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SPECIFICATIONS

Syringe size	10 microliter to 140 milliliter
Power	115/230 VAC, 50/60 Hz, internal selector switch
Fuse	5x20 mm, 250 V, 0.25 amp (slow-blow)
Voltage Operating Range	95-130 & 220-260 VAC
Drive Mechanism	Microprocessor controlled stepper motor 1/2 - 1/16 microstepping, driving a leadscrew through a belt and pulley drive mechanism
Pusher Advance per Microstep (1/16 step)	0.165 micron
Volume per Microstep (1/16) with 60 ml syringe	0.0919 μ l
Minimum Stepping Rate	1 step/30 sec
Maximum Stepping Rate	800 steps/sec
Speed Range	4.26 x 10 ⁹ :1
Flow Rate Range	0.001 μ l/hr to 70.57 ml/min (60 ml syringe)
Nominal Linear Force	35 lb
Dimensions	11 x 9 x 5.5 in. (28 x 23.5 x 14 cm)
Weight	9 lb (4 kg)

GENERAL DESCRIPTION

This manual applies to infusion pumps SP200i, SP220i, SP250i; infusion/withdrawal pumps SP210iw and SP230iw; and push-pull pump SP260p. Most features are common to all pumps. However, models SP210iw, SP230iw and SP260p have additional modes and related RS232 commands not available in infusion-only models.

Operation of the pump is simplified by using a keypad to select features from a menu displayed on an alphanumeric LCD.

All control functions are performed automatically by the pump microcontroller and are based on linear motion of the pusher block, associated with the syringe size (diameter) to deliver a known volume. After entering the syringe diameter, either directly or from a table in memory, all calibration and control functions are performed by the pump automatically.

model	number syringes	infusion	withdrawal
SP200i	2	X	
SP210iw	2	X	X
SP220i	10	X	
SP230iw	10	X	X
SP250i	4	X	
SP260p	4	X	X

FEATURES

1) Syringe identification

Look up Table — The pump contains a table of standard syringes arranged by manufacturer, material and size. Once the syringe is identified in the table the pump automatically enters the appropriate diameter.

Direct Entry — If the syringe used is not included in the table, the internal diameter of the syringe barrel can be measured in millimeters and entered directly from the keypad.

2) Infusion and refill rates

The two rates can be set independently and can be changed while the pump is running. After the operating mode selection is made the program will prompt only for the relevant rates associated with that mode.

3) Volume

A target volume can be entered for infusion and refill independently, and the pump automatically stops when this volume is reached. The pump displays an initial volume of zero and increases as the dispense process proceeds to the target volume. The target volume can be reviewed or changed as the pump continues to operate.

4) Modes of operation

Infusion — Rate and volume settings: pump infuses to the set volume and stops. Rate setting only: pump runs until manually stopped or stalls.

Withdrawal — Rate and volume settings similar to above.

Infusion/ withdrawal — Infusion automatically followed by withdrawal. Rate and volume settings can be made independently for infusion and withdrawal, hence the pump can infuse at one rate and volume and then change to a different withdrawal flow rate and volume setting.

Withdrawal/ infusion — Withdrawal immediately followed by infusion. Separate settings for rate and volume can be made for withdrawal and infusion.

Continuous operation — The pump cycles from infusion to withdrawal continuously. The infuse volume and withdrawal volume setting are the same but different infusion and withdrawal flow rates can be selected.

Note: The displayed menu which prompts the operator for Rate and Volume settings changes with Mode selection. For convenience, only the relevant settings associated with the selected mode are prompted. For example, in the Withdrawal / Infusion mode the menu prompts for withdraw and then infuse volumes, followed by withdraw and infuse rates. In Infusion only mode, the menu prompts only for infusion volume and infusion rate.

5) RS232C interface

Multiple pumps can be controlled in a “daisy chain” by a single PC. Programming is reduced to a small number of simple commands.

6) TTL

Input and output controls are available, such as, direction change, run indicator, footswitch or timer control, and valve or relay actuation.

7) Stall detection

The motor is monitored by an optical encoder to confirm the programmed

movement. If the back pressure increases due to jamming or flow restriction the motor may stall. Stall detection by the encoder results in a pump shutdown. The display will read "Stalled".

