

# User's Guide

## Xtreme Syringe Pump

### Models Xtreme-10 and Xtreme-60

Version 1.07

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**Daedalus Innovations LLC**

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United States

## TABLE OF CONTENTS:

SAFETY STANDARDS MET .....	4
SCOPE OF THIS MANUAL .....	6
QUICK REFERENCE GUIDE .....	7
SYRINGE PUMP SETUP .....	8
ALLOWED TRANSDUCING FLUIDS.....	10
CONNECTING THE NMR CELL TO THE PUMP .....	11
TIPS FOR OPERATION .....	13
CONTROLLER OPERATION .....	15
LIMITS SCREEN.....	15
OTHER FUNCTIONS SCREEN.....	17
DATA LOGGING SCREEN .....	18
DISPLAYING THE DATA.....	19
PROGRAMMED PRESSURE CHANGES .....	20
ADD PROGRAM STEP.....	21
DISPLAY PROGRAM STEPS.....	22
STATUS MESSAGES.....	22
EMERGENCY SHUTDOWN MONITORING .....	24
SYSTEM FLOW DIAGRAM.....	26
TROUBLESHOOTING.....	27
SUMMARY SPECIFICATIONS.....	28
OPERATING SPECIFICATIONS.....	29
FURTHER INFORMATION.....	29



The syringe pump is magnetic. The bulk of the weight of the pump component is made from stainless steel and aluminum, but the case, gears and motor contain steel and iron. The controller box case is also steel. Caution must be used when moving the syringe pump near high field magnets.



The large syringe pump component weighs 109 lbs (50 kg). Team lift methods should be used for transport to prevent injury.



The user can set a maximum allowed pressure to help prevent accidental over pressurization of the NMR tubes (See *Limits Screen* section).



The system has the capacity to actively monitor for pressure drops and possible leaks in the NMR cell setup. These routines should be used to protect NMR probes from damage. See the *Emergency Shutdown Monitoring* section for details.



Use only approved transducing fluids in the Xtreme syringe pump. Fluids such as water, alcohols, oils, and inert gases are examples of allowed fluids. See *Allowed Transducing Fluids* for more details.



This device uses high current for operation. Do not attempt to service the instrument with the power cord plugged in.



This system will tolerate power blinks up to 200 ms in duration. After a power failure leading to shutdown the system will come back up in the previous state, including resuming programmed steps. The run time displayed on the main screen will resume, but will not account for the duration of the power outage.



The system must be properly grounded to protect against electrical shock. Use an appropriate three-prong AC outlet. Do not remove the grounding plug from the AC power cord.



Use only proper rated fuses in the device. The power input module requires 10A for 125VAC (Type GMA) or 5A (Type GDB) for 230VAC. The Power Cable fuse holder requires a 20A fuse (Type ABC) rated to 250V.



The AC power cord must be rated to the maximum current indicated in the *Summary Specifications* section.

## **SAFETY STANDARDS MET**



The Xtreme-60 and Xtreme-10 complies with UL 61010A-1 and CSA C22.2 No. 61010-1.

Due to different requirements the Xtreme-60 Syringe Pump is only rated to 36,260 psi (2.5 kbar) in Canada. Thus, units destined for the United States bear a decal indicating "Not for use in Canada" and the units destined for Canada display a "For use in Canada" decal.

The Xtreme-10 Syringe Pump had the same standards applied for both the United States and Canada so does not bear these decals.

UL listing: E113048



This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

This Class A digital apparatus complies with Canadian ICES-003.



This system conforms to the European Community Council Directive 2004/108/EC for electrical equipment for measurement, control and laboratory use. The standard used for emissions requirements EN 61326-1:2006; Clause 7.2, and the immunity requirements conformed to EN 61326-1:2006; Table 2.

This system conforms to the European Community Low Voltage Safety Directive 2006/95/EC. The standard used was EN 61010-1:2001 for electrical equipment for measurement, control, and laboratory use, Part 1: General requirements.

