UltraMicroPump II

Microsyringe injector and Micro4 Controller

INSTRUCTION MANUAL

Serial No._____

0800

World Precision Instruments, Inc.

Contents

Introduction

Thank you for purchasing WPI's **UltraMicroPump II** and the microprocessor controller, **Micro4**™. This versatile injector uses microsyringes to dispenses picoliter sample volumes. Microsyringes are easily installed by placing the syringe barrel into the UltraMicroPump's clamps. UltraMicroPump accepts syringes from 0.5 µl to 1 ml.

UltraMicroPump can be useful for a wide range of applications including intracellular injection, micro delivery of biochemical agents or dyes, cell separation, *in vitro* fertilization, and can be mounted directly onto a stereotaxic frame or micromanipulator.

Operating parameters for the UltraMicroPump are set with the Micro4. Up to four pumps may be independently controlled. Operating parameters set by the user are stored in "non-volatile" memory for instant recall when the unit is powered on.

An optional footswitch can be plugged into an RS232 port on the rear of the controller for "hands free" start / stop operation. The same port may also be used to connect the controller to a computer or to some other device for TTL triggering.

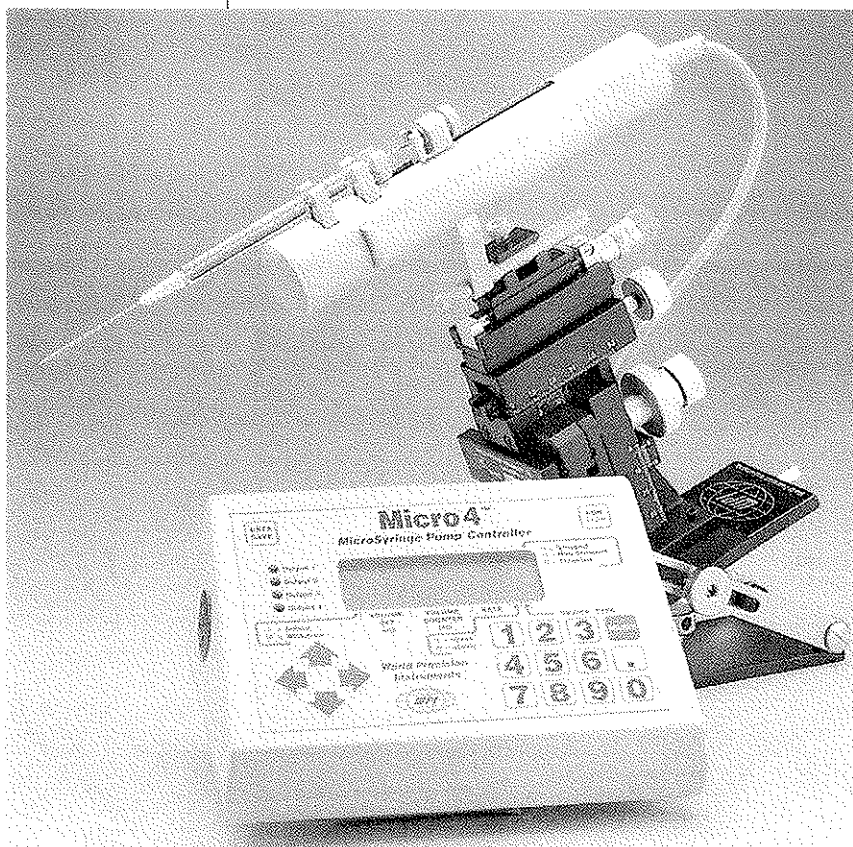*Fig. 1 — UltraMicroPump II and the Micro4 controller. The pump shown is mounted on WPI's M3301 micromanipulator (not included).*

Parts List

After unpacking, make certain that there is no visible damage to the instruments. Check to see that all items are included:

UMP2	UltraMicroPump II
UMC4	Micro4™ Controller, 4-Channel
40300	12-volt Power Supply
	Power Cable
	Instruction Manual

For a list of microsyringes available from WPI, see page 16.

