

### III. OPERATION

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#### Plumbing Options

The MicroPro pump has a variety of plumbing options which have been briefly described in Sections I and II. The plumbing options are more fully described here.

#### Valves

##### Low Pressure Active Valve

The low pressure active valve is shown in Figure 3.1. When installed in the inlet position (left side of syringe), the three ports correspond to: 1. From the solvent reservoir to valve. 2. From the inlet valve to the syringe (via outlet valve). 3. From the syringe to purge/waste (a reservoir to receive output from this port is not provided with the  $\mu$ Pro Pump system).

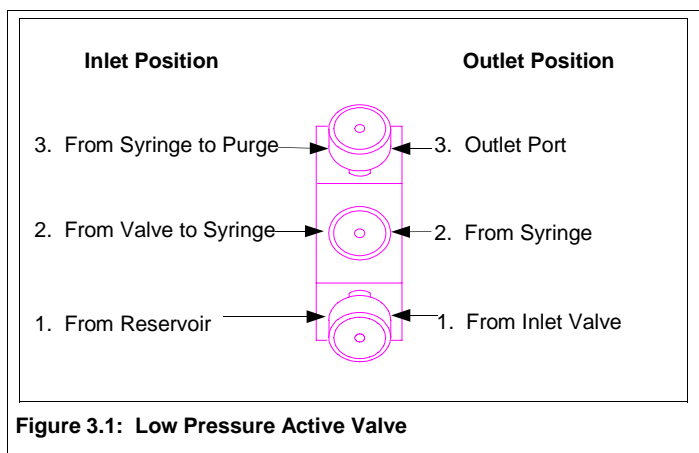


Figure 3.1: Low Pressure Active Valve

When the low pressure active valve is installed as an outlet valve (right side of syringe), the three ports correspond to: 1. From the inlet valve. 2. From the syringe. 3. Output of the pump to the downstream system.

All ports on the low pressure active valve are plumbed with a 1/4-28 plastic tube nut and “flangeless” ferrule which can be finger-tightened.

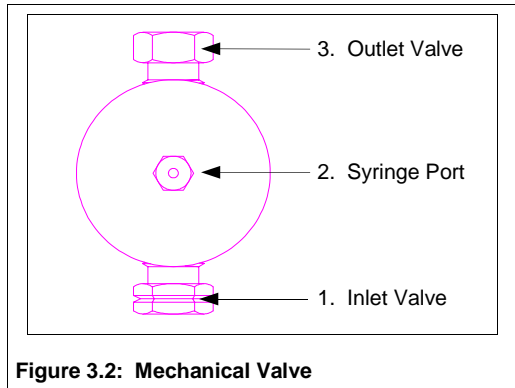
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**NOTE!** Do not strip the threads of the valve or the fitting.

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## Passive Mechanical Valve

The passive mechanical valve is shown in Figure 3.2. The inlet valve (1), with the groove on the hexagonal portion of the valve, is plumbed directly from the solvent reservoir with a 1/4-28 plastic tube nut and “flangeless” ferrule attached to tubing with a solvent filter on the reservoir end of the line (provided with the  $\mu$ Pro Pump).



Connection to the syringe is via the center port on the mechanical valve (2).

The outlet valve (3) is plumbed to the downstream system with a 10-32 tube nut and ferrule (provided with the  $\mu$ Pro Pump) using 1/16” tubing (not provided with the  $\mu$ Pro Pump).

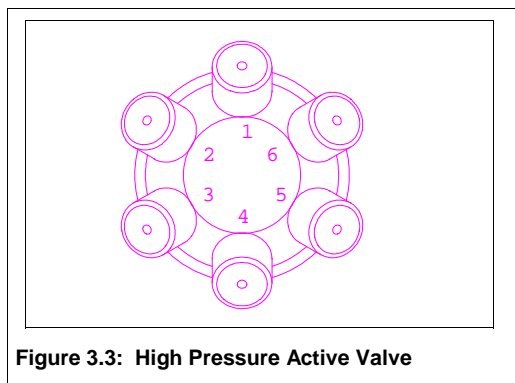
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**NOTE!** Do not seat the ferrule in the outlet valve, since doing so may damage components of the valve. You can seat the ferrule in the center port on the mechanical valve.

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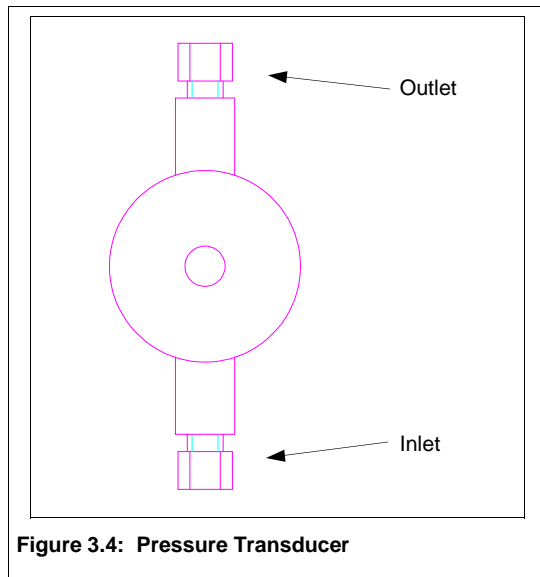
## High Pressure Active Valve

The high pressure active valve is shown in Figure 3.3. The high pressure active valve is used as an outlet valve in conjunction with a low pressure active valve functioning as the inlet valve. There are a variety of plumbing possibilities, depending on the configuration of your  $\mu$ Pro Pump. Section IV shows details of the plumbing for each configuration.



All ports on the high pressure active valve are plumbed with 10-32 tube nuts and ferrules using 1/16” tubing. All tubing lengths and connections are provided with the  $\mu$ Pro Pump except the output of the pump to the downstream system (always port 6 on the high pressure active valve), where only the tube nut and ferrule is provided.

## Pressure Transducers



### Low Pressure Transducer

The low pressure transducer is shown in Figure 3.4. The flow-through low pressure transducer is used in applications where pressure feedback and control is desired and where system pressure will not exceed 1000 psi. The lower port on the transducer is the transducer inlet and the upper port on the transducer is the transducer outlet.

When used with a high pressure active valve, the syringe is plumbed to the inlet of the transducer and the outlet port of the transducer is plumbed to one of the various ports on the active valve (see Section IV for plumbing details in various configurations). When used with mechanical valves, the outlet port of the valve (see Figure 3.2) is plumbed to the inlet of the transducer and the outlet port of the transducer is plumbed to the downstream system.

All ports on the low pressure transducer are plumbed with 10-32 tube nuts and ferrules using 1/16" tubing (all tubing lengths and connections are provided with the  $\mu$ Pro Pump).

### Medium Pressure Transducer

The medium pressure transducer is identical to the low pressure transducer with the exception of the maximum pressure capability, which is 5,000 psi.

### High Pressure Transducer

The high pressure transducer is identical to the low pressure transducer with the exception of the maximum pressure capability, which is 10,000 psi.

# Mixers

## Micro Mixer

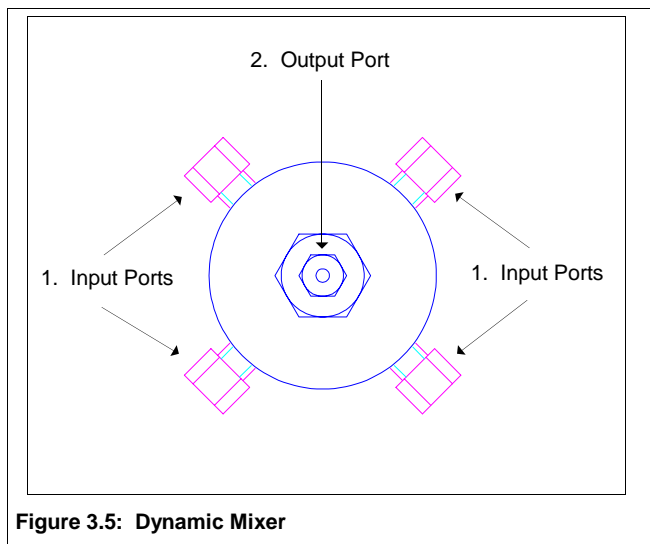
Gradient versions of the  $\mu$ Pro pump system are fitted with a mixer. The mixer uses a cartridge system to accommodate different mixer sizes. The different sizes allow you to exchange mixers easily when your application requires a change in flow rates. Table 3.1 indicates the various mixers available.

**Table 3.1: Mixer Sizes**

Mixer Size	Mixer Type	Syringe Size	Flow Rate Range	Mark to Distinguish
5 $\mu$ L	3 stage static	2mL	1-10 $\mu$ L/min	PEEK with nipple
15 $\mu$ L	1 stage dynamic	2mL	10-40 $\mu$ L/min	All PEEK material
50 $\mu$ L	3 stage dynamic	2mL and 10mL	20-100 $\mu$ L/min	2 steel bands
170 $\mu$ L	3 stage dynamic	10mL	100 $\mu$ L/min+	Grooves on steel bands

When shipped from the factory, a 2mL  $\mu$ Pro system is fitted with the 15 $\mu$ L mixer, a 10mL  $\mu$ Pro system is fitted with the 50 $\mu$ L mixer. 2mL  $\mu$ Pro systems are also provided with a 5 $\mu$ L mixer as an accessory (to install the 5 $\mu$ L mixer, be sure to remove the stir bar), 10 mL systems are provided with a 170 $\mu$ L mixer as an accessory.

The micro dynamic mixer is shown in Figure 3.5.



**Figure 3.5: Dynamic Mixer**

The input ports (1) of the mixer are plumbed from the output valve of the syringes. Up to four syringe outputs can be plumbed into the mixer using 10-32 tube nuts and ferrules using 1/16" tubing (unused input ports should be plugged).

The mixer has one output (2) to the downstream system, plumbed in the same manner as the mixer input ports. The fittings for the output of the mixer are provided with the  $\mu$ Pro Pump. Tubing for the output of the mixer is not provided.

# Local Control Software

## Overview

Operation of the  $\mu$ Pro pump system is controlled from a series of menus. All of the options available to you at any given time are visible on the LCD display.

In general, the  $\mu$ Pro pump recognizes the current configuration of your system. Consequently, the display will show you only the fields or parameters which are available on your system (for example, if you have only one syringe, you will not see the gradient, reciprocating, or multi-independent syringe options). As a general rule, this section will show the most complete version of the display and indicate in text where differences will be for other configurations.

Invalid entries made by an operator will either be ignored or result in an error message screen. Errors are removed by pressing the CLEAR key. The cursor will appear to the right hand side of the field. As valid entries are made in the field, the character entered will move to the left. Pressing the ENTER key moves to the next field (if the entry made was valid).

The menu screens shown in the following section are identified at the top by a unique alphanumeric designation (e.g., Main Menu, A, B2.2, etc.). The softkeys corresponding to lines on the display are referred to as "A", "B", "C", and "D".

## Key Definitions

$\Delta$ MENU: The  $\Delta$ MENU (Change Menu) key returns to the previous menu level.

DISPLAY: The DISPLAY key returns to the display screen (function and purpose of the display screen is described on page 3.8), repeated use of the DISPLAY key toggles between the display screen and the last used screen.

HOLD: The HOLD key stops the clock and freezes the file (time) running, while the pump continues to run; this key is only active when running a file.

RUN: The RUN key has four functions. First, it starts the pump in either real time, or a file/cycle or file/sequence. Second, the RUN key starts the refill and purge cycle. Third, the RUN key starts the system characterization. Fourth, the RUN key continues after a hold or stop. The key is active from screens A, C1, C2, D1.2, and D1.1.2..

STOP: The STOP key stops the clock and pump, whether in file execution, real time or refill and purge.

ENTER: The ENTER key enters values or accepts the displayed value.

CLEAR: The CLEAR key either clears invalid entries, or clears the field of entries, or, when in the flow field, moves cursor to the next field without affecting flow or gradient.

- : The - key (minus key) moves the cursor (non-destructively) one character to the left or begins the entry of a negative flow rate (when preceded by CLEAR).

DISPLAY then  $\Delta$ MENU: Pressing the DISPLAY key followed by the  $\Delta$ MENU key returns to the main menu, regardless of the level in the menu tree.

## Defaults and Limits

Table 3.2 lists the defaults and limits for various parameters for the  $\mu$ Pro pump system.

**Table 3.2**

Syringe Size	2mL				10mL			
	none	1000 psi <sup>1</sup>	5000 psi <sup>1</sup>	10000 psi <sup>2</sup>	none	1000 psi <sup>1</sup>	5000 psi <sup>1</sup>	10000 psi <sup>2</sup>
Flow: Minimum	+ or - 0.01 $\mu$ L <sup>3</sup>				+ or - 0.05 $\mu$ L <sup>3</sup>			
Flow: Maximum	+ or - 1950 $\mu$ L <sup>3</sup>				+ or - 9500 $\mu$ L <sup>3</sup>			
Pressure: Max. High Limit	n/a	1000 psi	5000 psi	10000 psi	n/a	1000 psi	5000 psi	5000 psi
Pressure: High Limit Default	n/a	1000 psi	5000 psi	10000 psi	n/a	1000 psi	5000 psi	5000 psi
Pressure: Max. Low Limit <sup>4</sup>	n/a	1000 psi	5000 psi	10000 psi	n/a	1000 psi	5000 psi	5000 psi
Pressure: Low Limit Default <sup>4</sup>	n/a	0	0	0	n/a	0	0	0
Refill: Maximum	5000 $\mu$ L				25000 $\mu$ L			
Refill: Default	1950 $\mu$ L				9500 $\mu$ L			
Purge: Maximum	1950 $\mu$ L				9500 $\mu$ L			
Purge: Default	1950L				9500L			
% of Syringe	100				100			
# of Cycles	1				1			

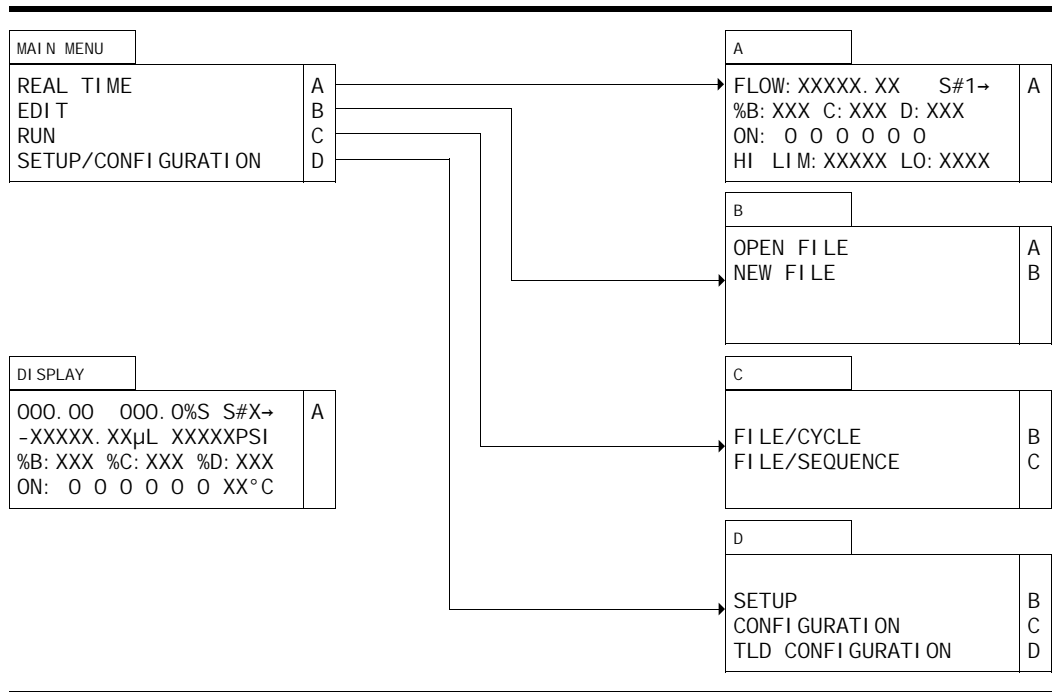
<sup>1</sup>Pressure limits valid for instruments with high pressure active valves or mechanical valves (not low pressure active valves).