Documentation regarding any of these standards can be obtained by contacting in writing:

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## SCOPE OF THIS MANUAL

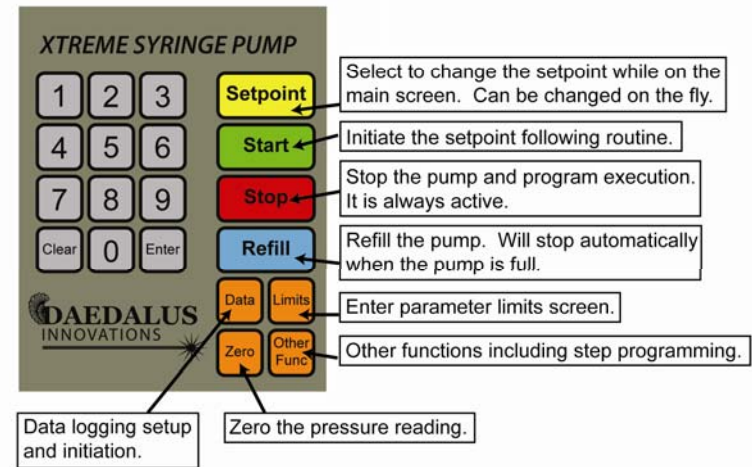
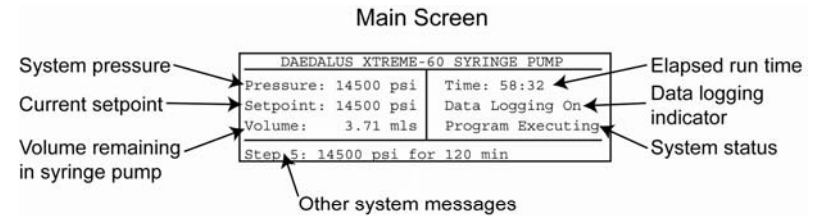
This manual provides operating instructions for both the Xtreme-60 and Xtreme-10 syringe pumps. The Xtreme-60 is a high pressure, low volume syringe pump intended for use with mostly incompressible fluids such as water. The displaced volume is only slightly larger than the dead volume making it a less than ideal choice for fluids requiring large compression cycles to reach pressure. The Xtreme-10 is a low pressure, high volume syringe pump. The displaced volume is more than ten-fold larger than the dead volume making it more ideal for gases and other highly compressible fluids.

The controller operation is identical for both pumps. There are differences in the connection port hardware, but it is assumed users will be able to make associations when not explicitly shown for the given model.

**If the equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.**

**The end-user of this equipment must supply a country-compliant AC power cord rated to the power input module fuse (10A for 100-120 VAC or 5A for 200-240). The power cord must have a grounding terminal. This does not apply to equipment sold in the United States or Canada.**

## QUICK REFERENCE GUIDE



## SYRINGE PUMP SETUP

Shown below is the back side of the syringe pump controller. Included with the controller are two cables that send power and signals to the pump component. The DB9 **SENSOR** cable should be plugged into the sensor cable on the controller and pump. The cable is bidirectional so it does not matter which end is plugged where. Use the finger screws to secure the sensor cable. The pump will not run if the sensor cable is not connected.

The two-pin **POWER** cable should be plugged into the power supply port on the controller and pump. This connector only fits into the receptacle one way as directed by a notch and key. Screw the cable housing fully in place.



Figure 1: Back of the pump controller box.

The RS-232 Port is for connecting the pump to an external computer. The Service Port is for uploading new revisions of the software. The **PROGRAMMING** cable is provided with the syringe pump for this purpose. It should **NOT** be connected to the controller during regular pump use.



Figure 2: Controller connected for standard operation.

The Xtreme-60 syringe pump was calibrated at the factory using distilled water and the Xtreme-10 was tested with liquid ethane. The water is removed from the Xtreme-60, but trace water will remain. If water will not be used in the syringe pump it is advisable to perform multiple refill cycles with a suitable solvent to remove the water. Using compressed gas such as nitrogen would also be useful for clearing excess water from the system.



Figure 3: 1/16" tubing used for the fill line connected to the Xtreme-60 inlet port.

Shown in Figure (3) is the Xtreme-60 syringe pump with the **REFILL** line connected to the inlet port. For purposes here the simplest method for filling the pump with a fluid is shown. For the Xtreme-60 the included HM4-AF1 adapter is used to connect

the 1/16" tubing to the pump. The Xtreme-10 requires no adapter for 1/16" tubing. This refill line should be run into a suitable fluid reservoir containing the solvent of choice. **If the transducing fluid is a gas at room temperature the cylinder can be connected directly to the inlet port. No elaborate refill process is required in that case.** Opening the inlet valve will allow the solvent to be drawn into the pump.



