User's Guide

Xtreme Syringe Pump

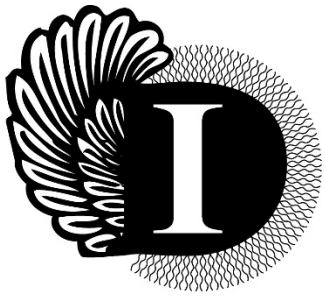
Models Xtreme-10 and Xtreme-60

Version 1.08

Daedalus Innovations LLC

Aston, Pennsylvania

United States



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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 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.

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

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.

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.

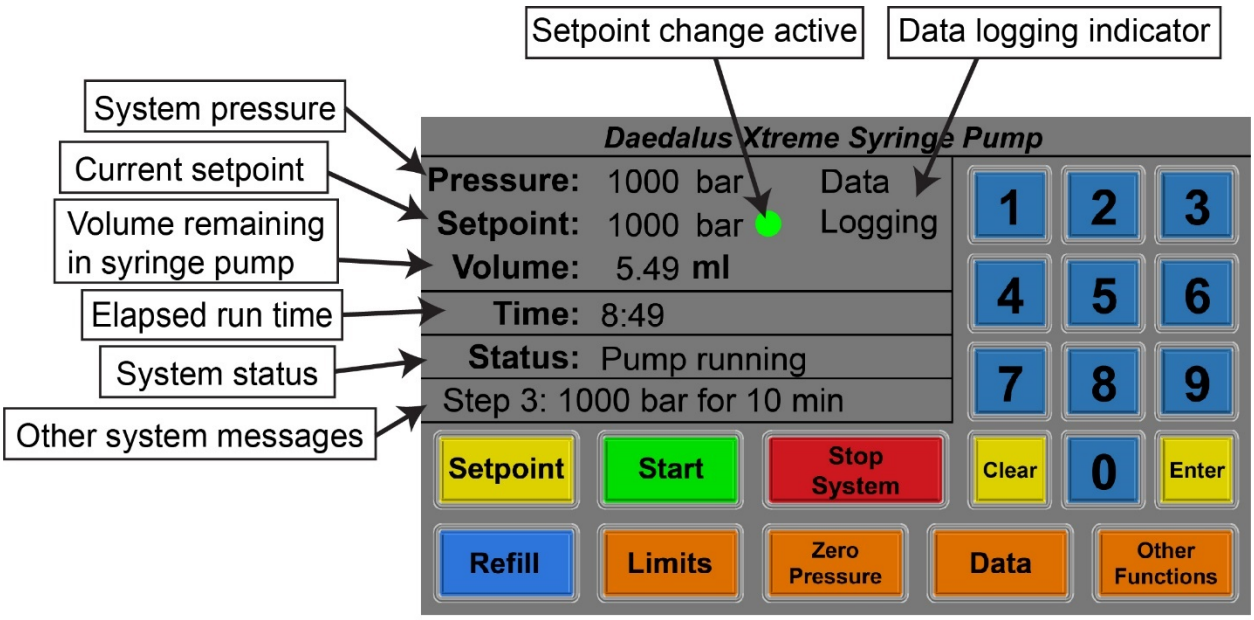
The controller operation is identical for both pumps. There are differences in the connection port hardware, but it is assumed users will be able to make associations when not explicitly shown for the given model.

If the equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired. See Appendix A for proper method for tightening high pressure tubing to the pump.

Always use two wrenches when tightening fittings: one to tighten and one to prevent counter rotation of the fixture. Failure to do so could break loose internal connections. See **Appendix A** for additional details.

The end-user of this equipment may need to 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



Main screen key functions:

Setpoint — Select to change the setpoint while on the main screen. When changing a green circle will appear until the new setpoint is accepted. Changes can be made while the pump is running. The setpoint number can also be touched to perform the same operation.

Start — Initiate the setpoint following routine. Hitting while the pump is running will reset the elapsed time to zero.

Stop System — Stops the pump and program execution. It is always active.

Refill — Initiates the refill operation if the pump is stopped. The pump will stop automatically when the pump is full.

Limits — Enter the parameter limits screen. Can only be done while the pump is stopped.

Zero Pressure — If the pump is stopped this will initiate the zero pressure reading routine.

Data — Opens the data logging and display menu. Can be done will running.

Other Functions — Enter the other functions menu and step programming. This can only be done if the pump is stopped.

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, and potential damage may occur if disconnected while powered-on.

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.

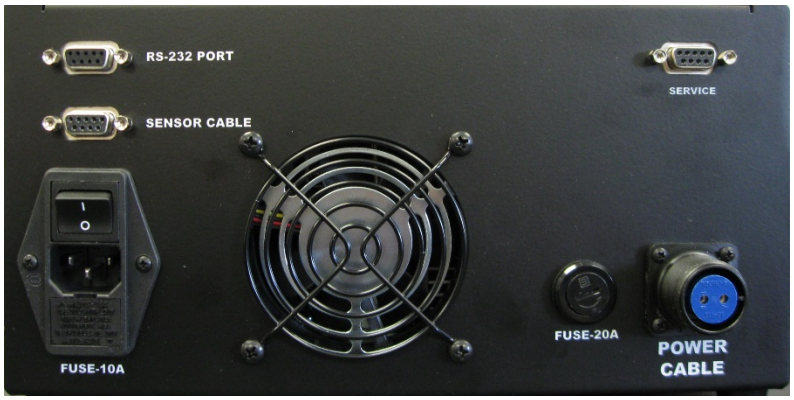


Figure 1: Back of the pump controller box.