<sup>2</sup>Pressure limits valid for instruments with mechanical valves (not high pressure or low pressure active valves).

<sup>3</sup>No negative flow rates are permitted in reciprocating mode. Flow rates are: for 2mL syringes: +0.01 - 500 $\mu$ L/min.; for 10mL syringes +0.05 - 2500 $\mu$ L/min

<sup>4</sup>Low Pressure limits only valid for flow rates above 10 $\mu$ L/min.

## Main & Display Menus



The above diagram shows the relationship between the Main Menu and the primary sub-menus in the  $\mu$ Pro pump system interface. Four choices are presented: Running the pump in “Real Time”, Editing a file, Running a file, and Setting up the system.

Each of these choices correspond to one of the softkeys. Pressing the corresponding softkey will automatically change the display to the corresponding sub-menu.

## Main Menu

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MAIN MENU	
REAL TIME	A
EDIT	B
RUN	C

---

The main menu screen appears on initial power-up after the system initializes itself (the system may take a few seconds to initialize and the keyboard will not respond during this period). All lines shown above will appear, regardless of the configuration of your system.

Each line corresponds to one of the softkeys to the right of the screen. Only the softkeys are valid entries and other entries will be ignored (unless the system is running, in which case the DISPLAY, RUN, HOLD, and STOP keys will work as defined on page 3.5).

Pressing softkey A (corresponding to REAL TIME) will automatically change the display to screen A.

Pressing softkey B (corresponding to EDIT) will automatically change the display to screen B.

Pressing softkey C (corresponding to RUN) will automatically change the display to screen C.

Pressing softkey D (corresponding to SETUP/CONFIGURATION) will automatically change the display to screen D.

## Display

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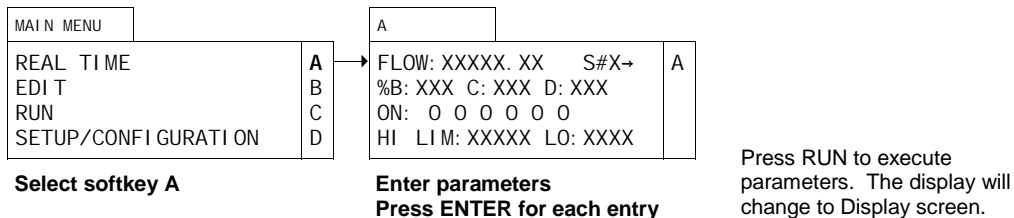
DISPLAY	
000.00 000.0% S S#X→	A
-XXXXX.XXμL XXXXXPSI	
%B: XXX %C: XXX %D: XXX	
ON: 0 0 0 0 0 0 XX°C	

---

The display screen appears when the DISPLAY key is pressed or after pressing the RUN key from the screens A or C1 or C2. The display screen allows you to monitor system activity and will always display the time, flow rate and percentage of syringe dispensed. If your pump is fitted with the appropriate options, it will also display the syringe number (or letter, if in gradient mode), system pressure (in psi), gradient composition, events on and off, and syringe temperature.

Pressing softkey A (corresponding to S#X) toggles to change the display to show the parameters for the other syringes in the system.

## Real Time Menu



## Running the System in Real Time

To run the pump in real time, select softkey A from the Main Menu. The display will automatically change to screen A. Real Time programming allows you to enter parameters for pump operation and execute them when the RUN key is pressed. You will enter the parameters appropriate to the configuration of your  $\mu$ Pro unit and press the RUN key to execute those instructions.

### Screen Configuration

Lines appearing in screen A depend on the configuration. S#X appears only when more than one syringe installed and multi-independent mode is chosen. In reciprocating mode REC appears in place of S#X. Line two only appears in gradient mode (%B is displayed when two syringes are installed; %C when three syringes are installed, etc.). Line three only appears when an I/O board is installed. Line four only appears when a pressure transducer is installed.

In multi-independent mode, pressing softkey A toggles to change the syringe number displayed. The syringe number displayed indicates the syringe number being programmed.

### Flow

The cursor appears in the FLOW field when screen A is displayed. The user may enter any number valid for the syringe size installed (see Table 3.2 (p. 3.6) for valid range). Valid numbers include negative numbers (negative flow rates are entered by pressing the clear key, followed by the negative symbol and the desired value). Flow output (or, in the case of negative flows, input) will be to (or from) the system (not to purge or reservoir).

If a valid number has been entered previously in this field, the screen will display that entry. Pressing ENTER accepts the entered value and moves the cursor to the next field.

### %B

The user may enter a valid number (only positive integers, from 1 to 100, plus 0, are allowed) in %B. Upon entering a valid number in %B and pressing ENTER, the cursor will move to %C (if three or more syringes are plugged into the system), where the same number constraints apply, except that the sum of B and C shall not exceed 100. On entering a valid number for %C and pressing ENTER, the cursor will move to %D, if a fourth syringe pump is present in the system, and if the sum of B and C is less than 100. The same number constraints apply to %D, except that the sum of B, C, and D shall not exceed 100.

Any remainder less than 100 from the sum of B, C, and D will automatically be entered for A. The same principle applies to the remainder for any number of syringes (for example, if two syringes are installed in the system, the remainder of 100 minus the value entered for B is entered for A).

If valid numbers have been entered previously into these fields, the screen will display those entries. Pressing ENTER accepts the entered value and moves the cursor to the next field.

## Events Field

The 6 contact closures on the I/O board correspond to the places on the display. “1” and “0” are valid values for these fields (1 corresponds to ON and 0 corresponds to OFF). Pressing ENTER moves to the next I/O position.

If valid values have been entered previously in these fields, the screen will display those entries. Pressing ENTER accepts the entered value and moves the cursor to the next field.

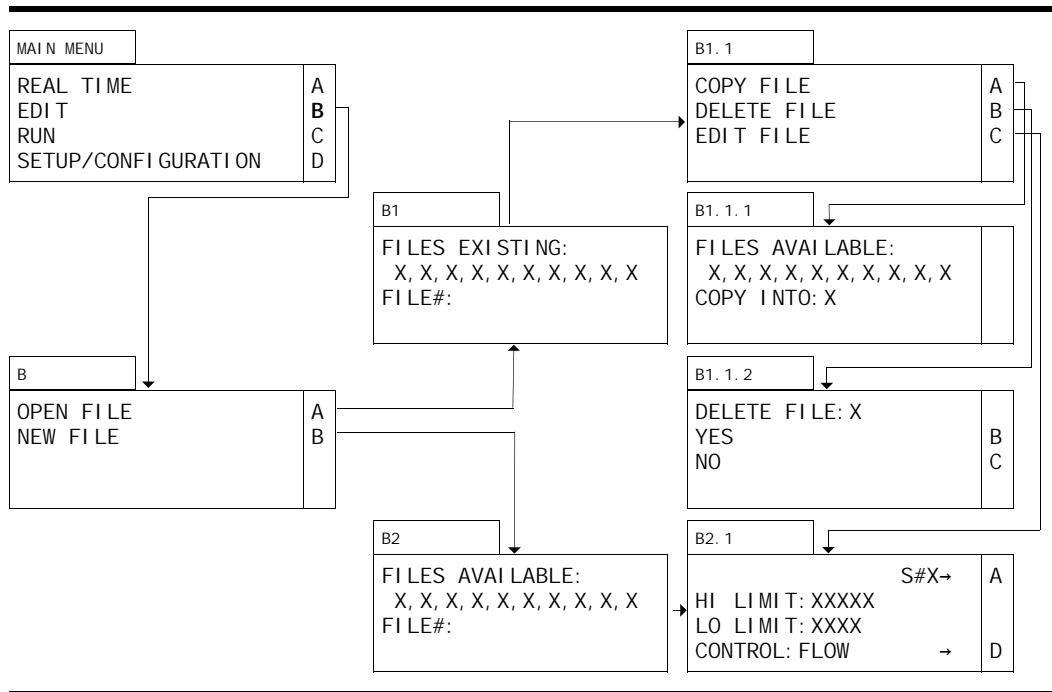
## Pressure Limit Field

The user may enter high and low pressure limits valid for the syringe size, transducer and valve options installed. Default values and valid ranges are shown in Table 3.2 (p. 3.6). Pressing ENTER accepts the default value. When a valid number is entered for the high pressure limit and the ENTER key is pressed, the cursor will move to the low pressure field.

When the high pressure limit is violated, the pump is turned off, the alarm is sounded, and an error message screen is displayed. When the low limit is violated the pump is turned off, the alarm is sounded and an error message screen is displayed. The low limit is activated when pressure increases 10% above the low limit setting and only takes effect at flow rates above 10 $\mu$ L/min.

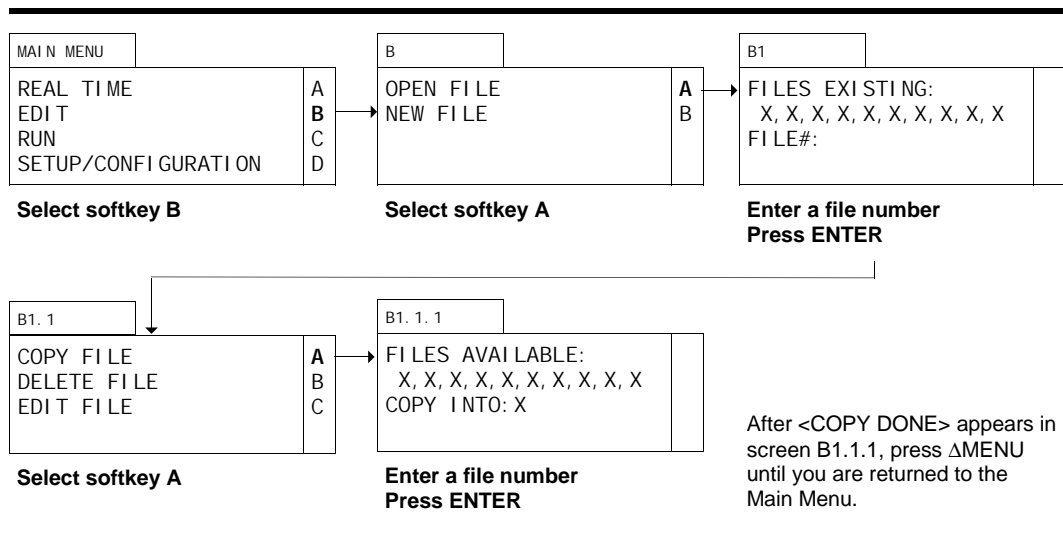
When valid entries are made in the last field and the RUN key is pressed, the instructions are executed (the pump system runs at the flow rate entered, in the composition entered, activates the events turned ON, and operates under the pressure limits entered). In addition, the display will automatically change to the Display screen.

## File Creation & Editing Menus



To create or edit a program, select softkey B (EDIT) from the Main Menu. The display will automatically change to screen B. You can select between opening a previously programmed file or creating a new file. If you select opening a previously programmed file (softkey A), you can copy, delete or edit the file. If you select creating a new file (softkey B), you will be prompted through the file programming screens.

## Copying a File



### Screen Configuration

All lines appear regardless of configuration.

### Open File

To copy a file, select softkey B (EDIT) from the Main Menu. The display will automatically change to screen B. Since you are copying a previously programmed file, select softkey A (OPEN FILE) from screen B. The display will automatically change to screen B1.

### File Existing

Screen B1 will display a listing of files which have been previously programmed. The cursor will appear in the FILE# field. By default, the lowest previously programmed file will be displayed in the FILE# field. You may enter any previously programmed file and press ENTER.

### Copy File

The display will automatically change to screen B1.1. Since you are copying a file, select softkey A (COPY FILE) from screen B1.1. The display will automatically change to screen B1.1.1.