8) Power disruption

After a temporary power disruption the pump always remains stopped if a dispense volume has been set. Otherwise, the pump can be programmed to resume operation, or remain stopped, when power is returned.

9) Non-volatile memory

All operational settings are stored in non-volatile memory for convenience and are used to set the pump when first switched on.

10) Automatic selection of rate and volume units

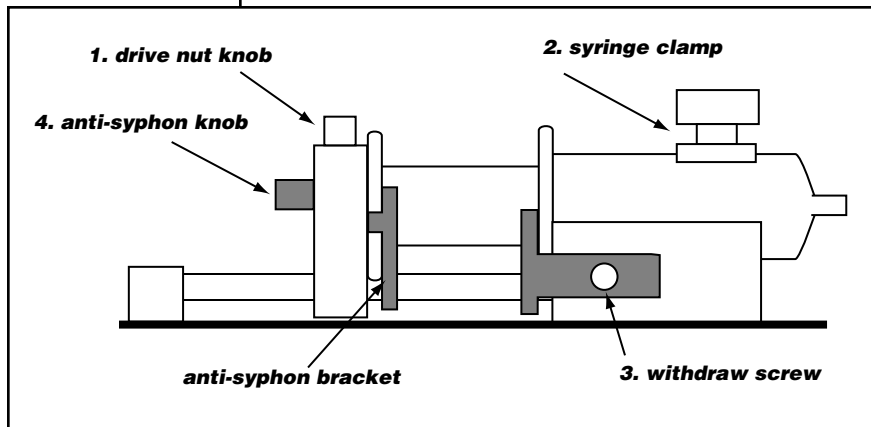
Units of flow rate and volume are preselected based on syringe size but can be changed if required.

OPERATING INSTRUCTIONS

Power Switch

Plug in the power cord and turn on the power using the switch located on the rear right corner of the pump.

Syringe Loading (except SP260p: see page 7)



To simplify syringe loading the pusher block can be disengaged from the leadscrew and manually moved along the guide rods, or the Fast-forward-Fast-reverse feature can be used.

Knob (1) is rotated to release the drive nut from the leadscrew. When the white line on the knob is facing toward the syringe barrel the drive nut is engaged and

when the white line faces the keypad the nut is dis-engaged.

Raise and rotate the spring loaded retaining arm (2) and place the syringe barrel in the "V" of the syringe holder. When the syringe is in place release the retaining arm so that it clamps down on the barrel and holds it securely in place.

Release the pusher block mechanism and slide the block along the guide rods until the block presses firmly against the syringe plunger. Rotate the knob (1) to re-engage the drive nut.

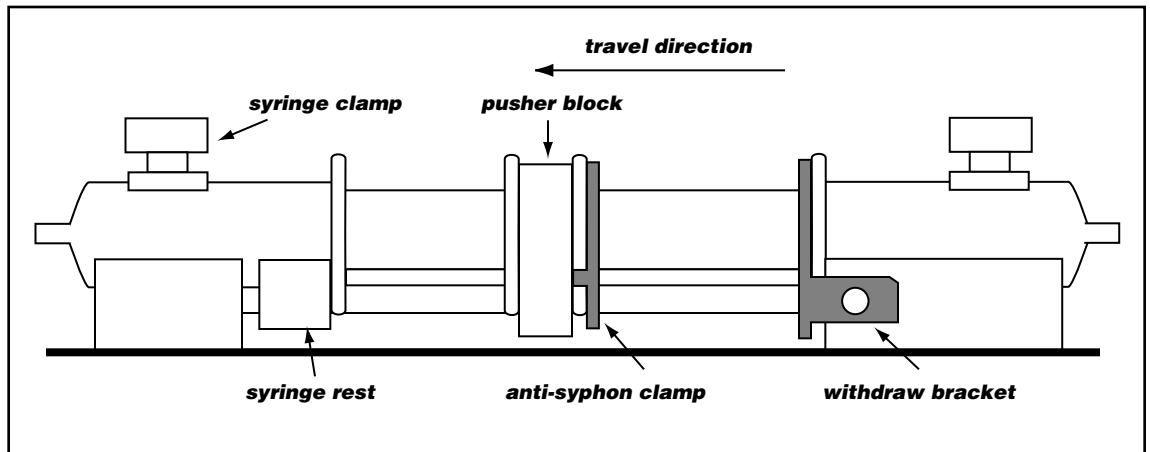
Withdrawal Operation

For withdrawal or refill operation the syringe plunger and barrel flange must be secured. Loosen screws (3) on the syringe holder and, after loading the syringe, press the retaining bracket against the barrel flange to secure the flange between the bracket and syringe holder. Tighten screws (3).