The RS-232 Port is for connecting the pump to an external computer. The Service Port is for uploading new revisions of the software in-the-field. The **PROGRAMMING** cable is not included with the syringe pump.

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 nitrogen gas or similar. 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.

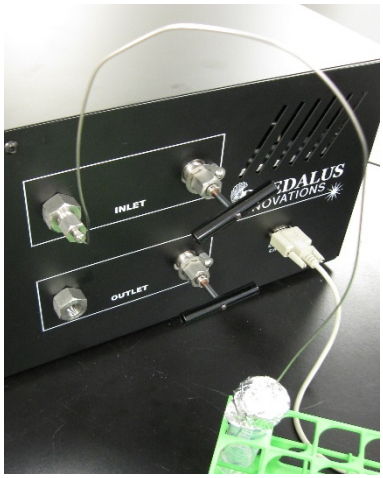


Figure 3: 1/16" tubing used for the fill line connected to the Xtreme-60 inlet port.

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 TRANDUCING 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 be realized. The Xtreme-10 has a much larger compressible volume relative to the system volume (about 11-fold) so it better suited for gases.

When using gases they should be introduced at the highest density possible or the liquid form. Doing so will increase the maximum pressure that is obtainable by compression. If pressure levels below the gas loading pressure are required when using a gas, the piston can be moved to an intermediate volume position then loaded. This would allow both lower and higher pressure points to be reached while still allowing for a maximum pressure condition. 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

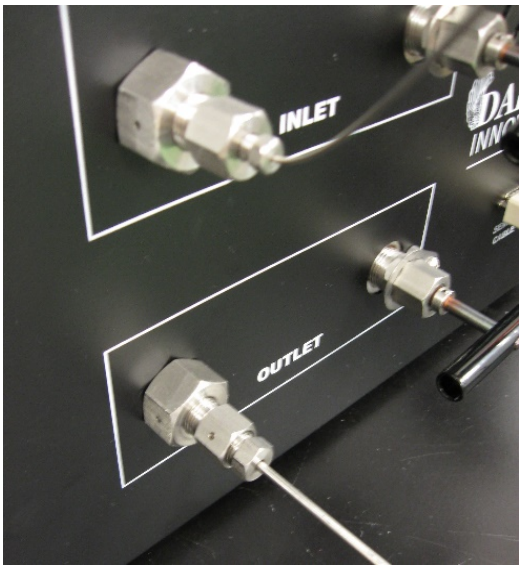


Figure 4: Connecting 1/8" tubing to the outlet port.

The NMR cells that are used with this pump have either ¼"-28 or ½"-20 high pressure fittings. Most commonly, the pump is used with ½"-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 of the fixture. Failure to do so could break loose internal connections. See **Appendix A** for additional details.

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.

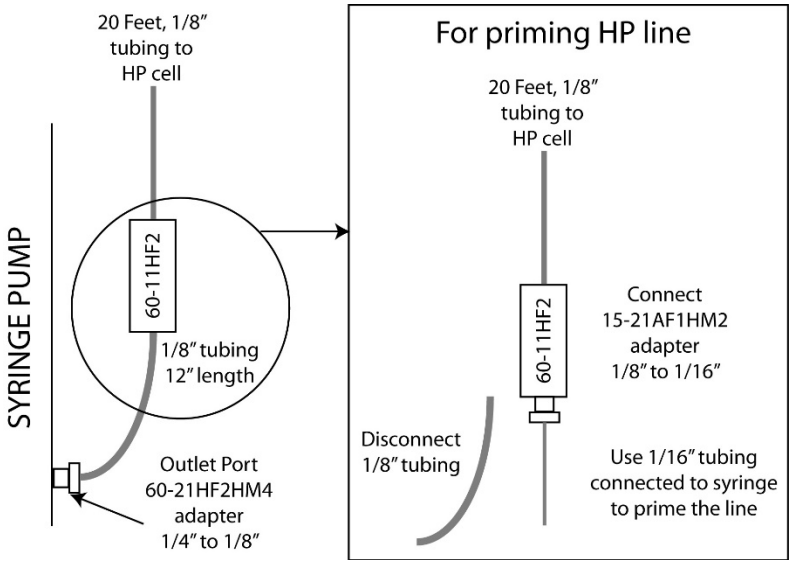


Figure 5: Using the high pressure valve to cap the line to the cell allows for switching out cells that are under pressure as well as the ability to prime the high pressure line with solvents that differ from the contents of the syringe pump. The part numbers correspond to High Pressure Equipment Company 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.

- After each session always perform a full refill. The refill operation homes the pump position as well as resets internal parameters that help adapt to the compressibility of the fluid.