### Copy Into

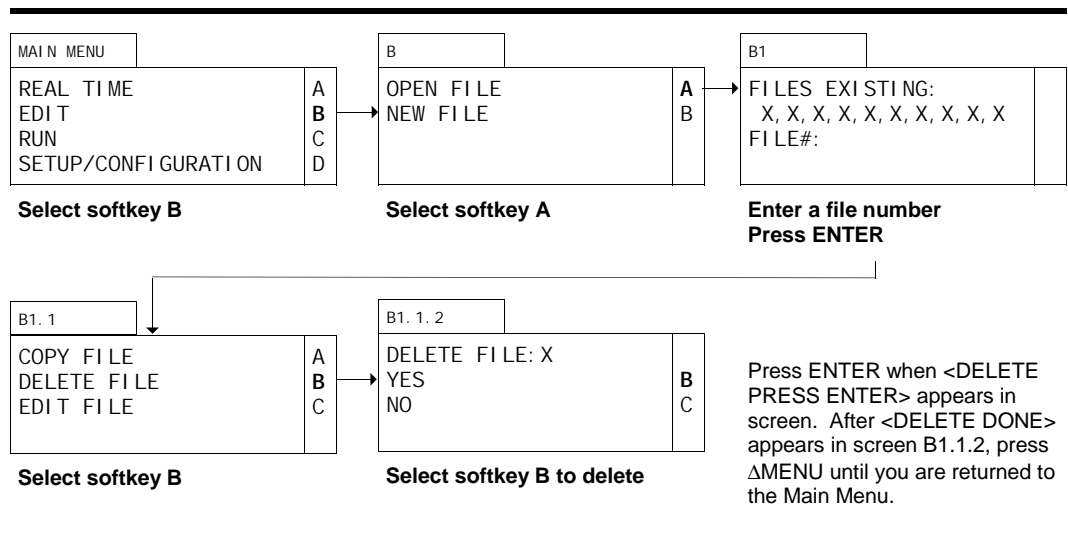
Screen B1.1.1 will display a listing of files which have not been programmed. The cursor will appear in the COPY INTO field. By default, the lowest available file will be displayed in the COPY INTO field. You may enter any available file and press ENTER. The phrase <COPY DONE> will appear in screen B1.1.1 after the copy has been completed. Press ΔMENU until you are returned to the Main Menu.

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**TIP:** If you are several layers deep in the software, pressing DISPLAY and then ΔMENU will return you directly to the Main Menu.

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## Deleting a File



### Screen Configuration

All lines appear regardless of configuration.

### Open File

To delete a file, select softkey B (EDIT) from the Main Menu. The display will automatically change to screen B. Since you are deleting a previously programmed file, select softkey A (OPEN FILE) from screen B. The display will automatically change to screen B1.

### File Existing

Screen B1 will display a listing of files which have been previously programmed. The cursor will appear in the FILE# field. By default, the lowest previously programmed file will be displayed in the FILE# field. You may enter any previously programmed file and press ENTER.

### Delete File

The display will automatically change to screen B1.1. Since you are deleting a file, select softkey B (DELETE FILE) from screen B1.1. The display will automatically change to screen B1.1.2.

### Delete Program

Screen B1.1.2 will display the file you have selected for deletion on line one. Pressing softkey B (corresponding to YES on the display) will delete the file. Pressing softkey C (corresponding to NO on the display) will automatically change the display to screen B.

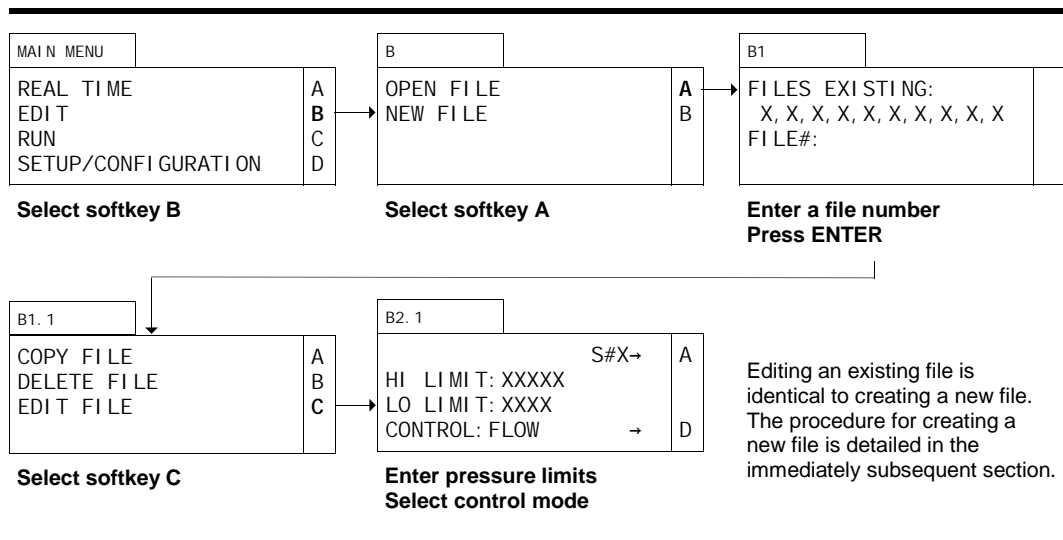
When softkey B has been pressed, the message <DELETE PRESS ENTER> will appear on the display. Press the ENTER key to delete the file. Once the deletion has been made, the message <DELETE DONE> will appear on the display. Press ΔMENU until you are returned to the Main Menu.

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**TIP:** If you are several layers deep in the software, pressing DISPLAY and then ΔMENU will return you directly to the Main Menu.

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## Editing an Existing File



## Screen Configuration

All lines in all screens appear regardless of configuration, except screen B2.1. In screen B2.1, the S# (syringe number) field only appears when more than one syringe is installed and multi-independent mode is chosen. In multi-independent mode, softkey A is pressed to change the syringe number being programmed. Lines two and three appear when a pressure transducer is installed. Line four appears when a pressure transducer is installed and the mode is either single or multi-independent.

## Open File

To edit a previously programmed file, select softkey B (EDIT) from the Main Menu. The display will automatically change to screen B. Since you are editing a previously programmed file, select softkey A (OPEN FILE) from screen B. The display will automatically change to B1.

## File Existing

Screen B1 will display a listing of files which have been previously programmed. The cursor will appear in the FILE# field. By default, the lowest previously programmed file will be displayed in the FILE# field. You may enter any previously programmed file and press ENTER.

## Edit File

The display will automatically change to screen B1.1. Since you are editing a file, select softkey C (EDIT FILE) from screen B1.1. The display will automatically change to screen B2.1 (if your system is fitted with a pressure transducer) or B2.2 (if there is no pressure transducer).

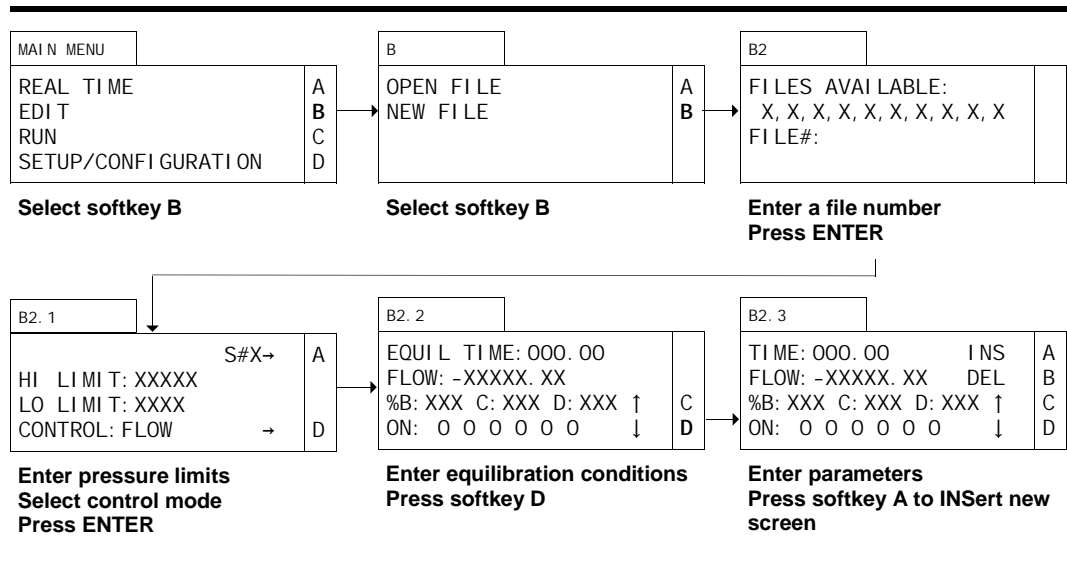
## Further Steps

Since editing an existing file is identical to creating a new file, the details for editing an existing file are explained in Creating a File starting at setting pressure limits (screen B2.1, described on p. 3.15).

Press DISPLAY and ΔMENU to return to the Main Menu.

## Creating a File

A file is a sequence of programmed instructions for the pump to execute. The overall file parameters are defined in screen B2.1. Equilibration conditions are programmed in screen B2.2. The program screen (B2.3) defines each step (up to 20 per file) of the file.



## Screen Configuration

All lines appear regardless of configuration, except screens B2.1, B2.2, and B2.3. In screen B2.1, the S# (syringe number) field only appears when more than one syringe is installed and multi-independent mode is chosen. In multi-independent mode, softkey A is pressed to change the syringe number being programmed. Lines two and three appear when a pressure transducer is installed. Line four appears when a pressure transducer is installed and the mode is either single or multi-independent. In screens B2.2 and B2.3, line three (%B, etc.) appears only when more than one syringe is installed and gradient mode is chosen. Line four (Events ON) only appears when an I/O board is installed.

## New File

To create a new file, select softkey B (EDIT) from the Main Menu. The display will automatically change to screen B. Since you are creating a new file, select softkey B (NEW FILE) from screen B. The display will automatically change to screen B2.

## Files Available

Screen B2 will display a listing of files which have not been programmed. The cursor will appear in the FILE# field. By default, the lowest available file will be entered in the FILE# field. You may enter any available file and press ENTER.

## Pressure Limits

When more than one syringe is installed and multi-independent mode is chosen, the S# field appears on the first line. Pressing softkey A toggles to other syringes on the system. The syringe number displayed is the one being programmed.

The cursor appears in the high limit field. Default values and valid ranges are shown in Table 3.2 (p. 3.6). Pressing ENTER accepts the default value. Entering a new valid value and then pressing ENTER will enter the new value. The cursor will move to the low limit field. The default values and valid ranges are shown in Table 3.2 (p. 3.6). Pressing ENTER accepts the default value. Entering a new valid value and then pressing ENTER will enter the new value. The

cursor will move to line four and blink.

When the high pressure limit is violated, the pump is turned off, the alarm is sounded, and an error message screen is displayed. When the low limit is violated the pump is turned off, the alarm is sounded and an error message screen is displayed. The low limit is activated when pressure increases 10% above the low limit setting and only takes effect at flow rates above 10 $\mu$ L/min.

Pressing softkey D toggles between constant flow and constant pressure modes. The selection between constant flow or constant pressure applies to all syringe operations in a file. Pressing ENTER accepts the value displayed and the display will automatically change to screen B2.2.

## Equilibration

### Overview

When Pre-Pressurization is turned ON (detailed on page 3.24), the  $\mu$ Pro system uses a portion of the equilibration time in a file to pre-pressurize the syringes. During pre-pressurization, the syringes in the system run at equal percentages (at an elevated flow rate) to get the system to pressure quickly (using the gain value derived from the characterization procedure described on page 3.26). Since the system is pressurizing to take account of system compliance and other factors, only nominal amounts of fluid are actually delivered to the output of the system.

Once the operating pressure is reached, the system operates under constant pressure mode for the remainder of the first half of the equilibration time (this is done to prevent backflow from one syringe to another which might otherwise occur due to solvent differences in equilibrated chromatography columns). During this time, the syringes deliver in the solvent percentages entered in the equilibration screen (B2.2).

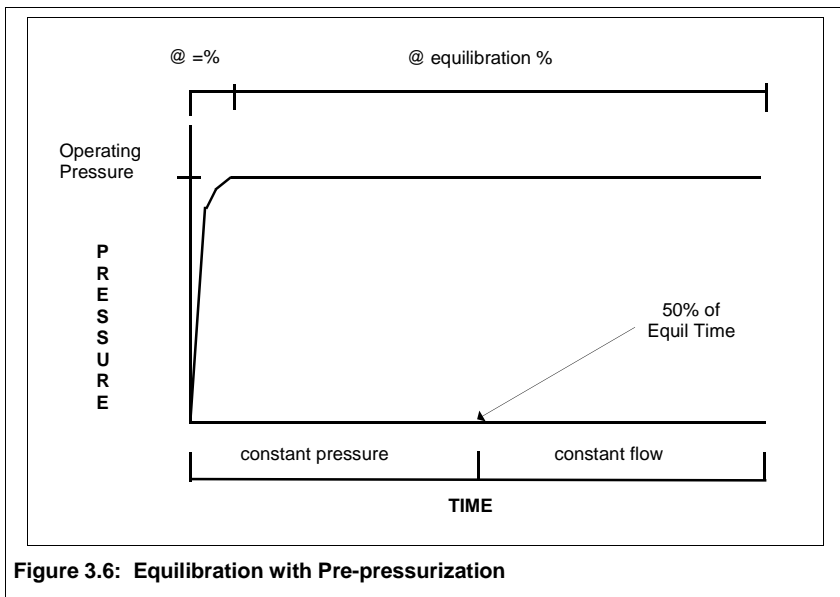
During the last half of equilibration, the system changes to constant flow mode, still in the solvent percentages entered in the equilibration screen.

When Pre-Pressurization is turned OFF, the  $\mu$ Pro system does not run the syringes at an accelerated level to take account of system compliance and solvent compressibility, and get to operating pressure. Often, with Pre-Pressurization OFF, it will take substantially longer to attain the operating pressure.

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**TIP:** By way of illustration: with a binary system and programmed parameters of an equilibration time of 20 minutes, a %B of 5% and a flow of 10 $\mu$ L/min; the system will operate each syringe at 50% of total flow for a few seconds while the system gets up to pressure. Then the system will run at 5% B and 95%A under constant pressure for the remainder of the first ten minutes. Ten minutes after the start of equilibration, the system changes to running at 10 $\mu$ L/min at 5%B.

---



**Figure 3.6: Equilibration with Pre-pressurization**

B2.2	
EQUIL TIME: 000.00	
FLOW: -XXXXX.XX	
%B: XXX C: XXX D: XXX ↑	C
ON: 0 0 0 0 0 ↓	D

**Equilibration Screen**

### Time

Equilibration conditions are executed at the beginning of each cycle of a file. The cursor appears in the EQUIL TIME field. Valid entries are from 000.00 minutes to 999.99 minutes. When a valid entry has been made and the ENTER key is pressed, the cursor moves to the second line.

### Flow/Pressure

When constant pressure mode is chosen from screen B2.1, the display will show RUN PRESS instead of FLOW. Valid entries for the RUN PRESS field are the same as for the pressure limits shown in Table 3.2 (p. 3.6).

Valid entries for the FLOW field are within the range shown in Table 3.2 (p. 3.6). Flow output will be to the system (not to purge or reservoir). When a valid entry is made and the ENTER key is pressed, the cursor moves to line three.