Set-up and Operation

These instructions will help you put the UltraMicroPump to immediate use. We recommend that you read the entire manual and familiarize yourself with the various operating procedures of the UltraMicroPump and Micro4.

Mounting the syringe

Syringes may be filled manually before mounting in the UltraMicroPump. Place the plunger button of the filled syringe into the plunger button holder (leaving the plunger retaining screw loose) while also placing the syringe collar into the collar stop (see Fig. 2). Take care not to damage the syringe collar during this installation. Gently tighten the plunger retaining screw so that the plunger button will not move when the pump is activated (this allows for zero volume error during pump operation).
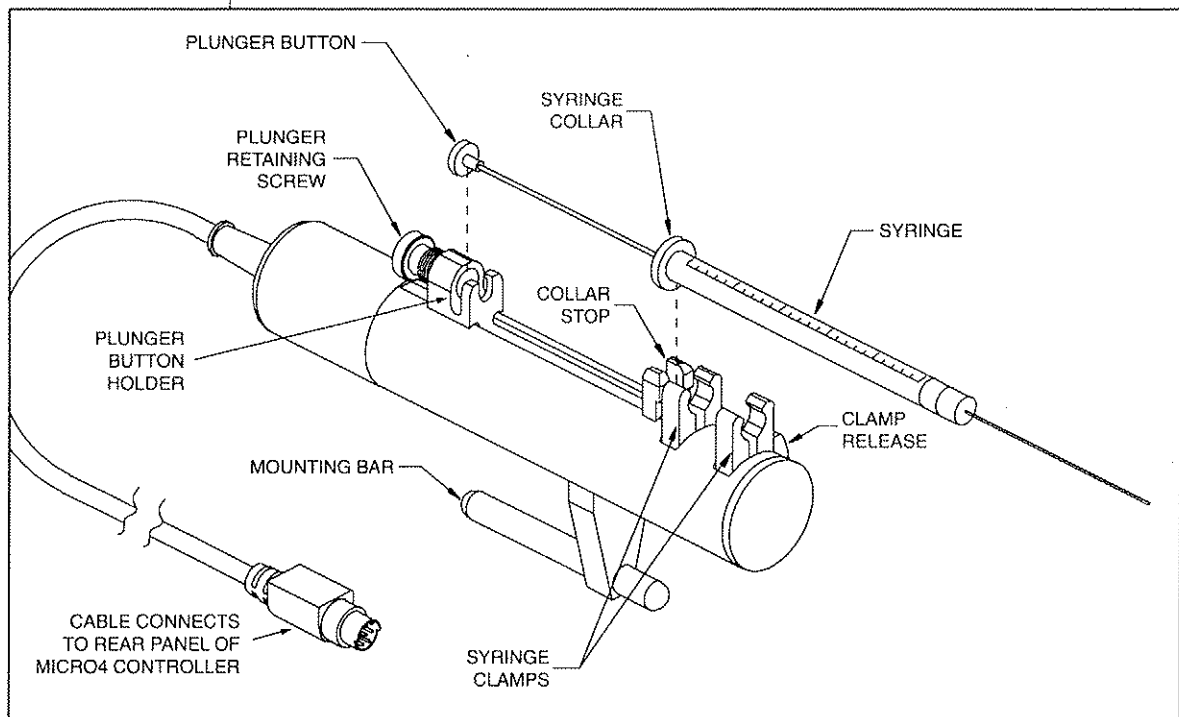