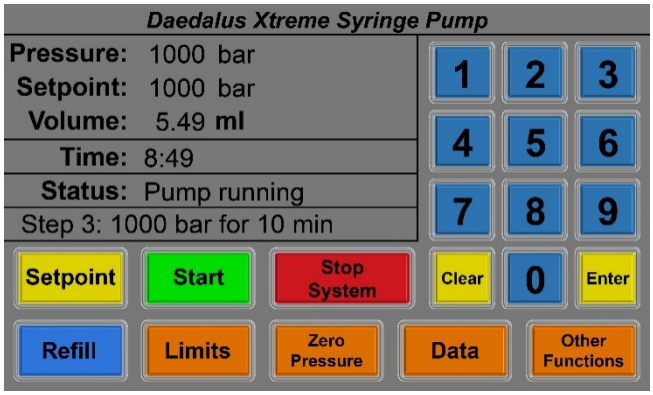
- Salty buffers should not be left in the syringe pump. It is better to avoid salt in the pump entirely and use water or ethanol as the pressurizing fluid with the buffer primed in the high pressure line to the cell (see explanation *Connecting the NMR Cell to the Pump*). A light paraffin oil has also 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 full 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. Because the barrel of the pump is horizontal it can be difficult to initially clear the air. Users have reported raising the end closest to the valves to force air to the top of the barrel. Typically this is not necessary, but it is a trick that seems to help.

CONTROLLER OPERATION

When the system is first turned on the Daedalus Innovations logo will be displayed followed by the appearance of the main screen. It takes approximately four seconds before the information populates after first appearance of the screen.



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 graphical key 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 stored in internal memory and will be restored after power cycling the pump.

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

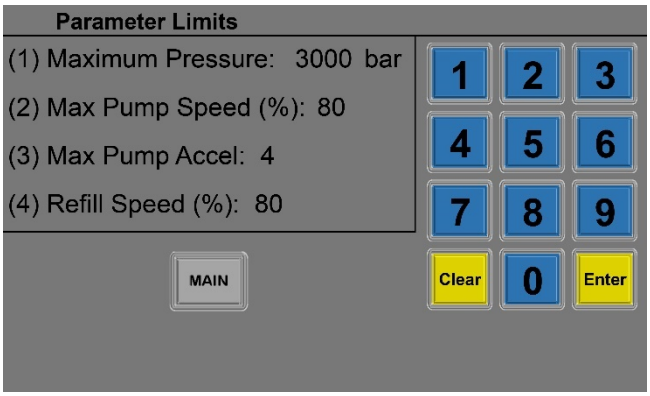
The **CLEAR** key is used as a backspace key during data entry events. It also provides an additional feature in that it will redraw the screen. This may be necessary if aberrant characters are draw when switching between menus.

The description that follows of the other menus will identify what the various options do and how it impacts the operation. Generally, the value for an option represent a touch region that can will directly to activate changing the parameter. This is also true of the setpoint value on the main screen even though there is a designated graphical key for this purpose.

The **MAIN** button at the bottom of the menu screens will return to this main screen.

LIMITS SCREEN

All parameters set on this screen are remembered after shutdown or power failure. Touch the option line to change the parameters. A green circle will display on top of the option number when active.



(1) Set Maximum Pressure: The maximum pressure allowed by the system is hard coded into the software. However, this number can be set to any lower value to prevent accidental overpressurizing of the target cell.

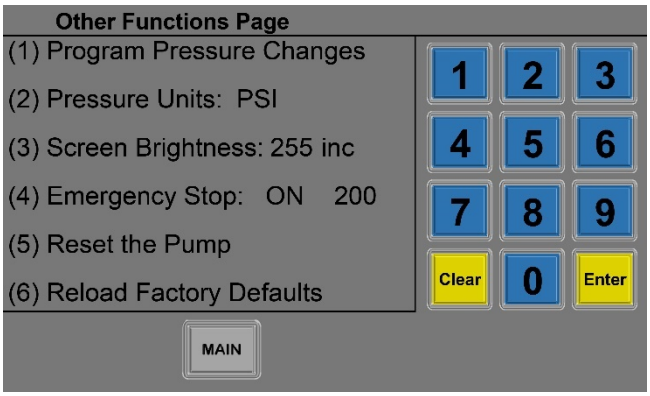
(2) Set Maximum Pump Speed: Sometimes it might be desirable to change the rate of pressure increase provided by the pump. This number can be changed from 1 to 100 to alter that rate of change. However, too low a setting might prohibit the pump from working since the speed is also related to the torque 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.

OTHER FUNCTIONS SCREEN

All changeable parameters accessed from this screen are remembered after shutdown or power failure. Simply touch the option line to select. When options require further input a green circle will overlay the option number when active.



(1) Program Pressure Changes: Enter the programming section described later.

(2) Pressure Units: The pressure output can be shown in PSI (pounds per square inch) or BAR. Selecting this option will toggle between units. This will be the units shown for all pressure readings.

(3) Screen Brightness (0-255): Changes the LCD backlighting intensity. Generally, the default of 255 is optimal.