For the first fill perform three cycles of refilling followed by full dispensing with the inlet valve open and the refill line in the fluid reservoir. This should help clear the bulk of the air in the system. If necessary the pump can also be filled through the outlet port to help clear trapped bubbles in the lower internal tubing sections.

### **ALLOWED TRANSDUCING FLUIDS**

The wetted parts in the Xtreme Syringe Pump consist of 316 and 17-4PH stainless steel and a Parker Poly Pak® seal. Fluids that have been tested in the Xtreme-60/10 are water, ethanol, light paraffin oil, xenon, liquid carbon dioxide, hexane, pentane, liquid propane, and liquid ethane. Other fluids that are compatible with the pump materials could also be used. It should be noted that the displacement volume for the Xtreme-60 is only slightly more than half the total system volume so fluids that are highly compressible may prevent the full dynamic pressure range from being realized. The Xtreme-10 has a much larger compressible volume relative to the system volume (about 11-fold) so it is better suited for gases.

When using gases they should be introduced at high density or the liquid form if possible. Doing so will increase the maximum pressure that is obtainable by compression. When flammable gases are used a suitable exhaust hood should be available when venting the syringe pump.



Do not use fluids or gases that self-ignite by compression in the Xtreme-60 or Xtreme-10.

### **CONNECTING THE NMR CELL TO THE PUMP**

The NMR cells that are used with this pump have either 1/4"-28 or 1/2"-20 high pressure fittings. Most commonly, the pump is used with 1/2"-20 fitting NMR cells so that will be used as the example here. The tubing size used is 1/8" tubing. This is flexible enough that it can still be inserted down the bore of the magnet without too much added difficulty. The fitting on the Xtreme-60 is for 1/4" tubing (HF4 type) so a 1/4" to 1/8" tubing adapter has been provided. The 1/8" tubing leading to the cell can be connected directly to this adapter as shown in Figure (4).




Always use two wrenches when tightening fittings: one to tighten and one to prevent counter rotation. Failure to do so could break loose internal connections.

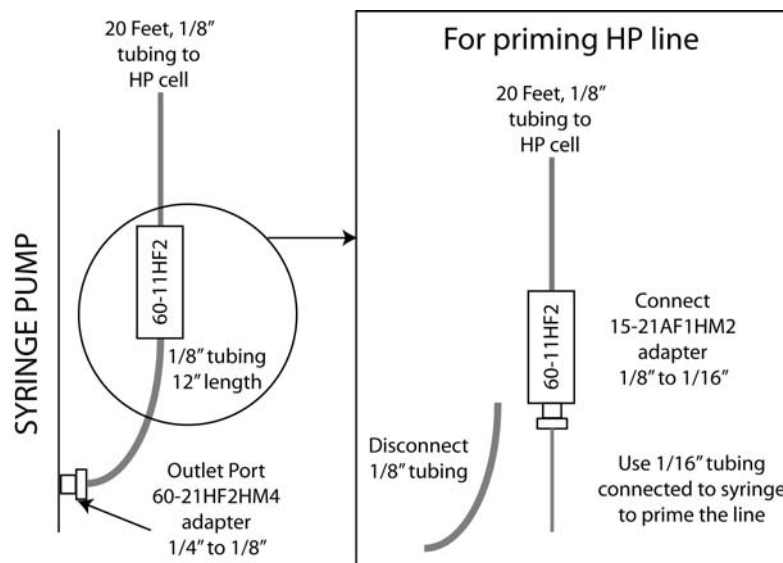


**Figure 4:** Connecting 1/8" tubing to the outlet port.

Alternatively, a short section of tubing can be used as a linker between the syringe pump and high pressure valves such as shown in Figure (5). Using this method allows the cell to be isolated from the syringe pump, which can be useful if multiple cells are being used with the same pump, or if the cell is to be stored in a pressurized state. This setup can also be useful for creating a barrier between the NMR sample and transducing fluid in the syringe pump. This can be done by filling the transfer line with a fluid immiscible with the NMR sample solvent prior to assembling the cell. This creates a large column of fluid between the syringe pump and sample and should eliminate any diffusion.



