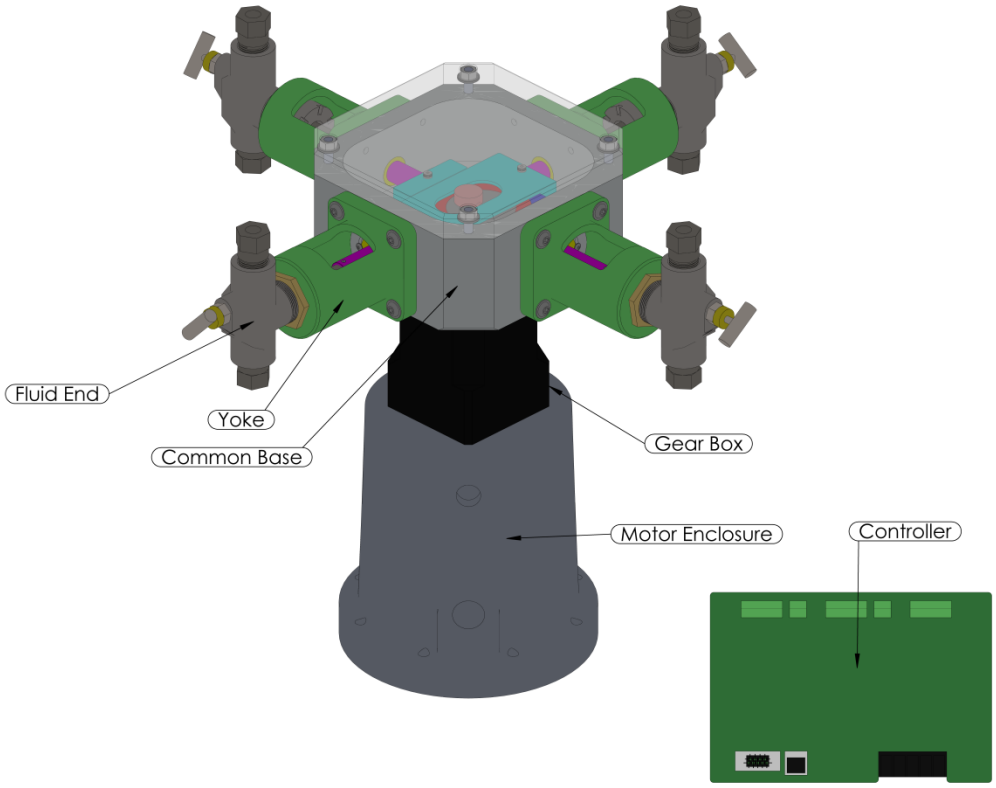
LCO TECHNOLOGIES

The CROSSFIRE

Ultra-low Power Chemical Injection Pump

Installation and Operations Manual



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UNLESS POWER HAS BEEN SWITCHED OFF OR THE AREA IS
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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
QUEL'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 EMPLACEMENTS
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QU'A L'UTILISATION DANS DES EMPLACEMENTS 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 EMPLACEMENTS
DE CLASSE 1, DIVISION 1, GROUPES C ET D, OU NE CONVIENT
QU'A L'UTILISATION DANS DES EMPLACEMENTS 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)[1]
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.

[1] 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 - 12 AWG wiring, when connecting to the Power and Motor connectors. The Controller data connectors can accept 22 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.

WARNING

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, Division1 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

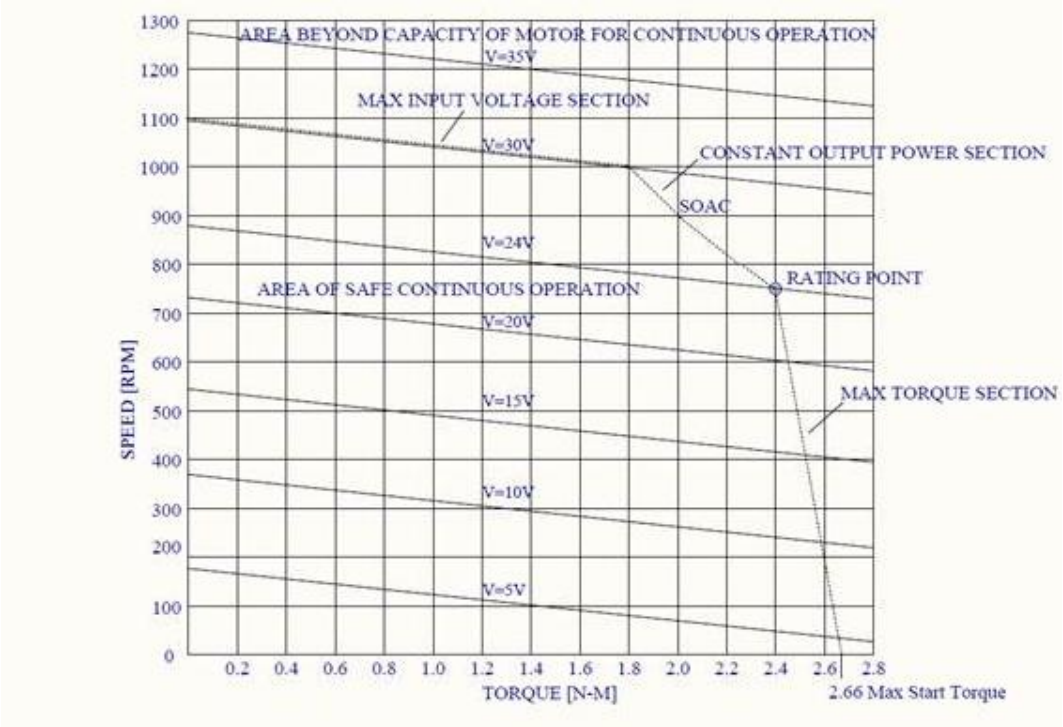


Figure: Safe Operating Area Curves (SOAC)

***CROSSFIRE* Installation Guide**

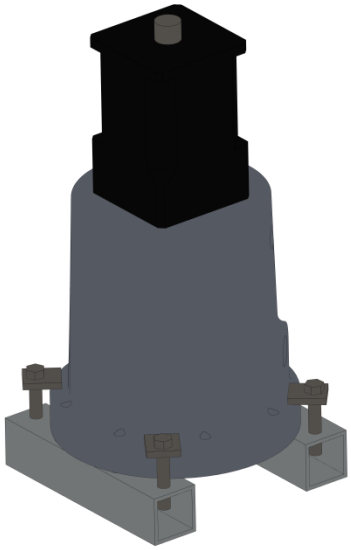
Step 1: Open Boxes

- 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 x17”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, 10-12-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, however they may be longer if a thicker tech cable is used

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 on page 29).

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

Step 5: 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.