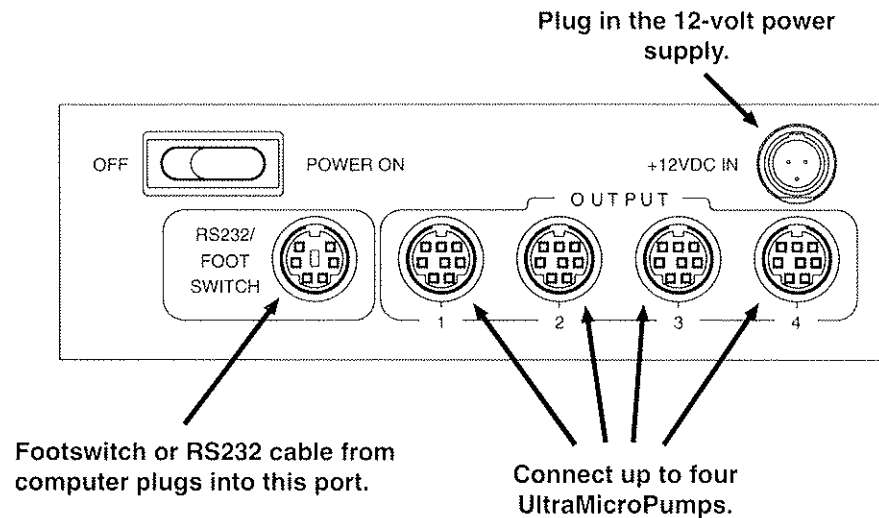*Fig. 2 — Mounting a microsyringe onto the UltraMicroPump II.*

Mount the pump

The UltraMicroPump can be mounted directly onto a stereotaxic frame or a micromanipulator, using the mounting bar (see Fig. 2). The mounting bar may be unscrewed and modified by the user, if necessary.

Connect the controller

Plug the UltraMicroPump cable into an output socket on the back of the Micro4 controller (see Fig. 3). Up to four pumps may be connected and independently controlled.

Plug in the 12-volt power supply.

Fig. 3 — Micro4 rear panel

Footswitch or RS232 cable from computer plugs into this port.

Connect up to four UltraMicroPumps.

Power up

Plug the 12-volt power supply into the rear panel of the Micro4 (see Fig. 3). The switchable power supply included with this unit automatically senses input line voltage between 100 and 240 V and converts it to 12 V. Connect the power cord to the power supply and plug it into an electrical outlet. The power switch is also located on the rear panel of the Micro4.

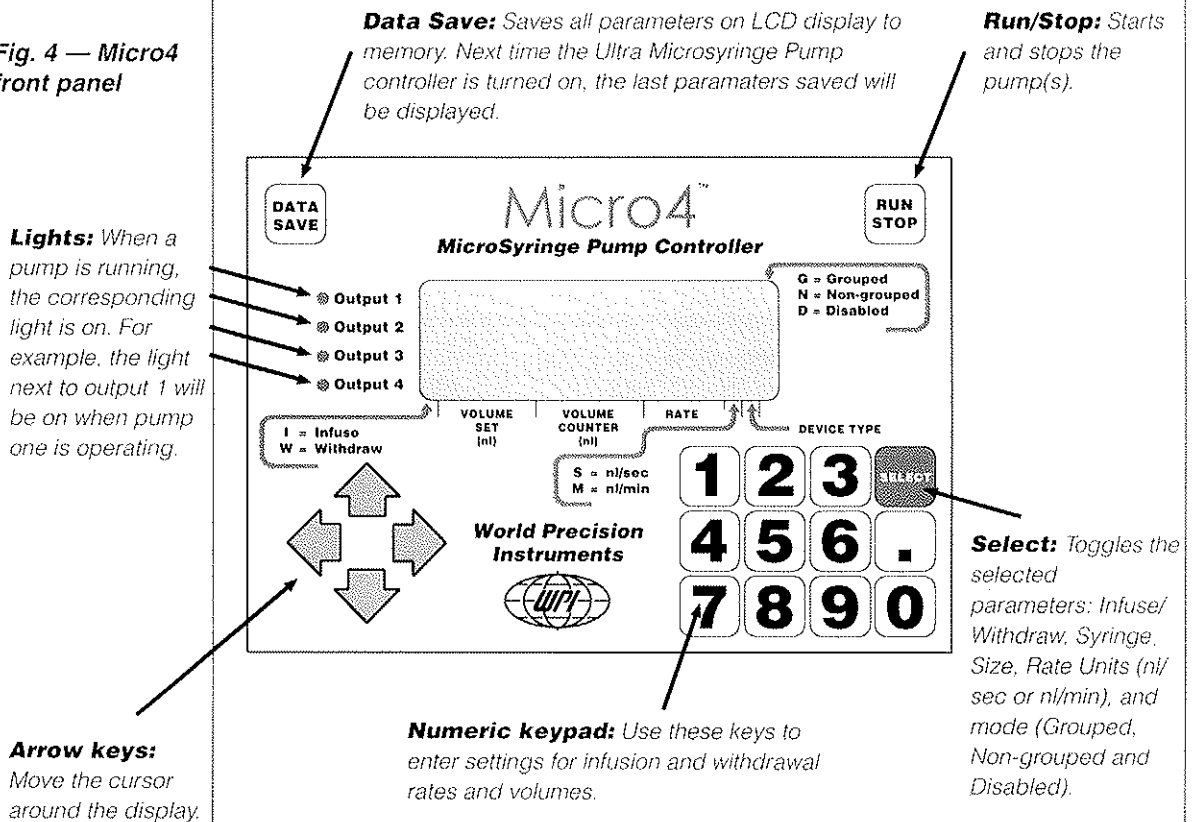Switch the Micro4 on and check that the LCD screen is illuminated.