The Xtreme-10 can only accept 1/16" tubing using AM1 type glands on the inlet and outlet ports.



**Figure 5:** Using the high pressure valve to cap the line to the cell allows for switching out cells that are under pressure as well as the ability to prime the high pressure line with solvents that differ from the contents of the syringe pump. The part numbers correspond to High Pressure Equipment Company number. For the Xtreme-10 the valve P/N is 15-11AF1 and the tubing should be 1/16" for all connections.

### **TIPS FOR OPERATION**

- After refilling the pump, the first pressure point takes longer to reach equilibrium. Therefore, it is recommended that the pump be pre-equilibrated at some setpoint before running a program. This is especially important if the first pressure point is below 1000 psi.
- When changing fluids in the pump always perform a full refill. This resets internal parameters that adapt to the compressibility of the fluid.

- Salty buffers should not be left in the syringe pump. It is better to avoid salt in the pump entirely and use water or ethanol as the pressurizing fluid with the buffer primed in the high pressure line to the cell (see explanation *Connecting the NMR Cell to the Pump*). A light paraffin oil has also been used successfully as the pressurizing fluid. See the *Allowed Transducing Fluids* section for more details.
- The total Xtreme-60 volume, assuming a closed inlet and open outlet valve, is 12.5 ml of which 6.7 ml in the pump cylinder. Thus 6.7 ml is the maximum displacement that can be achieved by the pump. When working with fluids that are highly compressible, such as ethanol, it is recommended having a full cylinder since large volume displacement is required to reach maximum pressure. It is good practice to fill the cylinder for all work since the larger the system volume the smaller the pressure variances due to minor system displacements.
- Clearing the system of air bubbles after the first fill can be difficult. The following method can help in this process when using liquids only. Close the system valves and run the pressure up to mid-range (30,000 psi Xtreme-60 or 5,000 psi Xtreme-10) or as high as can be achieved with the current fill state. Once at pressure start the refill routine. Let the system come up to speed, then open the inlet valve to blow out air into the reservoir. Performing this several times will help clear the system of air bubbles.

## CONTROLLER OPERATION

When the system is first turned on the Daedalus Innovations logo will be displayed followed by the appearance of the main screen.

DAEDALUS XTREME-60 SYRINGE PUMP	
Pressure: 50 psi	Time:
Setpoint: 14500 psi	
Volume: 3.71 mls	Pump Stopped

This screen contains the information describing the current state of the system. The quick reference guide shows what each line provides as well as the keyboard button functions. In the simplest operation the setpoint is set, the start button pressed, and the pump will go to that pressure. The setpoint is remembered after the pump is turned off.



The **STOP** key will terminate the operation of the pump, including execution of programs. This can be used as an emergency stop.

The **CLEAR** key is used as a backspace key during data entry events. It also provides an additional feature in that it will redraw the screen. This may be necessary if aberrant characters are drawn when switching between menus.

## LIMITS SCREEN

All parameters set on this screen are remembered after shutdown or power failure.



PARAMETER LIMITS	
(1) Set Maximum Pressure:	60000 psi
(2) Set Maximum Pump Speed:	80 %
(3) Set Maximum Pump Accel:	5 inc
(4) Set Refill Speed:	80 %
(5) Return to Main	
Select Option:	

- (1) **Set Maximum Pressure:** The maximum pressure allowed by the system is hard coded in to the software. However, this number can be set to any lower value to prevent accidental overpressurizing of the target cell.
- (2) **Set Maximum Pump Speed:** Sometimes it might be desirable to change the rate of pressure increase provided by the pump. This number can be changed from 1 to 100 to alter that rate of change. However, too low a setting might prohibit the pump from working since the speed is also related to the torque available. This number can also be changed to alter the noise of the pump. Higher numbers mean more noise. The value of 80 provides a good balance between performance and noise.
- (3) **Set Maximum Pump Accel:** This also contributes to the rate of change. It has to do with the step size taken by the pump while changing speed. It can be changed from 1 to 10. If the pump seems to be oscillating around setpoints try lowering this number to slow the motor acceleration. The value of 4-5 is a good range for water.
- (4) **Set Refill Speed:** This number is primarily used to influence the noise of the pump. The pump working in reverse with a negative load can be quite noisy. A lower number will decrease the noise but it will take longer to refill the pump.