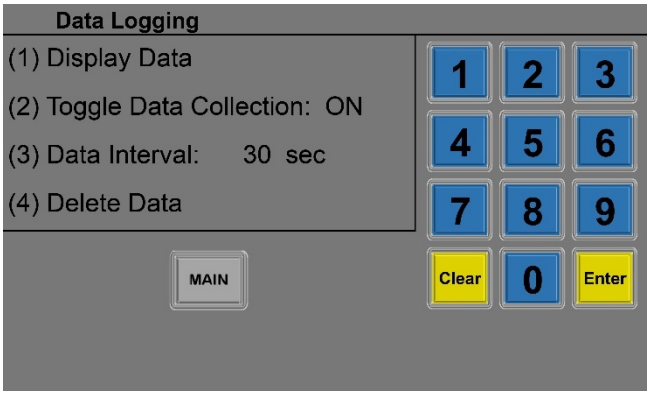
(4) Emergency Stop: When “On”, if the system is actively monitoring for excessive pressure drops and excessive dispensing of fluids after reaching the setpoint. Either situation is a potential sign the NMR cell setup is not sound. When turning the monitoring on, the user will also be prompted to select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

(5) 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. Selecting this option will open a window with a dialog asking to confirm the reset. This process can take a long time since the pump is run in reverse a 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 10 minutes or more to execute.

(6) Reload Factory Defaults: Selecting this option will open a new window with a dialog asking to confirm the operation. Typically, this feature would only be needed to reload the system constants after the internal battery is replaced.

DATA LOGGING SCREEN

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



(1) Display Data: Go to the data graphing screen

(2) Toggle Data Collection: Turn the data collection on or off. On the main screen there is a **DATA LOGGING** message displayed when active. Once the data collection has been turned off, it cannot 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.

DISPLAYING THE DATA

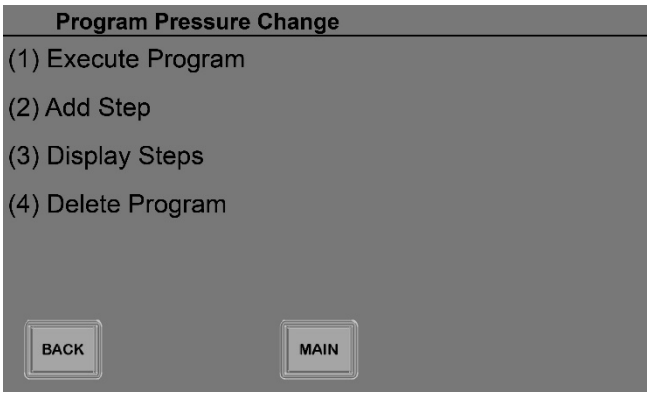
The ability to graph the data is provided more as a piece-of-mind assurance that the pump did as expected while unattended than as a quantitative tool. When entering the screen from the previous menu, the full data set will be displayed.

There are graphical keys available to change the maximum and minimum X and Y of the data being displayed. There is also a full scale key to display the full data set. 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.

Since the pump can be running while displaying the data there is a **STOP SYSTEM** key in this window to stop the operation of the pump. This will terminate any program that is running as well. It will not stop the data collection.

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.



(1) Execute Program: Opens a new window which allows the execution of 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.

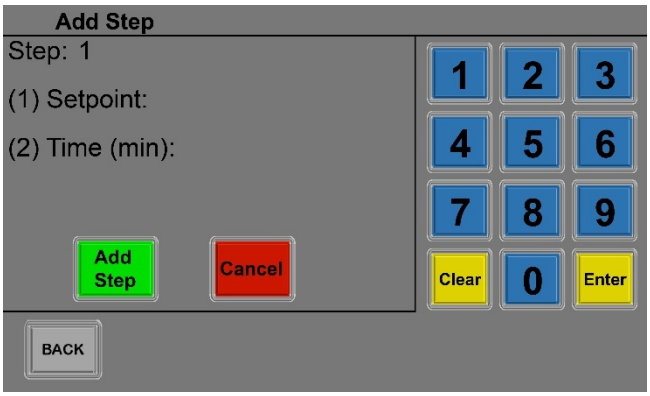
(3) Display Steps: Go to the display program steps screen.

(4) Delete Program: Will prompt for confirmation to delete the program in memory.

The **BACK** button returns to the previous screen.
The **MAIN** button will go to the main screen.

ADD PROGRAM STEP

Shown is the initial page for adding a step to the program. The new step number is indicated at the top. Touching the region for setpoint or time will allow for entry of the desired values. A green circle will overlay the option number until the operation is complete.



(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.

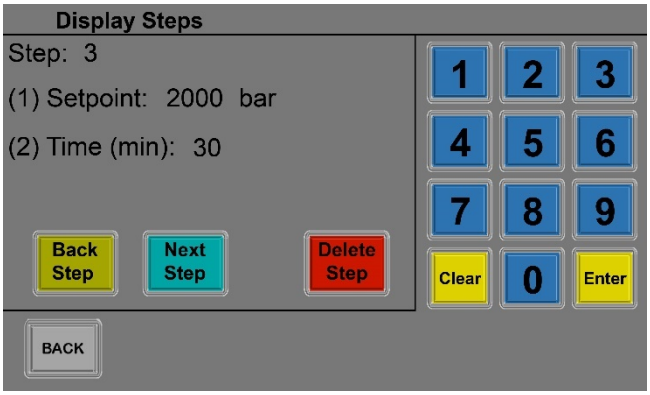
Add Step key: This option must be selected to add the step to the program stack. If either parameter is incomplete an error message will be displayed. Once accepted the window will update to allow for the next step to be added.