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

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 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

  - Wire the local switch to the Discrete Input DI1 terminal block on the controller
- Download and connect to the *CROSSFIRE* computer software as per the download and operations instructions on page 11
  - Log in as "Technician" for access to all tabs
  - Go to "*System Status*" panel (picture on page 16)
    - Set your Slave ID, Baud Rate, and Bit Parity
    - Press "*Save to controller*" button
  - Go to "*Advanced Automation*" Tab (pictures on page 19-21)
    - Select "*local remote switch control*" from the drop-down menu to enable the two-position selector switch
    - Press "*Save to controller*" 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

***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: In the event that 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 speaking, this step is not required when using ½" or 3/8" fluid ends, however when using 3/16" or 1/4" fluid ends, particularly under high pressures; this may be a necessary step.

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

- Hook up an RS 232 cable to the controller and computer
- Start up the chemical injection pump as per the operator interface instructions listed on page 12.

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 29

Software Installation:

Step 1: Download the Interface Software

- Go to www.lcotechnologies.com
- Click on download button and follow all prompted instructions
- ZIP file password: **crossfire2017**
- The Interface is compatible with the following operating systems:
  - Windows XP (32-bit)
  - Windows 7
  - Windows 8.1
  - Windows 10
- Both the operator and technician tabs are password protected.
  - Operator Password: **Pristine**
  - Technician Password: **Automation**

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 only have access to the *operator config* and *system status* panels. Technicians have access to all panels which includes the more advanced automation features.

Interface Overview

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

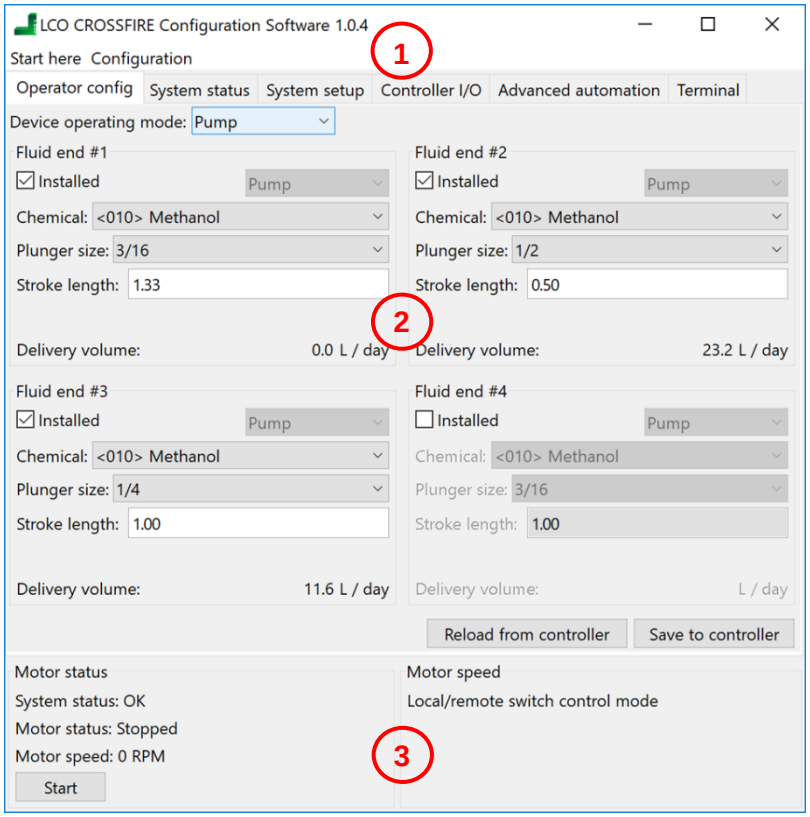


Figure: CROSSFIRE Configuration Software main window

1) Main menu bar: Used to connect and disconnect from the *CROSSFIRE* controller.
2) Configuration panel: Used to view and edit the configuration data stored on the *CROSSFIRE* controller (ex. plunger size, and chemical injected)
3) Motor control panel: Shows motor status and is used to start/stop the motor and set motor speed (available for both operators and technicians)

Main menu

Connect to Controller:

The *Start here* menu is used to connect or disconnect from the *CROSSFIRE* controller. Select *Connect to controller* and provide the following information:

1) Port: Select the number of the COM port that the RS232 serial cable or Bluetooth serial adapter is connected (see: Troubleshooting – COM Port Issues)
2) Login as: Select operator, or technician. Operators have access only to the *Operator config* tab of the configuration panel; Technicians have access to all tabs, including the advanced configuration tabs.
3) Password: Enter the correct password to log in to the controller as operator or technician.
    - Operator Password: **Pristine**
    - Technician Password: **Automation**

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

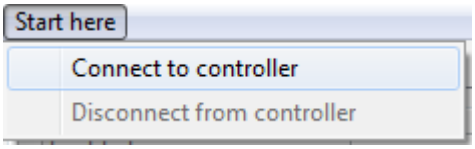


Figure: Main menu

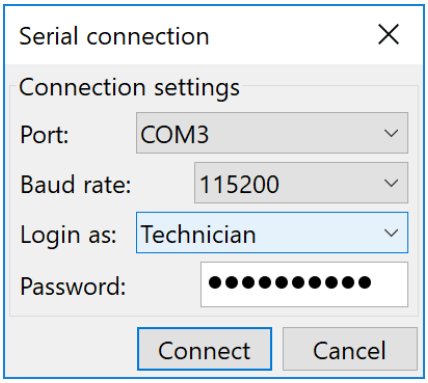


Figure: Connection window

(see: Troubleshooting – Connection Errors).

Disconnect from Controller:

Select *Disconnect from controller* to log out from the *CROSSFIRE* controller and end device connection. A pop-up message will be displayed to confirm successful device disconnection.

