

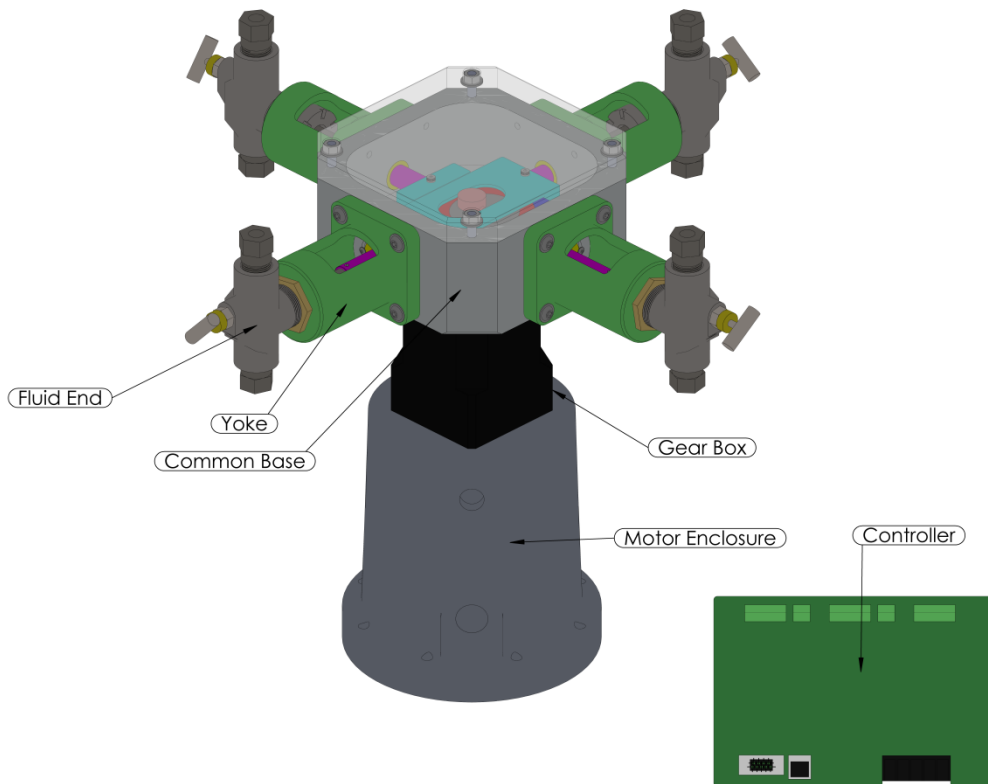
# LCO TECHNOLOGIES



## *The CROSSFIRE*

Ultra-low Power Chemical Injection Pump

Installation and Operations Manual  
Version 5.1



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## **CSA Requirements and Installation Requirements**

### **IMPORTANT SAFETY CONSIDERATIONS**

#### **WARNING**

##### **AVERTISSEMENT**

EXPLOSION HAZARD - SUBSTITUTION OF COMPONENTS  
MAY IMPAIR SUITABILITY FOR INSTALLATION IN HAZARDOUS LOCATIONS  
RISQUE D'EXPLOSION - LA SUBSTITUTION DE COMPOSANTS  
PEUT RENDRE CE MATÉRIEL INACCEPTABLE POUR LES  
EMPLACEMENTS DANS DES ENDROITS DANGEREUX (CLASSE 1, DIVISION 2).

#### **WARNING**

##### **AVERTISSEMENT**

EXPLOSION HAZARD - DO NOT REPLACE COMPONENTS  
UNLESS POWER HAS BEEN SWITCHED OFF OR THE AREA IS  
KNOWN TO BE NON-HAZARDOUS.  
RISQUE D'EXPLOSION - COUPER LE COURANT OU  
S'ASSURER QUE L'EMPLACEMENT EST DÉSIGNÉ NON  
DANGEREUX AVANT DE REMPLACER DES COMPOSANTS.

#### **WARNING**

##### **AVERTISSEMENT**

EXPLOSION HAZARD - DO NOT CONNECT OR DISCONNECT EQUIPMENT  
UNLESS POWER HAS BEEN SWITCHED OFF OR THE AREA IS  
KNOWN TO BE NON-HAZARDOUS.  
RISQUE D'EXPLOSION - AVANT DE DÉBRANCHER  
L'ÉQUIPEMENT, COUPER LE COURANT OU S'ASSURER  
QUE L'EMPLACEMENT EST DÉSIGNÉ NON DANGEREUX

#### **WARNING**

##### **AVERTISSEMENT**

THE CONTROLLER ASSEMBLY IS FOR USE IN CLASS I, DIVISION 2, GROUPS C AND D, AND OR  
NONHAZARDOUS LOCATIONS ONLY.  
L'APPAREIL DU CONTRÔLEUR CONVIENT À L'UTILISATION DANS LES EMBLEMES  
DE CLASSE 1, DIVISION 2, GROUPES C ET D, OU NE CONVIENT  
QU'À L'UTILISATION DANS DES EMBLEMES DÉSIGNÉS NON DANGEREUX.

#### **WARNING**

##### **AVERTISSEMENT**

THE MOTOR ASSEMBLY IS FOR USE IN CLASS I, DIVISION 1, GROUPS C AND D, AND OR  
NONHAZARDOUS LOCATIONS ONLY.  
L'APPAREIL DU MOTEUR CONVIENT À L'UTILISATION DANS LES EMBLEMES  
DE CLASSE 1, DIVISION 1, GROUPES C ET D, OU NE CONVIENT  
QU'À L'UTILISATION DANS DES EMBLEMES DÉSIGNÉS NON DANGEREUX.

**AGENCY  
CERTIFICATION****Controller Assembly**

**(Must be placed in a Cabinet/Enclosure that provides a minimum Ingress Protection of NEMA 4/IP54)**

Class 1, Division 2, Groups C and D, or nonhazardous.

Temperature Code: T4, Tamb: -40 – 60 Deg. C.

Suitable for Zone 2, IIB.

**Motor Assembly**

**(Motor is for indoor or protected environment use only)<sup>1</sup>**

Class 1, Division 1, Groups C and D, or nonhazardous.

Temperature Code: T6, Tamb: -40 – 60 Deg. C.

Suitable for Zone 1, IIB.

**Models:**

Explosion Proof Motor Assembly Model LCOM-1000

Controller Model LCOC-1000-A and Model LCOC-1000-B

**IMPORTANT: Conditions of Certification**

- ✓ The Controller must be installed within an enclosure suitable for the environment and requiring a tool or key to open. Controller Models LCOC-1000A and LCOC-1000B are intended for use in a Pollution Degree 2 environment.
- ✓ The RS232 connector must be retained with two screws on the mating connector.
- ✓ The Ethernet RJ45 connector must be retained with its original locking tab to withstand a 15 Newton pull force once engaged.
- ✓ Model LCOM-1000 must be used together to form a Certified Brushless DC (BLDC) Motor System. No substitutions of Motor types are permitted.

**Controller**

The controller input voltage rating is: 24 VDC. The Battery power supply must be capable of supplying 24 VDC to ensure reliable operation and motor start-up. For average current draw based on application, and help with solar sizing, please contact LCO directly. Average current draw on most applications is significantly less than 1 A, however the rated maximum current draw for the controller is 9.6A.

The Controller must be protected by external over current protection in keeping with CEC and NEC practices supplied at the time of installation.

**EXTERNAL CONNECTORS**

The controller features several external connectors. These are labelled as follows:

- Power In: connectors are used to connect the 24VDC power supply.
- To Motor: connectors are used for Phase A, Phase B and Phase C of BLDC. These connections are not phase sensitive.

---

<sup>1</sup> Note: Protected environment means the motor must be under a shelter and off the ground to protect the motor from moisture (such as rain, snow, ice etc.)

Use only Copper Conductors on Supply and Motor Load Terminal Blocks

**“TIGHTEN TO 10.54 pound-inches (1.2 N•m)”. Or Equivalent**

It is a CSA requirement to use #10 straight or ring lugs with 10 AWG wiring, when connecting to the Power and Motor connectors. The Controller data connectors can accept 20 to 24 AWG stranded wire.

All wiring and connections must be in line with accepted wiring practices as outlined by the Canadian Electrical Code (Canada) and the National Electrical Code (USA) and installed by qualified personnel only. (Use copper conductors only)

There are two patterns of mounting holes on the Controller unit. The four corner mounting positions are for a direct fastening to the enclosure using # 6 screws. The two patterns of 3 holes are for DIN Rail mounting brackets. Installer must supply screws and brackets as applicable.





It is required that a cutoff switch is installed on the +24 VDC power rail, between the controller and supply. This allows for safe servicing of the controller, and eliminates any arcing caused by manual connection or disconnection of the supply rail. Failure to do so may result in personal injury or damage to the controller.

## Motor

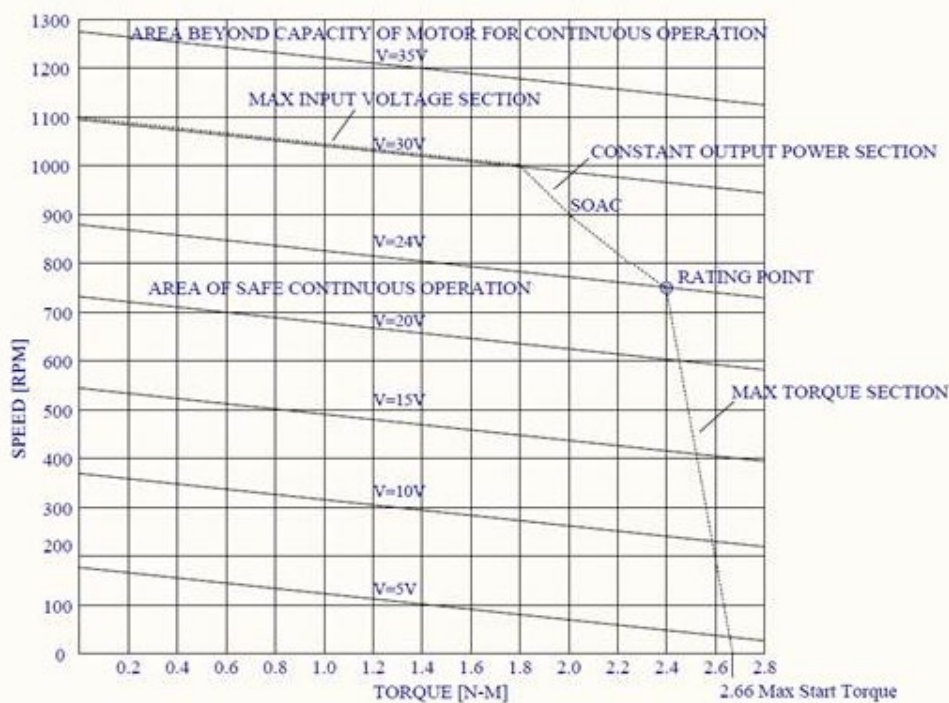
Accurate mechanical lineup is essential for successful operation. Mechanical vibration and roughness in running the motor may be an indication of poor alignment. It is recommended that the lineup be checked when installed.

For direct coupled applications, use flexible couplings when possible. Use of a sealed fitting at the motor wiring entrance point is required with a minimum of 5 full thread engagement to maintain the Class I, Division 1 rating of the motor when installed in a Hazardous Area.

The three Phase conductors and the Earth ground must be terminated in an approved Class I, Division 1 junction box. The green Earth lead must be grounded to the ground screw in the junction box.

**WARNING: Motor, Control and Grounding must be in accordance with the Canada - Canadian Electrical Code and/or USA – National Electrical Code and consistent with Local requirements and practices. Use Ground lug on exterior of Motor enclosure and Ground lead provided to ensure proper Grounding of the Motor.**

See below for Safe Operating Area Curves (SOAC) for the Motor



**Figure: Safe Operating Area Curves (SOAC)**



## **CROSSFIRE Installation Guide**

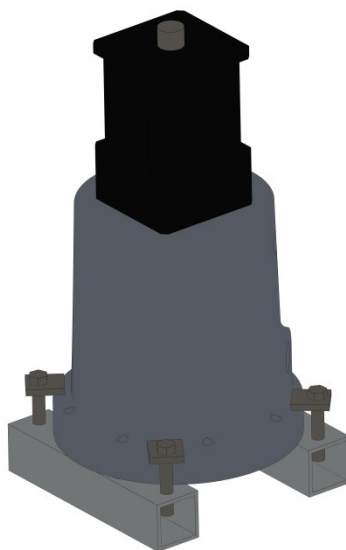
### **Step 1: Open Boxes**

- Confirm the following parts are present
  - LCOD-PUMP Box:
    - Assembled LCOD-Pump
    - Yoke covers
    - Mounting bracket
    - Additional accessories ordered
  - LCOC-1000-A or LCOC-1000-B Box:
    - Controller (advanced or basic)
- Check to ensure no parts were damaged during shipment
  - Contact the shipment carrier and file a claim if any damage has been identified
  - If replacement parts are required, please contact your supplier
- Familiarize yourself with all parts and pieces

### **Step 2: Mount the pump**

- Find a desired location for installation
  - A location that can accommodate pump dimensions (22" L x 22" W x 17" H)
  - Minimize elevation to exploit head pressure created by the chemical tank. This will assist in priming the inlet line.
- Mount the mounting bracket and LCOD-Pump within the bracket
  - The mounting bracket is designed to bolt down to the pattern of a 5100 series pump.
  - Bolt the two bracket pieces onto the existing 5100 pattern
  - Set the *CROSSFIRE* pump on top of the bracket
  - Attach the four-foot bolts to the base flange on the motor enclosure

*Note: The bracket can be drilled to accommodate other bolt pattern configurations. Alternatively, the pump can be free standing on the bracket; it can be attached to the bracket but not bolted down in a drip tray if preferred.*



## Step 3: Install the Smart Controller

- Mount the Controller in a Nema 4 Enclosure
- Hook the controller to a 24 VDC power supply
  - Connect the 2 conductor, **10 gauge tech cables** with appropriate environmental and classification seals to the controller
- Attach the three conductor cables from the motor to the controller. The green ground wire can be terminated at any ground. The conductor cables must be terminated in a Class 1, Division 1 junction box at the motor.
  - The three conductor cables will be terminated in the controller at termination points marked phase A, phase B, and phase C. Although the wires are not required to be in a particular order for the pump to function, to maintain consistency please attach the **red wire to PH A**, the **black wire to PH B**, and the **yellow wire to PH C**.
  - Cables are gauge 10 and can be a maximum length of 60 ft



**Warning:** If the resistance in the gauge 10 wires does not meet AWG standards, the distance must be reduced proportionately.

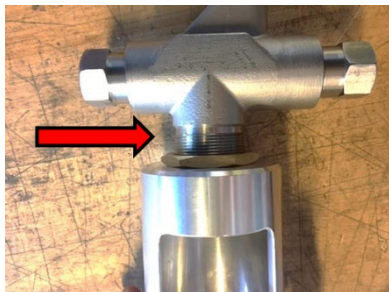
*Note: All conductor cables must be attached with proper end ferrule connectors and clamped down properly with the appropriate tools. Ensure installers double check that all screw terminals are tightened down to avoid any electrical connection issues. Similarly, if two wires must be spliced together, please use a proper splicer connector, clamp down sufficiently, and do not use electrician twist caps.*

**Note: Wiring instructions are per device. Multiple CROSSFIRE units cannot be wired off a single cable run. Any deviation can affect CROSSFIRE performance. Please consult LCO Technologies directly for assistance prior to deviation if required.**



**Step 4: Check Fluid Ends**

- Ensure that the fluid ends are showing 6-7 threads
  - If 6-7 threads are not showing, the plunger may bottom out and cause the pump to stall or draw higher than average current (details in *troubleshooting*)



- Check that the packing gland is snug but not over tightened

**Step 5: Manual Rotation Check**

- Complete a manual rotation fluid end check
- Remove the clear acrylic top cover from the pump
- Insert an Allen key into the bolt in the center motor shaft and manually spin the motor
  - If the fluid ends are installed correctly, the motor will spin all 360 degrees with no resistance
  - If there is resistance that cannot be pushed past, a fluid end is bottoming out on the plunger
  - Manually spin that fluid end out of the yoke, one turn at a time, until you can push past the fluid end to the next one
  - Re-check and complete a full 360-degree rotation
- For more information, and a visual representation of the manual rotation, please visit [www.lcotechnologies.com/resources.html](http://www.lcotechnologies.com/resources.html) and watch the YouTube Video called “**Video Tutorial Manual Fluid End Check**” or call LCO directly for more assistance



**Warning:** If the fluid ends are bottoming out, this will cause damage to the pump components and may lead to extreme wear and tear. Damage will not be covered by warranty and chemical leaks may occur due to misalignment.