The value of 80 provides a good balance between refill time and noise.

- (5) **Return to Main:** Return to the main screen.

## OTHER FUNCTIONS SCREEN

All changeable parameters accessed from this screen are remembered after shutdown or power failure.

OTHER FUNCTIONS	
(1) Program Pressure Changes	
(2) Screen Brightness:	40 inc
(3) Pressure Units:	PSI
(4) More Options	
(5) Return to Main	
Select Option:	

- (1) **Program Pressure Changes:** Enter the programming section described later.
- (2) **Screen Brightness (0-255):** Changes the LCD backlighting intensity.
- (3) **Pressure Units:** The pressure output can be shown in PSI (pounds per square inch) or BAR. Hitting key 3 will toggle between the units.
- (4) **More Options:** Switches to page two of the Other Functions section.
- (5) **Return to Main:** Return to the main screen.

OTHER FUNCTIONS - page 2	
(1) Emergency Stop:	ON
(2) Reset the Pump	
(3) Reload Factory Defaults	
(4) Previous Screen	
(5) Return to Main	
Select Option:	

- (1) **Emergency Stop:** When "On", if the system is actively monitoring for excessive pressure

drops and excessive dispensing of fluids after reaching the setpoint. Either situation is a potential sign the NMR cell setup is not sound. When turning the monitoring on, the user will also be prompted to select the maximum displacement volume in microliters. See the *Emergency Shutdown Monitoring* section for an extended explanation of this feature.

- (2) **Reset the Pump:** This feature is to be used if the pump experiences a position error. This might happen if the sensor cable is disconnected during operation or if there is a power outage while the pump is running. The system will display a message if a reset is required. The reset process can take a long time since the pump is run in reverse at low speed until it hits the stop switch and relocates to the home position. If the pump was near empty when this is initiated it could take 20 minutes to execute.
- (3) **Reload Factory Defaults:** This feature is used to reload the system constants after the internal battery is replaced.
- (4) **Previous Screen:** Returns to the previous screen of the Other Functions section
- (5) **Return to Main:** Return to the main screen.

## DATA LOGGING SCREEN

The data collected during a run will not be remembered after the system is shutdown. Due to the memory size of the controller, the number of points is limited to 10,000.

```
DATA LOGGING
(1) Display Data
(2) Toggle Data Collection:      ON
(3) Change Data Interval:      30 sec
(4) Delete Data
(5) Return to Main
Select Option:
```

- (1) **Display Data:** Go to the data graphing screen
- (2) **Toggle Data Collection:** Turn the data collection on or off. Once the data collection has been turned off, it can not be turned back on unless the old data is deleted. The data collection is not stopped when the **STOP** key is pressed.
- (3) **Change Data Interval:** This is the time the controller will wait before collecting the next data point. The maximum interval size is 32767 seconds. The data collection starts at time = 0 seconds.
- (4) **Delete Data:** The controller will prompt for confirmation to delete the current data set.
- (5) **Return to Main:** Return to the main screen.

## DISPLAYING THE DATA

The ability to graph the data is provided more as a piece-of-mind assurance that the pump did as expected while unattended than as a quantitative tool. When entering the screen from the previous menu, the full data set will be displayed. There are three options:

- (1) **Limits:** This allows the range of the graph to be selected in the time axis only. The first point is the starting time point, the second the last time point. The units for the selections match the units for the current graphing solution. If a sufficiently small window is chosen the available

units will change. For example starting with the axis at hours, selecting a window of 120 minutes will change the units to minutes. Selection of a 10 minute window will change the units to seconds.

- (2) **Full:** This will display the full data set as currently collected. It may update depending on whether more data points have been collected since the last display.
- (3) **Exit:** Return to the Data Logging menu.

## PROGRAMMED PRESSURE CHANGES

The ability to set a program with multiple setpoints allows for unattended pressure titrations. The memory allows for 100 steps to be programmed, and the program will be remembered after shutdown.

```
PROGRAM PRESSURE CHANGE
(1) Execute Program
(2) Add Step
(3) Display Steps
(4) Delete Program
(5) Return to Previous Screen
Select Option:
```

- (1) **Execute Program:** Starts the programmed setpoint following routine. The current step is displayed at the bottom of the main screen during execution. The elapsed run time resets at the start of each step. The program will execute until done or the **STOP** button is pressed. After the program execution, the setpoint maintenance routine will stop so the last setpoint will not be maintained. This command does not start the data logging function.
- (2) **Add Step:** Go to the Add Program Step screen.