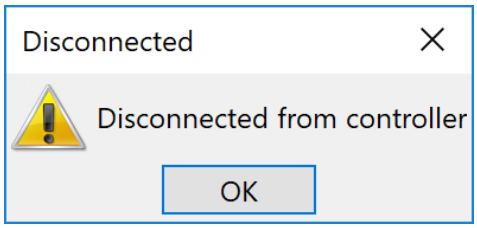


Figure: Successful disconnection

Configuration Panel – Operator configuration

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

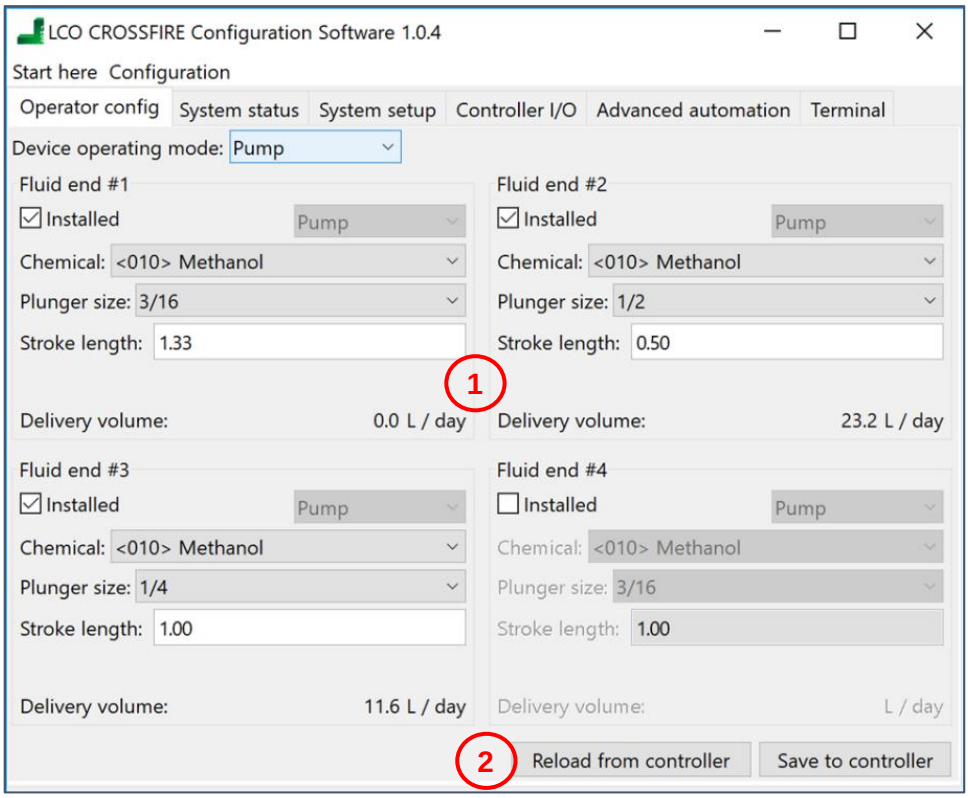


Figure: Operator config

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

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:

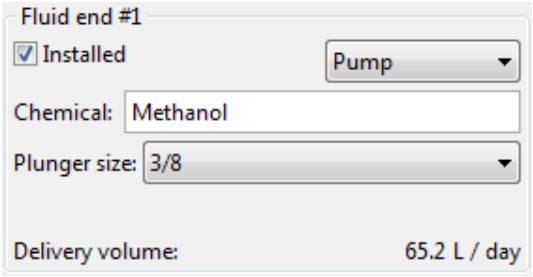


Figure: Pump setup

The *installed checkboxes* are used to indicate whether a fluid end is installed on each of the four available positions on the *CROSSFIRE* platform. This allows the controller to correctly track the total accumulated number of pump strokes the system has made; thus, it is **critical** to ensure these settings are correct.

The fluid end setting pane is also used to enter a descriptive label for the chemical mixture delivered by the fluid end and select the size of installed plunger in the pump. Based on the plunger size and configured 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 37 RPM.

Note: *The volume injected estimate is based on a one-inch stroke of the selected plunger size, and actual volume delivered will vary from this depending on factors such as system pressure and packing materials used in the fluid end.*

Figure: Save/Reload buttons

The *Save to controller* button saves any changes made to the fluid end settings and pump speed to the configuration data saved in the controller.

The *Reload from controller* 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 control panel* is used to configure and check the status of the system drive motor:

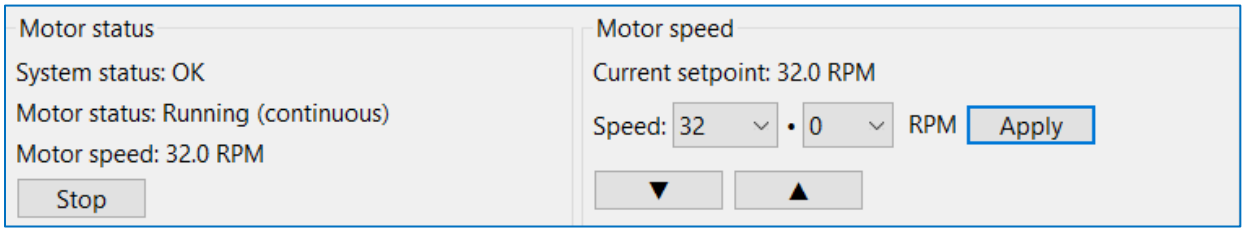


Figure – Motor control panel

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. The *apply* button will save the selected setpoint to the controller.

Configuration Panel – System setup

The *System setup* tab allows for setup and configuration of the advanced controller features and is divided into two regions:

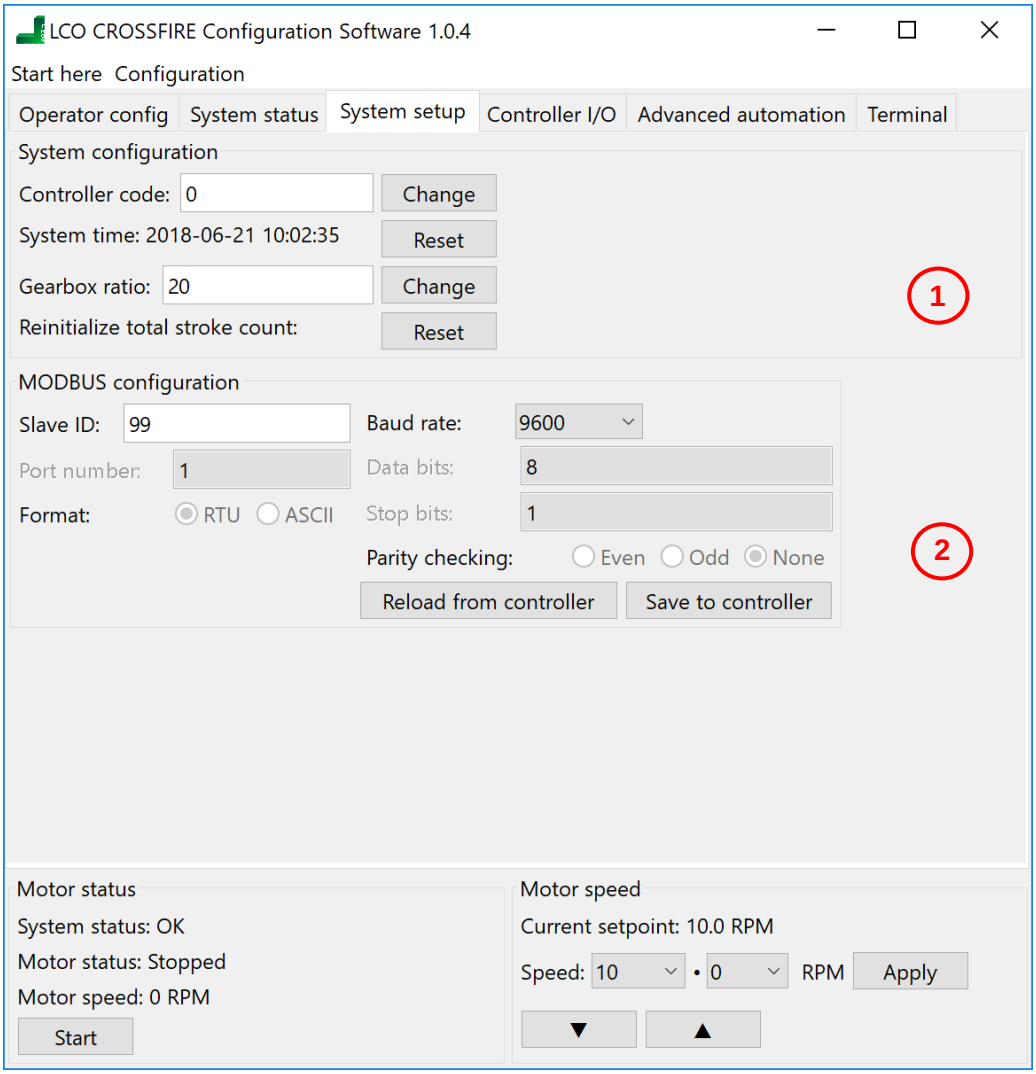


Figure: Technician config

1) System behavior and configuration
2) MODBUS configuration

The system behavior settings are used to reset and change controller behavior.

