below the *Open Casing Pressure Trip Point,* in order to declare a trip or reset condition.	0h00m05s
Open Casing/Line Differential Pressure Enable	Specifies whether the controller should monitor Casing/Line Differential Pressure at the end of Close before opening the valve.	Enabled

Screen	Description	Default
Open 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.	50.0 psi
Open 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 be opened.	55.0 psi
Open 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 *Open Casing/Line Differential Pressure Reset Point*, or below the *Open Casing/Line Differential Pressure Trip Point*, in order to declare a reset or trip condition.	0h00m05s
Close Casing Pressure Type	This determines which algorithm to use for closing the well when the *Casing Pressure Device Type* is *Sensor*. The options are: *Disabled* *Absolute* *Rate Drop* These optimization algorithms are discussed further in the 4.2.8.2.2 Close Casing Pressure section.	Absolute
Close Casing Pressure Rate Threshold	When the *Casing Pressure Device Type* is *Sensor*, defines the rate at which the casing pressure is falling that causes an event. It is used for Casing Pressure Rate of Change optimization and is the point at which the Trip Delay Timer is started, after which the well is shut. This screen is only visible if the *Close Casing Pressure Type* is set as *Rate Drop*.	1.0 psi/min

Screen	Description	Default
Close Casing Pressure Trip Point	When the *Casing Pressure Device Type* is *Sensor*, this defines the pressure above which the well will stay flowing. This screen is only visible if the *Casing Pressure Device Type* is set as *Absolute*.	150.0 psi
Close Casing Pressure Reset Point	When the *Casing Pressure Device Type* is *Sensor*, defines the pressure which will cause a trip condition to be reset. This screen is only visible if the *Close Casing Pressure Device Type* is set as *Absolute*.	155.0 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*.	0h00m05s
Trip Delay Time	This screen specifies the amount of time to delay before closing the well in when using Rate Drop Casing Pressure Optimization. Please refer to the Optimization screens for more information.	1h00m01s
Close Differential Pressure Trip Point	When the *Differential Pressure Device Type* is *Sensor*, this defines the pressure above which the well will stay flowing.	20.0 "WC
Close Differential Pressure Reset Point	When the *Differential Pressure Device Type* is *Sensor*, this defines the pressure which will cause a trip condition to be reset.	22.0 "WC

Screen	Description	Default
Close Differential Pressure Stable Time	When the *Differential Pressure Device Type* is enabled, this defines the time required for the pressure to stabilize below the *Flow Differential Pressure Point*, or above the *Flow Differential Pressure Reset Point*, in order to declare a trip or reset condition.	0h00m05s
Flow Rate Trip Point	When the *Differential Pressure and Line Pressure Device Types* are both *Sensor OR Flow is Sensor/Virtual*, this defines the rate above which the well will stay flowing.	18.0 e3m3/d
Flow Rate Reset Point	When the *Differential Pressure and Line Pressure Device Types* are both *Sensor OR Flow is Sensor/Virtual*, this defines the rate which will cause a trip condition to be reset.	19.0 e3m3/d
Flow Rate Stable Time	When the *Differential Pressure and Line Pressure Device Types* are both *Sensor OR Flow is Sensor/Virtual*, 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.	0h00m05s
Arrival Guard Time	This specifies a waiting period after the arrival of the plunger before we attach the pressure devices to ensure that their readings have stabilized.	Disabled

6.2.9 Modbus

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 17 - Modbus Menus

Screen	Description	Default
COM1	Sets whether COM1 is active or not as a Modbus Slave. It is disabled by default to save power.	disabled
Station Address	Defines the Modbus station. Valid values are 1 to 247. This setting must match the settings on your Modbus master.	1

Screen	Description	Default
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
Data Bits	Sets the number of data bits in each character. This setting must match the settings on your Modbus master.	8
Parity	The parity of the character. This setting must match the settings on your Modbus master.	None
Stop Bits	The number of stop bits per character. This setting must match the settings on your Modbus master.	1
Time Format	Specifies how time and dates are represented in the Modbus registers. Seconds format will utilize one or more registers to show elapsed seconds. H:M:S format allocates separate registers for Hours, Minutes, and Seconds. Please refer to the Modbus Communications User's Guide for more details.	seconds