### %B

The user may enter a valid number (only positive whole numbers, from 1 to 100, plus 0, are allowed) in %B. Upon entering a valid number in %B and pressing ENTER, the cursor will move to %C (if three or more syringes are plugged into the system), where the same number constraints apply, except that the sum of B and C shall not exceed 100. On entering a valid number for %C and pressing ENTER, the cursor will move to %D, if a fourth syringe pump is present in the system, and if the sum of B and C is less than 100. The same number constraints apply to %D, except that the sum of B, C, and D shall not exceed 100.

Any remainder less than 100 from the sum of B, C, and D will automatically be entered for A. The same principle applies to the remainder for any number of syringes (for example, if two syringes are plugged into the system, the remainder of 100 minus the value entered for B is entered for A).

If valid numbers have been entered previously into these fields, the screen will display those entries. Pressing ENTER accepts the entered value and moves the cursor to the next field.

### Events

The 6 contact closures on the I/O board correspond to the places on the display. “1” and “0” are valid values for these fields (1 corresponds to ON and 0 corresponds to OFF). Pressing ENTER moves to the next I/O position.

Events activated in the equilibration screen are turned ON at the beginning of the equilibration period.

### Exiting Screen

Press softkey D and the display will automatically change to screen B2.3.

### Program Screen

---

B2. 3			
TI ME: 000. 00	I NS	A	Program Screen
FLOW: -XXXXX. XX	DEL	B	
%B: XXX C: XXX D: XXX	↑	C	
ON: 0 0 0 0 0 0			

---

### Time

The cursor appears in the TI ME field. Valid entries are from 000.00 minutes to 999.99 minutes. Since the first time you see this screen will be the first step of your file, you will want to accept the default (000.00) by pressing ENTER. Files without a TI ME: 000. 00 will operate erratically. Flow and composition fields in the TI ME: 000. 00 screen must be identical to the values in the Equilibration screen (changing these fields in the zero time screen will also change them in the Equilibration screen). When a valid entry has been made and the ENTER key is pressed, the cursor moves to the second line.

### Flow

When constant pressure mode is chosen from screen B2.1, the display will show RUN PRESS instead of FLOW. Valid entries for the RUN PRESS field are the same as for the pressure limits shown in Table 3.2 (p. 3.6).

Valid entries for the FLOW field are within the range shown in Table 3.2 (p. 3.6). Valid numbers include negative numbers (to program a negative flow after a positive flow, you need to program a zero flow point; see the section IV exercise on single syringe programming for an example; page 4.5). Flow output (or, in the case of negative flows, input) will be to (or from) the system, not to purge or reservoir. When a valid entry is made and the ENTER key is pressed, the cursor moves to line three.

### %B

The user may enter a valid number (only positive whole numbers, from 1 to 100, plus 0, are allowed) in %B. Upon entering a valid number in %B and pressing ENTER, the cursor will move to %C (if three or more syringes are plugged into the system), where the same number constraints apply, except that the sum of B and C shall not exceed 100. On entering a valid number for %C

and pressing ENTER, the cursor will move to %D, if a fourth syringe pump is present in the system, and if the sum of B and C is less than 100. The same number constraints apply to %D, except that the sum of B, C, and D shall not exceed 100.

Any remainder less than 100 from the sum of B, C, and D will automatically be entered for A. The same principle applies to the remainder for any number of syringes (for example, if two syringes are plugged into the system, the remainder of 100 minus the value entered for B is entered for A).

If valid numbers have been entered previously into these fields, the screen will display those entries. Pressing ENTER accepts the entered value and moves the cursor to the next field.

### *Events*

The 6 contact closures on the I/O board correspond to the places on the display. "1" and "0" are valid values for these fields (1 corresponds to ON and 0 corresponds to OFF). Pressing ENTER moves to the next I/O position.

---

**TIP:** If you are pumping into a chromatography column, you may wish to avoid column shock during refilling the syringes using one of the following methods.

1. As a final file step, you may wish to program a decompression period in your file by quickly ramping down the flow to a nominal rate and holding at that rate for a period sufficient to decompress the system prior to refilling.
2. Enter a refill rate which is sufficiently slow to allow for natural decompression of the system prior to the completion of refilling the syringe (this is the preferred method).
3. As a final file step, you may enter a negative flow rate (going through a zero point first). Of course, you will not want the time associated with running a negative flow to be of a duration which would intermingle different solvents or draw a vacuum on your column.

---

### *Additional Program Steps*

You may program up to 20 steps in each file. Pressing softkey A (corresponding to I NSert) will automatically display a new screen. The inserted screen is completed in the same manner as the previous screen. The inserted screen will carry forward the entries from the previous screen, except time, which will be -1.00 until you change it. You may program the screens in any order you wish and the  $\mu$ Pro will organize them according to time.

---

**NOTE!** Programming a screen with the same time as a screen previously programmed will overwrite the previous screen.

---

The  $\mu$ Pro uses the steps to generate linear flow (or pressure, if in constant pressure mode), or compositional gradients between two end points.

---

**NOTE!** To program step increases or decreases in flow (or pressure, if in constant pressure mode) or composition, you will program an intermediate step at .01 minutes prior to the desired step increase. You will enter the old value in the intermediate step (see the section IV exercise for gradient operation for an example; page 4.22)

---

Since the  $\mu$ Pro generates a flow or composition gradient between two end points, it is sometimes necessary when programming external events to enter event times and numbers without creating a new endpoint. To do this, press CLEAR in the FLOW field.

Pressing softkey B (corresponding to DELete) will delete the currently displayed screen.

Pressing softkey C (corresponding to scroll up a screen) will scroll up to the previous screen.

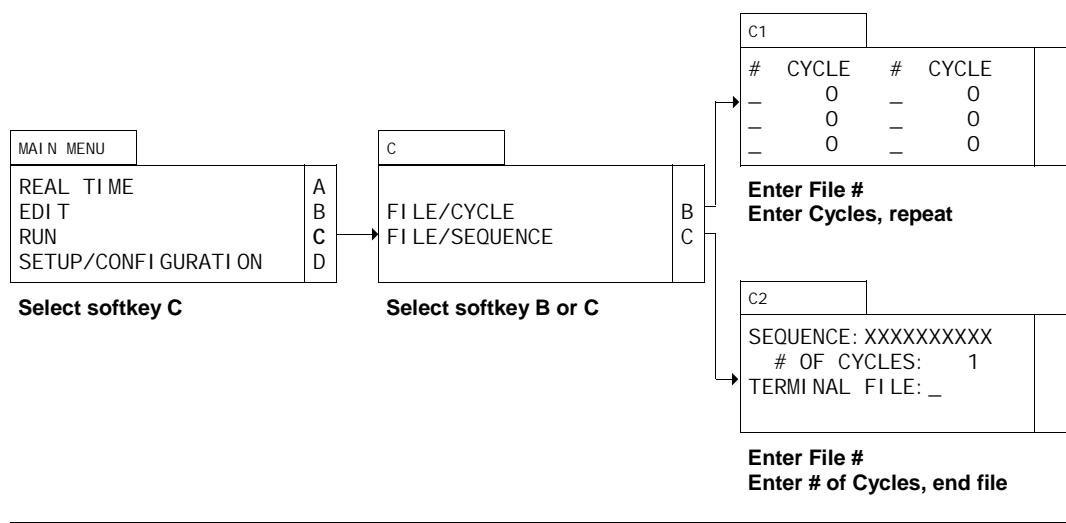
Pressing softkey D (corresponding to scroll down a screen) will scroll down to the next screen.

Pressing ΔMENU will return you to screen B2.2. If you are in multi-independent mode, you may program another syringe number by pressing ΔMENU again, which returns you to screen B2.1, where you may select another syringe for programming.

Press DISPLAY and ΔMENU to return to the Main Menu.

## File Linking and Running Menus

There are two ways to run files. One is called File/Cycle; the other is called File/Sequence.



### Entering a File/Cycle

The FILE/CYCLE method of running a file or series of files is used when you want to run a file one or more times. This method is also used when you want to run a file a one or more times followed by another file to be run one or more times. Up to six files may be entered in the FILE/CYCLE method.

### Screen Configuration

All lines appear regardless of configuration

### Run

To run a FILE/CYCLE, select softkey C (RUN) from the Main Menu. The display will automatically change to screen C. Since you want to run a FILE/CYCLE, choose softkey B. The display will automatically change to screen C1.

#

Enter a valid, programmed file number and press ENTER. The cursor will automatically move to the right of the first CYCLE field.

### Cycle

Enter a valid positive number from 1-999 or zero (which cycles the file infinitely) and press ENTER. The cursor will automatically move to the next # field. Repeat the instructions for the # field and CYCLE field for as many files as you wish to cycle.

### Running the Cycle

Once you have entered the files and cycles desired, press RUN. The display will automatically change to the Display screen. The system will run the first file number entered the desired number of cycles, then run the second (if entered) file number the desired number of cycles, etc.

When the system has finished running the files, it will continue to run under the last conditions until the volume of the syringe has been dispensed. The system will then shut off.

## Entering a File Sequence

The FILE/SEQUENCE method of running a files is used when you want to run a series of files in sequence, and possibly, cycle the sequence a number of times.

### Screen Configuration

All lines appear regardless of configuration

### Run

To run a FILE/SEQUENCE, select softkey C (RUN) from the Main Menu. The display will automatically change to screen C. Since you want to run a FILE/SEQUENCE, choose softkey C. The display will automatically change to screen C2.

### Sequence

Enter one or more valid, programmed file numbers in the SEQUENCE field (up to a total of ten file numbers) and press ENTER. The cursor will automatically move to the # OF CYCLES field.

### # of Cycles

Enter any positive number from 1-999 or zero (which cycles the files infinitely) and press ENTER. The cursor will automatically move to the TERMINAL FILE field.

### Terminal File

You may choose to enter a terminal file or not. The terminal file is the file run after all the files entered in the SEQUENCE and # OF CYCLES fields have been run. The terminal file is run only once. Entering “-” results in no terminal file being used. Entering a valid, programmed file number results in that file being used as the terminal file.

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**TIP:** The terminal file can be used to shut down the system. Program a file to run at a zero flow rate and turn off external events.

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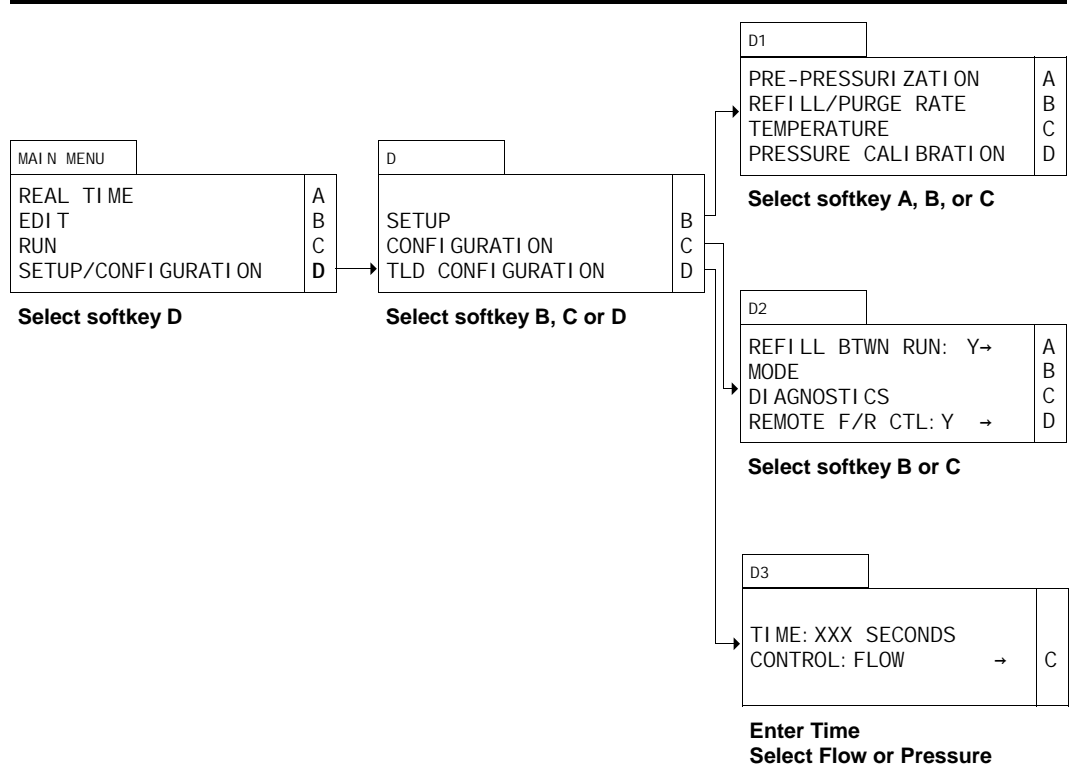
## Running the Sequence

Once you have entered the files to sequence, the number of cycles desired and the terminal file, press RUN. The display will automatically change to the Display screen. The system will execute the first file number entered, followed by the second, until all the files in the SEQUENCE field have been run. Then, the system will start over again and repeat the sequence until the files have been sequenced the number of times in the # OF CYCLES field. Once all the files have been run in sequence the entered number of cycles, the terminal file is run once.

When the system has finished running the files, it will continue to run under the last conditions until the volume of the syringe has been dispensed. The system will then shut off.