The hardware setup is now complete. Before operating the UltraMicroPump you must enter the parameters into the Micro4 controller.

Setting Parameters

Parameters are entered using the membrane keys on the front panel of the Micro4. The **LEFT** and **RIGHT ARROW** keys move the cursor on the LCD display to the desired position. The **UP** and **DOWN ARROW** keys select the channel (corresponding to the output channels on the rear of the instrument). The **NUMBER** keys and the **SELECT** key are used to change parameters.

Fig. 4 — Micro4 front panel

Data Save: *Saves all parameters on LCD display to memory. Next time the Ultra Microsyringe Pump controller is turned on, the last paramaters saved will be displayed.*

Run/Stop: *Starts and stops the pump(s).*

Lights: *When a pump is running, the corresponding light is on. For example, the light next to output 1 will be on when pump one is operating.*

Arrow keys: *Move the cursor around the display.*

Numeric keypad: *Use these keys to enter settings for infusion and withdrawal rates and volumes.*

Select: *Toggles the selected parameters: Infuse/ Withdraw, Syringe, Size, Rate Units (nl/ sec or nl/min), and mode (Grouped, Non-grouped and Disabled).*

Setting Infuse/Withdraw

The character displayed in the first field indicates the operating mode — **I** for Infuse, **W** for Withdraw. To change modes, use the **ARROW KEYS** to position the cursor in this field, then press **SELECT**.

I = Infuse
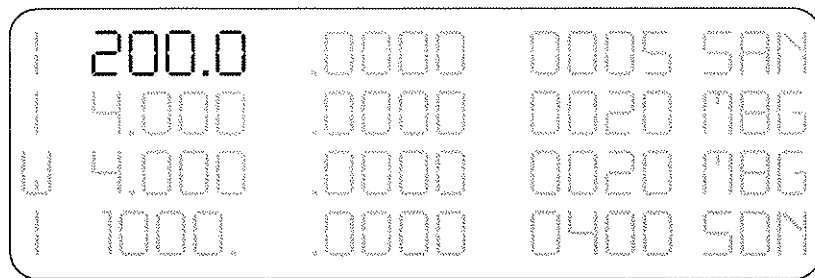**W = Withdraw**
 # = Option

In addition, the options below may be enabled or disabled when the cursor is in the Infuse/Withdraw field: position the cursor in the Infuse/Withdraw field and press the corresponding option number.

1 Disables audible tone.

2 Enables audible tone.

3 Changes the action of **RUN/STOP** key or footswitch. When this option is enabled the pump will operate as long as the **RUN/STOP** key or footswitch is pressed and stop when the **RUN/STOP** key or footswitch is released.