To restrain the plunger, rotate knob (4) to release the retaining bracket and position the syringe plunger between the pusher block and retaining bracket. Turn knob (4) clockwise to tighten the retaining bracket and then re-engage the drive nut (knob 1).

The mechanism is designed to accommodate a wide range of syringe sizes however, there are some syringes which require additional attention. (See page 7)

SP200 Series Syringe Pumps



Syringe Loading (SP260p)

This unique syringe pump has all the features of the model SP210iw pump and, for the push-pull operation the Withdrawal Mode should be selected from the menu. In this mode the pusher block will travel from right to left, as shown above.

Large volume dispenses using large syringes may not require the use of the syringe rest. Increase travel is possible if the infusion syringe is retained in the left syringe holder without use of the syringe rest.

Menu Features

When the pump is first turned on the LCD will display the last Rate or Volume setting. Pressing **select** repeatedly will always return the display to the main menu. The main menu consists of seven variables, three of which are displayed at all times. The center variable pulses to indicate that this option can be reviewed or changed. The menu acts as a continuous loop and the **arrow keys**, ← → are used to move around the loop. The variable to be changed can be selected with the **select** key.

<..> DIA <..> TABLE <..> RATE <..> VOL <..> MODE <..> RS232 <..> PWR UP <..>

Keypad Functions

A keypad is used for selection of features from the displayed menu and numerical entries.

← →

These keys move the displayed menu left and right respectively.

select

Used to select the highlighted menu feature (flashing).

enter	Used to select features and, when the numerical parameters of the feature selected are set, then enter places all the settings in memory ready for operation. All settings are stored in non-volatile memory and will be used next time the pump is operated.
-, 0 - 9	Numerical entry keys.
run/stop	Starts and stops the motor. Acts as a pause during a dispense.

Fast Forward, Fast Reverse

Keys **run** and → or ← pressed simultaneously causes the pump to run at maximum speed. This feature can be used for loading, purging and reversing out of a stall condition.

Syringe Diameter Entry

The pump must be calibrated by identifying the internal diameter of the syringe used. Once entered this data is stored in non-volatile memory and need be modified only when a different syringe is used.

TABLE

Use the **arrow** keys to move TABLE to the center of the display and press **select** to select this feature. The display now reads abbreviated names of syringe manufacturers and the type of syringe (plastic or glass).

Use the **arrow** and **select** keys to scroll through the list and select the manufacturers name of the syringe used. The display now lists the size of syringe. Again, use the **arrow** and **select** (or **enter**) keys to identify and enter the syringe used.

DIAMETER

If the syringe used is not listed in the table of syringes then the internal diameter of the syringe must be measured and entered directly. Scroll through the main menu and select **DIA**.

The display now prompts for entry of the syringe barrel internal diameter measured in **millimeters**. Enter by using the numerical keys and **enter**.

NOTE: If the diameter is changed, the volume and rate settings are set to zero.

Volume Setting

Volume can be reached directly from the main menu or will be prompted after mode selection.

Volume prompt: Vol: 00.00 ml →

- 1) Enter target volume from the numerical keypad.
- 2) If the units and value displayed are correct, **enter**.

The underlined display, or pulsing display segment, indicates that this parameter can be changed. The arrow symbol signifies direction of travel (→ indicates withdrawal) and pulses when the pump is running.

note: When dispensing, the volume display increments in units of the last significant figure of the volume entered. Therefore, to increment by .01 the volume should be set at 1.00. Similarly, if the volume is set at 1.000 then the volume increments by .001.

note: Volume setting = 0.0

- a) Infusion or Withdrawal modes. Volume = 0 is interpreted as no volume and the pump will run until manually stopped or a stall occurs. The LCD will display the rate setting.
- b) Infusion/withdrawal, Withdrawal/infusion and Continuous modes. A volume setting *must* be entered. A 0.0 volume is interpreted as no volume and the display returns to the mode selection menu to enable the user to select the appropriate mode.