**Step 6: Tube Fluid Ends**

- The fluid ends on the *CROSSFIRE* are a 5100 series equivalent
- The fluid ends have a ¼” Female NPT connection on the inlet and outlet
  - The arrow on the side of the fluid end body indicates fluid flow direction
- Tube the fluid ends inlets and outlets appropriately
- Overpressure protection must be used in conjunction with our pump
  - We recommend using a Panam Relief Valve (PRV-04-SS) with a set pressure established which is no greater than the maximum allowable working pressure (MAWP) of the system.
  - Only one relief valve is required if all fluid ends are going to a single injection point.

- **Recommendation:** Use a filter on the pump inlet, this ensures that no foreign matter particles get into the fluid ends during chemical injection.

## **Optional Step: Connect the CROSSFIRE to a SCADA/RTU System**

- Connect three 20 Gauge wires to the RS485 terminal blocks on the CROSSFIRE controller.
  - RS485+, RS485-, and RS 485 GROUND
- Connect the wires to the SCADA/RTU system
- Install a two-position selector switch on the outside of the NEMA 4 enclosure to ensure when an Operator is onsite completing maintenance, that the pump can be manually switched from remote control mode, into local control mode for safety. This switch is required for safety purposes; all MODBUS registers can be monitored remotely when the switch is on remote control mode.
  - Wire the switch to the Digital Input DI1 terminal block on the controller such that 24 VDC will be on DI1+ when remote position is selected and 0 VDC for the local positioner
- Download and connect to the CROSSFIRE computer software as per the download and operations instructions on page 14
  - Log in as “Technician” for access to all tabs
  - Go to “[System Setup](#)” panel (picture on page 22)
    - Set your Slave ID and Baud Rate
    - Press “[Save](#)” button
  - Go to “[Automation](#)” Tab (picture on page 28)
    - Select “[local remote switch control](#)” from the drop-down menu to enable the two-position selector switch
    - Press “[Save](#)” button
    - Label position one and two on the outside of the panel to “local” and “remote”



***For all MODBUS register maps and assistance to set up MODBUS, please contact your local distributor or LCO Technologies directly***

## **Optional Step: Wire in Motor soft stop switch (non-positive isolation feature)**

- If connecting over MODBUS, a C1D2 two-positioner switch may be wired to the controller for a local “Start/Stop” motor switch. This switch will allow Operators onsite to turn the motor ON or OFF with an easy switch (no laptop or Bluetooth connection App required) but will not prevent MODBUS users to view pump parameters remotely as the power to the controller has not been affected.
- Note: This is not a positive isolation method of stopping the motor, consider this equivalent to the “start/stop” buttons in the app and laptop software
- Wire the C1D2 two-positioner switch according to the diagram below (next page, page 11):
  - Apply 24 V to AI3+ and 0 V to Ground
  - Label the switch ON for 24V, and OFF for 0V
- Access the “[Terminal](#)” Tab in the software or mobile App and enter command “[setMotorSoftStopEn](#)” to enable function
- Confirm function by entering command “[showMotorSoftStopEn](#)”

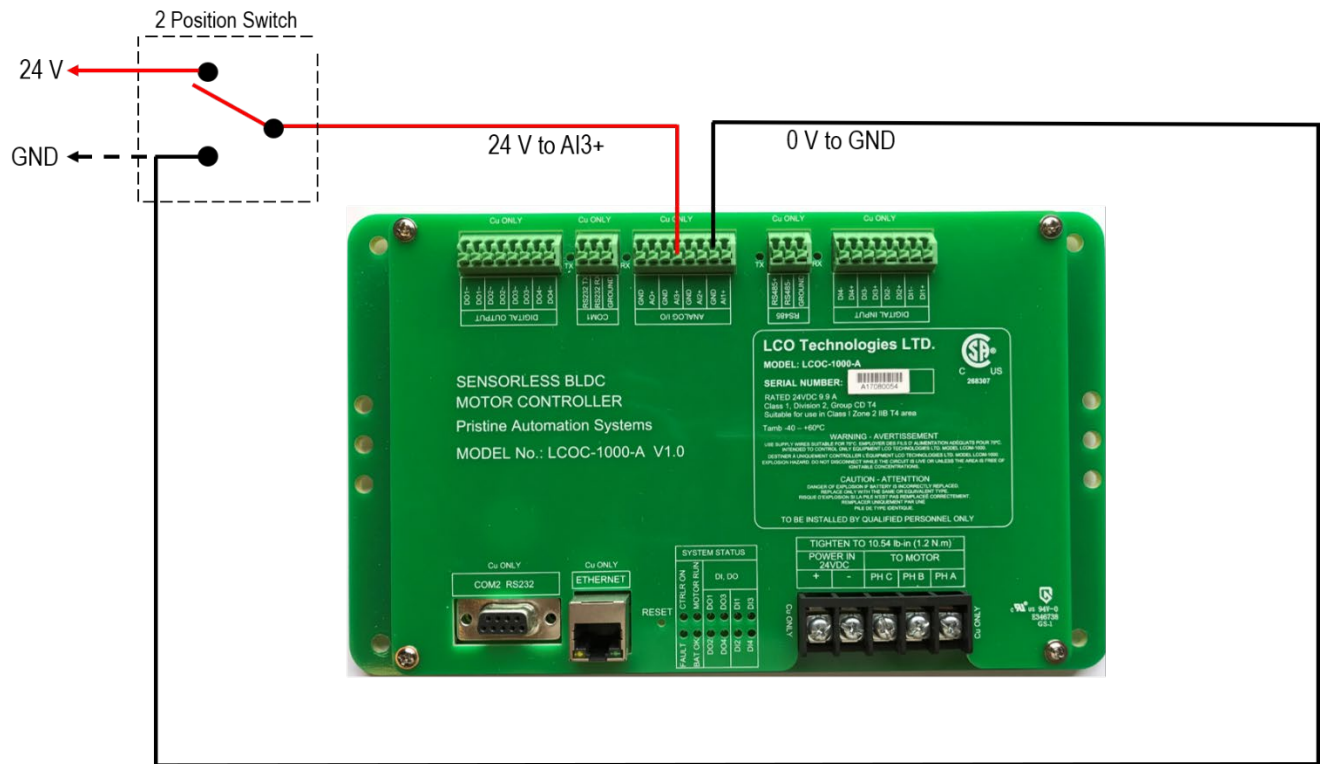
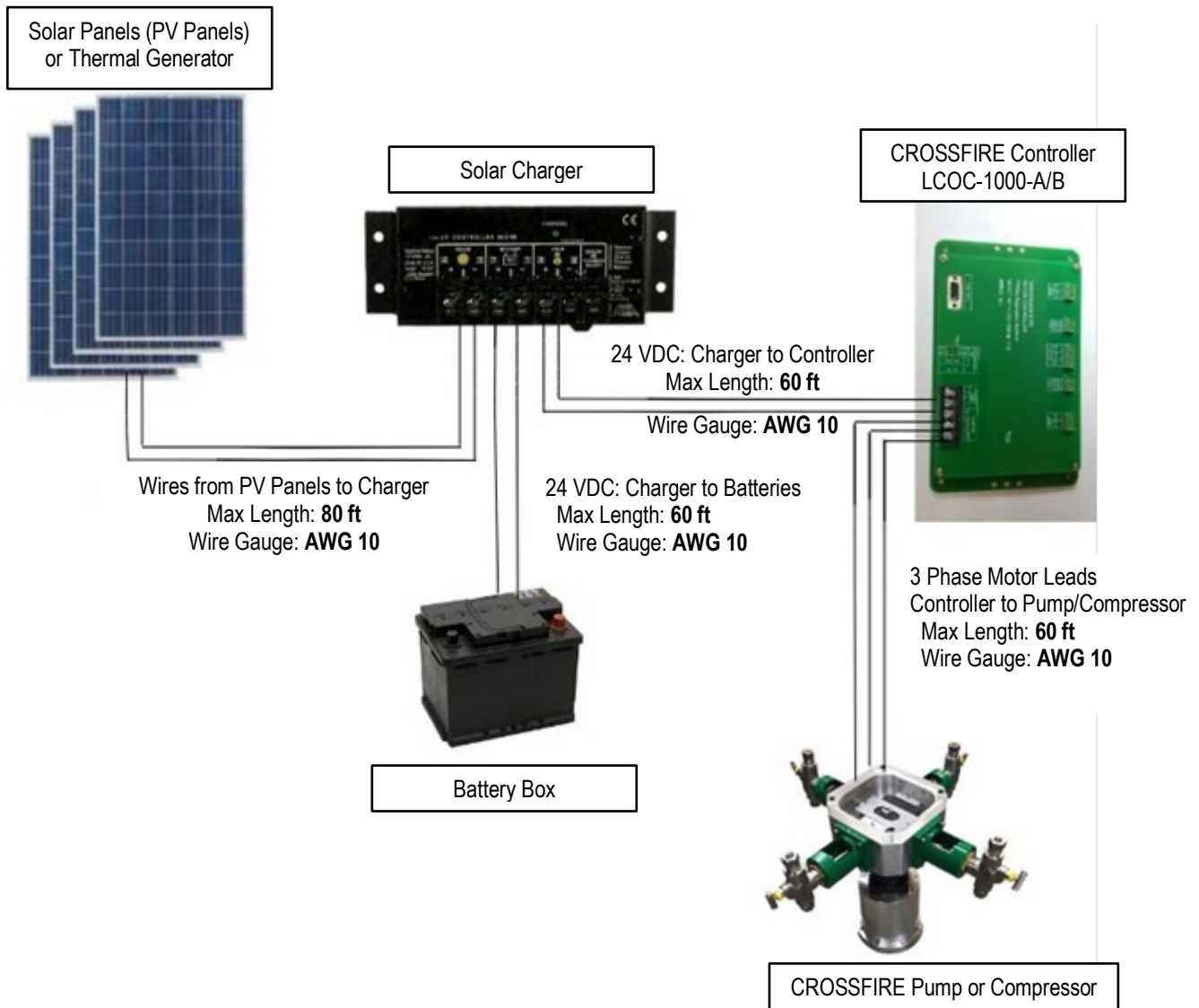


Figure: Wiring Diagram for Soft Stop Switch on AI3+

**Note: Please use Gauge 20, single strand wires for all signal terminals on the smart controller.**

## Installation Requirements – Summary Diagram:



**Note: Wiring instructions are per device. Multiple CROSSFIRE units cannot be wired off a single cable run. Any deviation from the above diagram can affect CROSSFIRE performance. Please consult LCO Technologies directly for assistance prior to deviation if required.**

## **CROSSFIRE Pump Start Up**

### **Step 1: Prime the Fluid Ends**

- Once fluid ends are tubed, install a 1/8" NPT x 1/4" or 3/8" compression fitting into the threaded outlet of the priming valve. Tube this fitting and use it to capture vented chemical that flows during the priming process.
- Open the priming valve and let the chemical run through the fluid end until you have a steady flow of chemical with no air bubbles to ensure no vapour is present in the system.
- Close the priming valve

*Note: If the pump does not deliver the chemical during this priming process as expected, flood the discharge line with a hand pump connected to the threaded vent of the priming valve. Generally, this step is not required when using 1/2" or 3/8" fluid ends, however when using 3/16" or 1/4" fluid ends, particularly under high pressures; this may necessary.*

#### *Optional Step: Priming with Hand Pump*

- *Connect the hand pump to the threaded vent on the priming valve*
- *Open the priming valve*
- *Push chemical through with the hand pump to completely flood the discharge line*

### **Step 2: Start the pump**

- Connect an RS 232 cable to the controller and computer
  - Alternative: connect an LCO Bluetooth dongle for wireless communication
- Start up the chemical injection pump as per the operator interface instructions starting on page 15.

#### **Warning: Pinch Hazard**

**Always keep the clear acrylic top plate on the unit while the pump is running**



### **Step 3: Gauge the Pump**

- After setup and installation is complete, run the pump and gauge chemical volume delivery rate
  - Recommended steps:
    - Install a calibrated sight glass
    - Fill the sight glass (the sight glass will fill to match the level in the chemical tank)
    - Isolate the tank
  - Open the isolation valve on the base of the sight glass
  - Close the isolation valve on the chemical tank
  - Run the pump, observe and adjust the chemical delivery rate as required
- Check for leaks from packing glands and tubing
  - If there are leaks from the packing gland, refer to page 42

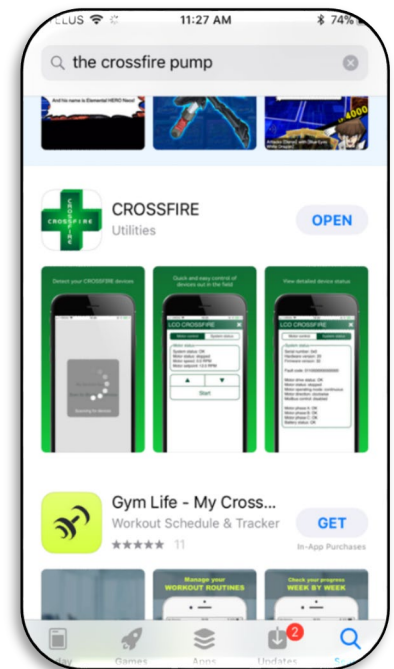
## Software Installation:

### **Step 1: Download the Computer Interface Software**

- Go to <https://lcotechnologies.com/resources.html>
- Click on download button and follow all prompted instructions
- ZIP file password: **crossfire2017**
- The Interface is compatible with the following operating systems:
  - Windows 7
  - Windows 8.1
  - Windows 10
- Both the operator and technician tabs are password protected.
  - Operator Password: **Pristine**
  - Technician Password: **Automatic**

### **Wireless Option:**

- In addition to the full computer software, there is a wireless communication option to the computer software or to a mobile phone or tablet
- Required Parts:
  - BT-SAI-01 (BT5-SAI) or BT-PTM-01 (BT5-PTM)
  - Optional: BT-USB-01 (BT5-USB) for laptop connection only
- Download mobile App on **Apple App Store** or **Android App Store**
  - Search “CROSSFIRE” or “LCO CROSSFIRE”
  - Alternative: go to the LCO website and click on the App store link listed under the “Resources” tab
- Both the operator and technician tabs are password protected
  - Operator Password: **Pristine**
  - Technician Password: **Automatic**
- If using BT-SAI-01 with a laptop for wireless connection, go to <https://lcotechnologies.com/resources.html> and download the device driver ([Drivers for USB->Bluetooth adapter](#))
  - No password required
- For any other information regarding wireless Bluetooth communication and installation details, please refer to the Bluetooth Product Spec Sheet found at: <https://lcotechnologies.com/resources.html>





## Interface Guide

The LCO Technologies **CROSSFIRE** Configuration Software is a tool used to easily monitor and configure the controller that drives the **CROSSFIRE** pump with a RS232 serial connection. Additionally, a mobile version of the software for cell phones and tablets is available using Bluetooth Low Energy communications.

There are two distinct logins for the interface – technician and operator. Operators have viewing access to all tabs, however, can only make changes within the [motor control](#) and [system status](#) panels. Technicians have access to all panels and can make changes to all settings, including the more advanced automation features in the [automation](#) tab.