- *Controller code* can be used to assign a name or number to the controller (maximum 8 characters)
- *Reset 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)
- *Reset system total stroke count* will reset the system record of total strokes to zero.

The *MODBUS configuration* panel is used to view and change the settings of the controller's MODBUS port, in order to properly integrate it with your SCADA system. Configurable options include *MODBUS slave ID*, connection *baud rate*, and *parity checking*. *Data bits* and *stop bits* are determined by the selected parity option, according to the MODBUS standard. The *Save to controller* and *Reload from controller buttons* will save the settings to the controller and reload the configuration from the controller, respectively.

When changes are made to total stroke count, a warning and confirmation window will appear to confirm action before proceeding.

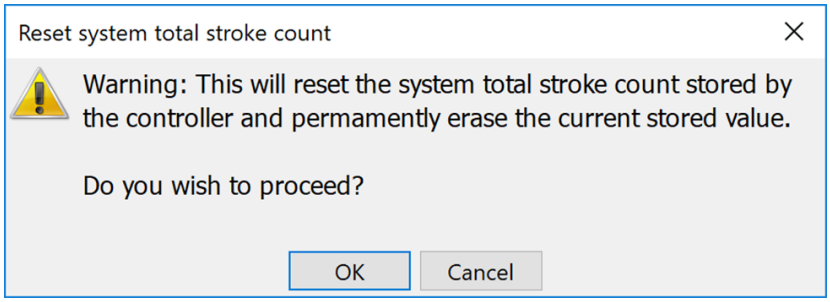


Figure: Reset stroke count warning

Configuration Panel – I/O config

The *Controller 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.

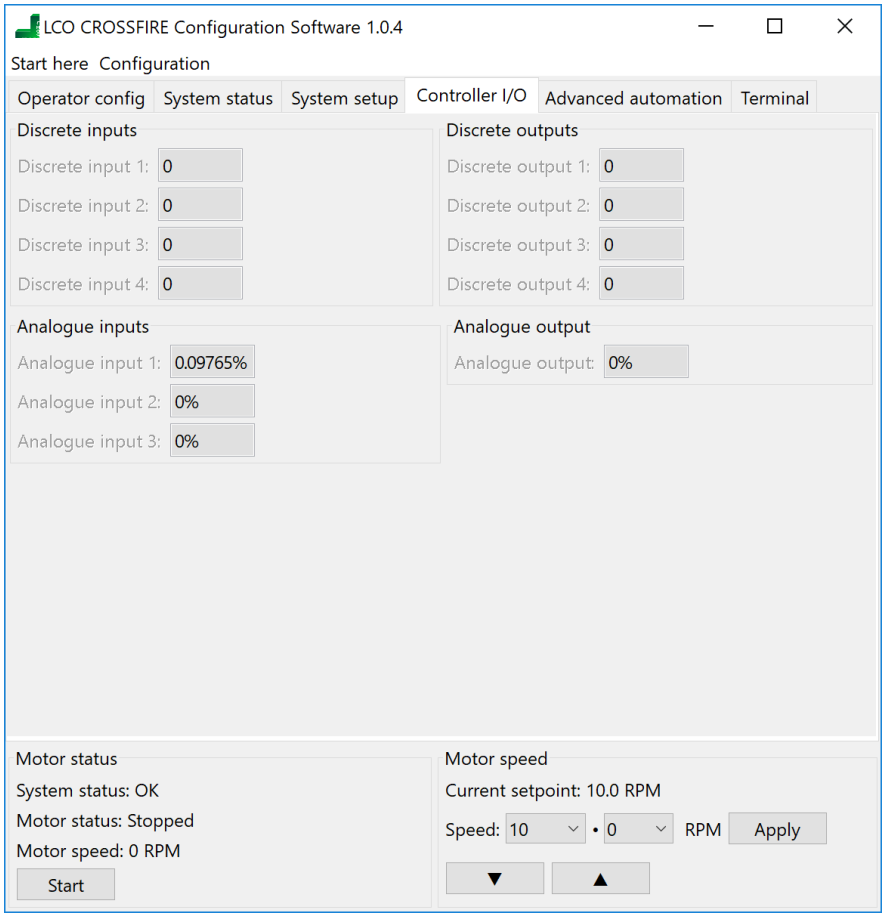


Figure - I/O config

Note: Monitored values are not automatically updated in the interface as they change on the controller. Manual action to press the reload button is required for update or refresh the valves.

Configuration Panel – Advanced Automation

The *advanced automation* tab is only available to Technicians. This allows selection between manual control mode, proportional control mode, local/remote switch control mode, and toggle switch control mode.