Units Setting

prompt: Vol: 00.00 ml ←

The units displayed can be changed if required.

- 1) Use the **RIGHT** arrow key to move the pulsing indicator to the units displayed.
- 2) Continue to use the **RIGHT** arrow key to scroll through the possible units.
- 3) The **LEFT** arrow key will move the active display back to the numerical value.
- 4) When the correct value and units are displayed press **enter**.

Possible units are: μ l and ml (microliter and milliliter)
 μ l/m, μ l/h and ml/m, ml/h (μ l or ml per minute or hour)

Rate Setting

Display reads: Rate 00.00 ml/h →

- 1) Enter the flow rate value required with the numerical keypad.
- 2) If necessary, change the units using the → key to move to and scroll through the possible units.
- 3) When the displayed settings are correct press **select** or **enter**.

note: If the number entered exceeds the maximum flow rate possible then the pump displays the maximum feasible rate. To continue enter a rate smaller than the maximum.

note: To check the maximum possible rate enter 9's to the required decimal position. For example, enter 99.9 and the maximum displayed is 12.3 whereas if 99.99 is entered, the the maximum displayed is 12.34.

Power Up run or stop

This option is only applicable when **no dispense volume** is selected. When power returns after an interruption the pump can resume operation (select RUN) or remain stopped (select STOP).

If the pump resumes operation the rate display will flash to indicate that a power interruption has occurred. Press **select** to clear the display to resume normal operation.

Run/Stop

After all settings are made the pump can be started by a single press of the **run/stop** key. This key also stops the pump operation. During a volume dispense the **stop** acts as a "pause" and **run** will resume the dispense.

Change or Review Volume Setting While Running

While the pump continues to run press **select** to return to the main menu. Scroll through the menu and **select** Volume to display the set dispense volume.

no volume change — Press **select**. The display returns to the incrementing display volume.

volume change — (1) Make the changes with the numerical keypad and **enter**. (2) The display moves to RATE, permitting a change if required. Use the numerical keypad and **enter** to make changes. The pump immediately changes to the new flow rate, if changed, and the volume continues to

increment, uninterrupted by the review process, to the new target dispense volume when it will stop automatically.

note: If the volume is changed to a volume smaller than the volume already accumulated then the pump will stop as soon as the new, smaller target volume is entered.

Mode Selection

Select MODE from the main menu and then scroll through the options displayed and **select** the mode required.

Possible modes are:

- infusion**
- withdrawal**
- infusion / withdrawal**
- withdrawal / infusion**
- continuous**

note: For bidirectional modes a volume is required.

infusion — Pump infuses at the set rate and stops automatically when the target volume is reached. The pump can be manually stopped and restarted at any time, that is, the dispense is paused and, when restarted will continue to the set dispense volume.

withdrawal — Pump withdraws at the set rate to the set volume.

infusion / withdrawal — The pump first infuses and when the target volume is reached it immediately changes direction and withdraws. *The volume settings for infusion and withdrawal can be different as can the infusion and withdrawal flow rates.*

withdrawal / infusion — The pump runs first in the withdrawal direction and then automatically changes to the infusion direction. Different setting of rate and volume for withdraw and infusion are permitted.

continuous — The pump first infuses and then withdraws, and then cycles continuously. Only one volume setting for infusion and withdrawal is permitted. Different flow rates can be set for infuse and withdraw. If the pump is matched to a valve, which is actuated by a TTL pulse from the pump, this mode can be used to infuse and then refill the pump for continuous operation.

The menu now prompts for volume and rate settings relevant to the mode selected.

Manual Stall Setting and Microliter Syringes

A movable collar, located on the rear guide rod, can be set to limit travel of the pusher block. The block moves until stalled against the collar when the electro-optical sensor detects the stall and stops the pump. Damage to the fine wire plungers of microliter syringes caused by forcing the plunger into the end of the syringe barrel can be prevented by careful adjustment of the collar position. Only the infusion pumps (designated by an "i" suffix) will have these stops.