Cancel key: This will cancel the operation and return to the previous screen without entering a step.

The **BACK** button will also return to the previous screen without entering the step.

DISPLAY PROGRAM STEPS

This screen is for confirming the steps of the program are as expected as well as editing existing programs. The current program step is displayed at the top of the screen. Selecting by touch either the setpoint or time will allow that value to be altered. While active a green circle will overlay with the option number. The currently displayed step can also be deleted from the program.



(1) 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.

Back Step key: move to the previous step in the program.
Next Step key: move to the next step in the program.
Delete Step key: this will delete the current step from the program stack.
The **BACK** key returns 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 reduces 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”.

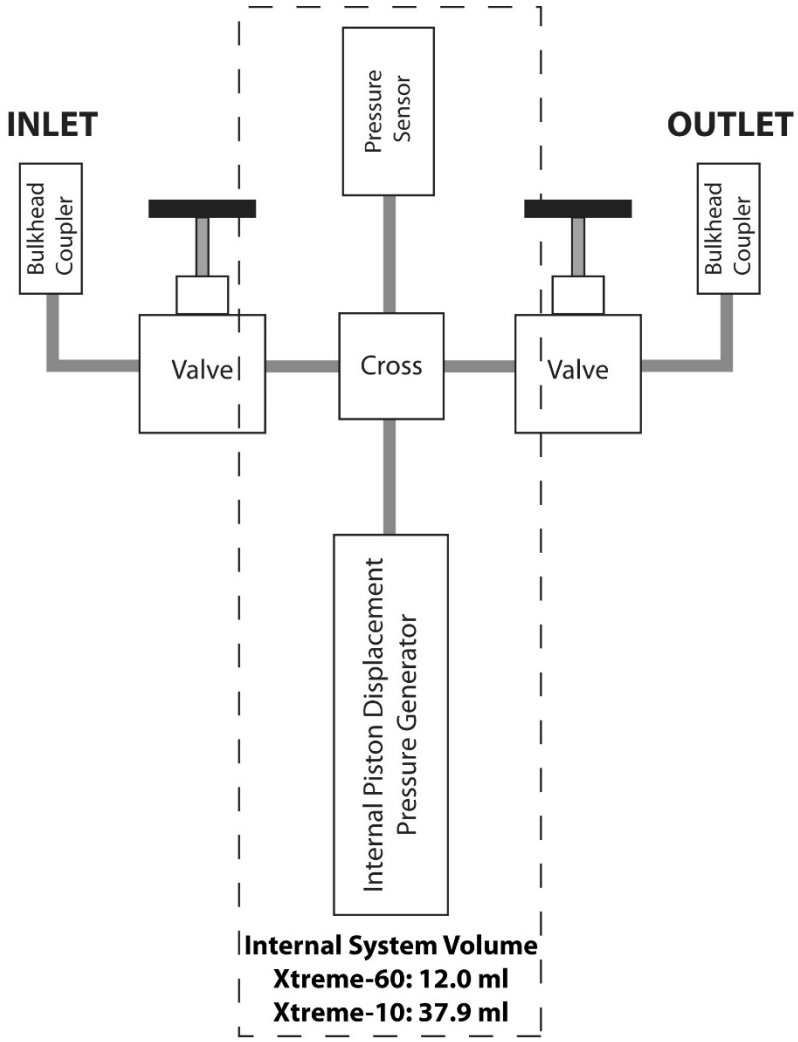
The second protection component is to monitor the amount of fluid displaced after the setpoint is achieved. The reason for this protection is if the NMR cell setup was not adequate and a slow leak developed such that the pump was able to reach pressure, but not hold the pressure stable it is conceivable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

The flow path for the Inlet and Outlet ports are identical. This means the system can be loaded from either port, and for initial loading it may be better to load from the outlet port. The same is true for connecting NMR cells to the system. If it is more convenient to connect the cell to the inlet port there is no reason not to do so.

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.
Emergency Stop status message	See Status Messages section.
Leak detected STOP status message	See Status Messages and Emergency Shutdown Monitoring sections.
Window appears indicating **No Constates Loaded!**	The internal microcontroller battery has failed and needs to be replaced. See Appendix B for information on how to replace the battery.
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	**Xtreme-60** 0-60,000 psi (4138 bar) maximum (US, Europe) 0-36,260 psi (2500 bar) maximum (Canada) **Xtreme-10** 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 *Allowed Transducing Fluids* for details
System volume	**Xtreme-60** 12 ml (to internal valve) 12.5 ml with inlet valve closed and outlet valve open **Xtreme-10** 37.9 ml (to internal valve) 37.95 ml with inlet valve closed and outlet valve open
Displacement volume	**Xtreme-60:** 6.7 ml **Xtreme-10:** 34.7 ml
Pressure connection	**Xtreme-60** Inlet / Outlet ports are HiP HF4 (9/16”-18 UNF) for use with 1/4” tubing **Xtreme-10** 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 in the support section for more recent versions of this document.