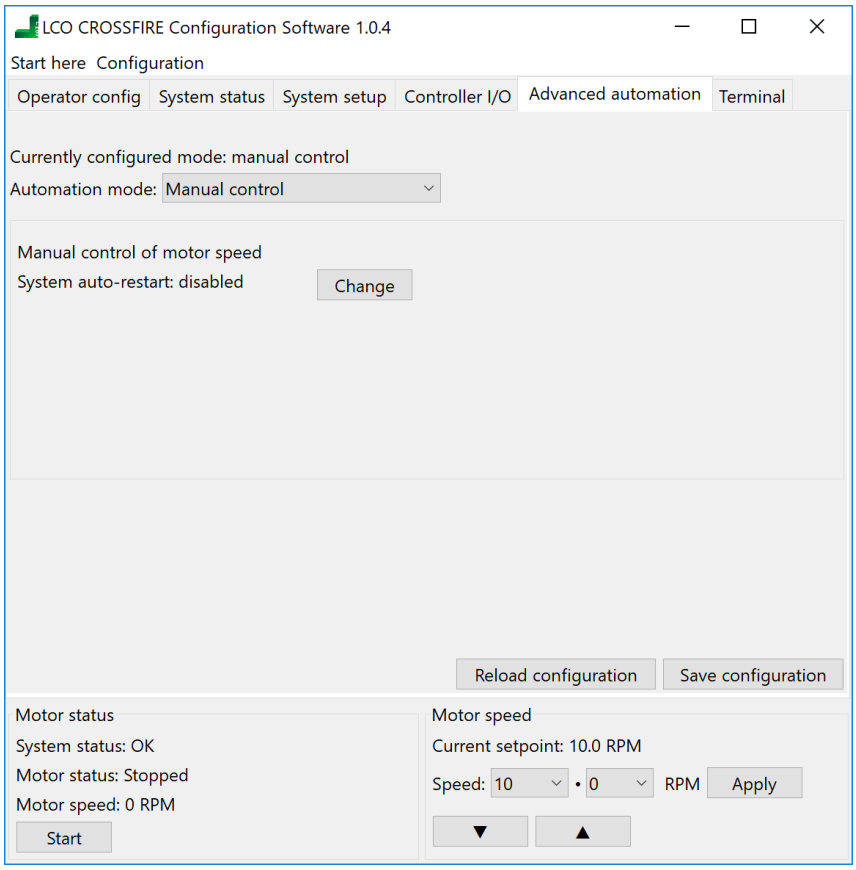
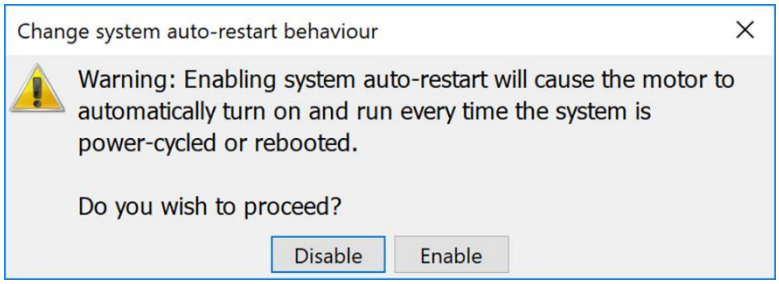


Figure - Manual control

When in *Manual Control*, all settings such as pump on/off and motor speed are controlled in the operator config 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 *Change system auto-restart*. A warning and pop-up notification window will appear for confirmation to engage this function.



The *Proportional Control* feature allows the motor speed to be driven by a value applied to the controllers *Analogue Input 1*. The motor speed is automatically scaled between the defined set minimum and maximum speeds (between 0 to 45 RPM) based on the signal applied to the analogue input – either a potential between 0 and 5 volts, or a current between 4 and 20 milliamps. The correct input mode for the signal applied must be selected.

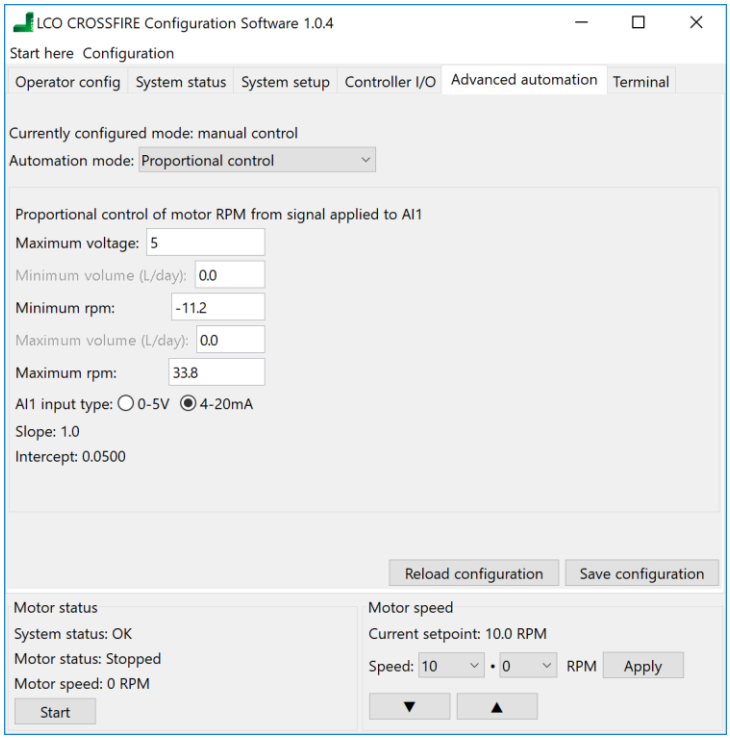


Figure – Proportional Control

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

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* function from the drop-down menu, set your *Maximum RPM* (45 RPM or less) and press *save configuration* to engage the 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.