## Setup and Configuration Menus

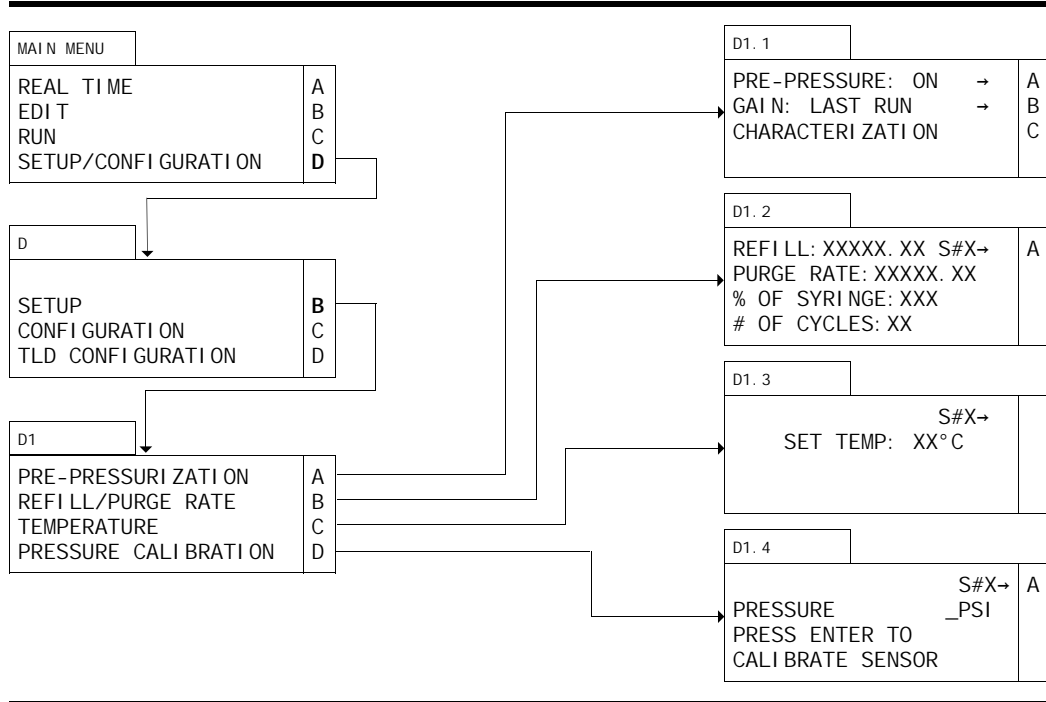
Many aspects of the  $\mu$ Pro system are either self-identifying or are already set prior to shipment from the factory. However, there are some aspects of system setup and configuration which you may wish to customize for your application. These aspects are accessed through the setup and configuration menus.



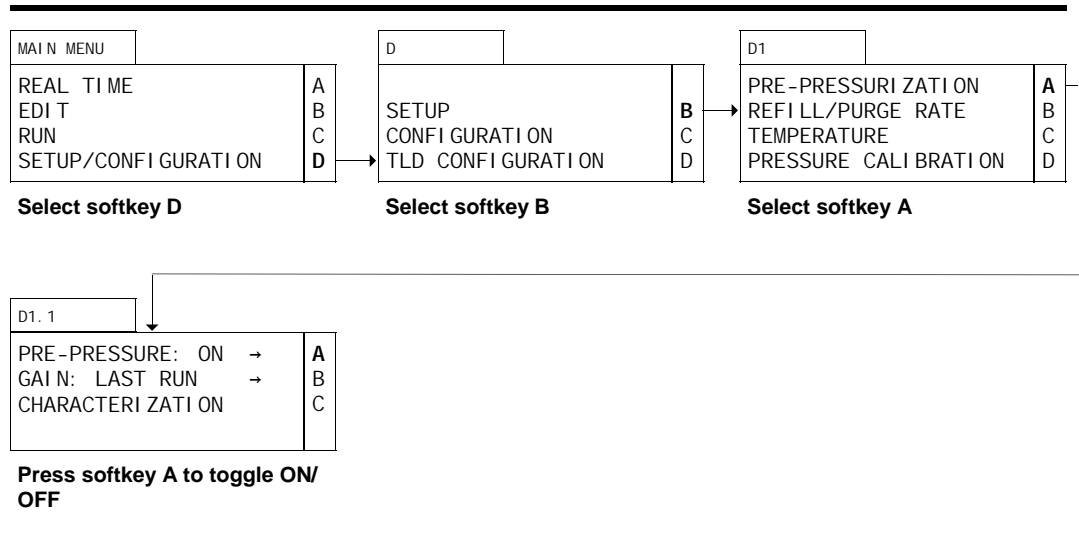
To review or change a setup or configuration parameter, select softkey **D** (**SETUP/CONFIGURATION**) from the Main Menu. The display will automatically change to screen **D**. You can select between **SETUP**, which pertains to more commonly accessed parameters, **CONFIGURATION**, which pertains to parameters which will rarely, if ever, need to be changed or examined, or **TLD CONFIGURATION**, which pertains to programming the transitional liquid delivery module.

## Setup Menus

To review or change a setup parameter, select softkey D (SETUP/CONFIGURATION) from the Main Menu. The display will automatically change to screen D. Select softkey B (SETUP) to access the setup parameters. The display will automatically change to screen D1. From screen D1 you will select the parameter you wish to review or change.



## Turning Pre-Pressurization ON or OFF



### Screen Configuration

Pre-Pressurization can only be turned ON or OFF when a pressure transducer is installed in the system. If your system is fitted with a pressure transducer, all lines in all screens appear regardless of configuration, except screen D and screen D1. Line four in screen D is displayed only in TLD mode. Line three in screen D1 is displayed when an Analog I/O board is installed.

### Setup

To access the Pre-Pressurization toggle, select softkey D (SETUP/CONFIGURATION) from the Main Menu. The display will automatically change to screen D. Since Pre-Pressurization is a SETUP parameter, select softkey B from screen D. The display will automatically change to screen D1.

### Pre-Pressurization

Select softkey A (PRE-PRESSURIZATION) from screen D1. The display will automatically change to screen D1.1. Pressing softkey A will toggle between PRE-PRESSURIZATION ON or OFF. Pre-Pressurization activates a software algorithm which speeds the syringe piston movement to compress the volume of the syringe to attain flow output at pressure equilibrium.

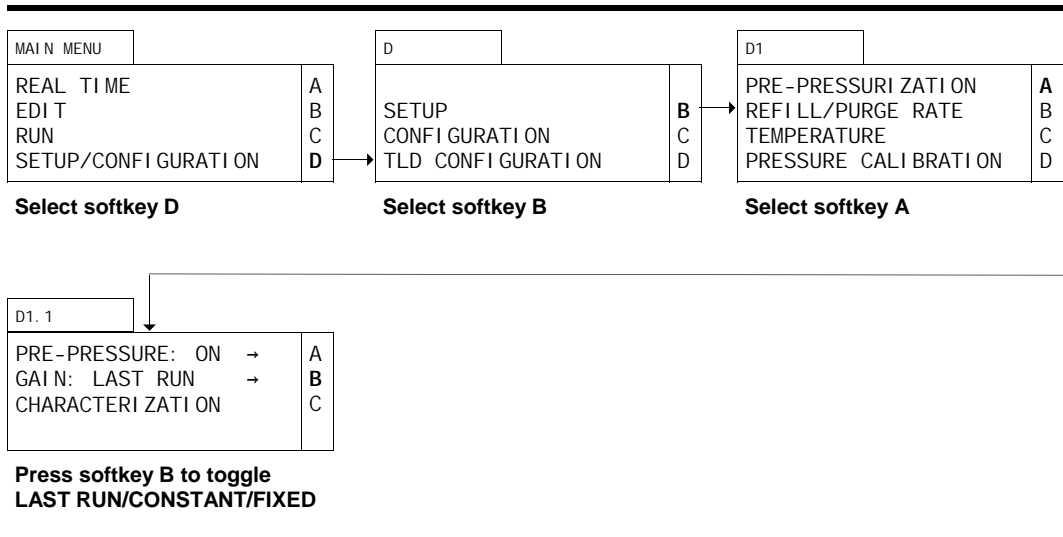
Press DISPLAY and ΔMENU to return to the Main Menu.

---

**TIP:** If your system is fitted with a pressure transducer, we recommend turning PRE-PRESSURIZATION ON unless you are running an initial system equilibration and characterization, as described on page 2.17)

---

## Selecting the Gain Mode



## Screen Configuration

Selecting the values in the GAIN field is only possible when a pressure transducer is installed in the system. If your system is fitted with a pressure transducer, all lines in all screens appear regardless of configuration, except screen D and screen D1. Line four in screen D is displayed only in TLD mode. Line three in screen D1 is displayed when an Analog I/O board is installed.

## Setup

To access the gain field toggle, select softkey D (SETUP/CONFIGURATION) from the Main Menu. The display will automatically change to screen D. Since the GAIN field toggle is a SETUP parameter, select softkey B from screen D. The display will automatically change to screen D1.

## Gain

Select softkey A (PRE-PRESSURIZATION) from screen D1. The display will automatically change to screen D1.1. Pressing softkey B will toggle between three different values in the GAIN field: LAST RUN, CONSTANT, and FIXED. Selection of the value in the GAIN field determines the value the  $\mu$ Pro system uses in the Pre-Pressurization algorithm. Selecting LAST RUN means that the system will use the value based on the pressure at the end of the equilibration period in your file. Selecting CONSTANT means that the system will use the value based on Characterization (see p. 2.18, or immediately following discussion for explanation of Characterization). Selecting FIXED means the system will pressurize to the TARGET PRESSURE you enter in Characterization (screen D1.1.1) and should generally be used when system pressure is fixed at a certain value, regardless of flow.

Press DISPLAY and  $\Delta$ MENU to return to the Main Menu.

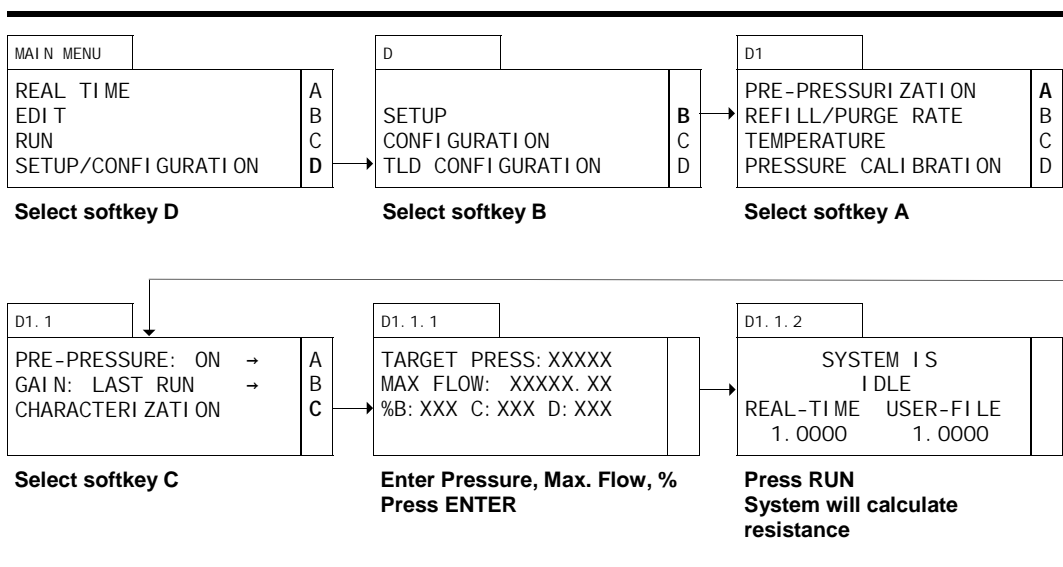
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**TIP:** We have generally found using LAST RUN yields the most reproducible results because of the slight changes in system pressure due to column and filter effects.

---

## Characterizing the System

Characterizing the system measures the system's resistance and is best accomplished immediately following Equilibration of the system (p. 2.17).



## Screen Configuration

Characterization can only be accomplished when a pressure transducer is installed in the system. If your system is fitted with a pressure transducer, all lines in all screens appear regardless of configuration, except screens D, D1 and D1.1.1. Line four in screen D is displayed only in TLD mode. Line three in screen D1 is displayed when an Analog I/O board is installed. In screen D1.1.1 the %B, C, and D fields only appear when more than one syringe is installed and gradient mode is chosen.

## Setup

To access system Characterization, select softkey D (SETUP/CONFI GURATI ON) from the Main Menu. The display will automatically change to screen D. Since Characterization is a SETUP parameter, select softkey B from screen D. The display will automatically change to D1.

## Characterization

Select softkey A (PRE-PRESSURI ZATI ON) from screen D1. The display will automatically change to screen D1.1. Toggle softkey A so that Pre-Pressurization is turned ON. Select softkey C from screen D1.1. The display will automatically change to screen to D1.1.1.

## Target Pressure and Maximum Flow

Enter the pressure value you arrived at after stabilization during equilibration plus 10% in the TARGET PRESSURE field (if you have chosen FI XED as the Gain Mode, enter the actual pressure). After you enter the pressure and press ENTER, the cursor will appear in the MAX FLOW field. Enter the maximum flow rate you want the system to run at during pre-pressurization and press ENTER.

**TIP:** Usually a minimum value of 100  $\mu\text{L}/\text{min.}$ , or 5 to 10 times the actual flow rate (whichever is greater) is a good value to enter in the MAX FLOW field. Too high a value will cause the system to overshoot the pressure, too low a value will cause the system to take an excessive amount of time in characterizing and pre-pressurizing.

## %B

If you have a gradient system, the %B field will be displayed on line three. Enter the value for % B (and C and D, if you have additional syringes installed) which you will use as your starting conditions. Press enter and screen D1.1.2 will be displayed.

Press RUN and screen D1.1.2 will change to display CHARACTERIZING instead of IDLE. The pump will begin running and calculating the resistance of the system. When it has completed characterizing the system, a value will be displayed in the REAL-TIME field and the pump will stop running. The gain value should be a number less than 1. You may press DISPLAY during the characterization process to monitor the progress if you wish (the FLOW field in the Display screen will display 0.00 when characterization is complete).

---

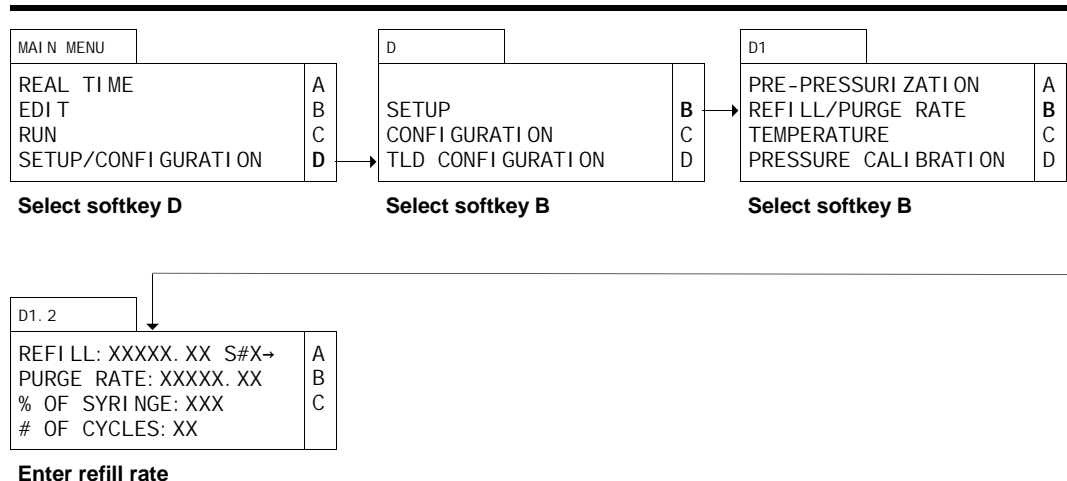
**TIP:** You will want to re-run the equilibration and characterization routines described above when you change the system in a way which alters the systems resistance (e.g., use a different column).