## Interface Overview

The **CROSSFIRE** configuration software is divided into three regions:

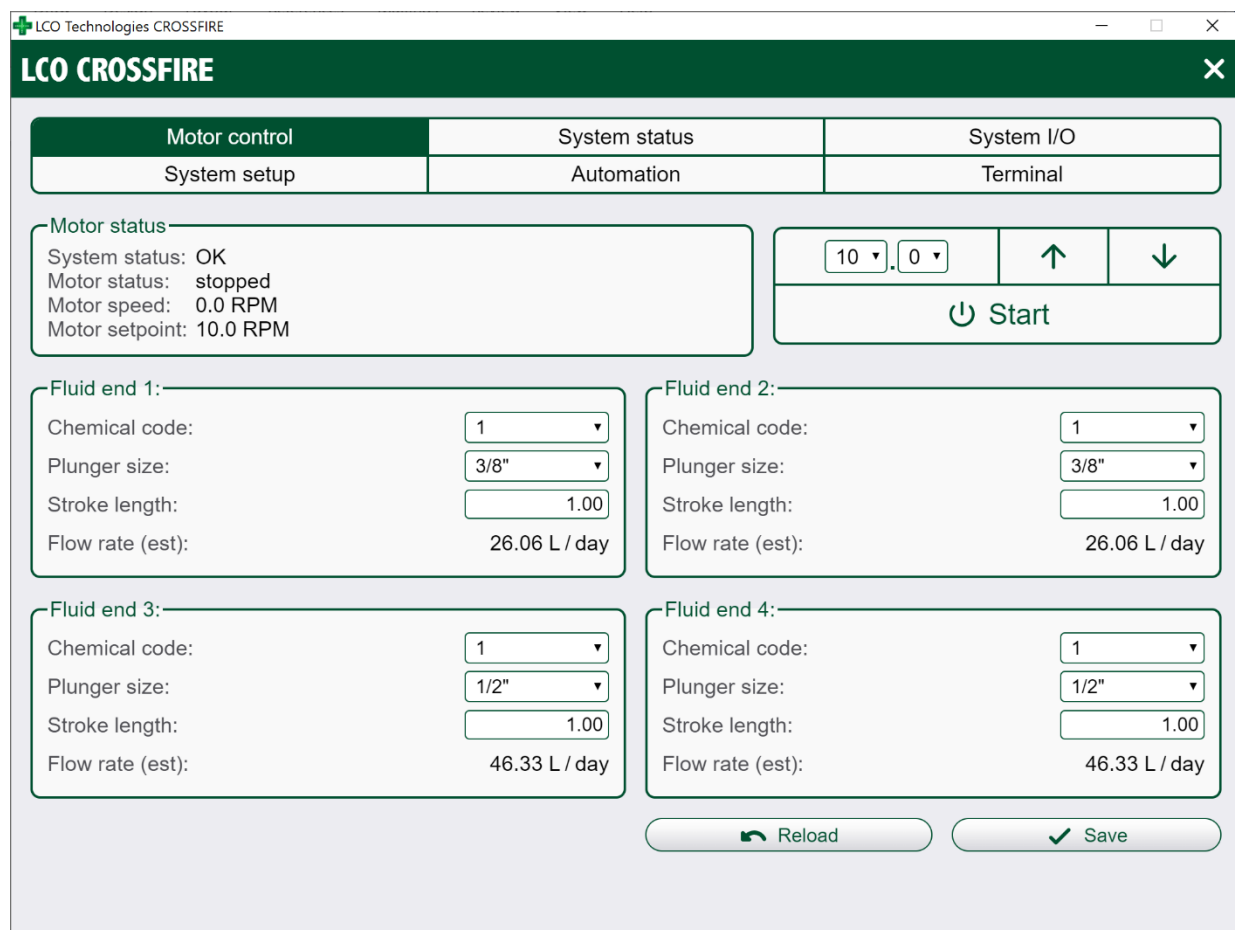


Figure: **CROSSFIRE** Configuration Software main window

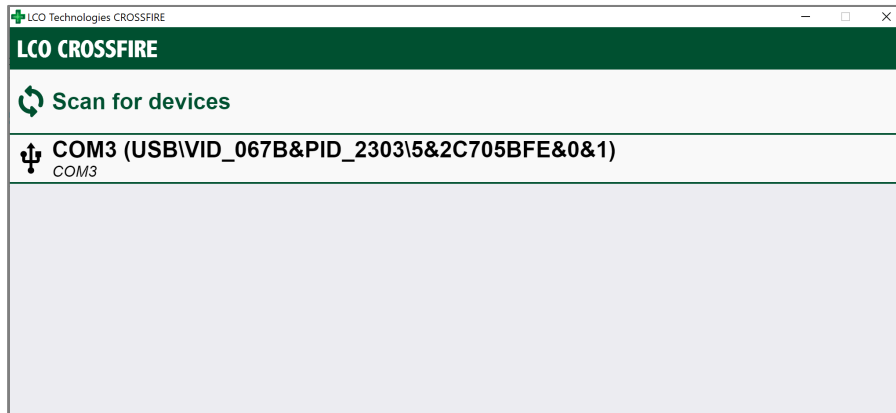
- 1) Main menu bar: Used to connect and disconnect from the **CROSSFIRE** controller and switch between operation tabs.
- 2) Motor control panel: Shows motor status and is used to start/stop the motor and set motor speed (available for both operators and technicians). Additionally, will display advanced automation mode instead of speed settings if configured.
- 3) Configuration panel: Used to view and edit the configuration data stored on the **CROSSFIRE** controller (ex. plunger size, and chemical injected)

## Main menu

### **Connect to Controller:**

The main screen is used to scan for devices and connect to the *CROSSFIRE* controller and pump. Ensure the pump is powered on and click [Scan for Devices](#) and select the appropriate COM Port.

- See: Troubleshooting – COM Port Issues if needed

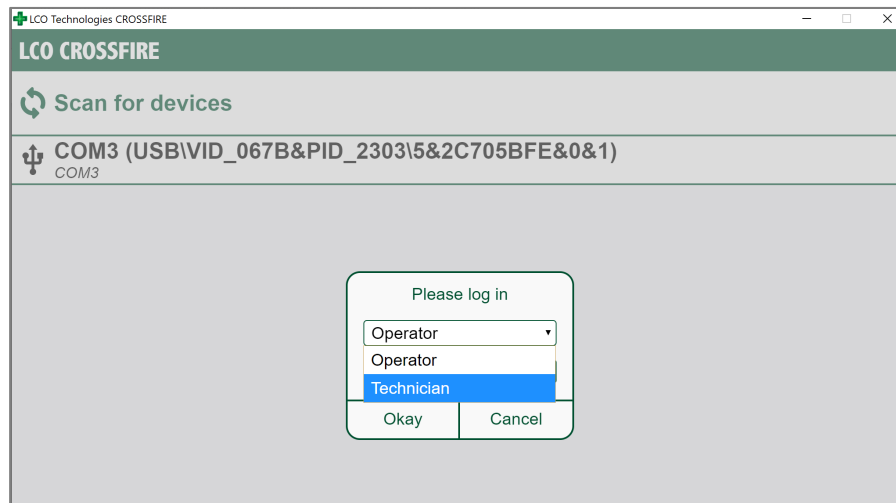


*Figure: Computer Interface Main Page – Connecting to a CROSSFIRE Controller*

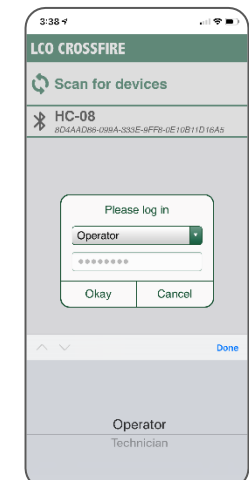


Log into the Controller:

- 1) Login as: Select operator, or technician. Operators only have access to change basic settings; Technicians have access to change all settings, including advanced configuration options.
- 2) Password: Enter the correct password to log in to the controller as operator or technician.
  - Operator Password: **Pristine**
  - Technician Password: **Automatic**



*Figure: Computer Interface Main Page – Log in as Operator or Technician*



*Figure: Mobile App Login*

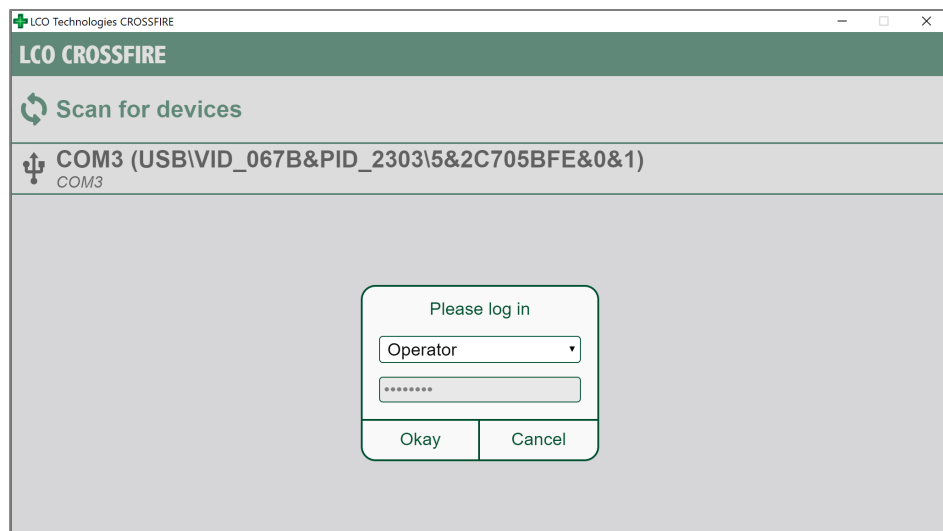


Figure: Computer Interface Main Page – Log in as Operator or Technician

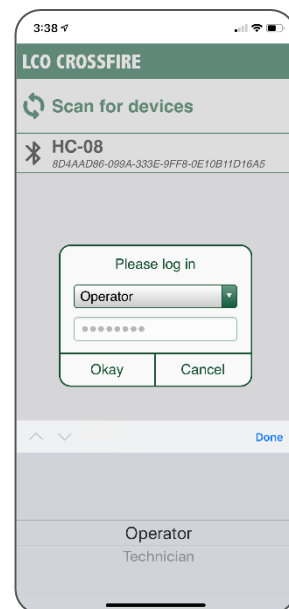


Figure: Mobile App Login

If connecting to the controller succeeds, the configuration and status panels will be enabled and will begin showing data from the pump. If the attempt to connect fails, an error message will be displayed (see: Troubleshooting – Connection Errors).

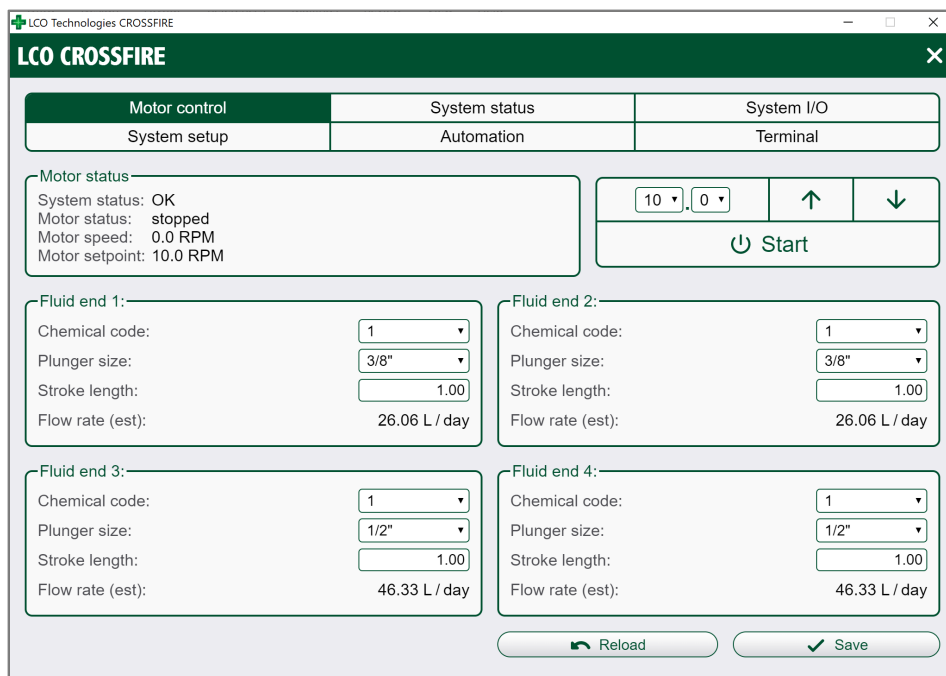
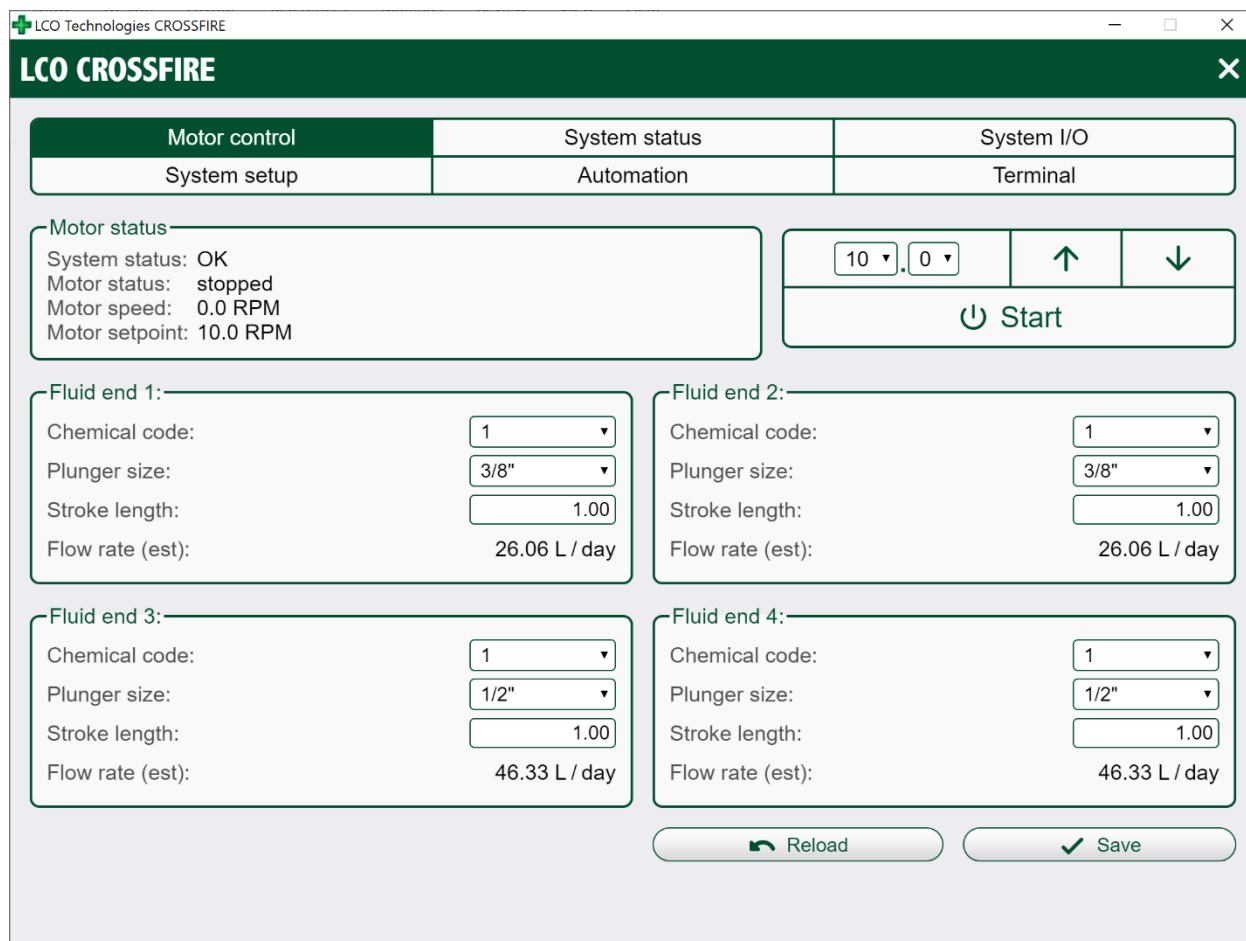


Figure: Computer Interface Main Page – Successful Login

## ***Disconnect from Controller:***

To disconnect from the controller, click the white X in the top right-hand corner.

## **Motor Control Tab**



Motor control	System status	System I/O
System setup	Automation	Terminal

**Motor status**  
 System status: OK  
 Motor status: stopped  
 Motor speed: 0.0 RPM  
 Motor setpoint: 10.0 RPM

10 0  
 ↑ ↓  
 Start

**Fluid end 1:**  
 Chemical code: 1  
 Plunger size: 3/8"  
 Stroke length: 1.00  
 Flow rate (est): 26.06 L / day

**Fluid end 2:**  
 Chemical code: 1  
 Plunger size: 3/8"  
 Stroke length: 1.00  
 Flow rate (est): 26.06 L / day

**Fluid end 3:**  
 Chemical code: 1  
 Plunger size: 1/2"  
 Stroke length: 1.00  
 Flow rate (est): 46.33 L / day

**Fluid end 4:**  
 Chemical code: 1  
 Plunger size: 1/2"  
 Stroke length: 1.00  
 Flow rate (est): 46.33 L / day

Reload Save

Figure: Motor Control Tab – Pump Setup

The **Motor control** tab is used to specify the physical setup and operational speed of the **CROSSFIRE** platform, and is divided into two regions:

- 1) Fluid end settings, to record configuration of the pump
- 2) Save/reload buttons, to transfer the configuration to and from the **CROSSFIRE** controller.