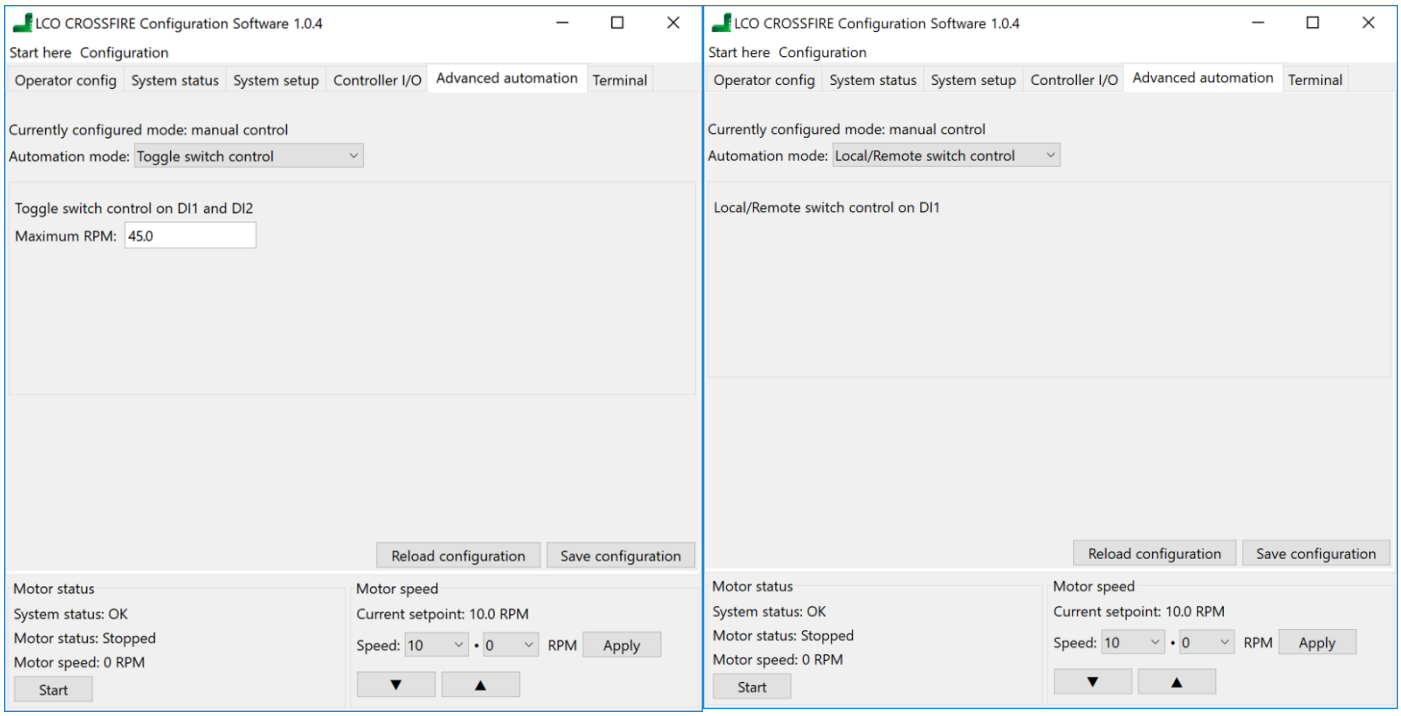
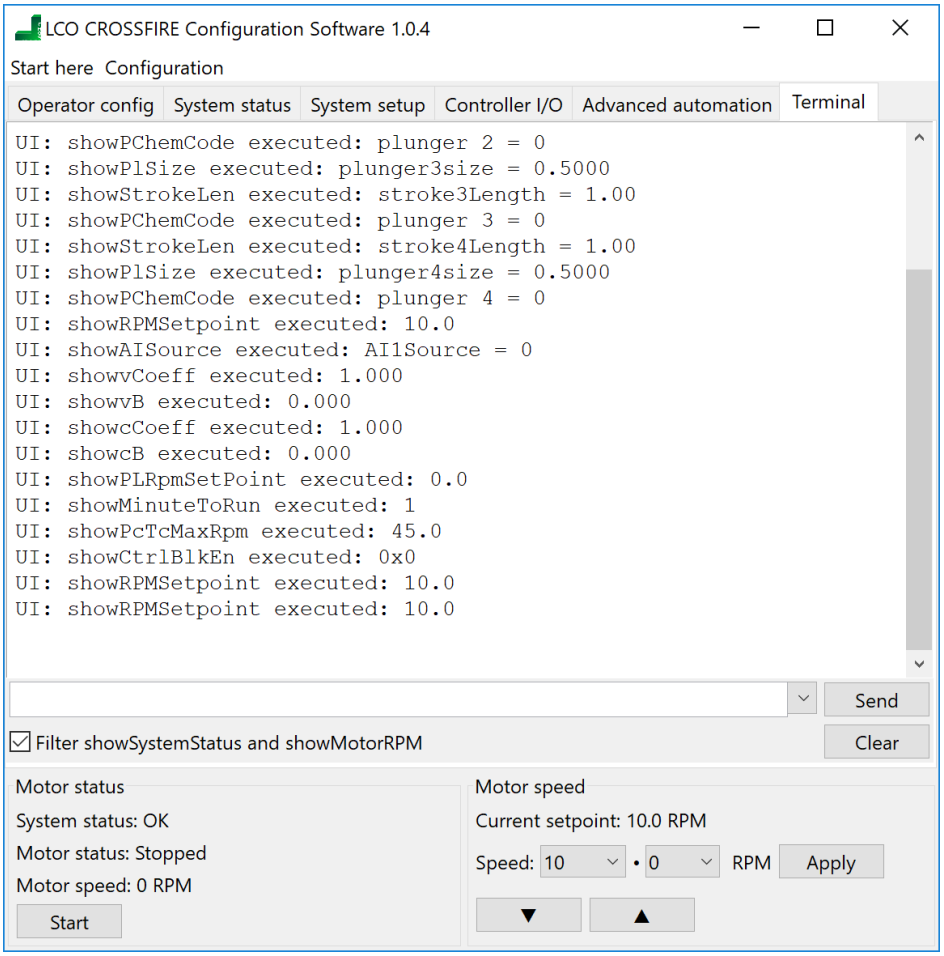


Figure – Advanced Automation Functions "Toggle Switch Control" and "Local/Remote Switch Control"

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* form the drop-down menu and press *save configuration* to engage function.

Configuration Panel – Terminal

The Terminal tab is only available to technicians and 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.



Configuration Panel – System status

The system status panel provides detailed status and diagnostic information about the motor and controller:

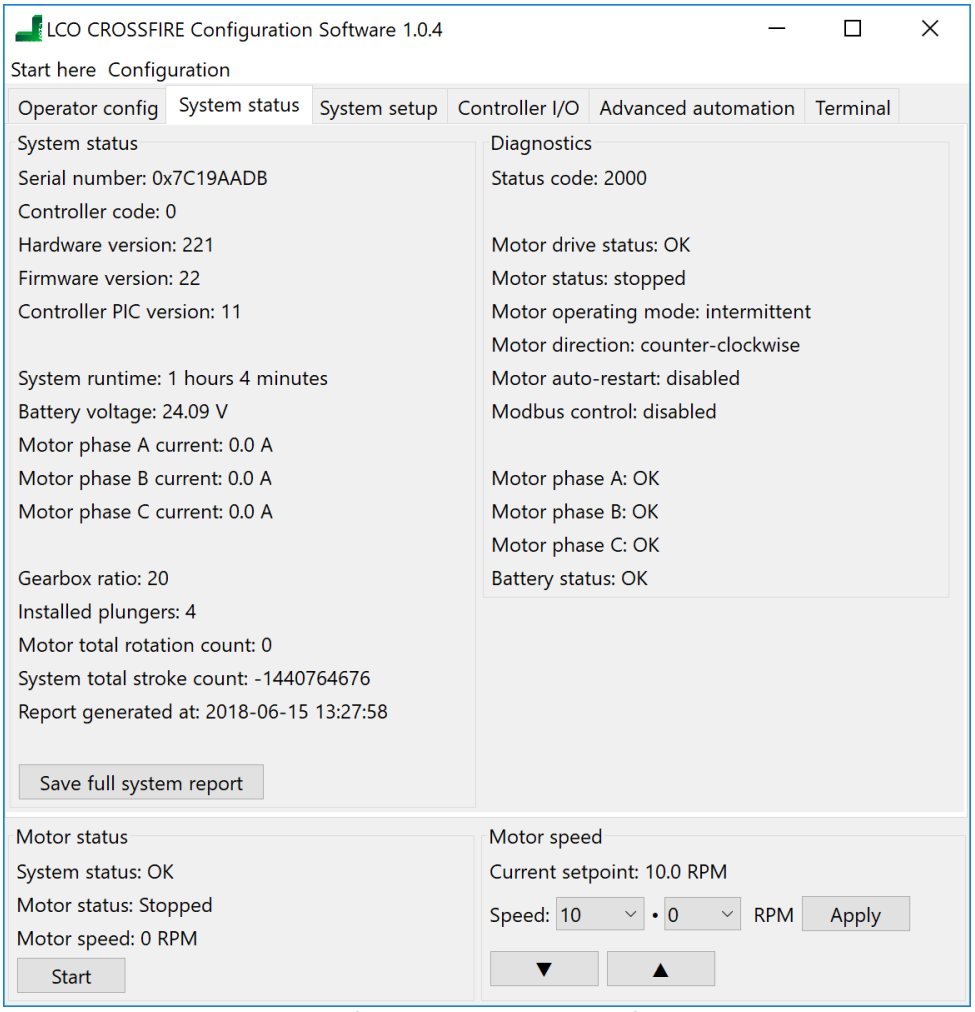


Figure: System status panel

System status shows the system name and uptime of the connected controller, electrical and thermal measurements from the controller board, and the configured state of the pump hardware. It also shows the total rotation count and total stroke count for the device. System status data can be exported as a spreadsheet by clicking *Save full system report* (the report will automatically save to computer desktop).