4 Returns **RUN/STOP** key or footswitch to normal operation.

5 Sets Volume per Step for syringe types not already preset in the Micro4's memory (see page 12).
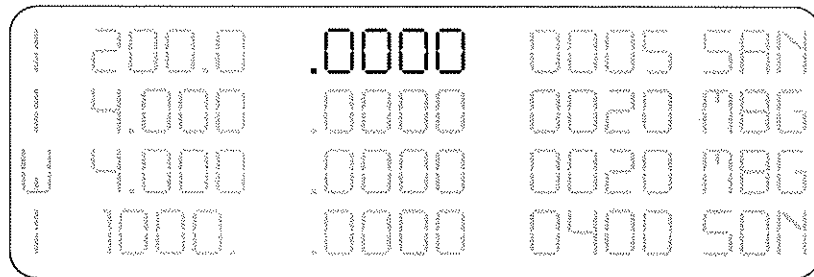
Volume Set

To select the desired volume to be infused or withdrawn, position the cursor in the volume set field and enter the numbers with the numeric keypad. The values shown on the LCD display are in nanoliters. *(Note: For 10 μl enter 10000).*

```
 |  200.0    .0000    0005 SAN
 |  4.000    .0000    0020 MBG
 U  4.000    .0000    0020 MBG
 |  1000.    .0000    0400 SON
```

**VOLUME
SET
(nl)**

Volume Counter

Real-time display of volume being delivered. When pump is not running, this number may be changed; when pump is restarted, counter will continue from the number entered.

```
 |  200.0    .0000    0005 SAN
 |  4.000    .0000    0020 MBG
 U  4.000    .0000    0020 MBG
 |  1000.    .0000    0400 SON
```
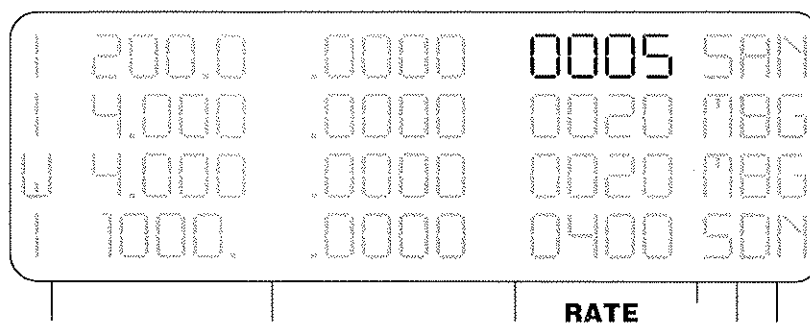
**VOLUME
COUNTER
(nl)**

Rate

To select the rate for infusion or withdrawal, position the cursor in this field and type in the desired value with the numeric keypad. If the rate entered is too large for the selected syringe type, the highest possible value will be displayed in this field. Next, select the rate units.
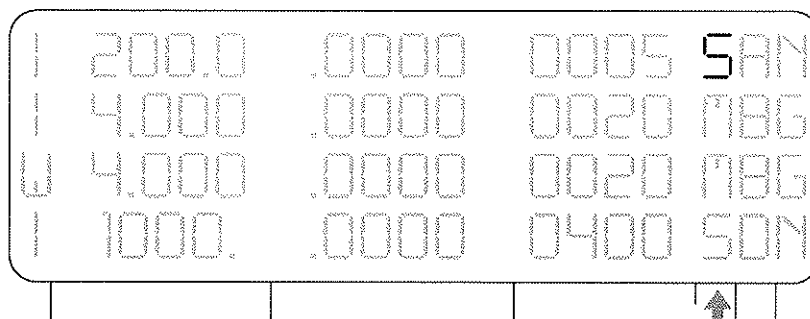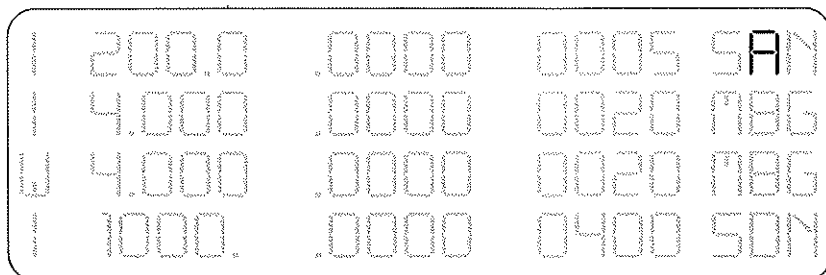
RATE

Rate Units

Two rate units are available — nanoliters per second and nanoliters per minute. Position the cursor in this field and use the **SELECT** key to choose either **S** (nl/sec) or **M** (nl/min).