**Note:** Fluid end settings are only visible when configured as a pump and hidden when configured as a compressor.

The fluid end settings are used to configure the four fluid ends that can be installed on the *CROSSFIRE* platform. Each fluid end has a separate setup pane:

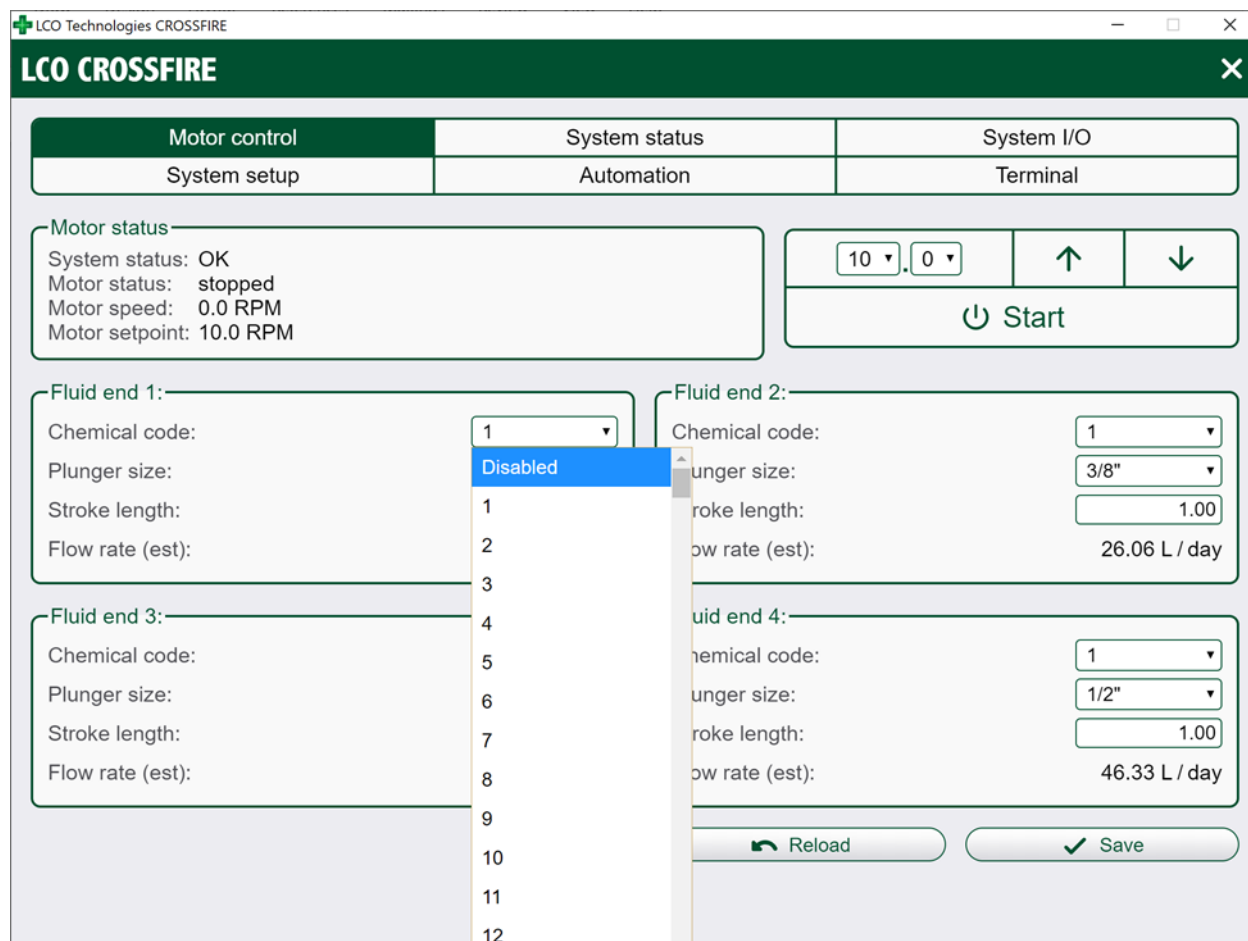


Figure: Motor Control Tab - Pump setup

The *chemical code* dropdown menu is used to indicate whether a fluid end is installed on each of the four available positions on the *CROSSFIRE* platform and to indicate chemical type. Enabling or disabling the fluid end allows the controller to correctly track the total accumulated number of pump strokes the system has made per motor rotation; thus, it is **critical** to ensure if a fluid end is not present, *disable* is selected and saved.

Fluid end *plunger size* and *stroke length* is also recorded here and based on those parameters in addition to speed of the pump, an estimated delivery rate will be displayed. The standard gearbox installed on the *CROSSFIRE* platform allows the system to be run between 1 and 45 RPM. *Stroke length* by standard is 1", however can range from between 0.35"-1.00" when an adjustable stroke length plunger is installed.

*Note: The volume injected is a theoretical calculation based on operation parameters, and actual volume delivered may vary from this depending on factors such as system pressure and packing materials used in the fluid end.*

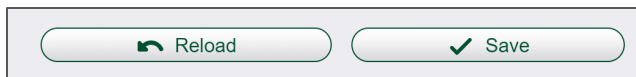


Figure: Save/Reload buttons

The [Save](#) button saves any changes made to the fluid end settings and pump speed to the configuration data saved in the controller.

The [Reload](#) button reloads the saved configuration data from the controller.

**Note: Any unsaved changes made to the settings will be lost.**



## Motor Control Panel

The [motor status panel](#) is used to configure and check the status of the system drive motor:

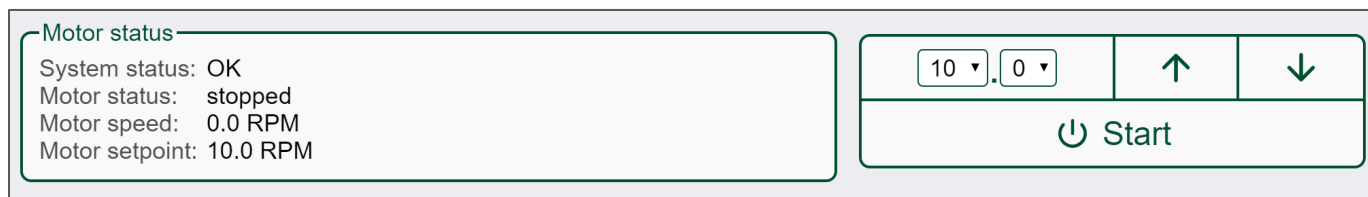


Figure: Motor control panel

When connected to the controller, the [start/stop button](#) will start or stop the motor when the controller is connected and online. The [motor speed selection](#) configures the RPM setpoint of the motor and can be changed from the drop-down menu or the up and down arrow buttons.

*Note: This panel will change based on the automation mode configured. If the chemical pump is configured in proportional control mode for example, the motor status will reflect the active configuration.*



## System Status Tab

The [system status](#) panel provides detailed status and diagnostic information about the motor and controller:

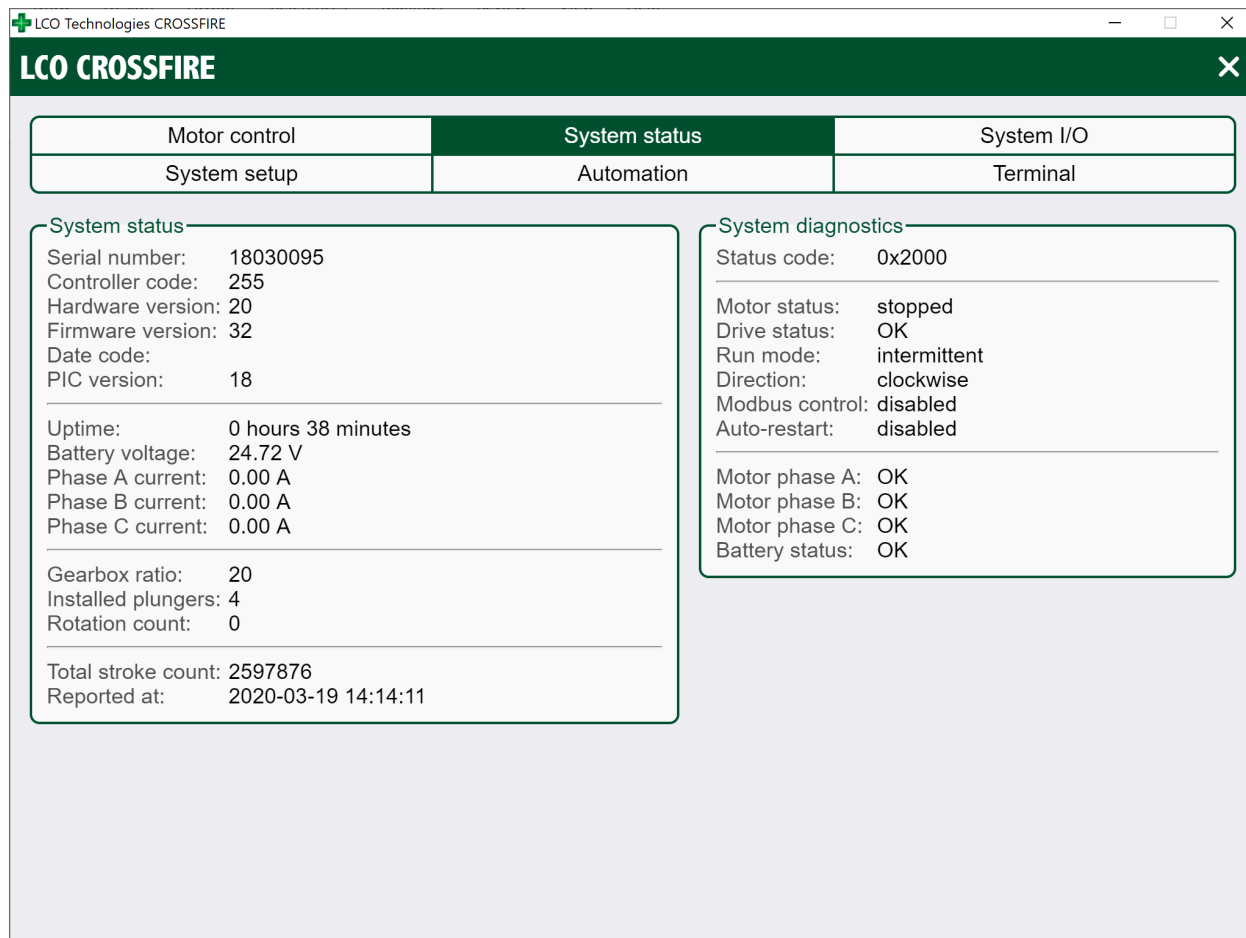


Figure: System status tab

[System status](#) shows the controllers unique serial number, hardware, firmware, uptime of the connected controller and the configured state of the pump hardware. It also shows the total rotation count and total stroke count for the device.

[System diagnostics](#) displays the current system status code; underneath, a detailed breakdown of the code will describe system condition any detected faults if applicable. This information is updated every few seconds. The most recent fault record is listed below if applicable.

**Note: Stroke count is based on the number of positions on the *CROSSFIRE* platform with fluid ends installed at the time of each motor revolution. It is critical that you have the chemical code drop down menu active or inactive for all present fluid ends to ensure accurate count.**



## System Setup Tab

The [System setup](#) tab allows for setup and configuration some advanced controller features, download of record and system reports, and is divided into four regions:

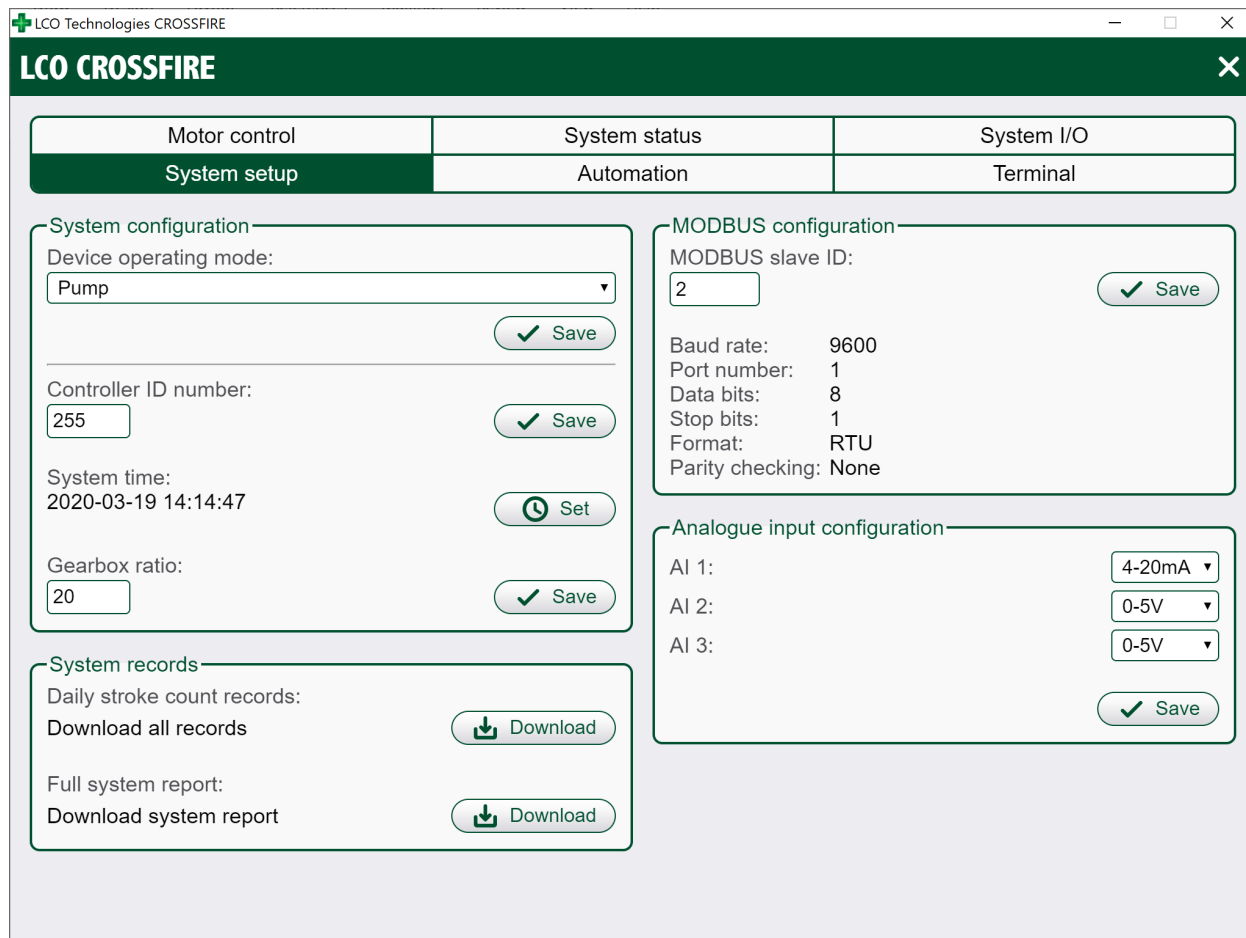
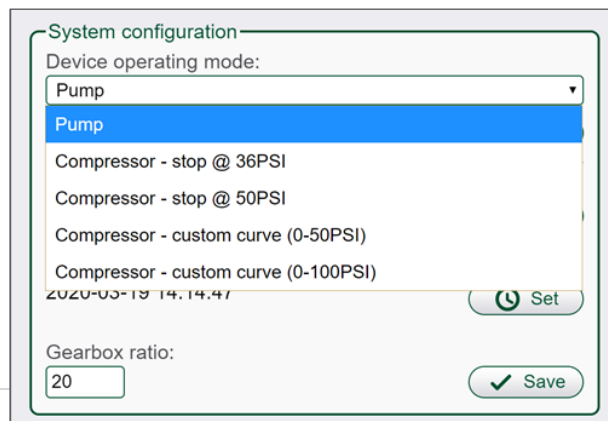


Figure: System Setup Tab

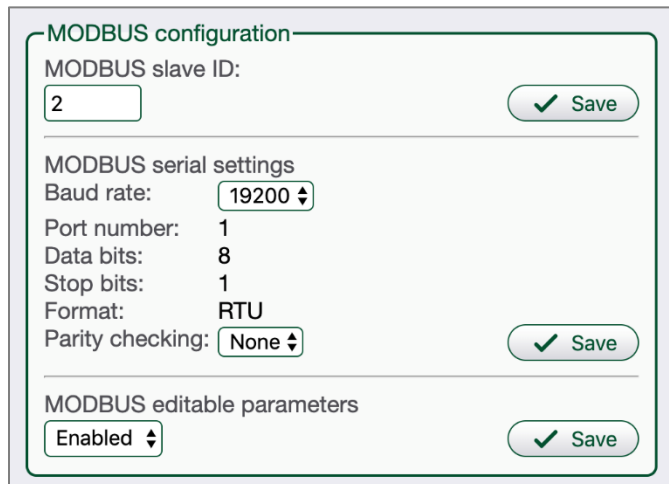
- 1) System configuration
- 2) MODBUS configuration
- 3) System records
- 4) Analogue input configuration

The [system configuration](#) settings are used to set the main operating device mode and reset or change controller parameters.

- [Device operating mode](#) is used to select between pump or compressor modes
- [Controller ID number](#) can be used to assign a number to the controller (any value between 0 to 255)
- [System time](#) sets the controller's system clock to the current date and time
- [Gearbox ratio](#) specifies the gear ratio of the installed gearbox on the motor (pump ratio is 20:1)



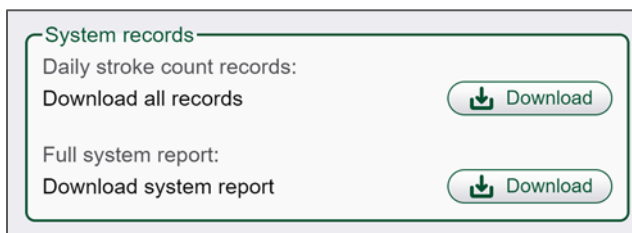
The **MODBUS configuration** settings are used to view and change the settings of the controller's MODBUS port, in order to properly integrate it with your SCADA system. Configurable option includes **MODBUS slave ID**, **parity checking** and **baud rate**. **Port number**, **data bits**, **stop bits**, and **format** are automatically determined according to the MODBUS standard. The **Save** button will save the settings to the controller.