Note: Stroke count is based on the number of positions on the *CROSSFIRE* platform with fluid ends installed at the time of each revolution made by the motor. It is critical that you have the checked boxes activated for all present fluid ends to ensure accurate count.

Diagnostics will display the current system status code; underneath, a detailed breakdown of the code will describe any detected faults. This information is updated every few seconds while the controller is connected.

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 – Reconnect conduit wire to controller – If conductor wire is broken, replace as needed
Motor phase B disconnected Fault Code: 40	Conductor wire from motor to Phase B has been disconnected	Field repairable – Reconnect conduit wire to controller – If conductor wire is broken, replace as needed
Motor phase C disconnected Fault Code: 80	Conductor wire from motor to Phase C has been disconnected	Field repairable – Reconnect conduit wire to controller – If conductor wire is broken, replace as needed
Battery over voltage Fault Code: 10	Battery voltage is over 32 V	Field Repairable – Adjust power supply to ensure 24 V is available to the *CROSSFIRE*
Battery under voltage Fault Code: 08	Battery voltage is under 18 V	Field Repairable – Adjust power supply to ensure 24 V is available to the *CROSSFIRE*
Motor Status: Fault Detected Fault Code: 02^2 or 04^2	Motor has stalled, due to: – Operating outside compressor design parameters – Insufficient voltage or current – Mechanical obstruction	Field Repairable – Ensure the maximum torque requirements are within the motors limits – Ensure the power supply has sufficient current capacity at the maximum load so that supply voltage will not drop below the required 24 VDC – Clear any mechanical obstruction that is preventing motor rotation

Motor drive status: faulted, motor overload, or controller needs repair Fault Code: 01[2]	Motor overload due to mechanical obstruction or insufficient power supply Or Controller is damaged and requires repair	Field Repairable – If overload is caused by mechanical obstruction or insufficient power supply, see below – Clear any mechanical obstruction that is preventing motor rotation – Ensure the power supply has sufficient current capacity at the maximum load so that supply voltage will not drop below the required 24 VDC Not Field Repairable – If the problem persists after following the suggested troubleshooting steps as listed above, your controller may require repair or replacement – Talk to your supplier for further instructions – Download a system status report, your supplier may request this to do additional troubleshooting – Go under “System Status” tab, press “Save full system report” and spreadsheet will automatically save to your computer desktop

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

[2] 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
Error: Password must not be blank	In order to successfully log in to the controller, the password must be entered. *Possible solutions:* 1) Retry connection and enter password (password is case sensitive)
Could not connect to controller: **No response**	When attempting to connect to the controller, the software received no response. *Possible solutions:* 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 *CROSSFIRE* controller. 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. 3) Ensure the correct COM port is listed (see: Troubleshooting – COM Port Issues). 4) Ensure the *CROSSFIRE* controller is powered on
Could not connect to controller: **Unknown response**	When attempting to connect to the controller, the software received an unrecognized response. Possible solutions: 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 *CROSSFIRE* controller. 2) Ensure the correct COM port is listed (see: Troubleshooting – COM Port Issues). 3) Ensure the BAUD rate listed is correct (default – 115200) 4) If the problem persists, try connecting with an alternate RS232 cable or Bluetooth serial dongle.
Could not connect to controller: **Incorrect password**	When attempting to connect to the controller, the wrong password was provided. *Possible solutions:* 1) Retry connection and ensure you have the correct password (note: the password is case sensitive)

	2) Ensure you are connecting under the right user (operator or technician) that corresponds to the correct password
Disconnected: **Login session with controller expired**	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. *Possible solutions:* 1) Reconnect and log back in to the controller.
Disconnected: **Communication with controller lost**	The software lost connection to the *CROSSFIRE* controller for unknown reasons. *Possible solutions:* 1) Check that the RS232 serial cable or Bluetooth serial adapter has not come loose either from the computer or from the *CROSSFIRE* controller. 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 *CROSSFIRE* controller. Move closer to the controller and away from any radio sources. 3) The *CROSSFIRE* controller may have lost power. Check that the controller is powered on and that the system voltage level is adequate.

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 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.

Maintenance Required	Recommended Time Frame
Inspect and replace fluid end soft goods	– Inspect fluid ends Semi Annually – Replace when leak or wear and tear is detected
Lubricate plungers	– Lubricate Monthly – With PTFE based lubricant or Krytox lubricant

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 of 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 26 and 27.

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 (or Krytox based) 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 PTFE (or Krytox based) 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

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 of 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

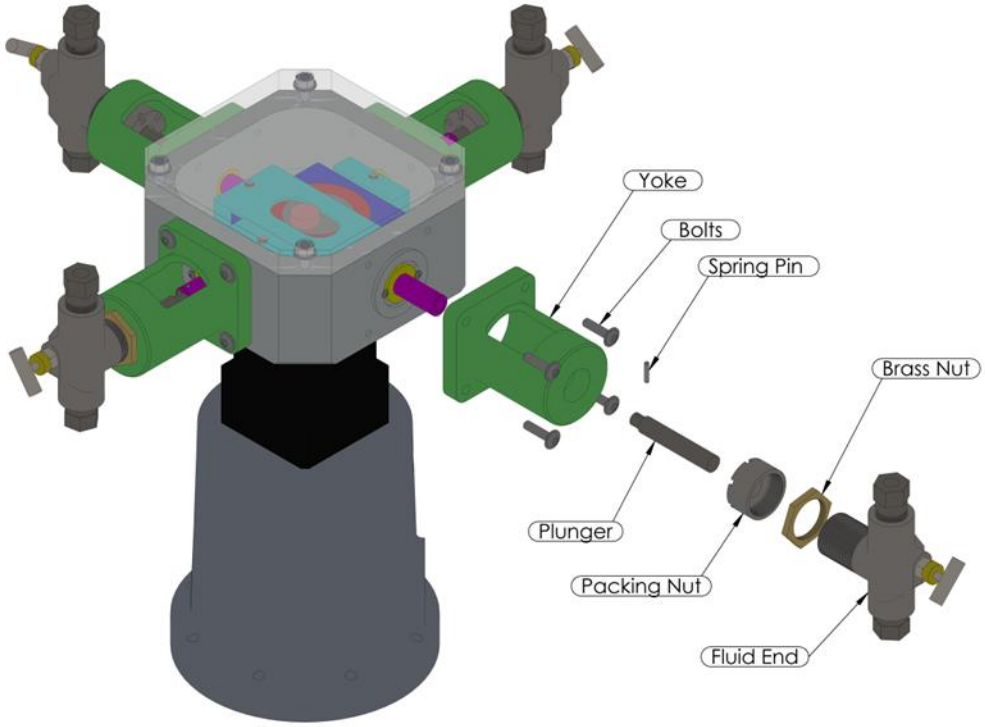
Step 10: Apply a pea sized amount of PTFE (or Krytox based) lubrication onto the plunger
Step 11: Slide the fluid end/Yoke combo onto the plunger
Step 12: Screw 4 hex cap bolts back through the yoke into the pump