S = nl/sec
M = nl/min

DEVICE TYPE

Device (syringe) Type

The volume per step and rate data for eleven microsyringes are already stored in Micro4's memory. To specify one of these syringes, position the cursor in this field and use the **SELECT** key to change the syringe type to a letter (**A** - **K**) corresponding to that of the syringe in the table below.

Predefined Syringe Settings			
Syringe Type	Syringe Volume	nl/step	Max. Rate (nl/sec)
A	0.5 μl	0.026	20
B	1.0 μl	0.052	40
C	5 μl	0.263	202
D	10 μl	0.528	406
E	25 μl	1.329	1022
F	50 μl	2.646	2035
G	100 μl	5.315	4088
H	250 μl*	13.191	9999
I	500 μl*	26.501	9999
J	1000 μl*	52.995	9999
K	Nanoliter 2000†		884
L	User defined—see appendix, page 12.		

*Not recommended for UMP2

† WPI's **Nanoliter 2000**, a nanoliter injector for the 2-70 nl range, comes with its own simple controller but may also be driven by the Micro4. For more information, enquire about WPI # **B203XV**.
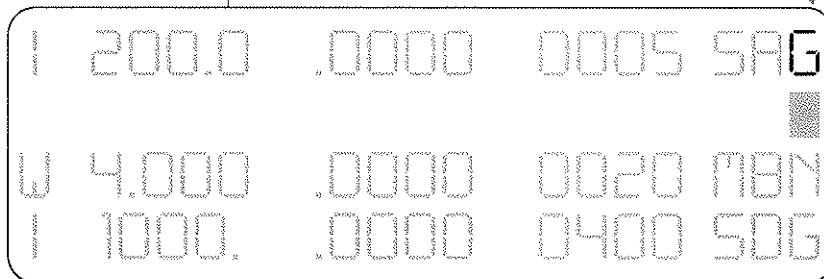
Grouped/Non-grouped/Disabled

For convenience in operating multiple pumps (whether of identical or various volumes), pumps may be grouped or non-grouped. Pressing the **SELECT** key while the cursor is in this field will toggle through three operating modes:

Grouped mode: Syringe channels with "G" in this field are started or stopped when the **RUN/STOP** key is pressed while the cursor is located on any grouped channel.

Non-grouped mode: When the cursor is positioned on a channel that is not grouped, indicated by the letter "N", *only that channel* will start or stop when the **RUN/STOP** key is pressed.

Disabled mode: When a channel is disabled, the line of data is hidden and the pump will not operate. No changes may be made to this channel while it is disabled. To re-enable it, move the cursor back to the Group/Nongroup field and press the **SELECT** key; the previously entered data will be restored.

G = Grouped
N = Non-grouped
D = Disabled
(blank)

Saving your settings

Pressing the **DATA SAVE** button will store these values into the controller's memory for future use.

UltraMicroPump/Micro4 Operation

When the pump runs, a series of beeps indicates that the pump is running. At the end of the program, the controller also beeps. A lamp on the back of the UltraMicroPump indicates a signal from the controller. As the pump runs, the counter increments as an indication of the plunger's motion. Multiple injections can be achieved by pressing the **RUN/STOP** button again after the pump has stopped.

Fast forward

RUN/STOP Press and hold the **RIGHT ARROW** key then press **RUN/STOP**. The syringe pump will continue running as long as these two keys are depressed.

Fast reverse

RUN/STOP Press and hold the **LEFT ARROW** key then press **RUN/STOP**. The syringe pump will continue running as long as these two keys are depressed.

In fast forward and fast reverse modes the delivery rate is set to maximum.

Typically, a microsyringe has a ± 3% error in volume. It is best if a syringe is chosen to reflect the volumes being injected. A 10 µl syringe would be used for volumes in the 1- 10 µl range where a 25 µl or a 100 µl syringe would be inappropriate due to this error.