The image shows a 'MODBUS configuration' window. It has three sections: 1. 'MODBUS slave ID' with a text input field containing '2' and a 'Save' button. 2. 'MODBUS serial settings' with fields for 'Baud rate' (19200), 'Port number' (1), 'Data bits' (8), 'Stop bits' (1), 'Format' (RTU), and 'Parity checking' (None), with a 'Save' button. 3. 'MODBUS editable parameters' with a dropdown menu set to 'Enabled' and a 'Save' button.

Figure: System Setup Tab – Modbus Configuration Section

The **Systems record** section allows users to download a daily stroke count record log and full system report. By clicking download, the report will automatically save to your desktop computer.

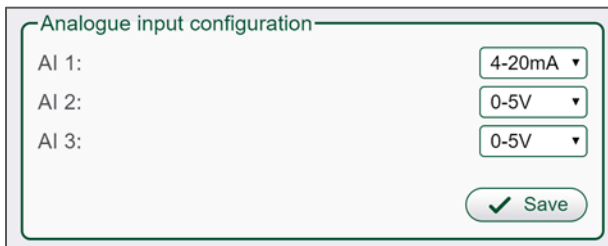


The image shows a 'System records' window. It contains two sections: 1. 'Daily stroke count records' with a 'Download all records' button. 2. 'Full system report' with a 'Download system report' button. Both buttons have a download icon.

Figure: System Setup Tab – System Record Section

**Note:** For mobile users, the app has an option to email or save the downloaded records. For iPhone users, the app will automatically save a copy of the file to the device, which can be found in the iOS system files app under “On My iPhone > CROSSFIRE > SystemReports”.

The **Analogue input configuration** section is used to set the Analogue inputs to 4-20mA or 0-5V. Once selected, press **save** to apply changes.



The image shows an 'Analogue input configuration' window. It has three rows: 'AI 1:' with a dropdown set to '4-20mA', 'AI 2:' with a dropdown set to '0-5V', and 'AI 3:' with a dropdown set to '0-5V'. There is a 'Save' button at the bottom right.

Figure: System Setup Tab – Analogue Input Configuration Section

## System I/O Tab

The [System I/O](#) panel is used to view the state of the controller's discrete input, discrete output, analogue inputs, and analogue output pins. Inputs will auto-populate when connected to the controller however, all I/O configuration for outputs must be done in the terminal tab. Specific control applications can be exercised under the [Terminal](#) tab, which will allow you to configure a wide variety of process logic parameters. Please contact LCO Technologies directly for assistance with I/O configuration.

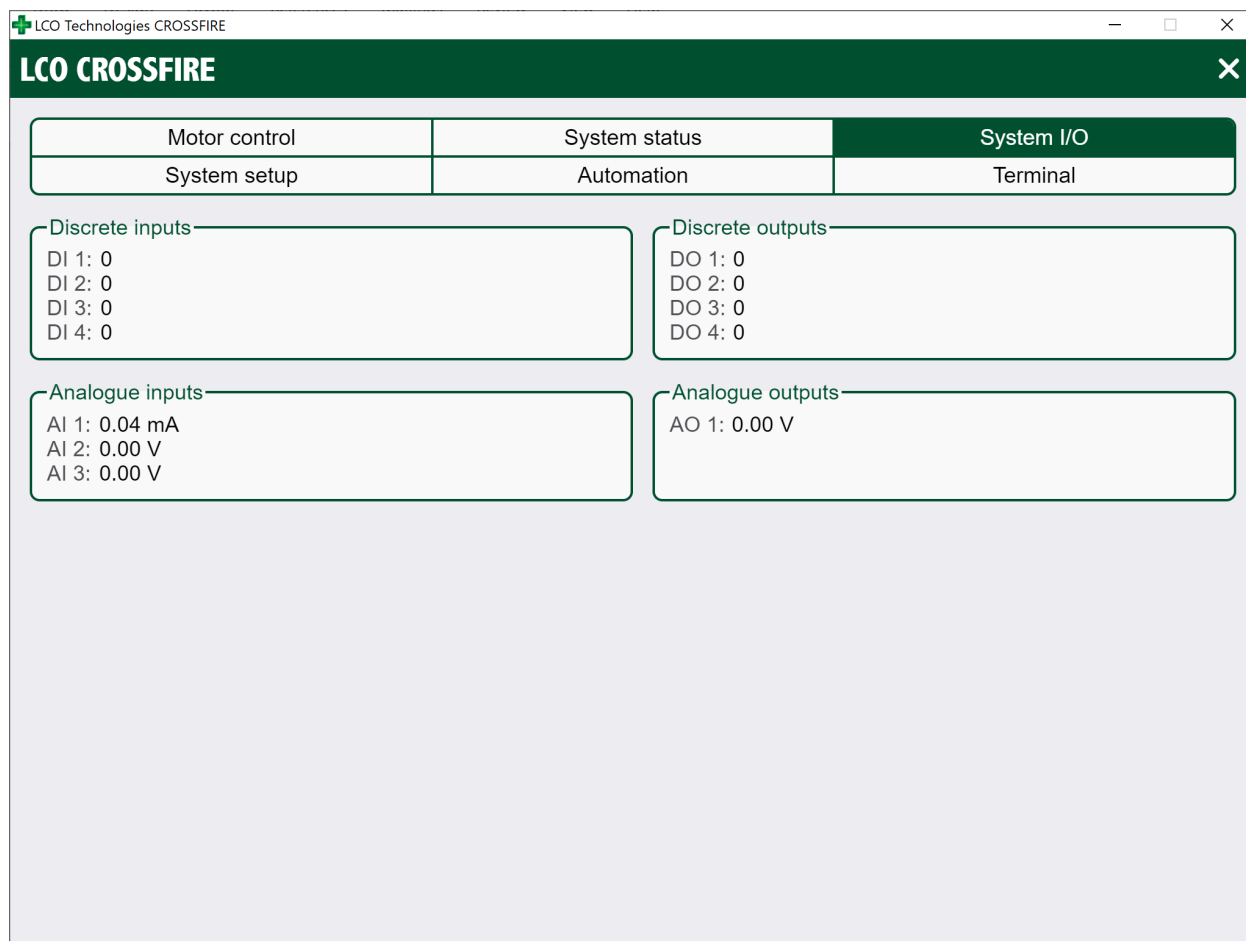


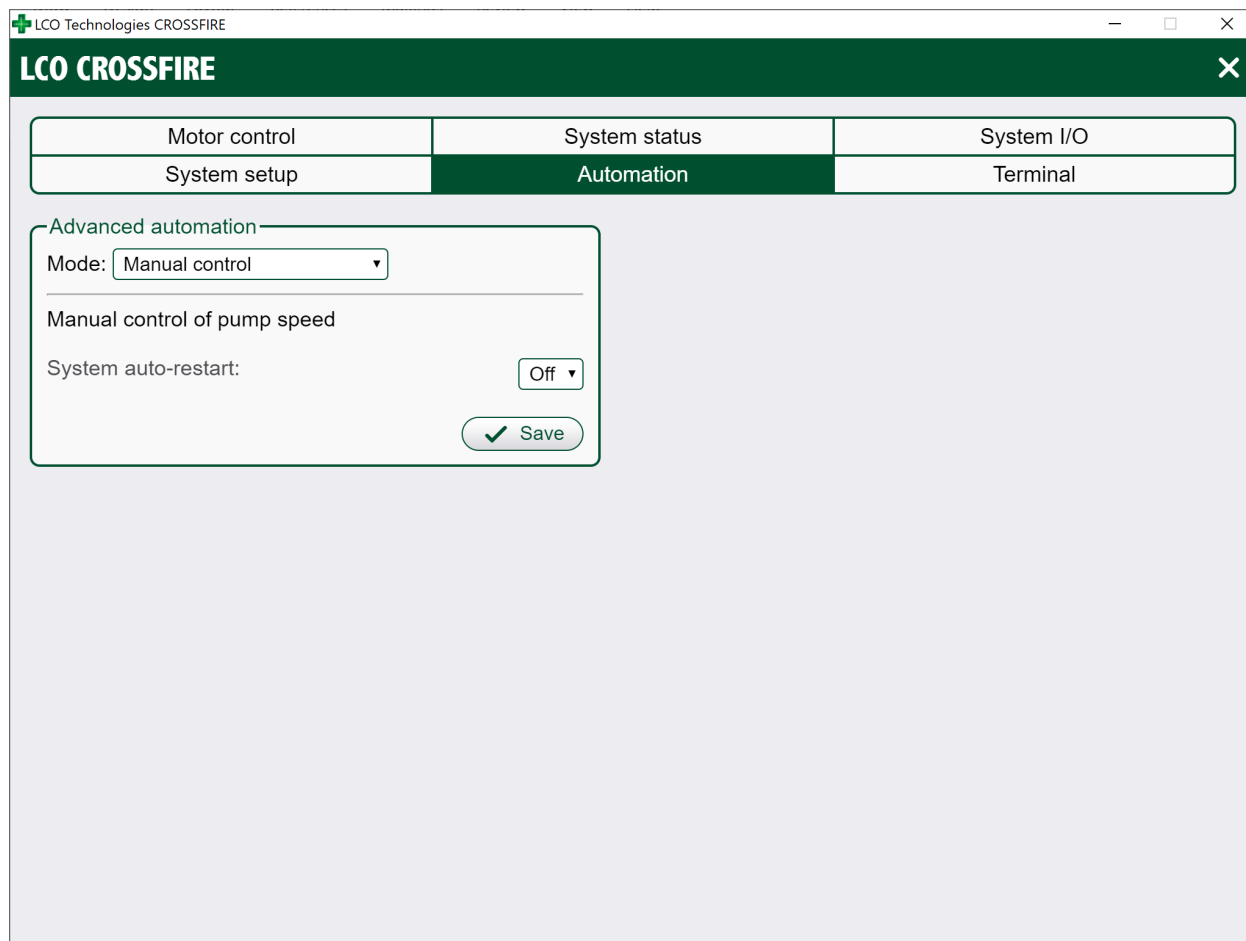
Figure: System I/O Tab

**Note:** Monitored values are refreshed every few seconds that the System I/O tab is open



## Automation Tab

The [automation](#) tab is only available to Technicians. This allows selection between manual control mode, proportional control mode, plunger lift control, potentiometer control, local/remote switch control mode, and toggle switch control mode.



*Figure: Automation Tab – Manual Control*

When in [Manual Control](#), all settings such as pump on/off and motor speed are controlled in the main [motor control](#) tab. By default, if the system has a power loss event, the pump will shut off and not start back up, even if 24V of power comes back on. To enable the pump to automatically start up after a system power loss, click the drop-down menu from OFF to ON for [system auto-restart](#). Press [save](#) to finalize change.

The **Proportional Control** feature allows the motor speed to be driven by a value applied to the controllers **Analogue Input 1**. As the analogue value changes, the motor speed will automatically change accordingly.

Select the appropriate input mode (4-20mA or 0-5V) and type the requested speed at corresponding analogue input signal. As changes are made, the visual graph will display the proportional control curve. Once the parameters are defined, press **save** to engage function. The motor speed will now automatically scale between the defined parameters.

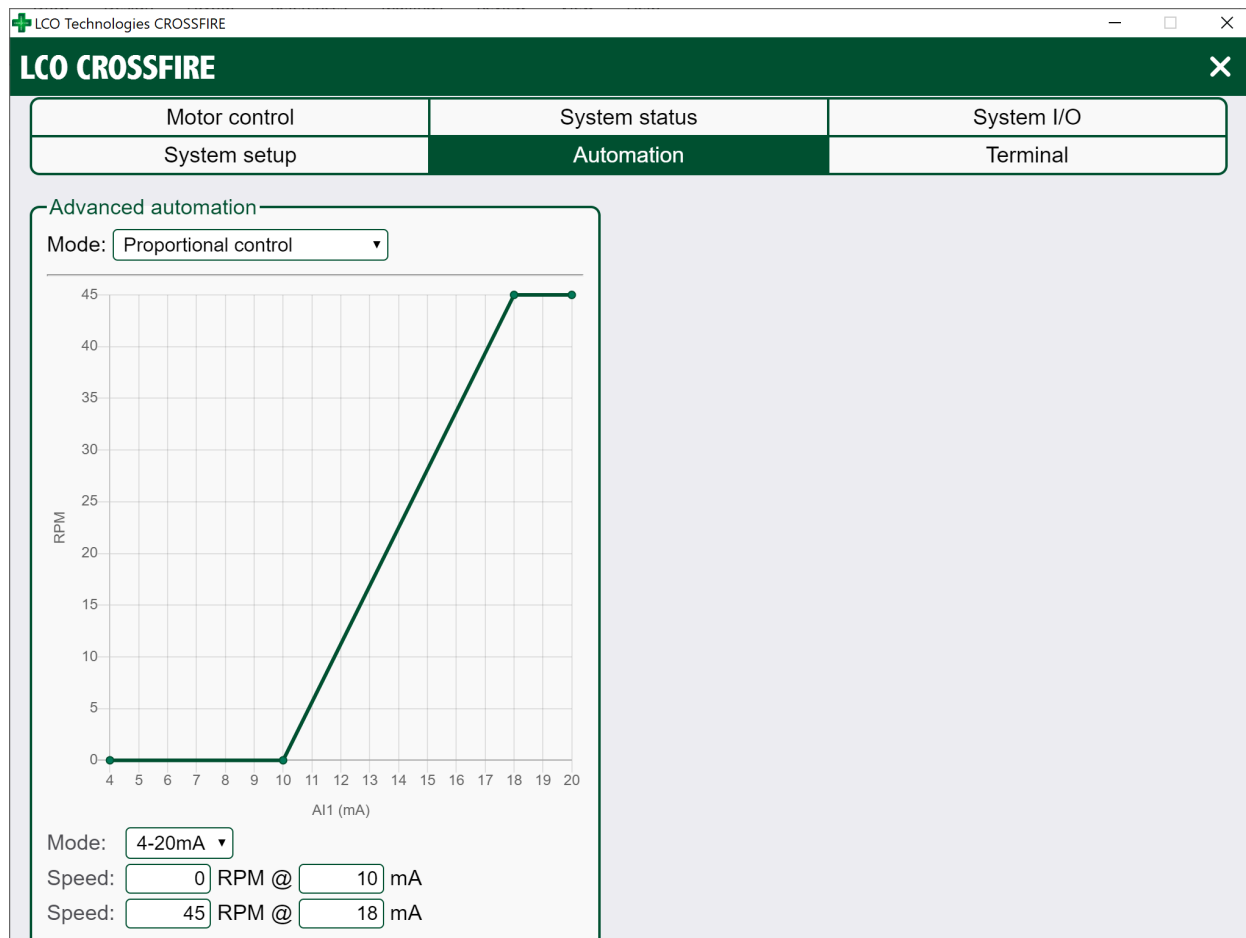
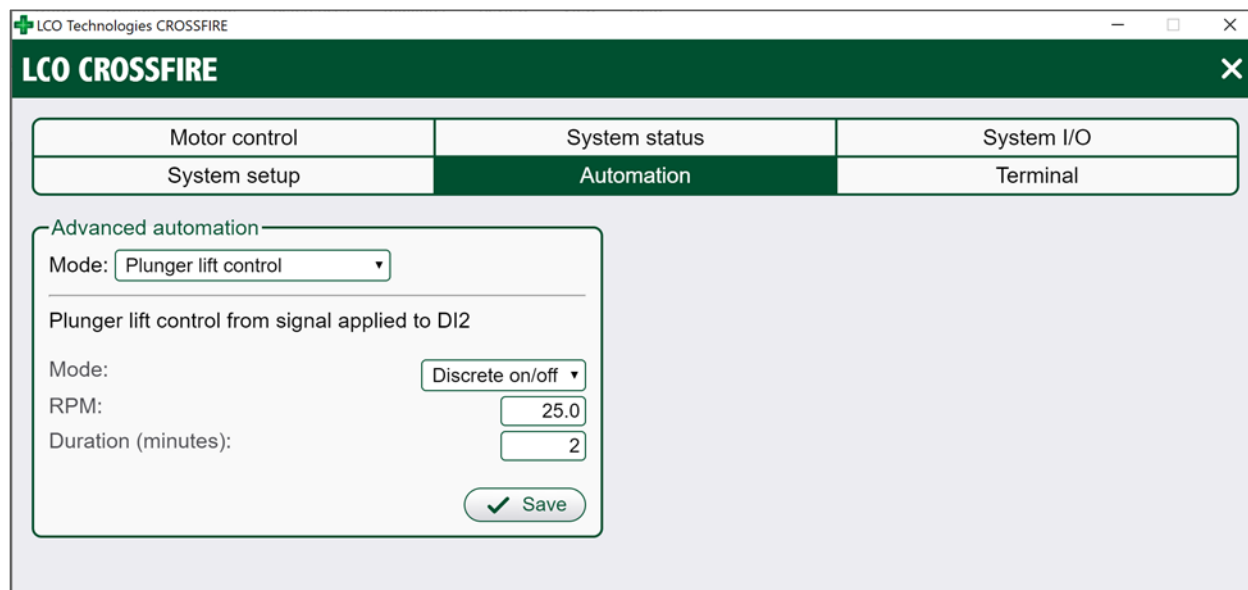


Figure: Automation Tab - Proportional Control

**Note:** When in proportional control mode, system auto restart function (as described on page 19) is automatically engaged.