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

Other correspondence can be directed to:

Daedalus Innovations, LLC
200 Racoosin Drive, Suite 106
Aston, PA 19014

APPENDIX A: USING WRENCHES ON HIGH PRESSURE COMPONENTS

Initial mating of the connections should be able to be achieved by hand. Occasionally the connections may not be lined up and the strain on the connection may make hand tightening difficult. This is especially true for connections made at the top and the bottom of the cell. Instead of forcing the connection with wrenches, small movements of the connections should be made to help engage the threads. Stainless to stainless connections are particularly prone to seizing under high torque so wherever permissible anti-seize compound for stainless steel should be used on the threads. For connections common to the overburden cell the AM2 style fittings are most prone to this. If the compound has worn off and applying more does not help lubricate the threads, the connections may need to be re-tapped.

Using Wrenches

Always ensure that the flats of the wrench are fully engaged on the connector. Failure to do so could result in slippage and damage the flats of the connector. This is shown in Figure 6.

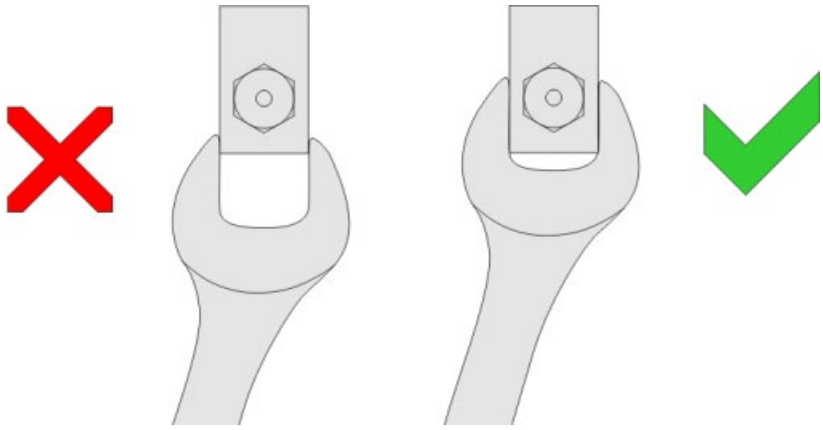


Figure 6: Proper engagement of wrenches

Using Torque Wrenches

A torque wrench is designed to yield slightly when the desired torque is applied. The desired torque is chosen by rotating the handle until the torque value (in-lbs.), is just visible above the handle indicator. The torque must always be applied in the direction of the arrow shown on one side of the torque wrench. Once the desired torque is reached the head will yield slightly and an audible click will be heard. When this happens no further

torque should be applied. The torque wrench is supplied with an instruction manual for proper setting and use of the wrench.

Tightening Fittings

When applying a large torque with two wrenches it is essential that the torque is always applied in a squeezing motion. When using a fixed wrench and a torque wrench to tighten the fittings it is significantly easier to control the motion and apply the desired torque if the angle between the two tools is kept at small as possible. The fixed wrenches supplied with the overburden cell have the opening at an angle of 15° from the main lever arm. Turning a wrench upside down will change the angle of the main lever arm by 30°, when the wrench is engaged on the same flats. When tightening the high pressure fittings the orientation of the fixed wrench should be chosen in conjunction with the flats on the connector to ensure that the angle is kept to a minimum. Figure 7 shows three options for arranging a torque wrench and a fixed wrench for a connector, and how the positioning can be altered to bring minimize the angle between the lever arms of the wrenches.

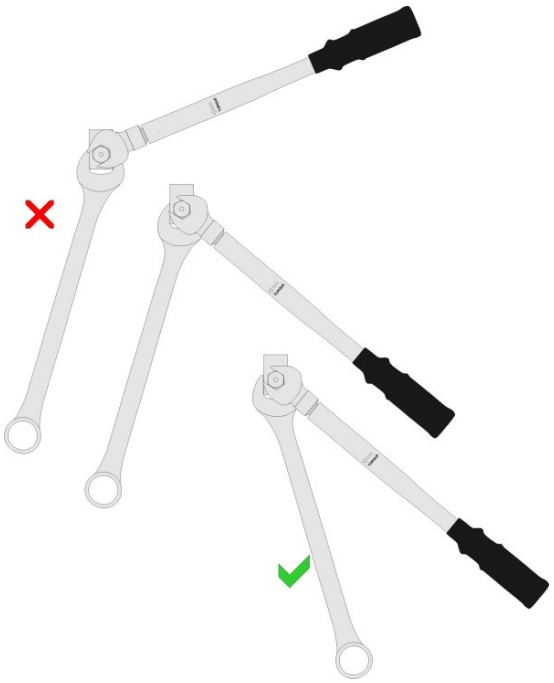


Figure 7: Positioning the fixed and torque wrenches for tightening

APPENDIX B: XTREME CONTROLLER BATTERY REPLACEMENT

These instructions apply to Xtreme system manufactured 2019 and newer. A similar instruction set is required for older systems.

The operational parameters of the Xtreme controller are hard coded in memory. Under normal operations these are retained in battery-backed RAM. This allows settings to be retained during power-off conditions. As with all batteries there is a finite lifetime for the battery and it will eventually need to be replaced. The battery contained in the Xtreme controller is a CR2477N, 3V lithium battery. Depending on the power-on time this battery can last for many years. To replace the battery, the following steps should be followed.

1) Disconnect all cables from the controller and move it to a suitable worktable.

2) Remove the 12 screws holding the cover on the controller.