---

The REAL-TIME field displays the gain value determined by characterization. The USER-FIELD field displays the gain value determined by LAST RUN results. The values in these fields will be the same if the gain mode is set to CONSTANT.

Press DISPLAY and ΔMENU to return to the Main Menu.

## Setting the Refill Rate



## Configuration

All lines in all screens appear regardless of configuration, except screen D, screen D1 and screen D1.2. In screen D line four is displayed only in TLD mode. In screen D1 lines one and four appear when a pressure transducer is installed, and line three appears when an Analog I/O board is installed. In screen D1.2, the S# (syringe number or letter) field only appears when more than one syringe is installed. In multi-independent or gradient mode, softkey A toggles to change the syringe number being programmed.

## Setup

To set the refill rate, select softkey D (SETUP/CONFIGURATION) from the Main Menu. The display will automatically change to screen D. Since setting the refill rate is a SETUP parameter, select softkey B from screen D. The display will automatically change to screen D1.

## Refill

Select softkey B (REFILL/PURGE RATE) from screen D1. The display will automatically change to screen D1.2. The cursor will appear on the first line of the display. The refill rate determines the flow rate into the syringe. The best rate to enter depends on your application.

At the maximum refill rate, the syringe refills from empty in approximately 30 seconds (since the  $\mu$ Pro system has a default operating mode of refilling at the end of each run, it would generally be unusual for the syringe to have to be completely refilled).

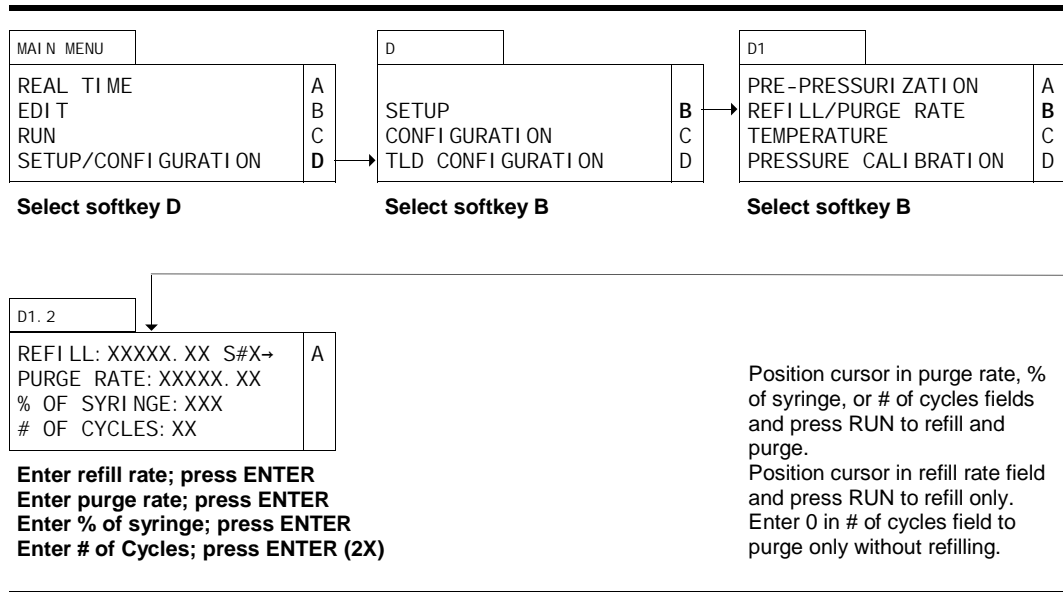
**TIP:** The slower the refill rate, the less likely the possibility of the introduction of air into the system as a consequence of cavitation; but, it will take longer to refill the syringes. Usually, accepting the default refill rate (p. 3.6) will provide an acceptable compromise for purposes of purging the syringes. You may wish to slow the refill rate down when the system is running files (see p. 3.19).

Press ENTER to accept the default rate or enter a valid number and press ENTER.

Pressing RUN with the cursor in the REFILL field; all pumps in the system and daisy chain are refilled simultaneously (no purge takes place). Once the syringes are refilled, the pumps stop.

Press DISPLAY and  $\Delta$ MENU to return to the Main Menu.

## Purging the System



## Screen Configuration

All lines in all screens appear regardless of configuration, except screen D, screen D1 and screen D1.2. In screen D line four is displayed only in TLD mode. In screen D1 lines three and four appear when a pressure transducer is installed, and line three appears when an Analog I/O board is installed. In screen D1.2, the S# (syringe number or letter) field only appears when more than one syringe is installed. In multi-independent or gradient mode, softkey A toggles to change the syringe number being programmed.

## Setup

To set the purge rate, select softkey D (SETUP/CONFIGURATION) from the Main Menu. The display will automatically change to screen D. Since setting the purge rate is a SETUP parameter, select softkey B from screen D. The display will automatically change to screen D1.

## Purge

Select softkey B (REFILL/PURGE RATE) from screen D1. The display will automatically change to screen D1.2. The cursor will appear on the first line of the display. The purge rate determines the flow rate out of the syringe. The best rate to enter depends on your application. Press ENTER to position the cursor in the PURGE RATE field.

Usually, accepting the default purge rate will be the best choice. Highly viscous fluids may require a lower purge rate entry to avoid an overpressure error.

Press ENTER to accept the default rate or enter the desired purge rate and press ENTER.

## % of Syringe

The % OF SYRINGE field determines the approximate percentage of the syringe expelled with each cycle of the purge routine.

---

**TIP:** It will rarely be necessary to purge the entire syringe repeatedly. A lower value of approximately 50% will be sufficient to accomplish the purposes of purge, and save solvent and time.

---

Enter a valid whole number (1-100) and press ENTER or press ENTER to accept the default.

## # of Cycles

The # OF CYCLES field determines the number of times the syringe is purged and refilled.

---

**TIP:** You will almost certainly want to enter a higher value in the # OF CYCLES field than the default to be certain that all the air has been expelled from the system. Usually 4 cycles of the purge program will be adequate.

---

Enter a valid whole number (0-99) and press ENTER or press ENTER to accept the default.

Pressing RUN when the cursor is in either the PURGE RATE, % OF SYRINGE or the # OF CYCLES fields will cause the syringe to purge and then refill. The  $\mu$ Pro repeats this the number of times entered; however, it executes these repeats purging the percentage of the syringe volume entered. Zero entered in the # OF CYCLES field will cause the syringe to purge only.

## Other Syringes in System

To program the same refill and purge rates for all syringes and run the cycle for all syringes simultaneously, toggle softkey A to ALL.

Toggle softkey A to program and run the additional syringes independently.

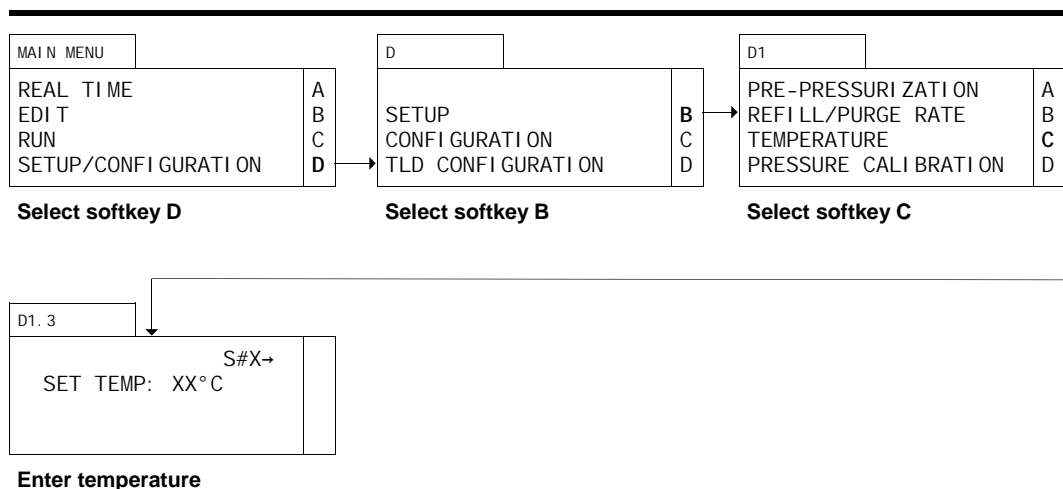
Press DISPLAY and  $\Delta$ MENU to return to the Main Menu.

---

**NOTE:** At the end of a Refill/Purge routine, the syringe(s) will be in the fully forward, or purged, state.

---

## Setting Temperature



## Screen Configuration

Setting syringe temperature can only be accomplished when temperature control is installed in the system. If your system is fitted with temperature control, all lines in all screens appear regardless of configuration except screen D and D1. In screen D line four is displayed only in TLD mode. In screen D1 lines one and four are displayed if a pressure transducer has been installed.

Since temperature control is fully integrated into the  $\mu$ Pro, it may not be immediately apparent whether your  $\mu$ Pro is fitted with temperature control. You can determine whether your system has temperature control by observing whether a fan is blowing air over the syringe when the power to the instrument is turned on.

## Setup

To set the temperature, select softkey D (SETUP/CONFIGURATION) from the Main Menu. The display will automatically change to screen D. Since setting the temperature is a SETUP parameter, select softkey B from screen D. The display will automatically change to screen D1.

## Temperature

Select softkey C (TEMPERATURE) from screen D1. The display will automatically change to screen D1.3. To program the same temperature for all syringes, toggle softkey A to ALL. The cursor will appear in the SET TEMP field. Valid entries are from 0 to 50°C. In order to control temperature, the setting must be at least 5°C above ambient temperature, 7°C above ambient is preferred. If you do not wish to use temperature control, enter a number lower than ambient temperature. When you have entered a valid number, press ENTER.

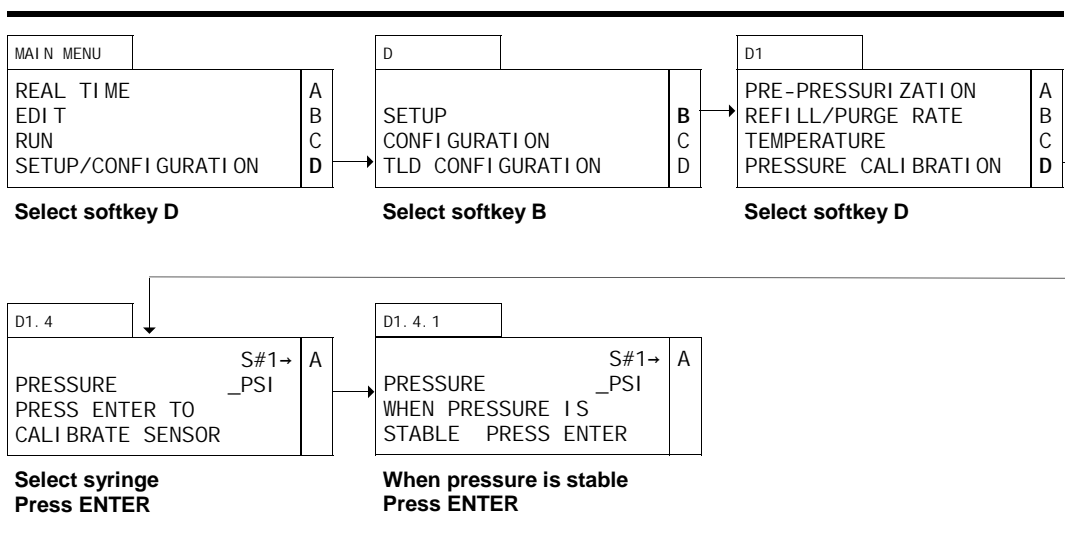
---

**TIP:** Temperature control is critically important, especially at flow rates in the lower range of the capacity of the syringe. Temperature control significantly enhances flow precision and the reproducibility of your results.

---

Press DISPLAY and  $\Delta$ MENU to return to the Main Menu.

## Calibrating Pressure Sensors



### Screen Configuration

Pressure sensor calibration can only be accomplished when a pressure transducer is installed in the system. If your system is fitted with a pressure transducer, all lines in all screens appear regardless of configuration, except screen D and screen D1.4. In screen D line four is displayed only in TLD mode. In screen D1.4, the S# field only appears when more than one syringe is installed. In multi-independent or gradient mode softkey A toggles to change the syringe number.

### Setup

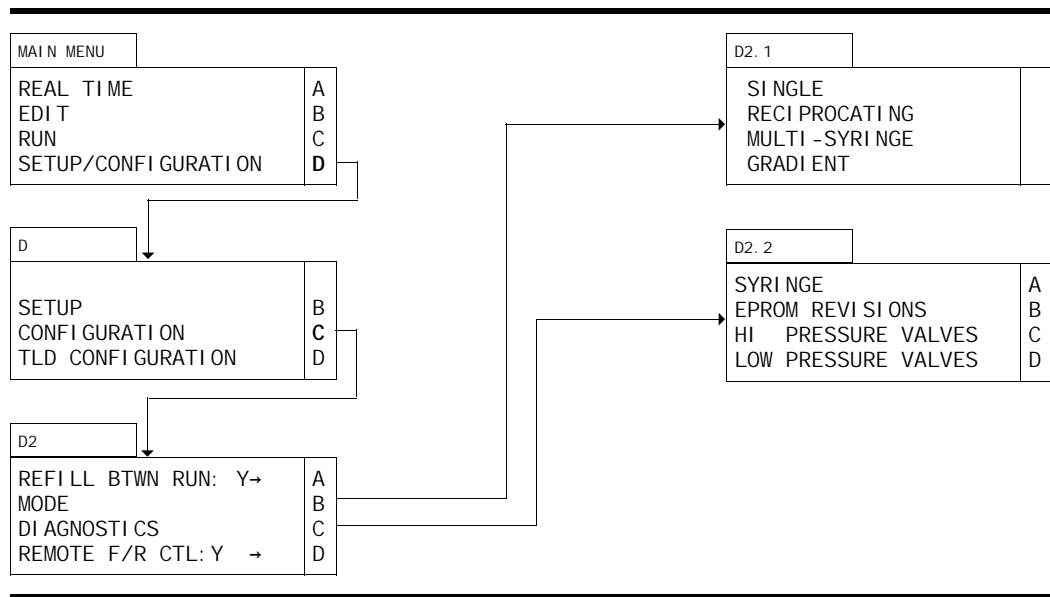
To access pressure sensor calibration, select softkey D (SETUP/CONFIGURATION) from the Main Menu. The display will automatically change to screen D. Since sensor calibration is a SETUP parameter, select softkey B from screen D. The display will automatically change to D1.