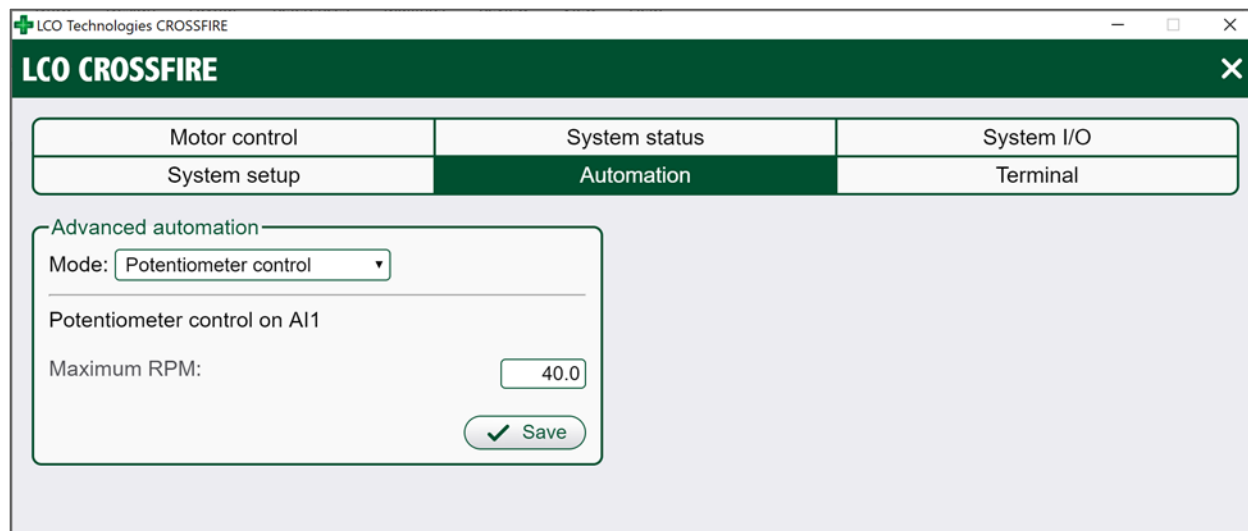
The *plunger lift control* function is used to automatically inject chemical at a set RPM for a specified time period once the plunger drops. Connect the plunger lift controller to the D1<sup>2+</sup> terminal on the *CROSSFIRE* controller and select the *mode*, *RPM*, and *duration*. Press *save* to activate function. Please contact LCO Technologies directly when engaging this function for further instructions.



The screenshot shows the LCO CROSSFIRE web interface. At the top, there's a green header with the LCO Technologies CROSSFIRE logo and a close button. Below the header is a navigation bar with three tabs: 'Motor control', 'System status', and 'System I/O'. The 'Automation' tab is selected and highlighted in green. Under the 'Automation' tab, there's a 'Terminal' sub-tab. The main content area is titled 'Advanced automation' and contains a dropdown menu for 'Mode' set to 'Plunger lift control'. Below this, it says 'Plunger lift control from signal applied to DI2'. There are three input fields: 'Mode' (set to 'Discrete on/off'), 'RPM' (set to '25.0'), and 'Duration (minutes)' (set to '2'). A green 'Save' button with a checkmark is at the bottom right of the form.

Figure: Automation tab – Plunger Lift Control

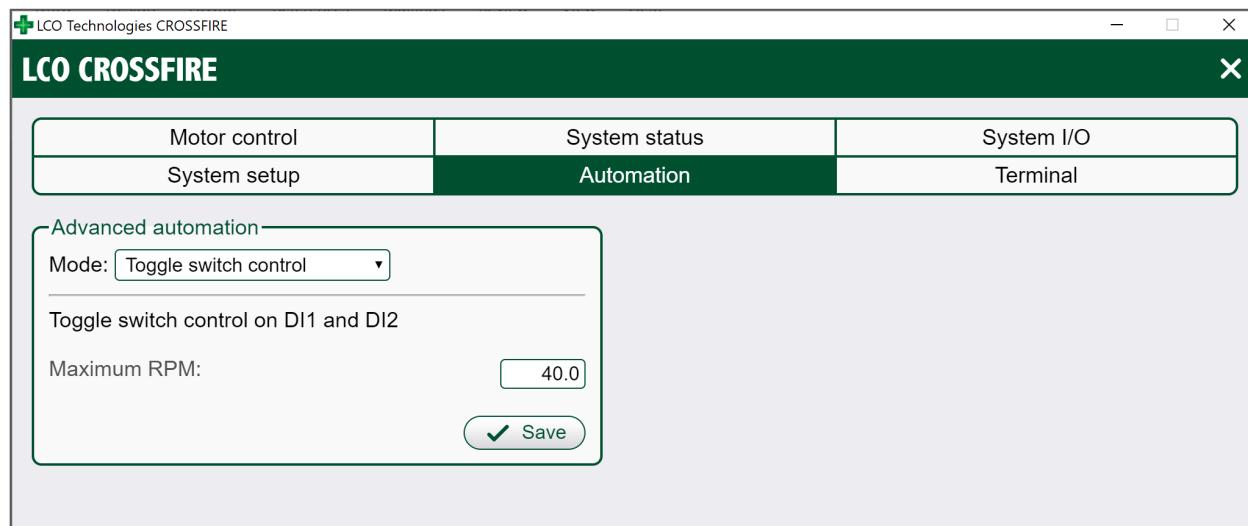
The *potentiometer control* function is a special feature that requires additional instruction from LCO Technologies. Please contact the factory for assistance.



The screenshot shows the LCO CROSSFIRE web interface. At the top, there's a green header with the LCO Technologies CROSSFIRE logo and a close button. Below the header is a navigation bar with three tabs: 'Motor control', 'System status', and 'System I/O'. The 'Automation' tab is selected and highlighted in green. Under the 'Automation' tab, there's a 'Terminal' sub-tab. The main content area is titled 'Advanced automation' and contains a dropdown menu for 'Mode' set to 'Potentiometer control'. Below this, it says 'Potentiometer control on AI1'. There is one input field: 'Maximum RPM' (set to '40.0'). A green 'Save' button with a checkmark is at the bottom right of the form.

Figure: Automation tab – Potentiometer Control

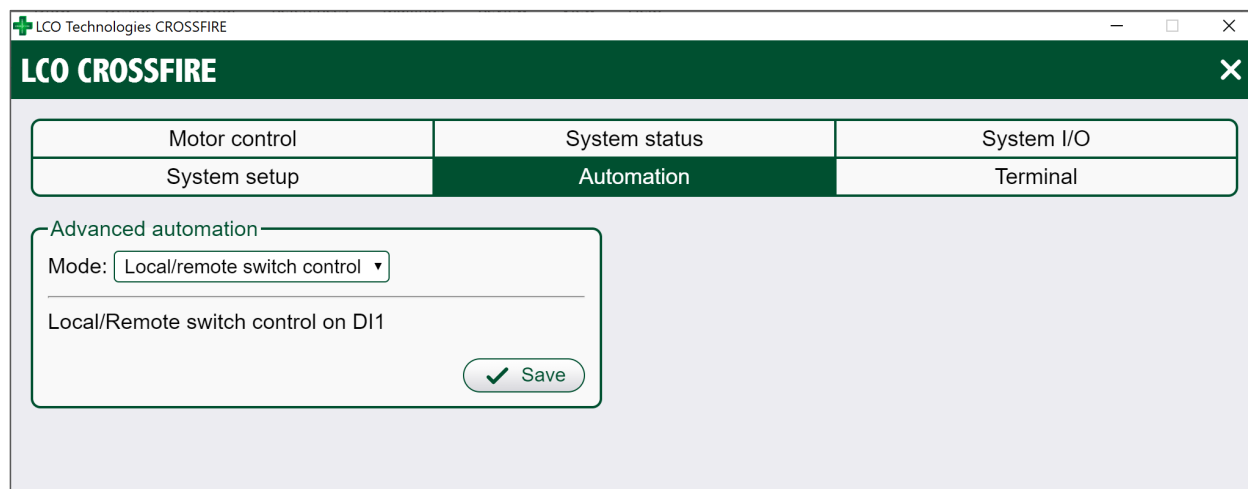
The **Toggle Switch Control function** allows motor speed to be manually controlled by a momentary contact switch on the outside of the electrical NEMA 4 panel. Ensure the switch is connected to the DI1 and DI2 ports on the controller. Once connected, select the **toggle switch control** function from the drop-down menu, set your **Maximum RPM** (45 RPM or less) and press **save** to engage function. Each click of the toggle switch up or down will equal 0.5 of an RPM. Ensure appropriate labels are applied to the panel so Operators can easily identify up/down directions and that each click represents 0.5 RPM.



The screenshot shows the LCO CROSSFIRE web interface. At the top, there's a navigation bar with 'LCO CROSSFIRE' and a close button. Below it is a tabbed interface with three tabs: 'Motor control', 'System status', and 'System I/O'. The 'Automation' tab is selected, showing a sub-tabbed interface with 'System setup', 'Automation', and 'Terminal'. The 'Automation' sub-tab is active, displaying the 'Advanced automation' section. This section includes a 'Mode' dropdown menu set to 'Toggle switch control', a label 'Toggle switch control on DI1 and DI2', a 'Maximum RPM' input field with the value '40.0', and a 'Save' button with a checkmark icon.

Figure: Automation Tab - Toggle Switch Control

**Local Remote Switch Control** is a function that must be engaged when connecting the **CROSSFIRE** to a remote-control monitoring system (such as SCADA or RTU systems). By connecting a two-position selector switch to the DI1 terminal on the controller, operators can manually switch the control from remote to local before completing any maintenance on the pump. Select **Local/Remote switch control** from the drop-down menu and press **save** to engage function.



The screenshot shows the LCO CROSSFIRE web interface, similar to the previous one. The 'Automation' tab is selected, and the 'Local/Remote switch control' function is configured. The 'Mode' dropdown menu is set to 'Local/remote switch control'. The label indicates 'Local/Remote switch control on DI1'. A 'Save' button with a checkmark icon is visible at the bottom of the configuration section.

Figure: Automation tab – Local/Remote Switch Control

## Terminal Tab

The Terminal tab is available to both Operators and Technicians however, the commands will be limited when logged in as Operator. This tab allows users to by-pass any software selections and speak directly to the controller. This tab can be used for troubleshooting to determine if communication errors exist on the controller or software and can also be used for more advanced configuration such as I/O commands specific to applications. For a full list of applicable commands contact LCO Technologies directly.

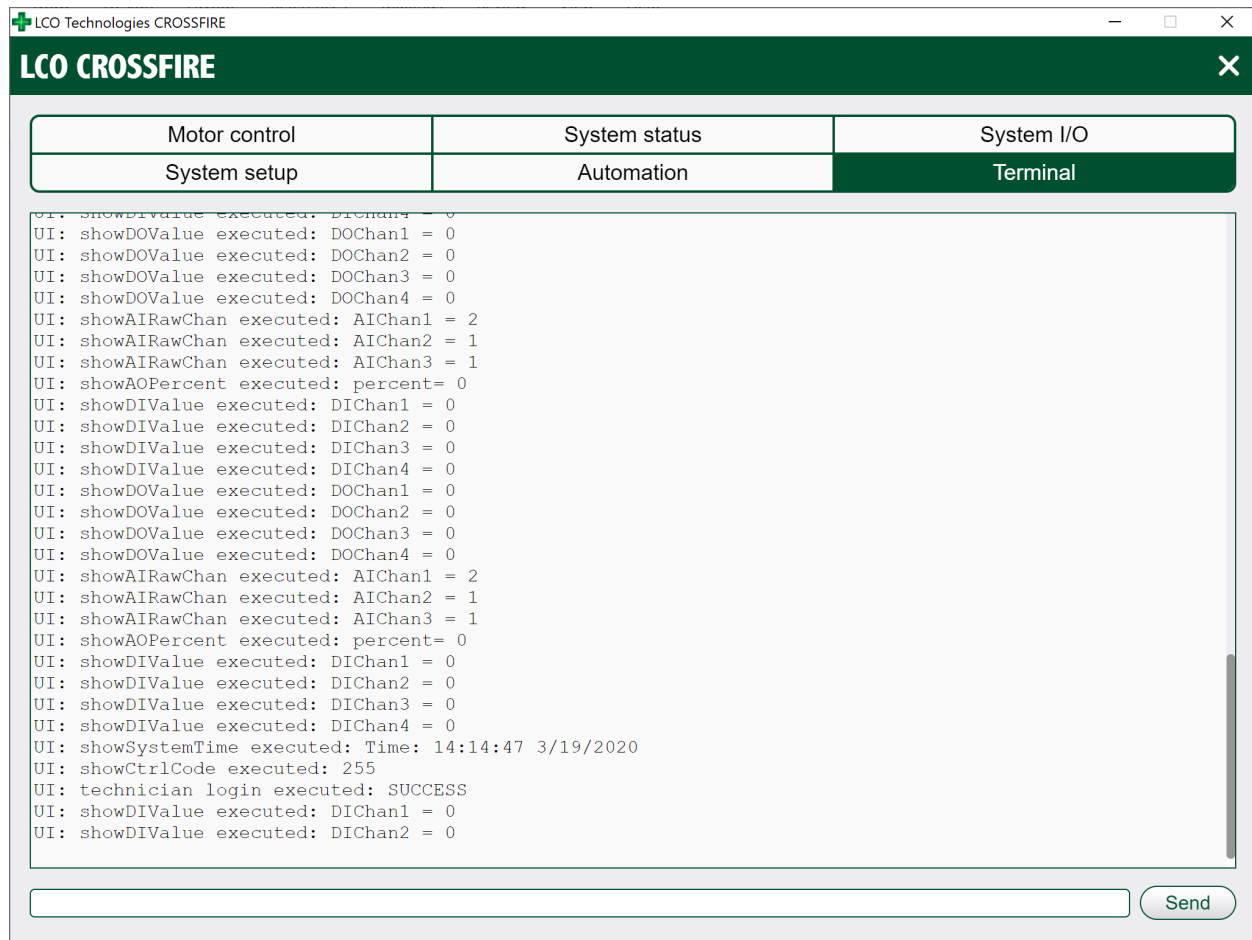
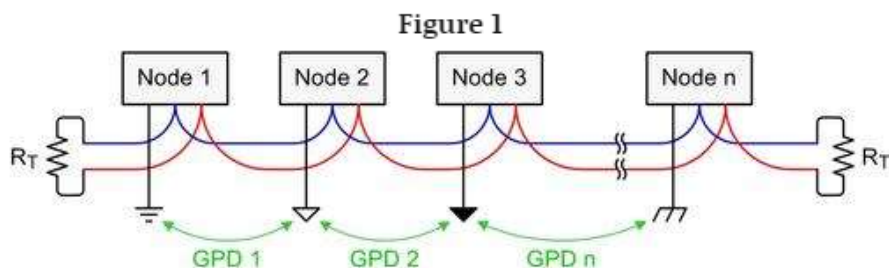


Figure: Terminal Tab

## Frequently Asked Questions: Automation & MODBUS

- Q: Can you tie multiple CROSSFIRE controllers on the same RS485 Modbus
  - A: Yes, you can daisy chain multiple CROSSFIRE controllers on the same Modbus even with other devices set up as Modbus slaves. Every slave must have a unique Modbus Slave ID, from 1 to 247. 0 is reserved for the master. Default slave ID is 2 for the CROSSFIRE Controller.
- Q: Do you need to connect the GND terminal on the RS485 port?
  - A: No, connecting GND terminal is not mandatory for the 2-Wire RS485 bus. If the Modbus has multiple slaves and the site is electrically noisy, connecting all the slaves' RS485 GND to the master RS485 GND may help to improve Modbus communication. Ensure the RS485 GND should never be connected to the power supply ground or the safety ground.
- Q: Does the Modbus need to be terminated?
  - A: Yes, the trunk of this RS485 based Modbus should be terminated on both ends with a 120 Ohm resistor across RS485+/A+ and RS485-/B-. This usually means the master or RTU and the last slave at the end of this RS485 bus.



- Q: What are the valid baud rates and serial com settings?
  - A: Default is 9,600. Other choices are 14,400 and 19,200. 8 data bits, no parity, 1 stop bit and no flow control.
- Q: How often can you poll a CROSSFIRE controller?
  - The CROSSFIRE controller can be polled every 500ms
- Q: Can you poll all the registers provided by the CROSSFIRE Controller?
  - Yes, you can poll all 300+ registers **but we do not recommend this** as it will severely slow down Modbus communication due to the heavy traffic on the RS485 bus. There is no reason to poll all the registers, most sites require 40 registers or less to fully control and monitor a pump or a compressor onsite. We recommend you choose the registers most important to monitor the CROSSFIRE. **In an effort to reduce power consumption we have limited the maximum number of read or write registers to eight (8) per poll.**
- Q: Where can I get the Modbus register map?
  - You can get the latest Modbus register map from LCO Technologies.