3) With the screws removed slide the cover slightly to the left and slowly lift off. The LCD is powered through a jack on the side. This cable can be pulled out and set aside. The other wire harness connects to the computer board. It has sufficient length to allow the case cover to be set on its side as shown in the figure. If necessary, this wire harness can be disconnected from the interface board. These connectors have a lock tab that must be depressed to extract from the receptacle.

Figure 8: Remove cover and set to the side.

4) The coin battery is located near the center of the microcontroller. It is held in place by four tabs. The bottom two might be slightly hidden by the green daughter board. The coin battery has a ridge along the top edge. Using a finger on the left side pry up on this ridge to loosen and remove the old battery. One could also use a small screwdriver or hook to pry along the bottom surface of the battery. There is no circuitry below the batter that would be damaged should the board be scored.

5) After extracting the battery, press the new battery into the battery housing. Typically, this can be

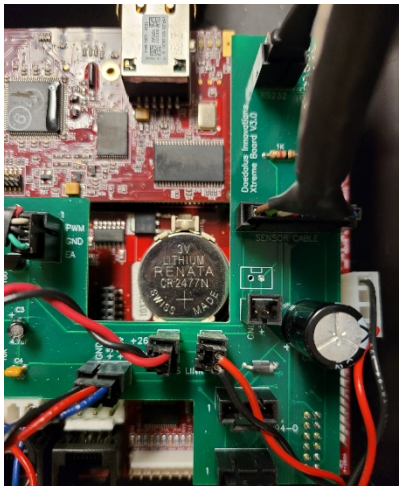


Figure 9: Identify battery component and remove

done by hand. Be certain the positive side of the battery is facing up.

6) Bring the cover back over the top of the case and plug the power jack cable back into the LCD. Place the cover on the case skewed slightly to the left so the power jack can be slid under the upper case mounting tab. Put the cover back in place and secure in place with the 12 cover screws.

7) Reconnect the controller to the pump section. Be certain the sensor cable is connected to the sensor port.

8) Turn on the controller. Instead of returning to the usual main screen the following screen will appear after a few seconds.. Touch the screen to reload the constants and continue to the main screen.

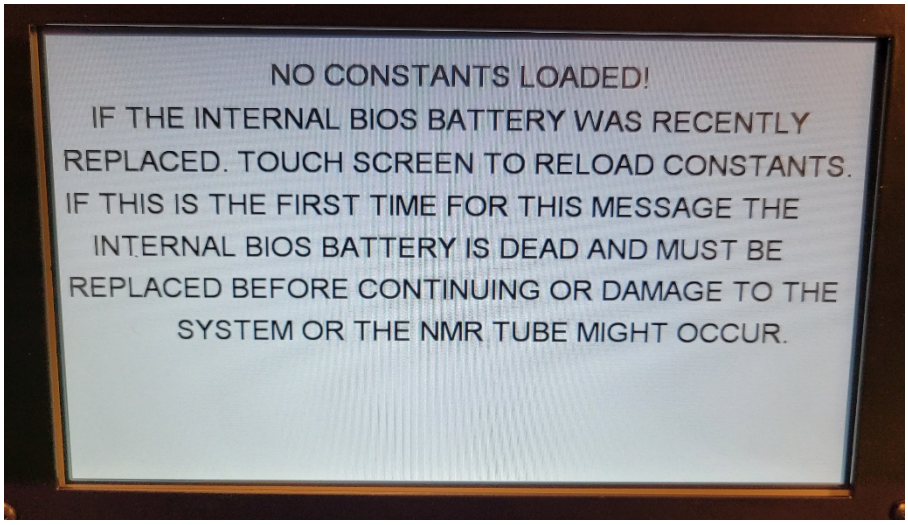


Figure 10: Boot up screen after battery replacement. Touch the screen to reload constants and continue.

9) After the reload completes and the main screen appears go ahead and shut the controller off and back on again. If the battery replacement was successful, the system should go directly to the main screen.

10) It should be assumed the pump volume reading is incorrect, and should be reset to return the pump to the home position. To reach this option hit the “OTHER FUNC” key, followed by Option 4, for “More Options”, then select Option 2 for “Reset the Pump” and follow the instruction. Depending on the position of the pump when the battery failed this process might take several minutes. An error message indicating the pump must be reset may appear, but can be ignored.

11) The pump is no longer properly zeroed. Be sure the pump is open to the atmosphere and hit the “ZERO” button.

12) The maximum limit of the pump should also be reset. This is under the “LIMITS” screen. The maximum pressure allowed should be equal to the maximum pressure of the tube in use. If necessary, change the pressure units of the system (see Step 13) to more accurately set this parameter.

13) Other parameters might also need to be changed such as the pressure units and screen brightness. Both parameters can be found on the “OTHER FUNC” page. On the second page of this section the Emergency Stop parameter should also be checked to assure it is turned on and an appropriate volume parameter is selected.

14) Any programs in the system will have been lost. Before running a program, it is a good idea to perform a Delete of existing programs to assure there are no garbage numbers the might remain from the reboot. As always check the program before running it.

This completes the battery change process.