Defining Other Syringes

Eleven microsyringes with volumes ranging from 0.5 µl to 1000 µl are already preset in the Micro4 (syringe types **A** through **K** — see table on page 9). A microsyringe with a volume other than those preset may be entered as device type **L**. However, the Volume per Step of the type L syringe must be defined for the Micro4.

First, calculate the Volume per Step using the formula below. Syringe displacement is the distance between 0 and the maximum volume marked on the syringe in inches. Syringe volume is in nanoliters.

$$\text{Volume per Step} = \frac{\text{Syringe Volume}}{\text{Syringe Displacement}} \times 0.000125 \text{ in. } (3.175 \times 10^{-3} \text{ mm})$$

For example, if you have a syringe with a 2.5 µl volume, use the formula above to determine its Volume per Step. Move the cursor to the Volume Set field of output channel 1 and enter the calculated value (in this case, 0.1329 nl):
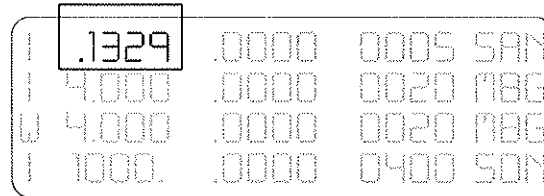
Then use the **LEFT ARROW** key to scroll the cursor to the first position on the LCD display and press **5**. This sets your calculated definition for your type **L** syringe into the Micro4's memory.
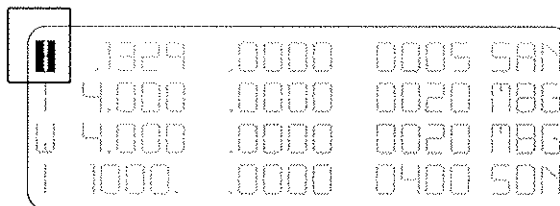
Note that this does not yet affect the action of any channel since **L** has not been entered as device type for any channel. Before proceeding, move the cursor back to the Volume Set field and re-enter the correct volume for the syringe on output channel 1 (which may be any type — not necessarily type L).

After defining your syringe in Micro4's memory, move the cursor to the Device Type field of the output channel to which that pump is connected and press **SELECT** until **L** appears.

Any number of channels may use type **L** syringes, but since a single definition for type **L** is stored in Micro4 all **L** devices must be identical. (That is, you cannot use two non-standard types, such as 2.5 µl and 0.25 µl.)

The minimum delivered volume depends on the syringe size and is listed in the syringe type table under Volume per Step. The actual volume delivered is divisible by the volume per step. For example, using a syringe with a Volume per Step of 1 nl, actual delivered volume for the given set volume is listed below.

Volume Set	Actual volume delivered
0-0.9999 nl	0
1 nl-1.999 nl	1 nl
2 nl-2.999 nl	2 nl
and so on...	

Computer Control

RS232 commands are used to control the Micro4 via the serial port of a PC or Macintosh computer.

RS232 Commands

All commands are case sensitive. The settings for the RS232 port are baud rate 9600, 8 data bits, 1 start bit, 1 stop bit. Numbers and decimal points are indicated below by the "#" symbol.

V######; Sets the delivered volume. Number must have a decimal point.
C######; Sets the volume counter. Number must have a decimal point.
R####; Sets the delivery rate. Number must have a decimal point.
I Infuse mode.
W Withdraw mode.
G Go — Starts the syringe pump.
H Halt — Stops the syringe pump.
S Sets the rate units to nanoliters/second.
M Sets the rate units to nanoliters/minute.
L#; Line number — sets the syringe number on display (Micro4 only).
N Not Grouped mode.
P Grouped mode.
D Disabled mode.
Tx Syringe Type. The letter indicating syringe type follows the T. For example, to select syringe type "A" the command is "TA".

Query Commands

All query commands begin with a question mark. Below is a list of the query commands.

?V Returns the set volume.

?C Returns the volume counter

?R Returns the delivery rate

?M Returns a G for grouped mode, N for nongrouped mode, and D for disabled mode.

?S Returns the letter of the syringe type.

?D Returns the syringe pump direction: I=infuse, W=Withdraw.

?U Returns the rate units: S=nl/second, M=nl/minute.