7 Troubleshooting

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

Table 18 - 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 the controller 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 us 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 contact us to arrange for the controller to be repaired.
	The main core of the controller has been shocked	The controller core must be replaced. Please contact us 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 the Setup Menu	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, please contact us to generate a new ID on a per controller basis.
Timer Optimization adjustments are too large	The algorithm is setup to be too aggressive.	Reduce the appropriate scale factor.
Timer Optimization takes too long to adjust to the right value	The algorithm is not setup to be aggressive enough.	Increase the appropriate scale factor.
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 fast trip alarm mode is set to fail open	Change the Fast Trip Fail Mode to Closed in the Alarms menu.
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.
	The non-arrival alarm mode is set to fail open	Change the Non-Arrival Fail Mode to Closed in the Alarms menu.
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 non-arrivals 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

8.1.2 Setup

1. Ensure that the USB to RS485 adapter is configured in 2 wire mode.
2. Wire the RDA(-) to COM1 A and RDB(+) to COM1 B. The GND can be wired to the unlabeled 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 ***install*** button down
2. Plug the battery into the controller
3. Release the ***install*** button
4. If the controller does not enter the upgrade program, the previous software that was installed may not include this program.
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 ETC Vision

b. Browse to the latest .etc file.

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.

Err 4 – Flash Buffer Over Run. This means that there is a back log saving to the controller.

Err 5 – Character Buffer Under Run. The controller was expecting to parse more incoming characters, but there are none available.

8.1.5 Software Variants

Not all available features are available in one software build for the controller. All software builds start with “Alien”, followed by a SW variant identifier. Each variant has a unique number shown in the System Menu, SW Variant screen. Here’s a list which shows which features are available in which build.

Filename: Alien-vx-x-x.etc
SW Variant: 0
Features: Surface Velocity

Filename: AlienFlow-vx-x-x.etc
SW Variant: 1

Features: Flow, Flow Optimization

Filename: AlienLoadFactor-vx-x-x.etc
SW Variant: 4
Features: Sensor Multiplexor, Load Factor

Filename: AlienVirtualSensors-vx-x-x.etc
SW Variant: 5
Features: Virtual Sensor, Flow Optimization

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 19 - Available Replacement Parts and Accessories

Part Number	Name	Description
ET-00000-0000-0247	1.1 W Solar Panel	6V, 1.1W CSA Class 1 Div 2 Intrinsically safe solar panel
ET-12001-1008-0001	5 Ah Replacement Battery	CSA approved replacement battery with intrinsically safe protection.
ET-12001-1008-0002	8 Ah Replacement Battery	CSA approved replacement battery with intrinsically safe protection.
ET-12000-1011-0001	Single Valve Assembly, 3/8" tubing, AMP-DUAC connector	Includes a pneumatic valve solenoid, 2 3/8” NPT elbows, an O Ring, Nylon Lock Nut and connector.
ET-12000-1011-0002	Dual Valve Assembly, 3/8" tubing, AMP-DUAC connector	Includes 2 pneumatic valve solenoids, 2 3/8” NPT elbows, a Tee, a 3/8” NPT connector, 2 O Rings, 2 Nylon Lock Nuts, and connectors.
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-12000-1009-0003	Battery Bracket	Replacement bracket used to retain either battery.
ET-11000-1019-0000	Plunger Arrival Sensor	Use with the plunger lift controller to detect a plunger arrival.
ET-00000-0000-0235	2 Pin Connector	2 Pin Weidmuller connector
ET-00000-0000-0236	3 Pin Connector	3 Pin Weidmuller connector
ET-00000-0000-0060	1/2" Liquid Tight Knockout Seal	NEMA rated plug to prevent water and dust from entering unused holes.

8.3 Technical Support

8.3.1 Contacting Support

Support is available from your current service technician. If an issue does arise, they should be the first point of contact. Service companies that are currently authorized distributors of the ALiEn^2/ALiEn^2 Expert 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

Please contact your service technician and 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 be addressed in a timely fashion. Returned controllers will take approximately 4 – 6 weeks to be diagnosed and repaired.