- (3) **Display Steps:** Go to the display program steps screen.
- (4) **Delete Program:** Will prompt for confirmation to delete the program in memory.
- (5) **Return to Previous Screen:** Return to the other functions screen.

## ADD PROGRAM STEP

```
ADD PROGRAM STEP
(1) Pressure Setpoint: 14500
(2) Time (min): 120
(3) Add Step and Return
(4) Return to Previous Screen
Select Option:
```

- (1) **Pressure Setpoint:** Enter the setpoint for this step. The pressure cannot be above the maximum pressure set in the parameter limits screen. If it is, it will default to that pressure limit.
- (2) **Time (min):** Set the time for this step in minutes. The time begins with the change in setpoint and will include the time required to reach the pressure setpoint. This is not equal to the time the setpoint was maintained. This is deliberate. The time to reach a setpoint is variable so attempting to time external data collection events would be much more difficult if the timing started when the setpoint was reached. Using this approach, a fixed delay can be added to the data collection event to account for the time to reach the setpoint and subsequent equilibration.
- (3) **Add Step and Return:** This option must be selected to add the step to the program stack. If the time is zero the step will not be added. The

program returns to the Program Pressure Change screen.

- (4) **Return to Previous Screen:** Return to the Program Pressure Change screen.

## DISPLAY PROGRAM STEPS

This screen is useful for confirming the steps of the program as well as editing existing programs. The current program step is displayed at the top of the menu.

```
DISPLAY PROGRAM STEPS
Step 5
(1) Pressure Setpoint: 14500
(2) Time (min): 120
(3) Delete Step
(4) Return to Previous Screen
(Enter) Next / (Clear) Previous
```

- (1) **Pressure Setpoint:** Selecting this option allows the step setpoint to be changed.
- (2) **Time (min):** Selecting this option allows the step time duration to be changed.
- (3) **Delete Step:** This will delete the current step from the program stack.
- (4) **Return to Previous Screen:** Return to the Program Pressure Change screen.

## STATUS MESSAGES

**Pump Running** – The pump is running in standard setpoint following mode.

**Pump Stopped** – The pump is idle.

**Refilling Pump** – The refill routine is active. This also re-homes the pump so occasionally the message HOMING may appear in the volume space.

**Stop Pump First** – The refill routine was selected when the pump was running.

**Pressure Too High!** – The setpoint selected was higher than the maximum pressure allowed. The setpoint will be reset to the maximum.

**Pump Empty** – The pump is empty and must be refilled before it can be started. Program execution will stop with this condition.

**Program Executing** – The user program is being executed. This will be displayed until the program is finished or the **STOP** key is pressed.

**Emergency Stop** – The system experienced a rapid depressurization and shutdown the pump.

**Leak Detected STOP** – The pump displaced the maximum volume allowed after the setpoint was reached. This is likely an indicator the external pressure connections are leaking. Check the setup.

**Data Table Full** – The maximum 10,000 data points was collected so data logging was terminated.

**Motor Overcurrent** – This is a troubleshooting error. The system was shutdown to protect damage to the motor controller. Attempt the following:  
1) Restart the pump and see if the situation repeats.

- 2) Increase the volume of fluid in the cylinder to decrease the rate of pressure change per turn of the motor.
- 3) Decrease the maximum speed of the motor to reduce the rate of pressure change per turn of the motor.
- 4) Contact Daedalus if the previous solutions fail

**Position Error** – This occurs when the system loses track of the position of the internal piston. Under normal refill operations the pump will re-home itself so this should not be an issue. However, if this message appears the pump should be reset by selecting option two from page two of the Other Functions menu.

### ***EMERGENCY SHUTDOWN MONITORING***

The Xtreme monitors the performance of the system in two ways that are intended to minimize any damage to the probe caused by failure of the NMR cell setup. When the system pressure is above 5,000 psi, it begins actively looking for a rapid pressure drop rate of at least 50,000 psi / sec. If detected the system immediately shuts down rather than continue to pump the remaining fluid through the NMR tube and into the NMR probe. An example of this might be the catastrophic rupture of the NMR cell seal that could occur if used above 100°C. This monitoring is active if the Emergency Stop is toggled “On”.