Glass Syringes

Glass syringes with rounded corners, particularly at the flange/barrel and plunger head / plunger junctions sometimes lift up from the syringe holder. This is most often experienced in the withdrawal mode and can be significantly reduced by placing a rubber O-ring around the plunger or barrel at the junction of the plunger head or flange.

Clearing a Stall Condition

Should a stall occur the pump motor is stopped to prevent damage.

To clear the display press **select**.

To move the stalled mechanism use the **fast forward** or **fast reverse** to move the pusher block. Using the fast forward or fast reverse feature is not only the most simple way to deal with the stall, it also reduces potential damage to the mechanism which could be caused by using the cam to release the halfnut from the leadscrew.

NV RAM Failure—If the settings in the non-volatile memory become corrupted the display will read "NV Ram Failure" and the pump will not operate. To recover from this condition the pump must be powered down and then turned on again. The pump will be re-initialized to the default settings and can be programmed as normal.

RS232C

The RS232 connections are made through two modular telephone connectors, labelled IN and OUT, located on the rear panel.

A single PC can control up to 100 pumps via a "daisy chain" using the IN and OUT connectors. When using the daisy chain each pump must be assigned an address and set to the same baud rate. When controlled via RS232 the pump will still respond to keypad commands but will not respond to keypad and RS232 commands simultaneously. All RS232 command settings, similar to keypad settings, are stored in non-volatile memory.

Select RS232 from the main menu.

BAUD RATE 300, 1200, 2400, 4800, 9600

The available baud rates will now be displayed and can be selected using the **arrow** and **select** keys. The display now prompts for assignment of a pump address.

ADDRESS If no address is assigned then the pump defaults to a 0 setting. All pumps with the same address respond simultaneously to the same commands.
Use the > key to enter an address, 0 - 99 and press **select** to return to the main menu.

RS232C Commands

RS232 is used for remote computer control of up to 100 pumps, identified with an address from 0 to 99 and set to the correct baud rate. Each pump can be controlled either from the keypad or via RS232 at all times but the pump can only respond to one command at a time. When under RS232 control the display reads "REMOTE". All settings made via RS232 are stored in nonvolatile memory.

To move the pump from Remote (RS232) to keypad control press **select**.

After each command is received and executed by the pump, the pump responds with a message and a prompt.

Commands and Responses

Commands are not case sensitive.

After each command is received and executed the pump responds with prompt sequence:

- a)** Query commands — carriage return (<CR>), line feed, text, (<CR>), line feed, 1 or 2 digit address, prompt character
- b)** Other commands — <CR>, line feed, 1 or 2 digit address, prompt character

Prompts

>	running in infusion direction
<	withdrawing
:	stopped

NA	not applicable
E	error (see <i>error?</i> command)
carriage return <CR>	All pumps in the chain interpret this as a stop command.
pump address, <CR>	Pump with the specified address responds with a prompt.
pump address (optional), command, <CR>	Pump at the address executes the command and then responds with a prompt.

Note: If there are multiple pumps in the daisy chain and a pump address is not used, then all pumps will respond to the non-specific command and return prompts. Multiple prompts results in a communications breakdown.

RS232 Pump Commands and Responses

run	Starts pump running to present settings, returns prompt > or <. If already running, command is ignored.
stop	Stops pump if running, otherwise is ignored. Returns prompt :
dia nn.nn	Sets syringe diameter in millimeters n = 0 to 9
run?	Queries run status, returns prompt
del?	Queries delivered volume (requires a dispense volume to be set) Response: nn.nn u where nn.nn is ., 0 to 9 and u is units, ul or ml.
dia?	Requests present diameter setting. Response: nn.nn where n = 0 to 9 (units always millimeters).
ratei?	Queries infusion rate Response: nn.nn u/u where nn.nn is ., 0 to 9 u/u are units ul/m, ul/h, ml/m, or ml/h.
ratew?	Queries withdrawal rate Response: nn.nn u/u where nn.nn is ., 0 to 9 and u/u is rate unit.
ratei nn.nn u/u	Sets infusion rate