9 Appendix A – Optimization Formulas

Due to the large number of ways to configure optimization there are a large number of resultant formulas that detail their operation. Users will not normally need to know the optimization algorithms to this level of detail but they are here for reference just in case.

9.1 Afterflow Optimization

Formulas used for **Error! Reference source not found.**

- Optimization Source: Average Velocity – Adjust Using: Current Time

$$\Delta Afterflow = \frac{TargetRise - ActualRise}{TargetRise} \times ScaleFactor_{AF} \times Afterflow$$

- Optimization Source: Average Velocity – Adjust Using: Max-Min

$$\Delta Afterflow = \frac{TargetRise - ActualRise}{TargetRise} \times ScaleFactor_{AF} \times [Max_{AF} - Min_{AF}]$$

- Optimization Source: Surface Velocity – Adjust Using: Current Time

$$\Delta Afterflow = \frac{TargetSrfVel - SrfVel}{TargetSrfVel} \times ScaleFactor_{AF} \times Afterflow$$

- Optimization Source: Surface Velocity – Adjust Using: Max-Min

$$\Delta Afterflow = \frac{TargetSrfVel - SrfVel}{TargetSrfVel} \times ScaleFactor_{AF} \times [Max_{AF} - Min_{AF}]$$

9.2 Close Optimization

Formulas used for **Error! Reference source not found.**

- Optimization Source: Average Velocity – Adjust Using: Current Time

$$\Delta Close = \frac{TargetRise - ActualRise}{TargetRise} \times ScaleFactor_{CL} \times Close$$

- Optimization Source: Average Velocity – Adjust Using: Max-Min

$$\Delta Close = \frac{TargetRise - ActualRise}{TargetRise} \times ScaleFactor_{CL} \times [Max_{CL} - Min_{CL}]$$

- Optimization Source: Surface Velocity – Adjust Using: Current Time

$$\Delta Close = \frac{TargetSrfVel - SrfVel}{TargetSrfVel} \times ScaleFactor_{CL} \times Close$$

- Optimization Source: Surface Velocity – Adjust Using: Max-Min

$$\Delta Close = \frac{TargetSrfVel - SrfVel}{TargetSrfVel} \times ScaleFactor_{CL} \times [Max_{CL} - Min_{CL}]$$

9.3 Close then Afterflow Optimization

This method of optimization uses the same formulas and Close Optimization and Afterflow Optimization. Refer to those formulas above.

9.4 Casing Pressure Rate Drop Optimization

Formulas used for Casing Pressure Rate Drop Optimization

- Optimization Source: Average Velocity – Adjust Using: Current Time

$$\Delta TripDelay = \frac{TargetRise - ActualRise}{TargetRise} \times ScaleFactor_{AF} \times TripDelay$$

- Optimization Source: Average Velocity – Adjust Using: Max-Min

$$\Delta TripDelay = \frac{TargetRise - ActualRise}{TargetRise} \times ScaleFactor_{AF} \times [Max_{AF} - Min_{AF}]$$

- Optimization Source: Surface Velocity – Adjust Using: Current Time

$$\Delta TripDelay = \frac{TargetSrfVel - SrfVel}{TargetSrfVel} \times ScaleFactor_{AF} \times TripDelay$$

- Optimization Source: Surface Velocity – Adjust Using: Max-Min

$$\Delta TripDelay = \frac{TargetSrfVel - SrfVel}{TargetSrfVel} \times ScaleFactor_{AF} \times [Max_{AF} - Min_{AF}]$$

9.5 Acronyms

ADC	**Analog-to-Digital Converter**
AI	**Analog Input**
ALiEn	**Artificial Lift Enhancement**
CVC	**Configurable Valve Controller**
DAC	**Digital-to-Analog Converter**
DI	**Digital Input**
DO	**Digital Output**
ESD	**Emergency Shut Down**
ETC	**Extreme Telematics Corp.**
N/C	**Normally Closed**
N/O	**Normally Open**
PAS	**Plunger Arrival Sensor**
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**

10 Index