- Q: What can you control over Modbus the pump?
  - Turn a pump on or off, set the speed (motor RPM) etc.
- Q: What are the steps to activate the pump under remote control over Modbus?
  - Two things must be done to transfer control from local to remote:
    - Put 24V on DI1 terminals with the use of a two position Local/Remote hand switch. 0V on DI1 will disable remote control and put pump on local control mode.
    - Select “Local/Remote Switch Control” under the Automation tab in the software
- Q. Do you need to put the controller in remote control mode in order to read its registers?
  - A: No, you can read any register in both local and remote modes. You can, however, control speed and pump on/off in remote mode only.
- Q: How do you know the current status of the pump or the compressor?
  - Connect with the computer or app interface software and select the “System Status” tab. This tab provides detailed status and diagnostic information.
- Q: If a pump has faulted and stopped for an unknown reason, how can I find out the fault code to troubleshoot if it doesn’t show up as an active fault in the “system status” panel?
  - Depending on which version of the software you are using, the systems status tab will display the most recent fault record, under systems diagnostics, if available.
  - Alternatively, as the CROSSFIRE controller records the last fault code in the non-volatile memory, it can be accessed through the Terminal Tab as well. Select the “terminal” tab to send commands to the controller directly. Enter "**showFaultRecord**" and click the send button. The controller will respond with a time tag and a 6 digits hex number. The last two digits of the hex number is the fault flag.
    - 01: Motor stalled due to mechanical jam
    - 02: Motor overload causing over-current or under-voltage
    - 04: Over-current detected by firmware
    - 08: Battery/power supply under-voltage
    - 10: Battery/power supply over-voltage
    - 20: Motor phase A wire is discounted
    - 40: Motor phase B wire is discounted
    - 80: Motor phase C wire is discounted
    - 6X: Motor driver ASIC is damaged (where X is any single digit hex number)
  - Example: faultRecord: 20:4:15 13-11-23: 0x6460**08**

## Possible Fault Codes:

Fault Code	Details	Suggested Troubleshooting
Motor phase A disconnected Fault Code: 20	Conductor wire from motor to Phase A has been disconnected	Field repairable <ul style="list-style-type: none"> <li>– Reconnect conduit wire to controller</li> <li>– If conductor wire is broken, replace as needed</li> </ul>
Motor phase B disconnected Fault Code: 40	Conductor wire from motor to Phase B has been disconnected	Field repairable <ul style="list-style-type: none"> <li>– Reconnect conduit wire to controller</li> <li>– If conductor wire is broken, replace as needed</li> </ul>
Motor phase C disconnected Fault Code: 80	Conductor wire from motor to Phase C has been disconnected	Field repairable <ul style="list-style-type: none"> <li>– Reconnect conduit wire to controller</li> <li>– If conductor wire is broken, replace as needed</li> </ul>
Battery over voltage Fault Code: 10	Battery voltage is over 32 V	Field Repairable <ul style="list-style-type: none"> <li>– Adjust power supply to ensure 24 V is available to the <i>CROSSFIRE</i></li> </ul>
Battery under voltage Fault Code: 08	Battery voltage is under 18 V	Field Repairable <ul style="list-style-type: none"> <li>– Adjust power supply to ensure 24 V is available to the <i>CROSSFIRE</i></li> </ul>
Motor Status: Fault Detected Fault Code: 02 <sup>2</sup> or 04 <sup>2</sup>	Motor has stalled, due to: <ul style="list-style-type: none"> <li>– Operating outside compressor design parameters</li> <li>– Insufficient voltage or current</li> <li>– Mechanical obstruction</li> </ul>	Field Repairable <ul style="list-style-type: none"> <li>– Ensure the maximum torque requirements are within the motor limits</li> <li>– Ensure the power supply has sufficient current capacity at the maximum load so that supply voltage will not drop below the required 24 VDC</li> <li>– Clear any mechanical obstruction that is preventing motor rotation</li> </ul>



<p>Motor drive status: faulted, motor overload, or controller needs repair</p> <p>Fault Code: 01<sup>2</sup></p>	<p>Motor overload due to mechanical obstruction or insufficient power supply</p> <p>Or</p> <p>Controller is damaged and requires repair</p>	<p>Field Repairable</p> <ul style="list-style-type: none"> <li>– If overload is caused by mechanical obstruction or insufficient power supply, see below</li> <li>– Clear any mechanical obstruction that is preventing motor rotation</li> <li>– Ensure the power supply has sufficient current capacity at the maximum load so that supply voltage will not drop below the required 24 VDC</li> </ul> <p>Not Field Repairable</p> <ul style="list-style-type: none"> <li>– If the problem persists after following the suggested troubleshooting steps as listed above, your controller may require repair or replacement</li> <li>– Talk to your supplier for further instructions</li> <li>– Download a system status report, your supplier may request this to do additional troubleshooting</li> <li>– Go under “System Setup” tab, press “Download full system report” and spreadsheet will automatically save to your computer desktop</li> </ul>
<p>Motor drive status: faulted</p> <p>Fault Code: 30 or 3X</p>	<p>Two phases (such as phase A and phase B) read as broken, one phase (such as phase C) OK</p>	<p>Not Field Repairable</p> <ul style="list-style-type: none"> <li>– This fault code indicates that the IC Component on the controller had been damaged by excessive voltage</li> <li>– This damage can be confirmed in the software terminal tab</li> <li>– Start the pump and read the generated values listed in the terminal tab</li> <li>– The line of interest will be “<b>Motor Start: Resistor A</b>” and “<b>Motor Start: Resistor B</b>”</li> <li>– If either of these values exceed 0.5 ohm or read “INF” the IC component is damaged</li> </ul>

*Note: Other fault codes not listed above may be displayed. Please contact LCO Technologies directly if you have any questions or concerns.*

<sup>2</sup> Please note that fault codes 01, 02, and 04 may have similar symptoms and resolutions

## Controller Troubleshooting

### Connection Errors

When attempting to connect to the controller, a connection error may occur. The following table lists common errors, and solutions:

Error Message	Description & Solution
<b>Error: Password must not be blank</b>	<p>In order to successfully log in to the controller, the password must be entered.</p> <p><i>Possible solutions:</i></p> <ol style="list-style-type: none"> <li>1) Retry connection and enter password (password is case sensitive)</li> </ol>
<b>Could not connect to controller:</b>  <b>No response</b>	<p>When attempting to connect to the controller, the software received no response.</p> <p><i>Possible solutions:</i></p> <ol style="list-style-type: none"> <li>1) Ensure that the serial cable or Bluetooth serial adapter used to connect to the controller is inserted securely into both the computer and the <i>CROSSFIRE</i> controller.</li> <li>2) If you are connecting using a Bluetooth serial adapter, you may be out of signal range or near a radio interference source. Move closer to the controller.</li> <li>3) Ensure the correct COM port is listed (see: Troubleshooting – COM Port Issues).</li> <li>4) Ensure the <i>CROSSFIRE</i> controller is powered on</li> </ol>
<b>Could not connect to controller:</b>  <b>Unknown response</b>	<p>When attempting to connect to the controller, the software received an unrecognized response.</p> <p><i>Possible solutions:</i></p> <ol style="list-style-type: none"> <li>1) Ensure that the serial cable or Bluetooth serial adapter used to connect to the controller is inserted securely into both the computer and the <i>CROSSFIRE</i> controller.</li> <li>2) Ensure the correct COM port is listed (see: Troubleshooting – COM Port Issues).</li> <li>3) Ensure the BAUD rate listed is correct (default – 115200)</li> <li>4) If the problem persists, try connecting with an alternate RS232 cable or Bluetooth serial dongle.</li> </ol>

<b>Could not connect to controller:</b>  <b>Incorrect password</b>	<p>When attempting to connect to the controller, the wrong password was provided.</p> <p><i>Possible solutions:</i></p> <ol style="list-style-type: none"> <li>1) Retry connection and ensure you have the correct password (note: the password is case sensitive)</li> <li>2) Ensure you are connecting under the right user (operator or technician) that corresponds to the correct password</li> </ol>
<b>Disconnected:</b>  <b>Login session with controller expired</b>	<p>For security reasons, the login session with the controller is automatically terminated after one hour. This can be configured to customize an alternate logout time period if requested.</p> <p><i>Possible solutions:</i></p> <ol style="list-style-type: none"> <li>1) Reconnect and log back into the controller.</li> </ol>
<b>Disconnected:</b>  <b>Communication with controller lost</b>	<p>The software lost connection to the <i>CROSSFIRE</i> controller for unknown reasons.</p> <p><i>Possible solutions:</i></p> <ol style="list-style-type: none"> <li>1) Check that the RS232 serial cable or Bluetooth serial adapter has not come loose either from the computer or from the <i>CROSSFIRE</i> controller.</li> <li>2) If connecting using a Bluetooth serial adapter, the connection may have been lost due to signal interference or from moving too far away from the <i>CROSSFIRE</i> controller. Move closer to the controller and away from any radio sources.</li> <li>3) The <i>CROSSFIRE</i> controller may have lost power. Check that the controller is powered on and that the system voltage level is adequate.</li> </ol>

## COM Port Issues

If the software continues to have trouble connecting to the *CROSSFIRE* controller, it may be caused by the serial link to the controller.

- 1) Select a different COM port in the connection window.
- 2) Close all other software that could be using the serial connection
- 3) Close and reopen the *CROSSFIRE* software
- 4) Restart the computer

## Other Miscellaneous Issues

If the software is having trouble saving configurations, or showing other miscellaneous problems or inconsistencies, please ensure you have the most up-to-date software version by visiting [www.lcotechnologies.com/resources.html](http://www.lcotechnologies.com/resources.html) and downloading the software (zip file password: crossfire2017). The top menu bar within the software will indicate the version number for your reference. If these problems persist after downloading the most recent software version, please contact your supplier.

## **CROSSFIRE Maintenance**

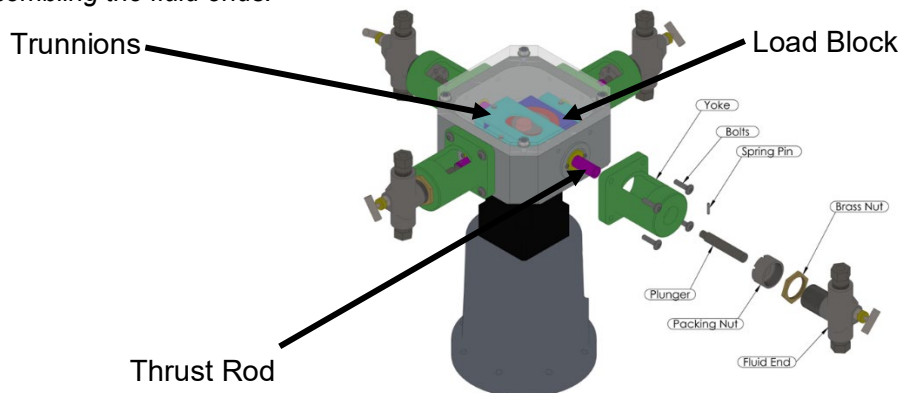
The *CROSSFIRE* requires minimal maintenance, however, below is a list of recommended maintenance practices. The recommended time frame is estimated and may need to be adjusted based on usage.



**Warning:** Customers must exercise standard lockout procedures for electrical equipment prior to servicing any component on the *CROSSFIRE*

Maintenance Required	Recommended Time Frame
Inspect and replace fluid end soft goods	<ul style="list-style-type: none"> <li>– Inspect fluid ends Semi Annually</li> <li>– Replace when leak or wear and tear is detected</li> </ul>
Clean and lubricate plungers	<ul style="list-style-type: none"> <li>– Monthly</li> <li>– Wipe and clean out old dirty grease</li> <li>– Lubricate with Red N Tacky lubricant</li> </ul>
Clean & lubricate thrust rod, load block and trunnions	<ul style="list-style-type: none"> <li>– Monthly</li> <li>– Wipe and clean out old dirty grease</li> <li>– Lubricate with Red N Tacky brand lubricant</li> <li>– Lubricate all four sides of load block in addition to top</li> </ul>
Clean yokes	<ul style="list-style-type: none"> <li>– Monthly</li> <li>– Clean out any debris or chemical particulate</li> <li>– Pay extra attention to threaded port at base of yoke</li> <li>– If the yoke port is blocked, any chemical leaks will sit in the yoke and may leak into top works, gearbox, and motor causing damage</li> </ul>

*Note: Please follow all appropriate safety protocols when handling the fluid ends as they may have been in contact with very dangerous chemicals. Please reference MSDS sheets and your company safety protocols prior to disassembling the fluid ends.*



**Fluid End Disassembly, Maintenance, and Re-Assembly**

- Step 1: Ensure the motor is powered off and the priming valve is completely closed
- Disconnect all fluid lines and isolate chemicals
- Step 2: Remove the four hex cap bolts on the fluid end yoke
- Step 3: Slide the fluid end and yoke off the plunger
- Step 4: Unscrew the packing gland adjustment nut and yoke
- Step 5: Remove the top and bottom bushings off the fluid end
- Step 6: Replace the O-rings in the bottom bushing and inside seat
- Item #4, #17, and #18 as shown in the labelled technical drawing on page 40 and 41.
- Step 7: Remove old packing and replace with a new packing
- Remove the packing gland and old packing
  - Add a pea sized amount of PTFE lubrication in the fluid end packing cavity
  - Put a new packing in and ensure the Vee ring “point” is pointing outwards
  - Insert the packing gland on top of the new packing
- Step 8: Screw the yoke and bushing back onto the fluid end

**Ensure 6-7 threads are showing between yoke and the brass lock nut/lock ring**



- Step 9: Screw the packing gland adjustment nut back onto the fluid end
- Do not overtighten the packing gland adjustment nut, it should be snug
- Step 10: Apply a pea sized amount of Red N Tacky lubrication onto the plunger
- Step 11: Slide the fluid end/Yoke combo back onto the plunger
- Step 12: Screw 4 hex cap bolts back through the yoke into the pump

- Step 13: Complete a manual rotation fluid end check (Video Tutorial on LCO Website)
- Insert an Allen key into the bolt in the center motor shaft and manually spin the motor
  - If the fluid ends are installed correctly, the motor will spin all 360 degrees with no resistance
    - If there is resistance that cannot be pushed past, a fluid end is bottoming out on the plunger
    - Manually spin that fluid end out of the yoke, one turn at a time, until you can push past the fluid end to the next one
    - Re-check and complete a full 360-degree rotation

**Replace Fluid End**

- Step 1: Ensure the motor is powered off and the priming valve is completely closed
- Disconnect all fluid lines and isolate chemicals
- Step 2: Remove the four hex cap bolts on the fluid end yoke
- Step 3: Slide the fluid end and yoke off the plunger
- Step 4: If the new fluid end is a different size, tap out the spring pin holding the plunger
- Use a hammer and a 1/8” metal punch
- Step 5: Insert new plunger and tap spring pin back in
- Step 6: Unscrew packing gland adjustment nut
- Step 7: Unscrew and remove yoke from fluid end
- Step 8: Screw the yoke onto the new fluid end

**Ensure 6-7 threads are showing between yoke and the brass lock nut/lock ring**



Step 9: Screw the packing gland adjustment nut onto the new fluid end

- Do not overtighten the packing gland adjustment nut, it should be snug

Step 10: Apply a pea sized amount of Red N Tacky lubrication onto the plunger

Step 11: Slide the fluid end/Yoke combo onto the plunger

Step 12: Screw 4 hex cap bolts back through the yoke into the pump

Step 13: Complete a manual rotation fluid end check (Video Tutorial on LCO Website)



### ***Inspection***

In addition to regular maintenance, inspect all pump components on a semi-annual basis. Replace or repair parts as necessary.