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	<p>where nn.nn is ., 0 to 9, and u/u are units. If no units specified, defaults to automatic setting based on syringe diameter.</p>
ratew nn.nn u/u	Sets withdrawal rate
voli nn.nn uu	<p>Sets infusion target volume where nn.nn is ., 0 to 9, and uu are units ul or ml If units not specified, defaults to automatic setting.</p>
volw nn.nn uu	<p>Sets withdrawal target volume Queries volume setting response nn.nn uu where nn.nn is ., 0 to 9 and u are units ul or ml</p>
mode i	Sets mode to infusion
mode w	Sets mode to withdrawal
mode i / w	Sets mode to infusion / withdrawal
mode w / i	Sets mode to withdrawal / infusion
mode con	<p>Sets mode to continuous Note: A dispense volume must be entered in I/W, W/I and CON modes.</p>
mode?	Query mode. Response: I, W, I/W, W/I, CON
dir rev	Changes direction of <i>running</i> pump. (If pump is not running, command is ignored.) Available only in Infusion and Withdrawal modes.
dir?	Queries direction. Response: I (infusion) or W (withdrawal). Not applicable in infusion-only models.
error?	<p>Queries for error type after E prompt. Response: 0 = No error 1 = RS232 communication error 2 = Stalled 3 = RS232 error <i>and</i> stalled 4 = Serial overrun 5 = Serial error <i>and</i> serial overrun 6 = Stall <i>and</i> serial overrun 7 = Stall <i>and</i> serial error <i>and</i> serial overrun</p>

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Queries software version
 Response: number 200.0xx or 210.0xx

OUT IN

RS232 Format

8 data bits
 No parity
 1 stop (can use 2 stops)

PC with 9-pin connector	PC with 25-pin connector
data IN pin 2	data OUT pin 2
data OUT pin 3	data IN pin 3
ground pin 5	ground pin 7

TTL SPECIFICATIONS

5 4 3 2 1
9 8 7 6

As viewed from rear of pump.

Pin	
3	Vss, ground ref
1,6	controllable output (could be used for relay or valve control — low: infusing; high: refilling)
8	footswitch falling edge starts /stops pump
4	timer control change from high to low: starts change from low to high: stops
2	directional output high: infuse; low: refill
5	undefined input or output
7	run indicator high: running; low: stopped
9	reverse direction high/low change causes pump to reverse direction
logic low	0 - 0.5V, max 2 ma current sink
logic high	2V - 5V

POWER SELECTION

The pump is equipped with an internal voltage selector switch which is set at the factory to the voltage appropriate for the destination country. The voltage setting is indicated on the serial number label found on the rear panel.

FUSE: 5x20mm, 250 VAC 0.250A (slow-blow)

MAINTENANCE

Maintenance is required only for the moving mechanical parts which should be kept clean and lubricated. Occasionally, a little light machine oil should be applied to the guide rods and a little grease or oil to the leadscrew.

Surface cleaning may be performed on the pump by using a dampened cloth, taking care that no excess cleaner be allowed to seep into the interior of the pump housing. *Do not use organic solvents.*

Table 1 SYRINGE DIAMETERS

(1) Air-Tite "All Plastic"

1cc	4.70mm
2.5	9.70
5.0	12.48
10	15.89
20	20.00
30	22.50
50	28.90

(6) Ranfac

2cc	9.12mm
5	12.34
10	14.55
20	19.86
30	23.20
50	27.60

(2) Becton Dickinson
Interim, WW design, Plastipak

1cc	4.70mm
3	8.59
5	11.99
10	14.48
20	19.05
30	21.59
60	26.60

**(7) Scientific Glass Engineering
SGE**

25ul	0.73 mm
50	1.03
100	1.46
250	2.30
500	3.26
1ml	4.61mm
2.5	7.28
5	10.30
10	14.57

(3) Becton Dickson
Glass - all types

0.5cc	4.64mm
1	4.64
2.5	8.66
5	11.86
10	14.34
20	19.13
30	22.70
60	28.60

(8) Sherwood - Monojet Plastic

1cc	4.65mm
3	0.94
6	12.70
12	15.90
20	20.40
35	23.80
50	26.60

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(4) Hamilton

1000-Series Gastight

10ul	0.46mm
25	0.78
50	1.03
100	1.46
250	2.30
500	3.26

1ml	4.61mm
2.5	7.28
5	10.30
10	14.57
25	23.03
50	32.57

(5) Popper & Sons, Inc.