### Sensor Calibration

Select softkey D (PRESSURE CALIBRATION) from screen D1. The display will automatically change to screen D1.4. Toggle softkey A to display the syringe number of the pressure sensor you wish to calibrate. The display will automatically change to screen D1.4.1. Allow the pressure sensor to stabilize. Press ENTER. The system will re-zero the pressure sensor. Repeat for other pressure sensors.

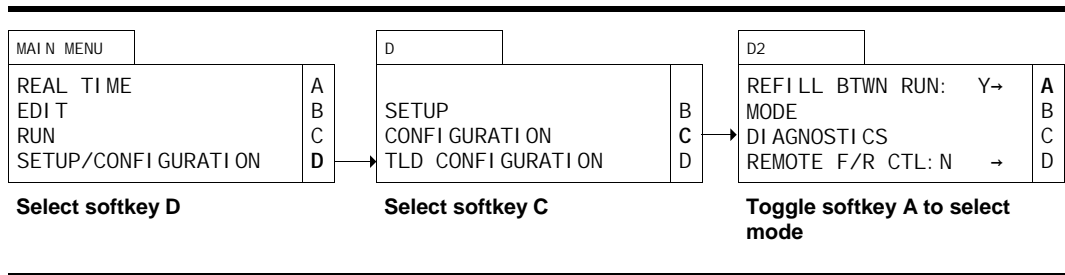
Press DISPLAY and ΔMENU to return to the Main Menu.

## Configuration Menus



To review or change a configuration parameter, select softkey **D** (SETUP/CONFIGURATION) from the Main Menu. The display will automatically change to screen **D**. Select softkey **C** (CONFIGURATION) to access the configuration parameters. The display will automatically change to screen **D2**. From screen **D2** you will select the parameter you wish to review or change.

## Setting Refill Between Run Mode



### Screen Configuration

All lines in all screens appear regardless of configuration, except screen D and screen D2. In screen D line four is displayed only in TLD mode. In screen D2 the first line does not appear when the unit is configured for reciprocation, and line four is displayed only when Analog I/O and I/O boards have been installed and the unit is configured for single or reciprocating mode.

### Configuration

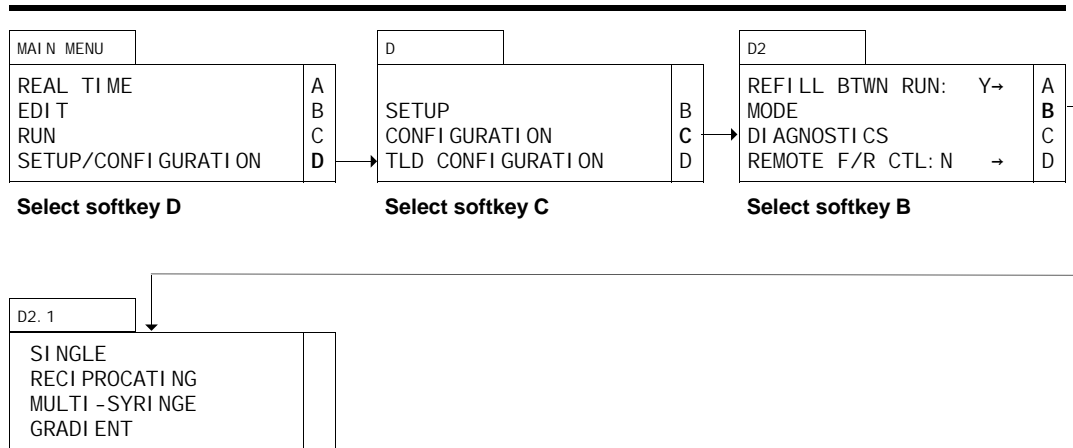
To set the REFILL BTWN RUN mode, select softkey D (SETUP/CONFIGURATION) from the Main Menu. The display will automatically change to screen D. Since selecting the refill mode is a CONFIGURATION parameter, select softkey C from screen D. The display will automatically change to screen D2.

### Refill

Press softkey A to toggle between refilling syringes(s) between running each file (Y) or not refilling syringe(s) between running each file (N). As a general rule, refilling between runs (Y) enhances reproducibility due to slight surface anomalies in the syringe cylinders.

Press DISPLAY and ΔMENU to return to the Main Menu.

## Viewing the Mode of Operation



### Screen Configuration

All lines in all screens appear regardless of configuration, except screen D, screen D2 and screen D2.1. In screen D line four is displayed only in TLD mode. In screen D2 the first line does not appear when the unit is configured for reciprocation, and line four is displayed only when Analog I/O and I/O boards have been installed and the unit is configured for single or reciprocating mode. In screen D2.1 the options of RECIPROCATING, MULTI-SYRINGE, and GRADIENT only appear if more than one syringe is installed in your system.

### Configuration

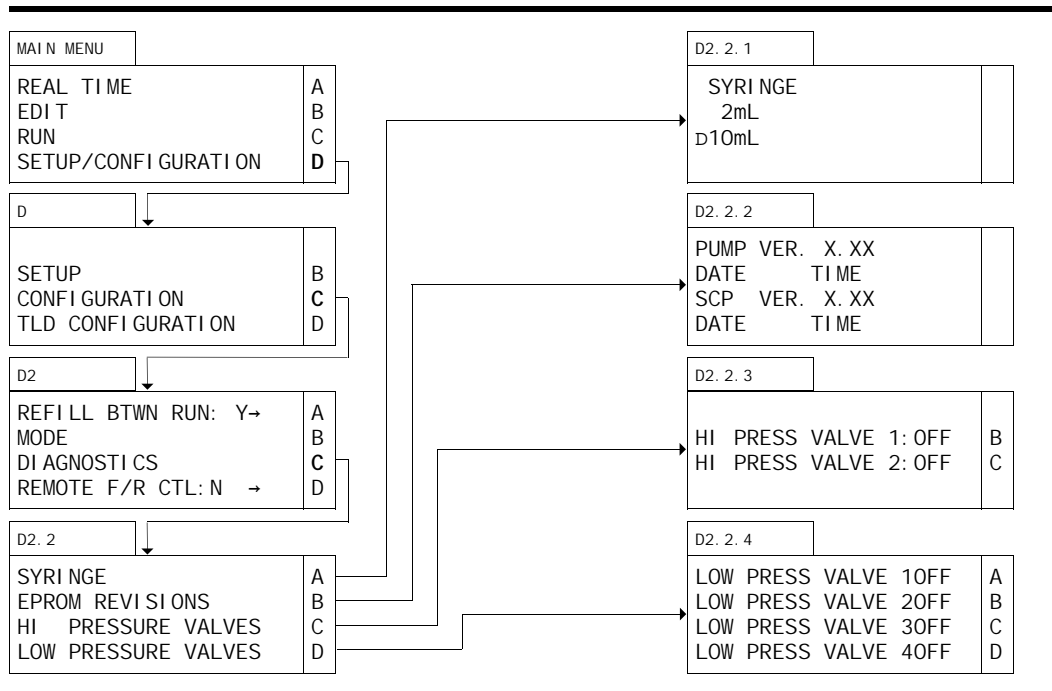
To view the mode of operation, select softkey D (SETUP/CONFIGURATION) from the Main Menu. The display will automatically change to screen D. Since viewing the mode is a CONFIGURATION parameter, select softkey C from screen D. The display will automatically change to screen D2.

### Mode

Select softkey B (MODE) from screen D2. The display will automatically change to screen D2.1. An arrow appears to the left of the mode of operation.

Press DISPLAY and ΔMENU to return to the Main Menu.

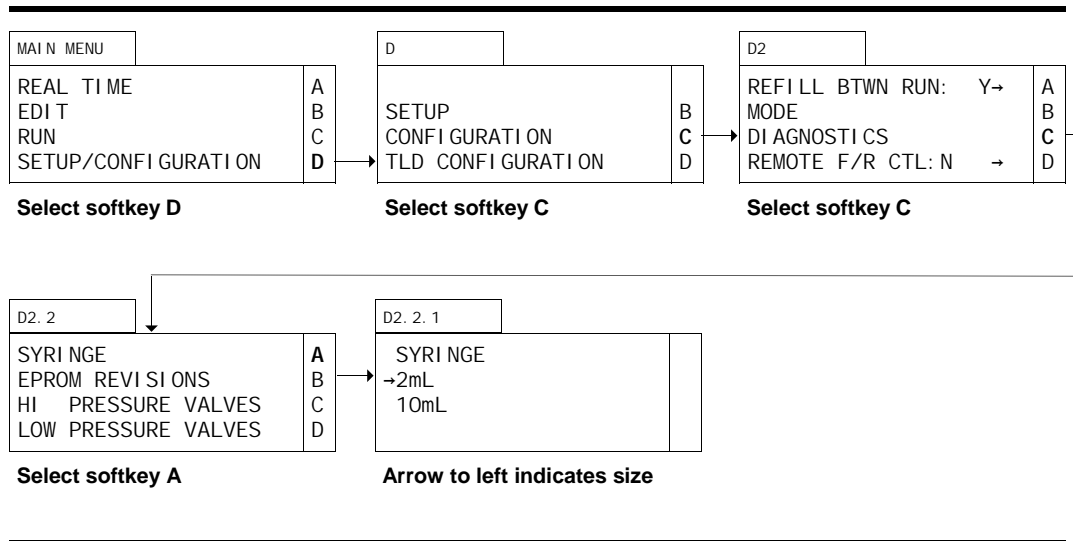
## Diagnostics Menus



To troubleshoot your  $\mu$ Pro, you may wish to review or test a diagnostic parameter. To review or test a diagnostic parameter, select softkey D (SETUP/CONFIGURATION) from the Main Menu. The display will automatically change to screen D. Select softkey C (CONFIGURATION) to access the diagnostic parameters. The display will automatically change to screen D2. Select softkey C (DIAGNOSTICS) from screen D2. The display will automatically change to screen D2.2. From screen D2.2 you will select the parameter you wish to review or test.

The diagnostics screen displays information or tests devices of the syringe being displayed in the Display screen. To change the syringe being viewed or tested, press DISPLAY and toggle softkey A to the syringe you wish to view or test.

## Viewing Syringe Size



## Screen Configuration

All lines in all screens appear regardless of configuration, except screen D, screen D2 and screen D2.2. In screen D line four is displayed only in TLD mode. In screen D2 the first line does not appear when the unit is configured for reciprocation, and line four is displayed only when Analog I/O and I/O boards have been installed and the unit is configured for single or reciprocating mode. In screen D2.2 the third line only appears if a High Pressure Valve board is installed, and the last line only appears if an I/O board has been installed in your system.

## Configuration

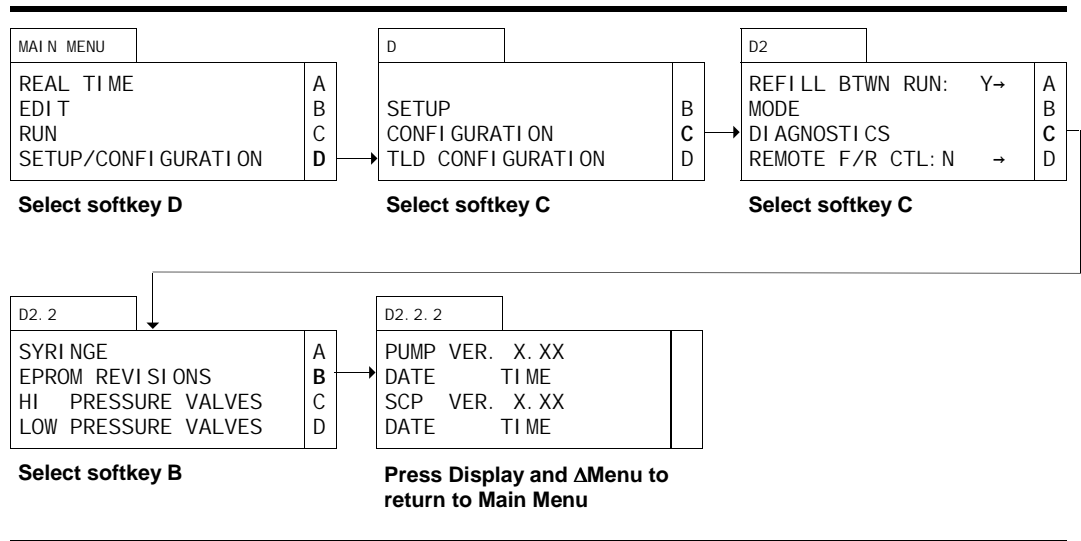
To view the syringe size (as recorded by the software), select softkey D (SETUP/CONFIGURATION) from the Main Menu. The display will automatically change to screen D. Since viewing the syringe size is a CONFIGURATION parameter, select softkey C from screen D. The display will automatically change to screen D2. Select softkey C (DIAGNOSTICS) from screen D2. The display will automatically change to screen D2.2.

## Syringe Size

Select softkey A (SYRINGE) in screen D2.2. The display will automatically change to screen D2.2.1. An arrow will appear to the left of the syringe size installed in your system.

Press DISPLAY and ΔMENU to return to the Main Menu.

## Viewing EPROM Level



## Screen Configuration

All lines in all screens appear regardless of configuration, except screen D, screen D2 and screen D2.2. In screen D line four is displayed only in TLD mode. In screen D2 the first line does not appear when the unit is configured for reciprocation, and line four is displayed only when Analog I/O and I/O boards have been installed and the unit is configured for single or reciprocating mode. In screen D2.2 the third line in the display only appears if an High Pressure Active Valve has been installed. The fourth line in the display only appears if an I/O board has been installed in your system.