The second protection component is to monitor the amount of fluid displaced after the setpoint is achieved. The reason for this protection is if the NMR cell setup was not adequate and a slow leak developed such that the pump was able to reach pressure, but not hold the

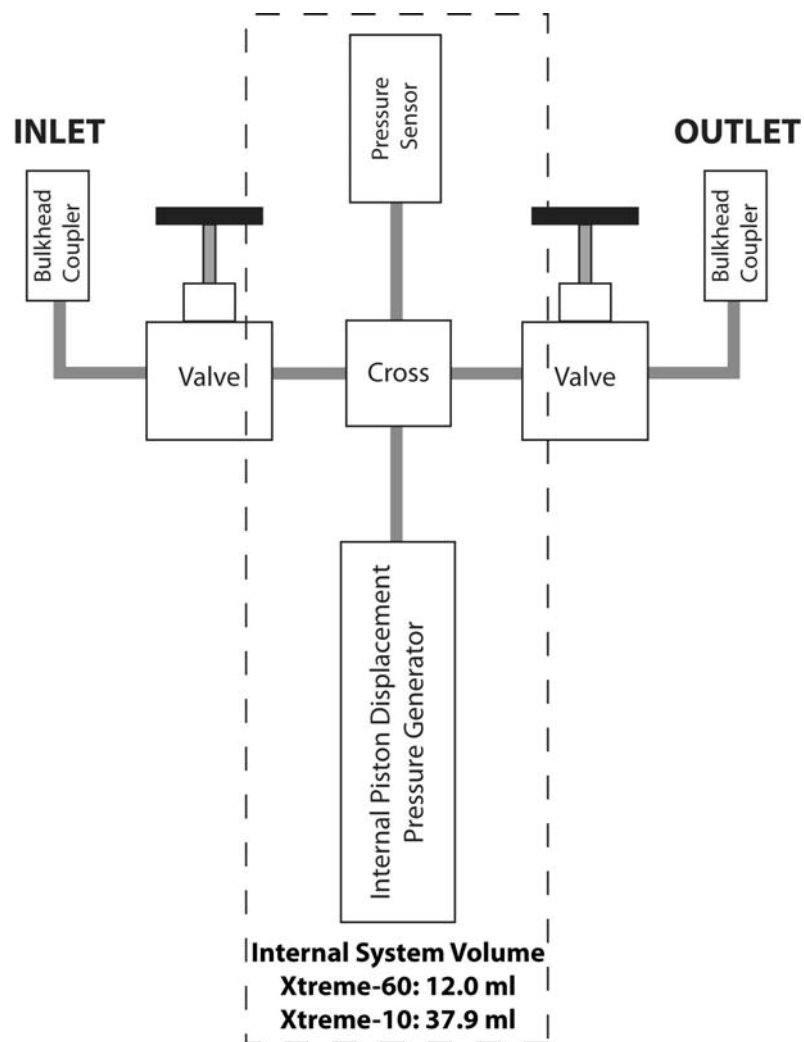
pressure stable it is conceivable the pump would dispense all remaining fluid into the probe through the slow leak from the NMR cell. To prevent this situation the system notes the volume when the pump first reaches the setpoint and stops the pump if the user defined limit is dispensed after that point. Entering a new setpoint or the next program step executing will restart this volume test. Hitting start while the pump is already running will not reset the count.

During normal operation the pump reaches the setpoint and will oscillate up and down until the system comes to equilibrium. It is possible for the pump to displace extra volume during this equilibration time. For water this extra volume is usually on the order of tens of microliters. For more compressible fluids such as ethanol this number will be larger. Hence the selection of this number is important. Too small and the pump may stop running though nothing is wrong; too large and the benefit of the monitoring decreases.

The default parameter for the displacement monitoring is 500 microliters. Though likely excessive for water and other mostly incompressible fluids it should provide sufficient range to accommodate most fluids, as well as offer reasonable protection against probe damage due to improper NMR cell setups. For water a value as small as 100 microliters is likely sufficient.