APPENDIX C: DAEDALUS XTREME CONTROLLER RS-232 COMMUNICATION

A basic command set is available for communication between an external computer and the Xtreme controller for control of parameters by the external device. A minimal control program can consist of the following commands:

- Initiate remote control (CMD 0x40)
- Return to local control (CMD 0x41)
- Start pump (CMD 0x42)
- Stop pump (CMD 0x43)
- Change pressure setpoint (CMD 0x44) with appropriate limit checks to prevent overpressure conditions. The pressure parameter must be sent in PSI.
- Report status (CMD 0x55) to obtain feedback to report on the current pressure and volume of the system. An optional report on the status (Run, Stop, Pump Empty) can also be obtained with this command.

The Xtreme controller RS-232 port uses 19,200 baud, no parity, 8-bits, 1 stop bit. The port will respond to RS232-to-USB converter cables.
Due to the limited scope of the command set certain functions that are ordinarily handled by the controller are passed to the external control program. Some items to note when using this command set:

- The pressure setpoint is not checked against the internal maximum pressure setting. Therefore, the control program must limit the allowed setpoint to prevent over pressure conditions.
- The pump must be stopped before the refill command is sent.
- The pump must be stopped before zeroing the pressure.
- Communication must be initiated (CMD 0x40) before commands can be sent.
- The controller STOP button will terminate all control. It is the only active button on the controller during remote access.

Command format:
[Initiate codes] [Command] [Data – Text] [Termination Code]
Initiate codes = Dec 15 01
Hex 0F 01
Command: (see command list)
Data - Text: If the command requires data this is transmitted as plain text corresponding to the data characters
Termination code = Dec 13
Hex 0D
Response format:

- The general acknowledgement of command receipt: Ascii “AE<CR>”
- When the controller responds with data, the text is included between the initiating ‘A’ and ending ‘E’ as shown:

A[Data – Text]E<CR>

Available commands:

Initiate remote control	
Hex	40
Dec	64
This command must be transmitted first. It will transfer control of the pump to an external device. The controller keypad is inactive with the exception of the STOP button which will override external control.	
Response	AE<CR>
Example	Command string: 0F 01 40 0D

Return to local control	
Hex	41
Dec	65
Cancels external control and returns operations to the controller.	
Response	AE<CR>
Example	Command string: 0F 01 41 0D

Start pump	
Hex	42
Dec	66
Starts the pump to adjust to the current setpoint.	
Response	AE<CR>
Example	Command string: 0F 01 42 0D

Stop pump	
Hex	43
Dec	67
Stops the pump.	
Response	AE<CR>
Example	Command string: 0F 01 43 0D

Change pressure setpoint	
Hex	44
Dec	68
This command transmits the new setpoint to the controller. The setpoint is in PSI and is represented in text format. The BAR units are not supported. Any conversion must be done by the external device.	
Response	AE<CR>
Example	Command string: 0F 01 44 **5 0 0 0** 0D This will change the setpoint to 5000 psi.

Initiate refill

Hex	45
Dec	69
Start the refill pump routine. The pump must be stopped prior to sending this command. The external controlling program should check for the stopped condition prior to sending this command.	
Response	AE<CR>
Example	Command string: 0F 01 45 0D

Zero pressure reading	
Hex	46
Dec	70
Zero the pressure reading. The pump must be stopped prior to sending this command. The external controlling program should check for the stopped condition prior to sending this command.	
Response	AE<CR>
Example	Command string: 0F 01 46 0D

Report current system pressure in PSI	
Hex	4C
Dec	76
Requests a report of the current system pressure in PSI regardless of the unit setting on the controller. The conversion to other units must be done by the external control program.	
Response	**A**[DATA]**E<CR>**
Example	Command string: 0F 01 4C 0D Response: A5000E<CR> The DATA response is reported in plain text format so in this case 5000 psi is the current pressure.

Report operational parameters		
Hex	4E	
Dec	78	
Requests a report of the current operational parameters. This includes the current setpoint, maximum pressure allowed, maximum pump speed, maximum acceleration, the maximum refill speed, and the current index of the data array on the controller.		
Response	**A**[Setpoint data]**E<CR>** **A**[Max pressure]**E<CR>** **A**[Max pump speed]**E<CR>** **A**[Max acceleration]**E<CR>** **A**[Max refill speed]**E<CR>** **A**[Data array index]**E<CR>**	(0-60000 psi) (0-60000 psi) (1-100) (1-10) (1-100) (0-99999)
Example	Command string: 0F 01 4E 0D	

	Response: A 5000E<CR> A39500E<CR> A 80E<CR> A 4E<CR> A 80E<CR> A 0E<CR> The pressure values are reported in PSI in plain text format. Each response is padded with spaces corresponding to the digits required for full scale.

Report status	
Hex	55
Dec	85
Requests the status of the pump. This report the current pressure (psi), volume (ml), and status flag in a single response.	
Response	**AP**[Pressure]**V**[Volume]**S**[Status]E<CR>
Example	Command string: 0F 01 55 0D Response: AP 5000V 5.83S 1E<CR> The single string can be parsed to obtain the current pressure in PSI, the volume as a float value, and the status of the pump. The status will typically be one of the following: 0 – Pump stopped 1 – Pump running 5 – Refilling pump 6 – Pump empty 8 – Remote control (remains active status flag until cleared by another command) 13 – Rapid pressure loss; pump automatically stopped 14 – Slow pressure loss; pump automatically stopped