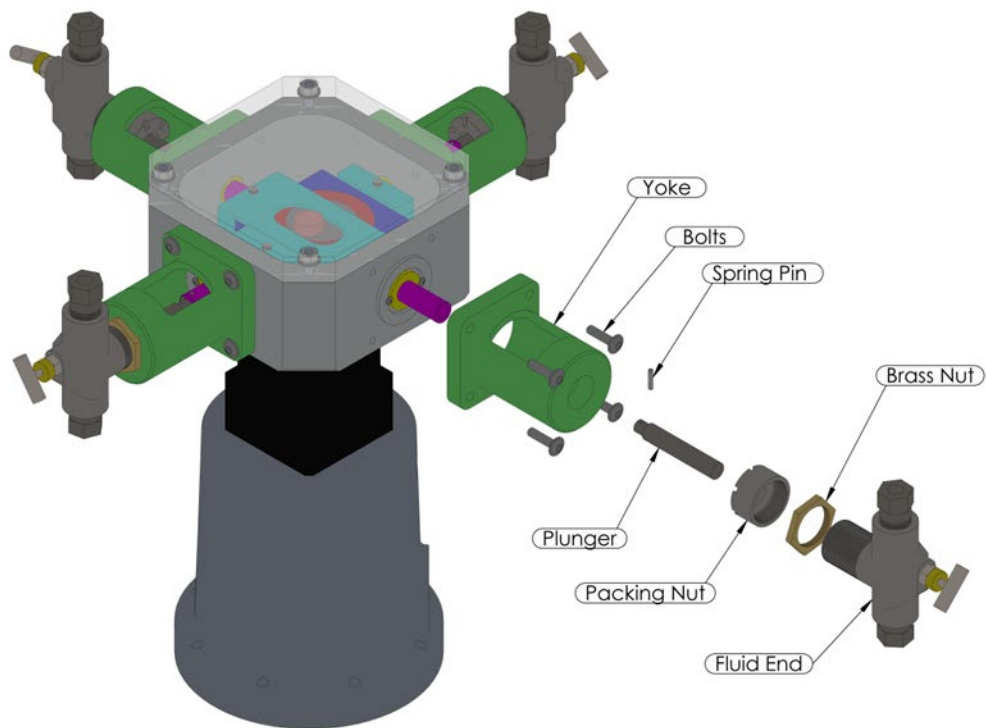
Recommended Inspection practice:

- Check for any signs of corrosion or pitting with in the fluid ends or on the pump
  - Check with supplier to ensure you have appropriate metallurgy and soft goods to prevent further damage. Replace any damaged components.
- Inspect all seals and soft goods for damage or wear and tear
  - Replace seals and soft goods if they appear damaged or leaks occur that cannot be corrected by tightening the packing gland adjustment nut.
- Inspect the interior cavity of the fluid end for any pitting or damage
  - Replace the fluid end and check with suppliers for chemical compatibility.
- Inspect all aspects of the pump for any damage
  - Special attention should be paid to all cables and connectors for signs of damage. If there is any damage to these cables or connectors, **replace immediately.**

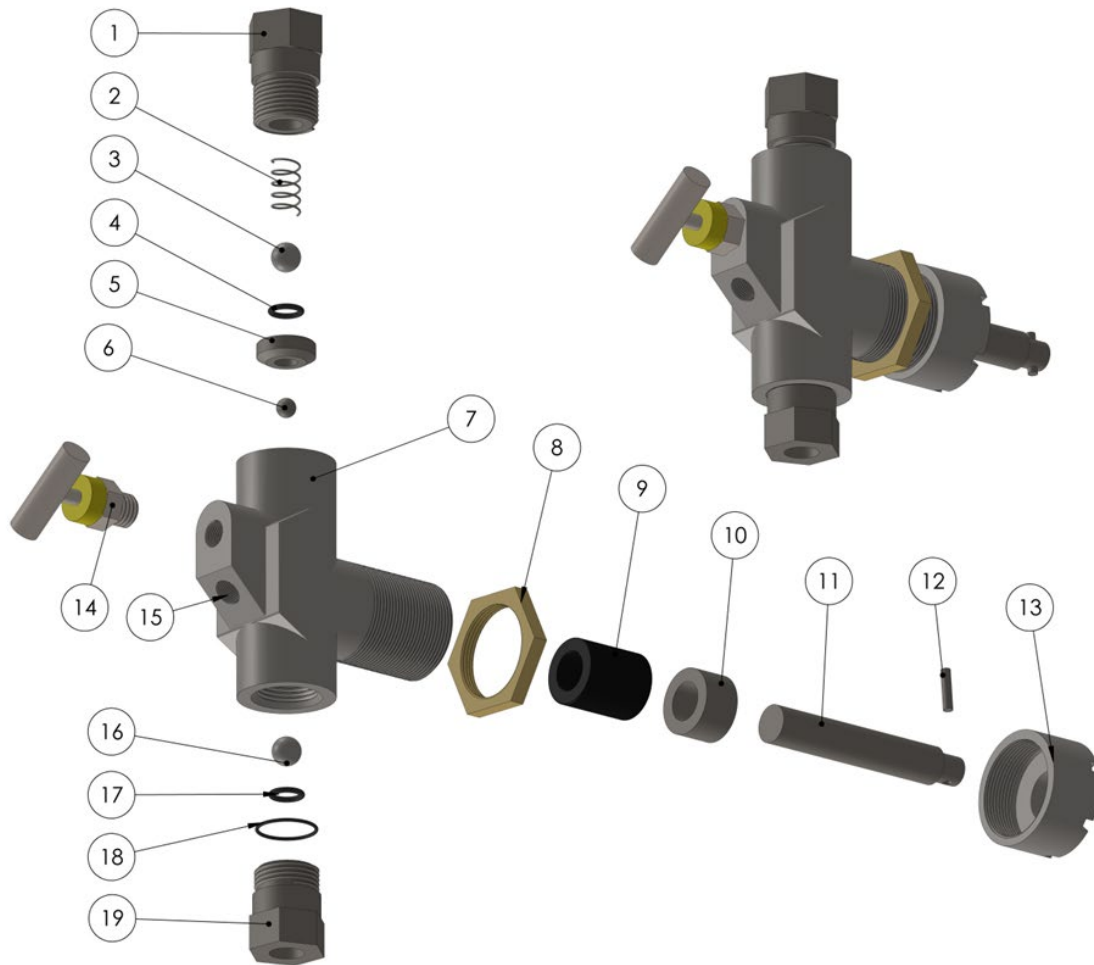


**Complete a manual rotation check every time a fluid end is removed or adjusted (video tutorial available on [www.lcotechnologies.com](http://www.lcotechnologies.com))**

***Assembled CROSSFIRE Chemical Injection Pump:***



***CROSSFIRE Panam Fluid End: Technical Drawing***





## ***CROSSFIRE Panam Fluid End (PFE-SS-00-X): Internal Components***

Item	Part Description	Material
1	Top Bushing	316 SS
2	Spring	316 SS
3	3/8" Ball Bearing	316 SS
4	Small O-ring	Buna
		Teflon
		Viton
		Fluorosilicone
5	Inside Seat	17-4 PH
6	1/4" Ball Bearing	316 SS
7	Panam Fluid End – Body	316 SS
8	Brass Lock Nut/ Lock Ring	Brass
9	Packing	Buna
		Zebra (Buna/Teflon)
		Teflon
		Viton
		Fluorosilicone
		Rock Hard
10	Packing Gland	316 SS
11	Plunger	17-4 PH
12	Spring Pin	420 SS
13	Packing Gland Adjustment Nut	316 SS
14	Bonnet Assembly	Viton Packed
15	Threaded Vent Port	316 SS
16	3/8" Ball Bearing	316 SS
17	Small O-ring	Buna
		Teflon
		Viton
		Fluorosilicone
18	Large O-ring	Buna
		Teflon
		Viton
		Fluorosilicone
19	Bottom Bushing	316 SS

## CROSSFIRE Pump Troubleshooting

Issue	Suggested Resolution
<b>Fluid End Leaking</b> – From priming valve	– Tighten handle on bonnet assembly
<b>Fluid End Leaking</b> – From packing	– Check to see if packing gland adjustment nut is loose <ul style="list-style-type: none"> <li>○ Tighten packing gland adjustment nut until leak stops</li> <li>○ Ensure packing gland adjustment nut is not over tightened – this may cause damage of the plunger and packing leading to additional leaks</li> <li>○ If packing gland adjustment nut appears to be bottomed out on the inside of the green yoke, manually rotate the fluid end one-turn in to expose more threads on the yoke interior</li> <li>○ Complete a manual rotation check to ensure plungers are not bottoming out</li> </ul> – Remove fluid end from pump and inspect plunger and packing <ul style="list-style-type: none"> <li>○ If plunger is scored or damaged, replace both the plunger and packing</li> <li>○ It is critical to not over tighten the packing gland adjustment nut</li> </ul> – Replace packing if leak continues, this may be due to general wear and tear and is a part of regular maintenance <ul style="list-style-type: none"> <li>○ When replacing packings, ensure each individual Vee ring is inserted one at a time to avoid packing damage</li> </ul> – Talk to your chemical supplier and ensure the packing material is compatible with the chemical; replace packing with a different material if required.
<b>Fluid Ends Not Priming</b> – Detected by inconsistent or no flow during sight glass gauge test	– When completing a sight glass gauge test, the fluid flow is inconsistent or does not flow at all – This may indicate that your fluid end is not fully primed, or that the ball bearing in the bottom fluid end bushing is sticking <ul style="list-style-type: none"> <li>○ Option 1: Connect a hand pump to the threaded vent on the priming valve, open priming valve, and push chemical through the fluid end to completely flood the discharge line.</li> <li>○ Option 2: Remove tubing attached to the bottom bushing and unscrew the bushing. Check if the ball bearing is sticking in the O-ring and simply unstick and place back O-ring seat if need be.</li> </ul>

<p><b>Plunger Bottoming out</b></p> <p>Four Ways to Detect:</p> <ol style="list-style-type: none"> <li>1. Manual Fluid End Check</li> <li>2. The fluid end is not showing 6-7 threads</li> <li>3. The pump stalls and stops</li> <li>4. The pump is achieving shorter than expected system autonomy</li> </ol>	<p><b>Manual Fluid End Check</b></p> <ul style="list-style-type: none"> <li>– When completing a manual fluid end check, you cannot spin the motor all 360 degrees</li> <li>– Identify the fluid end showing resistance</li> <li>– Manually back off fluid end one turn at a time while checking manual rotation in between</li> <li>– Once a manual rotation can be made past the fluid end, secure the brass lock nut</li> </ul> <p><b>Pump Stall</b></p> <ul style="list-style-type: none"> <li>– Pump will stop and the fault light on controller will flash</li> <li>– Controller will display fault code (Motor Status: Fault Detected)</li> <li>– Manually back off fluid end to correct thread count to 6-7 threads showing</li> <li>– Complete manual rotation check</li> <li>– Pump will not automatically start up, use computer or app to re-start pump</li> </ul> <p><b>Shorter Autonomy than Anticipated</b></p> <ul style="list-style-type: none"> <li>– Stop pump and motor</li> <li>– Manually back off fluid end to correct thread count to 6-7 threads showing</li> <li>– Complete a manual rotation check</li> <li>– Start pump back up</li> </ul> <p>Note: A data logging multi meter can be used to troubleshoot this error. Run the positive 24V wire through the data logging multi meter and check for any abnormal current peaks. If there are peaks, determine which fluid end they correspond to and adjust thread count. There should be 6-7 threads showing.</p>
<p><b>Loose Gearbox Collar</b></p> <ul style="list-style-type: none"> <li>– Detected by: motor seems to be running, but the pump is not turning.</li> </ul>	<ul style="list-style-type: none"> <li>– A clamp in the gearbox grips the output shaft of the motor (called gearbox collar)</li> <li>– Access the collar through two plastic plugs on the side of the gearbox.</li> <li>– Remove plug and reach in with a 4mm Allen key to spin the collar until the Allen bolt is facing straight out through the plug hole.</li> <li>– Tighten the Allen bolt.</li> <li>– There are two Allen bolts that are 180 degrees opposite to one another; tighten both</li> </ul>
<p><b>Fault Indication on Controller</b></p> <ul style="list-style-type: none"> <li>– Red LED light flashing</li> </ul>	<ul style="list-style-type: none"> <li>– Connect to the configuration software and go to “system status” panel <ul style="list-style-type: none"> <li>○ Read fault code</li> <li>○ Refer to page 32 for a list of fault codes and recommended troubleshooting steps</li> </ul> </li> </ul>

<p><b>Motor not spinning as expected</b></p> <ul style="list-style-type: none"> <li>– Detected by: Software motor status reads “running” however motor and pump is not spinning</li> <li>– Potential Fault Code listing two motor phases broken, and one ok (such as phase A and phase B broken, phase C ok)</li> </ul>	<ul style="list-style-type: none"> <li>– Go to the “system status” tab and look at the system diagnostics section <ul style="list-style-type: none"> <li>○ Read the fault code</li> <li>○ If fault code indicates two phases broken, other one ok, the controller IC component may be damaged from power surge on site</li> </ul> </li> <li>– Go to the “terminal” tab, start motor and read generated motor start values</li> <li>– Two lines of interest: <ul style="list-style-type: none"> <li>○ <b>MotorStart: Resistor A</b></li> <li>○ <b>MotorStart: Resistor B</b></li> </ul> </li> <li>– If the resistor value listed is reading a numerical value below 0.5 ohms, the IC component is not damaged</li> <li>– If the resistor value listed is above 0.5 ohms, or reads “INF” for infinite, the IC component has been damaged</li> <li>– Contact LCO Technologies for more assistance</li> <li>– Controllers with damaged IC components can be repaired at the factory</li> </ul>
<p><b>Motor RPM set point not holding with power cycle</b></p> <ul style="list-style-type: none"> <li>– Detected by: RPM changing from set value</li> <li>– May default to 10 RPM</li> </ul>	<ul style="list-style-type: none"> <li>– Go to <a href="http://www.lcotechnologies.com">www.lcotechnologies.com</a> and download the newest software version. A newer software version may identify and fix a previously existing bug if applicable.</li> <li>– Re-set RPM <ul style="list-style-type: none"> <li>○ Stop pump</li> <li>○ Use software or app to set required motor RPM</li> <li>○ Press Save</li> <li>○ Start pump</li> </ul> </li> <li>– Ensure System Auto Restart is active when running in Manual Mode <ul style="list-style-type: none"> <li>○ Activate in “Automation Tab” by changing “System auto-restart” to On</li> <li>○ Press Save</li> </ul> </li> </ul>
<p><b>Worn out top works components</b></p> <ul style="list-style-type: none"> <li>– Detected By: Slack or movement between the white load block and trunnions, thrust rod and trunnions, or any other component in the top works</li> </ul>	<ul style="list-style-type: none"> <li>– If any movement between components can be identified, contract LCO Technologies for assistance <ul style="list-style-type: none"> <li>○ Video and photo's may be requested to help identify which components are damaged</li> </ul> </li> <li>– Replacement parts are available for purchase</li> </ul>

<p><b>Pump motor or gearbox out of alignment</b></p> <ul style="list-style-type: none"> <li>– Detected By: rubbing sound, excessive grinding or noise coming from gearbox or motor</li> </ul>	<ul style="list-style-type: none"> <li>– Remove the pump top works from the gearbox motor drive system <ul style="list-style-type: none"> <li>○ Remove the four M8 bolts connecting the top works from the gearbox</li> <li>○ Pull the top works up and off the gearbox</li> <li>○ Start the pump (gearbox and motor still connected) and observe</li> </ul> </li> <li>– Remove the gearbox from the motor <ul style="list-style-type: none"> <li>○ Remove the two plugs on either side of the gearbox</li> <li>○ Reach inside the gearbox plug hole with a 4mm Allen key and loosen the collar bolt</li> <li>○ Repeat on the other side of the gearbox; there are two Allen bolts holding the collar in place</li> <li>○ Remove the four M6x40mm bolts holding the gearbox on the motor</li> <li>○ Pull the gearbox up and off the motor</li> <li>○ Start the motor and observe</li> </ul> </li> <li>– By removing and running the motor separate from the gearbox and top works, this will help identify which component is causing the excessive noise</li> <li>– Consult the LCO factory for further assistance and relay test results</li> </ul>
<p><b>Undetected issue</b></p> <p>Controller or Interface is not responding</p>	<ul style="list-style-type: none"> <li>– Go through all interface troubleshooting steps and the above pump troubleshooting steps</li> <li>– If no resolution, reset and reboot the controller and computer</li> </ul>

## **CROSSFIRE Return and Repairs**

The below list dictates which parts can be repaired in the field and which parts constitute a return and replacement if under warranty.

*Note: When repairing a unit or disassembling to be sent back for replacement, please take every step to ensure the safety of people and environment. Follow all protocols as set out by your company and ensure all employees are properly trained prior to disassembly.*

### **Repairs**

- Fluid Ends
  - Fluid ends can be fully repaired and swapped out in the field. Regular maintenance with semi-annual inspection of soft goods (packings and O-rings) is recommended.
  - Fluid end repair kits are available for purchase

### **Replacement**

- Motor/Gearbox
  - If the motor or gearbox stops working out in the field, this will constitute a replacement if under warranty
- Controller
  - If the controller stops working, and it is not due to a troubleshooting error, this will require a complete replacement unit if under warranty

### **Return Procedure**

- Please follow the distributors return protocols to ensure that all components are properly cleaned prior to sending gear back

### **Warranty Exceptions**

- Pump Motor, Gearbox, and Top Works
  - Damage from chemical leaks will not be covered by warranty. If there has been chemical damage, contact LCO Technologies directly for assistance as some components may be repairable.
  - Similarly, if there is damage from misalignment and bottomed out plungers, this is not covered by warranty. Rebuild components can be purchased for cost effective repair.
  - Damage due to poor maintenance will not be covered by warranty and full warranty evaluations can be performed by the factory if cause of damage is unknown.
- Controller
  - Damage from improper installation, voltage surges, or poor power conditions will not be covered by warranty
  - Controllers can be repaired for a fee, contact LCO factory for more details

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