To turn off all monitoring set the Emergency Stop function toggle to “Off”. If only the pressure monitoring is desired, the max dispensed volume can be increased to the displacement volume for the pump or 6,700 microliters for the Xtreme-60 and 34,700 microliters for the Xtreme-10.

## SYSTEM FLOW DIAGRAM



Note: Inlet and Outlet ports are identical flow

## TROUBLESHOOTING

The following table covers some problems that may arise during routine use.

Controller does not turn on	1) Check power plug 2) Check 10 A / 5 A fuse
Pump started but is not running	1) Check Power Cable 2) Check 20 A fuse 3) Contact Daedalus
Message: Sensor Cable Not Connected	Make sure the sensor cable is attached. Run the refill routine to home the pump.
Unusual screen appearance or line placement	Hit clear to redraw the screen.
Pump is running but the volume is not changing on the display	Make sure the sensor cable is fully connected. Reset the pump to home.
<b>Emergency Stop</b> status message	See Status Messages section.
<b>Leak detected STOP</b> status message	See Status Messages and Emergency Shutdown Monitoring sections.
The pressure, setpoint, and volume values are meaningless numbers	The battery backed ram has failed. Contact Daedalus for assistance.
Pump noise increases noticeably when decreasing pressure or during refill	This is normal operational noise.
Odor when the pump is running full speed.	Normal during high speed operation. This is from the grease heating up.
Pump is running but it sounds like the motor is stalled. No motor overcurrent message.	Follow the steps for the motor overcurrent message.

## SUMMARY SPECIFICATIONS

Power requirements	100-120 VAC / 200-240 VAC, 50/60 Hz
Power Cord	End-user supplied country compliant power cord with grounding terminal (except USA and Canada)
Input current	7.9 A / 3.95 A
Input fuse	10 A (GMA, 125V) / 5 A (GDB, 250V)
Power output	24 VDC, 20 A maximum
Output fuse	20 A (ABC, 250V)
Temperature range	10 °C to 70 °C
Weight	Main pump section: 109 lbs (49.5 kg) Controller: 15 lbs (6.8 kg)
Dimensions	Main pump section: 12" W x 29" D x 11" H Controller: 11" W x 17" D x 6" H
Pressure range	<b>Xtreme-60</b> 0-60,000 psi (4138 bar) maximum (US, Europe) 0-36,260 psi (2500 bar) maximum (Canada) <b>Xtreme-10</b> 0-10,000 psi (690 bar) maximum
Wetted Parts	316 and 17-4PH stainless steel. Parker Poly Pak® is standard.
Operating medium	Water, Oils, Alcohols, Inert Gases. See <i>Allowed Transducing Fluids</i> for details
System volume	<b>Xtreme-60</b> 12 ml (to internal valve) 12.5 ml with inlet valve closed and outlet valve open <b>Xtreme-10</b> 37.9 ml (to internal valve) 37.95 ml with inlet valve closed and outlet valve open
Displacement volume	<b>Xtreme-60:</b> 6.7 ml <b>Xtreme-10:</b> 34.7 ml
Pressure connection	<b>Xtreme-60</b> Inlet / Outlet ports are HiP HF4 (9/16"-18 UNF) for use with 1/4" tubing <b>Xtreme-10</b> Inlet / Outlet ports are HiP AF1 (1/4"-28 UNF) for use with 1/16" tubing

## OPERATING SPECIFICATIONS

Warm up time	5 minutes recommended from cold power-up
Normal operating temperature	15 °C to 40 °C
Resolution	0.01% FS (5 psi)
Pressure Sensor Specifications	Non-linearity: 0.35% FS Hysteresis: 0.10% FS Repeatability: 0.10% FS
Programmed pressure changes	100 steps (99999 minutes per step maximum)
Data acquisition	10000 data points 1-99999 second intervals
Maintenance of pressure setpoint	Indefinite
Full displacement	4 minutes at maximum speed

## FURTHER INFORMATION

This document may be updated periodically to reflect questions from users. Please check back at [www.daedalusinnovations.com](http://www.daedalusinnovations.com) in the support section for more recent versions of this document.

Technical support can also be obtained by emailing questions to [support@daedalusinnovations.com](mailto:support@daedalusinnovations.com), or contacting Daedalus directly at 610-358-4728.

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