Inspection

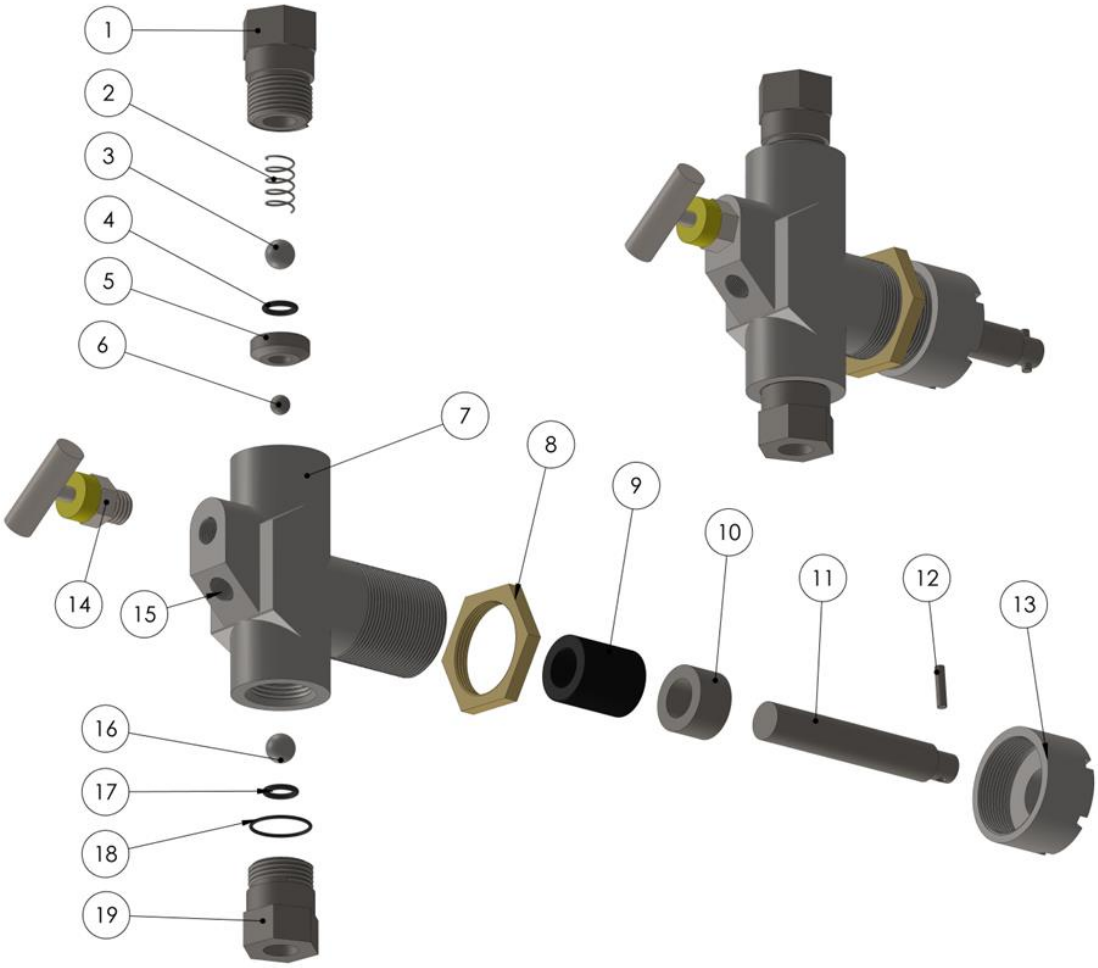
In addition to regular maintenance, inspect all pump components on a semi-annual basis. Replace or repair parts as necessary.

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 glad 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.**

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
		Flurosilicone
5	Inside Seat	17-4 PH
6	¼” 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
		Flurosilicone
		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
		Flurosilicone
18	Large O-ring	Buna
		Teflon
		Viton
		Flurosilicone
19	Bottom Bushing	316 SS

***CROSSFIRE* Pump Troubleshooting**

Issue	Suggested Resolution
Fluid End Leaking – From priming valve	– Tighten handle on bonnet assembly
Fluid End Leaking – From packing	– Check to see if packing gland adjustment nut is loose o Tighten packing gland adjustment nut until leak stops o Ensure packing gland adjustment nut is not over tightened – this may cause damage of the plunger and packing leading to additional leaks – Remove fluid end from pump and inspect plunger and packing o If plunger is scored or damaged, replace both the plunger and packing o It is critical that you do not over tighten the packing gland adjustment nut – Replace packing if leak continues, this may be due to general wear and tear and is a part of regular maintenance o When replacing packings, please ensure that each individual Vee ring is inserted once at a time to avoid damaging the packing – Talk to your chemical supplier and ensure the packing material is compatible with the chemical; replace packing with a different material if required.
Fluid Ends Not Priming – Detected by inconsistent or no flow during sight glass gauge test	– When completing a sight glass gauge test, the fluid flow appears 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 o 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. o 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.
Plunger Bottoming out Three Ways to Detect: 1. The fluid end is not showing 6-7 threads 2. The pump stalls and stops 3. The pump is achieving shorter than expected	Pump Stall – Pump will stop and the fault light on controller will flash – Controller will display fault code (Motor Status: Fault Detected) – Manually back off fluid end to correct thread

system autonomy	count to 6-7 threads showing – Pump will not automatically start up, use controller interface to re-start pump Shorter Autonomy than Anticipated – Stop pump and motor – Manually back off fluid end to correct thread count to 6-7 threads showing – Start pump back up 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.
Loose Gearbox Collar – Detected by: motor seems to be running, but the pump is not turning.	– A clamp in the gearbox grips the output shaft of the motor (called gearbox collar) – Access the collar through two plastic plugs on the side of the gearbox. – 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. – Tighten the Allen bolt. – There are two Allen bolts that are 180 degrees opposite to one another; tighten both
Fault Indication on Controller – Red LED light flashing	– Connect to the configuration software and go to “system status” panel ○ Read fault code ○ Refer to page 21 for a list of fault codes and recommended troubleshooting steps
Undetected issue – Controller or Interface is not responding	– Go through all interface troubleshooting steps and the above pump troubleshooting steps – If no resolution, reset and reboot the controller and computer – Reset controller by pressing a pin into the reset button on the controller

***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 distributers return protocols to ensure that all components are properly cleaned prior to sending gear back

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