## Configuration

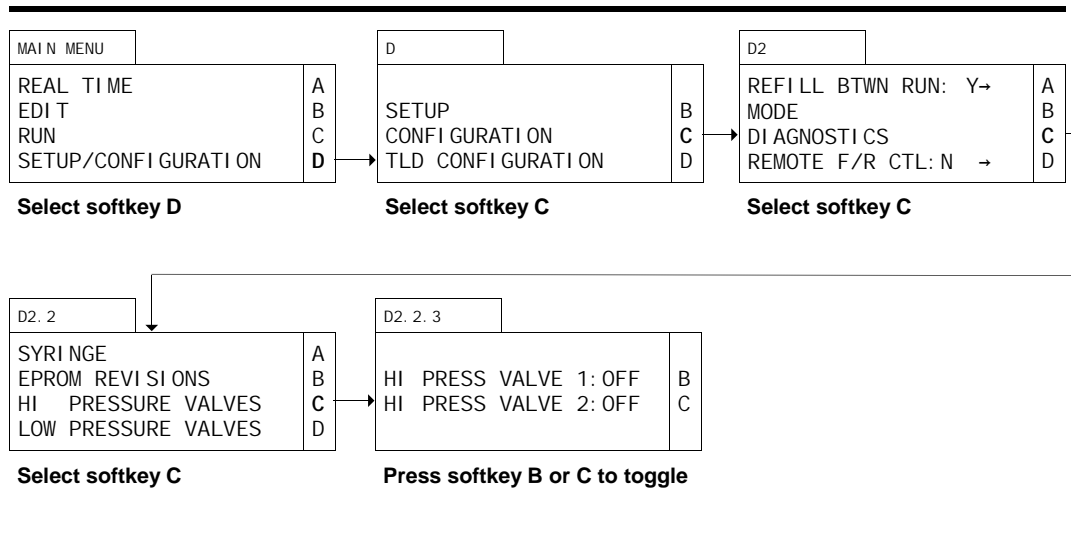
To view the EPROM revision level, select softkey D (SETUP/CONFIGURATION) from the Main Menu. The display will automatically change to screen D. Since viewing the EPROM revision level is a CONFIGURATION parameter, select softkey C from screen D. The display will automatically change to screen D2. Select softkey C (DIAGNOSTICS) from screen D2. The display will automatically change to screen D2.2.

## EPROM Level

Select softkey B (EPROM REVISIONS) from screen D2.2. The display will automatically change to screen D2.2.2. The EPROM revision level is indicated, as well as a date and time. You may wish to make a note of the level installed in your instrument.

Press DISPLAY and ΔMENU to return to the Main Menu.

## Testing High Pressure Active Valves



### Screen Configuration

Testing the High Pressure Active Valves requires a High Pressure Active Valve be installed in your system. If your system is fitted with a High Pressure Active Valve, all lines in all screens appear, regardless of configuration, except screen D, screen D2, screen D2.2 and screen D2.2.3. In screen D line four is displayed only in TLD mode. In screen D2 the first line does not appear when the unit is configured for reciprocation, and line four is displayed only when Analog I/O and I/O boards have been installed and the unit is configured for single or reciprocating mode. In screen D2.2 line four only appears if an I/O board has been installed in your system. In screen D2.2.3 the HI PRESS VALVE 2 field only appears if a second High Pressure Active Valve has been installed in your system.

### Configuration

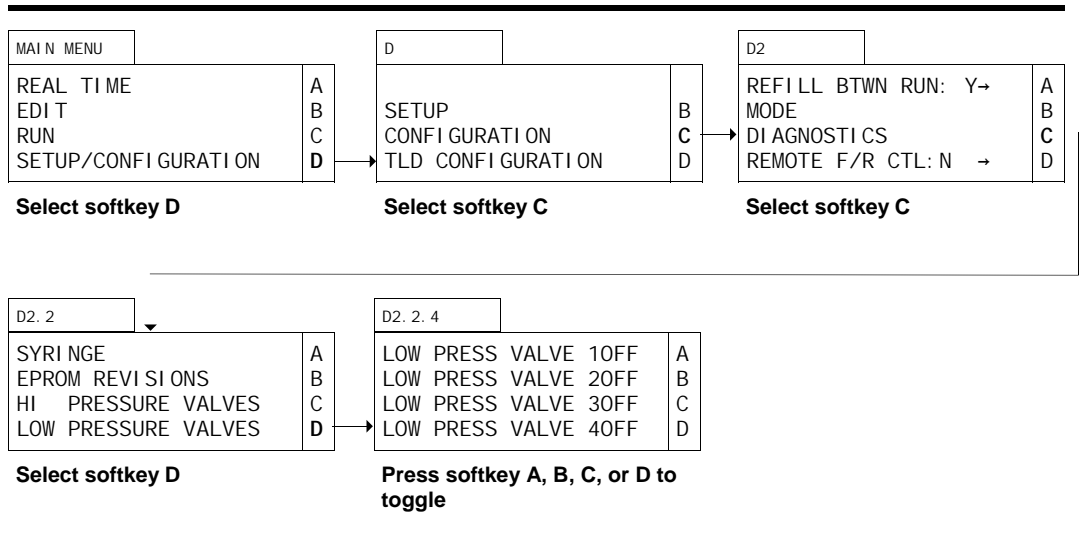
To test the High Pressure Active Valve, select softkey D (SETUP/CONFIGURATION) from the Main Menu. The display will automatically change to screen D. Since testing the High Pressure Active Valve is a CONFIGURATION parameter, select softkey C from screen D. The display will automatically change to screen D2. Select softkey C (DIAGNOSTICS) from screen D2. The display will automatically change to screen D2.2.

### High Pressure Active Valve

Select softkey C (HI PRESSURE VALVES) from screen D2.2. The display will automatically change to screen D2.2.3. Pressing the softkey corresponding to the High Pressure Active Valve you wish to test will toggle the Valve to the ON or OFF position (ON connects ports 1 and 6 and 3 and 4; OFF connects ports 1 and 2 and 4 and 5). In single syringe, multi-syringe and gradient systems, OFF connects the syringe to the reservoir, ON connects the syringe to the system.

Press DISPLAY and ΔMENU to return to the Main Menu.

## Testing Low Pressure Active Valves



### Screen Configuration

Testing the Low Pressure Active Valves requires an I/O board be installed in your system. If your system is fitted with an I/O board, all lines in all screens appear, regardless of configuration, except screen D, screen D2 and screen D2.2. In screen D line four is displayed only in TLD mode. In screen D2 the first line does not appear when the unit is configured for reciprocation, and line four is displayed only when Analog I/O and I/O boards have been installed and the unit is configured for single or reciprocating mode. In screen D2.2 the HI PRESS VALVES field only appears if a High Pressure Active Valve has been installed in your system.

### Configuration

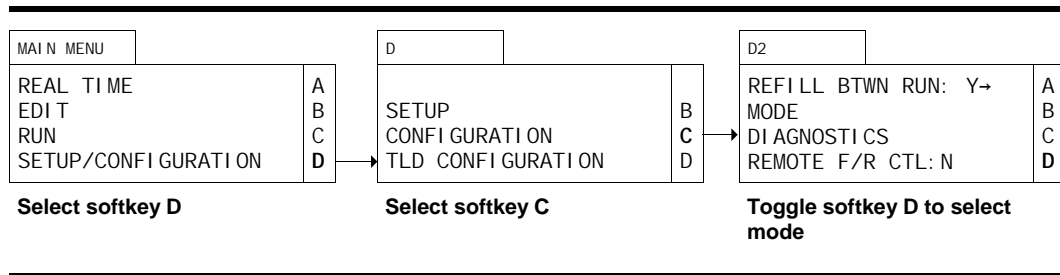
To test the Low Pressure Active Valve, select softkey D (SETUP/CONFIGURATION) from the Main Menu. The display will automatically change to screen D. Since testing the Low Pressure Active Valve is a CONFIGURATION parameter, select softkey C from screen D. The display will automatically change to screen D2. Select softkey C (DIAGNOSTICS) from screen D2. The display will automatically change to screen D2.2.

### Low Pressure Active Valve

Select softkey D (LOW PRESSURE VALVES) from screen D2.2. The display will automatically change to screen D2.2.4. Pressing the softkey corresponding to the Low Pressure Active Valve you wish to test will toggle the Valve to the ON or OFF position (ON connects ports 2 and 3; OFF connects ports 1 and 2). ON connects ports 2 and 3 in Figure 3.1 (p. 3.1); OFF connects ports 1 and 2.

Press DISPLAY and ΔMENU to return to the Main Menu.

## Setting Remote Flow Rate Control



### Screen Configuration

All lines in all screens appear regardless of configuration, except screen D and screen D2. In screen D line four is displayed only in TLD mode. In screen D2 the first line does not appear when the unit is configured for reciprocation, and line four is displayed only when Analog I/O and I/O boards have been installed and the unit is configured for single or reciprocating mode.

### Configuration

To set the REMOTE F/R CTL mode, select softkey D (SETUP/CONFIGURATION) from the Main Menu. The display will automatically change to screen D. Since selecting the remote flow rate control is a CONFIGURATION parameter, select softkey C from screen D. The display will automatically change to screen D2.

### Remote Flow Rate

Press softkey D to toggle between the default condition of no remote flow rate control (N) and remote flow rate control (Y).

Press DISPLAY and ΔMENU to return to the Main Menu.

### Operation of Remote Flow Rate Control

Selecting REMOTE F/R CTL allows you to operate the flow rate of the μPro using analog and digital signals. You will make connections to the I/O and Analog I/O boards. By sending a voltage signal of 1-5V, you can remotely control the μPro flow rate. Table 3.3 shows the connections you may need to make. You may wish to connect to additional I/O and Analog I/O positions for pressure or flow outputs, or % syringe dispensed.

**Table 3.3: Remote Flow Rate Control Inputs**

Board	Position	Function
I/O	15 & 16	Run
I/O	21 & 22	Stop
I/O	17 & 18	Negative Flow Rate*
I/O	23 & 24	Refill
I/O	27 & 28	End of Refill
Analog I/O	1	Ground
Analog I/O	5	1-5V for Refill Rate
Analog I/O	6	1-5V for Flow Rate

\*Does not operate in reciprocating mode.

### *Running a Positive Flow*

To remotely run the  $\mu$ Pro with a positive flow rate, you will connect a 1-5V output to position 6 (1-5V for Flow Rate) and a ground to position 1 (Ground), both on the Analog I/O board. In addition, you will connect contact closures to positions 15 and 16 (Run) to start running, and positions 21 and 22 (Stop) to stop running, both on the I/O board .

When these connections are made and the  $\mu$ Pro is in the remote flow rate control mode, you can remotely control the flow rate of the  $\mu$ Pro by closing the contact on positions 15 and 16 (Run) of the I/O board. The  $\mu$ Pro system will then look for a 1-5V signal on position 6 (1-5V for Flow Rate) of the Analog I/O board and run at the corresponding flow rate (1-5V corresponds approximately linearly with the flow rate range of the pump).

### *Running a Negative Flow*

To remotely run the  $\mu$ Pro with a negative flow rate, you will connect a 1-5V output to position 6 (1-5V for Flow Rate) and a ground to position 1 (Ground), both on the Analog I/O board. In addition, you will connect contact closures to positions 15 and 16 (Run), 17 and 18 (Negative Flow Rate), and 21 and 22 (Stop), all on the I/O board.

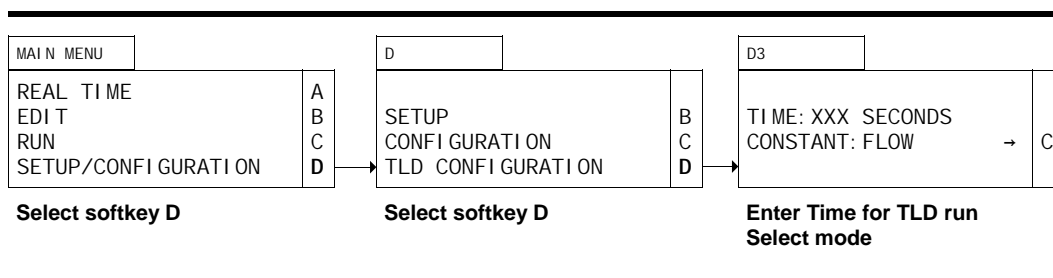
When these connections are made and the  $\mu$ Pro is in the remote flow rate control mode, you can remotely control the negative flow rate of the  $\mu$ Pro by closing the contacts on positions 17 and

## Other Aspects of Remote Flow Rate Control

Choosing to operate in remote flow rate mode has several important consequences.

1. There is no pre-pressurization; the syringes do not begin operation at an accelerated flow rate to ramp up to pressure quickly.
2. When in single or multi-independent syringe mode, once the syringe piston reaches the end of the syringe cylinder, the pump stops and does not automatically refill. You must refill as described above.
3. You may use the local interface to program the syringe while the system is operating in remote flow rate mode.
4. Pressing STOP will stop the pump. Pressing RUN when in the refill/purge screen (D.2.1) will operate as described on p.3.29 and 3.30 (unless you are already running in remote mode). Pressing RUN in the real time screen (A) will start the pump, running at the remote analog flow rate.
5. The response time to commands when in the remote flow rate mode is slower than when under the control of the local interface. In the reciprocating mode when the syringes are in a transition, the delay in response times may be noticeable.
6. If you enter a new refill rate in the local interface, you must exit the refill/purge screen to store the new value as the new default refill rate.

## Programming TLD Flow Time and Mode



### Screen Configuration

All lines in all screens appear regardless of configuration, except D and D3. Line four in screen D and all of screen D3 do not appear unless the unit is configured for continuous flow gradient mode, with a transitional liquid delivery (TLD) pump.

### Configuration

To set the time for TLD running, select softkey D (SETUP/CONFIGURATION) from the Main Menu. The display will automatically change to screen D. Since setting the time for TLD running is a TLD CONFIGURATION parameter, select softkey D from screen D. The display will automatically change to screen D3.

### TLD Time

The cursor will appear in the TIME field. Valid entries are from 0 to 999 (seconds). When you have entered a valid number, press ENTER.

### TLD Mode

Upon pressing ENTER in the TIME field, the cursor will move to the CONSTANT field. Pressing softkey C will toggle between FLOW and PRESSURE. Using the flow mode will result in the TLD pump running at the last flow rate in the gradient program. Using the pressure mode will result in the TLD pump running at the last pressure of the gradient program run.

Press DISPLAY and ΔMENU to return to the Main Menu.

**NOTE!** We recommend you limit the time for TLD running to well under 75% of the syringe volume. Entering times longer than that taken to dispense approximately 75% of the syringe may result in unanticipated operation.

### Additional Notes on Menus

Pressing CLEAR on power up (within about 2 seconds) will display a screen asking if you want to reset the system to factory defaults. Pressing softkey C resets the system to factory defaults (including changing the Mode to single syringe). Pressing softkey D does not reset the system. Press ΔMENU to return to the Main Menu.