Perfektum glass

0.25	3.45mm
0.5	3.45
1	4.50
2	8.92
3	8.99
5	11.70
10	14.70
20	19.58
30	22.70
50	29.00

(9) Terumo

1cc	4.73 mm
3	9.00
5	13.04
10	15.79
20	20.18
30	23.36
60	29.45

(10) Unimetrics

Series 9000

10ul	0.46mm
25	0.73
50	1.03
100	1.46
250	2.30
500	3.26
1000	4.61

Table 2 FLOW RATES

<u>Syringe size</u>	<u>Minimum</u>	<u>Maximum</u>
10 µl	0.001 µl/h	22.98 µl/min
25 µl	0.001 µl/h	60.68 µl/min
50 µl	0.001 µl/h	105.8 µl/min
100 µl	0.001 µl/h	212.6 µl/min
250 µl	0.001 µl/h	527.6 µl/min
500 µl	0.001 µl/h	1.06 ml/min
1 ml	0.001 µl/h	2.203 ml/min
2.5 ml	0.001 µl/h	5.28 ml/min
3 ml	0.001 µl/h	7.36 ml/min
5 ml	0.001 µl/h	14.33 ml/min
10 ml	0.001 µl/h	20.91 ml/min
20 ml	0.001 µl/h	36.19 ml/min
30 ml	0.001 µl/h	46.49 ml/min
60 ml	0.001 µl/h	70.57 ml/min

Note: Syringes from different manufacturers can have slightly different limits.

Warranty

WPI (World Precision Instruments, Inc.) warrants to the original purchaser that this equipment, including its components and parts, shall be free from defects in material and workmanship for a period of one year from the date of shipment. WPI's obligation under this warranty shall be limited to repair or replacement, at WPI's option, of the equipment or defective components or parts upon receipt thereof f.o.b. WPI, Sarasota, Florida U.S.A. Return of a repaired instrument shall be f.o.b. Sarasota.

The above warranty is contingent upon normal usage and does not cover products which have been modified without WPI's approval or which have been subjected to unusual physical or electrical stress or on which the original identification marks have been removed or altered. The above warranty will not apply if adjustment, repair or parts replacement is required because of accident, neglect, misuse, failure of electric power, air conditioning, humidity control, transportation, or causes other than normal and ordinary usage.

To the extent that any of its equipment is furnished by a manufacturer other than WPI, the foregoing warranty shall be applicable only to the extent of the warranty furnished by such other manufacturer. This warranty will not apply to appearance terms, such as knobs, handles, dials or the like.

The foregoing obligations set forth in this paragraph are in lieu of all obligations and liabilities, including all warranties of merchantability or otherwise, expressed or implied or statutory, and state WPI's entire and exclusive liability and purchaser's exclusive remedy for any claim of damages in connection with the sale or furnishing of all equipment, including design, suitability for use, operation, or installation. There are no warranties which extend beyond the description of the face hereof. In no event shall WPI be liable for any special or consequential damages.

Warning: This equipment is not designed or intended for use on humans.



SP200 Series Syringe Pumps

Digital Infusion/Withdrawal Syringe Pumps

INSTRUCTION MANUAL

Serial No. _____

8/95

World Precision Instruments, Inc.

International Trade Center • 175 Sarasota Center Boulevard • Sarasota FL 34240-9258 USA
Tel: 941-371-1003 • Fax: 941-377-5428 • E-mail: wpi@wpiinc.com • Internet: <http://www.wpiinc.com>

UK: Astonbury Farm Business Centre • Aston, Stevenage, Hertfordshire SG2 7EG England • Tel: 01438-880025 • Fax: 01438-880026

Germany: Liegnitzer Str. 15, D-10999 Berlin, Germany • Tel: 030-6188845 • Fax: 030-6188670

Japan: 1-4-2-702 Naka-Meguro, Meguro, Tokyo 153 Japan • Tel: 03-3220-5200 • Fax: 03-3220-5201