?G Returns a R if pump is running, S if pump is stopped.

Footswitch Connections

Since the footswitch produces Run and Stop signals by connecting +5 volts (from pin 4) to pin 6, this port may also be used for TTL signals from other sources.

RS232 Cable Pinouts

To control the Micro4 by computer, the RS232 cable must be configured as shown here:

From Micro4 6-pin mini-DIN	To 9-pin DSUB connector	To 25-pin DSUB connector
pin 1: ground	pin 5: ground	pin 7: ground
pin 2: UMC data in	pin 3: PC data out	pin 2: PC data out
pin 5: UMC data out	pin 2: PC data in	pin 3: PC data in

Mini-DIN connector on rear panel of Micro4 controller
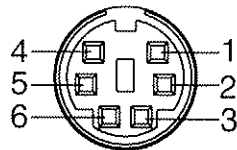
Micro4 cable with 9-pin connector is WPI **#40500**.

Syringes

UltraMicroPump II is designed to be used with glass syringes having barrel diameters from 5.5 mm to 9 mm. WPI stocks the following syringes (with replaceable beveled needles):

*H = Hamilton

15861	0.5 µl Glass Microsyringe, 25 ga. needle (H)*
15862	1.0 µl Glass Microsyringe, 25 ga. needle (H)*
15863	5 µl Glass Microsyringe, 24 ga. needle (H)*
15942	10 µl Glass Microsyringe, 26 ga. needle (H)*

The capacity of the above syringes is so small that the entire sample is contained within the needle. The plunger extends to the tip of the needle, displacing the full sample during injection — giving the syringe zero dead volume.

†S = SGE

15864	25 µl Glass Microsyringe, 22 ga. needle (H)*
SGE010RN	10 µl 26 ga. 50mm needle (S)†
SGE025RN	25 µl 25 ga. 50mm needle (S)†
SGE050RN	50 µl Glass Microsyringe, 25 ga. needle (S)†
SGE100RN	100 µl Glass Microsyringe, 25 ga. needle (S)†

Syringes with luer fitting (no needle)

14392	10 µl Glass Microsyringe, Luer Tip Fitting (H)*
15930	25 µl Glass Microsyringe, Luer Tip Fitting (H)*
15895	50 µl Glass Microsyringe, Luer Lock Fitting (H)*
15896	100 µl Glass Microsyringe, Luer Lock Fitting (H)*
SGE250TLL	250 µl Glass Microsyringe, Teflon Luer Lock Fitting (S)†
SGE500TLL	500 µl Glass Microsyringe, Teflon Lock Fitting (S)†
SGE1000TLL	1 ml Glass Microsyringe, Teflon Lock Fitting (S)†

Replacement needles

15935	For Syringe #15861 (25 ga., 7 cm long)
15936	For Syringe #15862 (25 ga., 7 cm long)
15937	For Syringe #15863 (24 ga., 7 cm long)
15938	For Syringes #15864, #15865, #15866 (22 ga., 51 mm, pkg of 3)
15943	For Syringe #15942 (26 ga., 51 mm, pkg of 3)
RN0005	For Syringe SGE0005RN, 23 ga. (0.63 mm) 70 mm long
RN001	For Syringe SGE001RN, 26 ga. (0.47 mm cone) 70 mm long
RN010	For Syringe SGE010RN, 26 ga. (0.63 mm) 50 mm long, 5-pack
RN025	For Syringe SGE025RN, 25 ga. (0.63 mm) 50 mm long, 5-pack
RN025	For Syringe SGE050RN, 25 ga. (0.63 mm) 50 mm long, 5-pack
RN025	For Syringe SGE100RN, 25 ga. (0.63 mm) 50 mm long, 5-pack

Hamilton is a trademark of Hamilton Co. SGE is a trademark of Scientific Glass Engineering.

General Maintenance

UltraMicroPump requires minimal maintenance; regular laboratory cleaning will keep this instrument in optimum operating condition. *Do not apply solvents or oils to any part of the UltraMicroPump.*

This instrument is not autoclavable.

Always hold UltraMicroPump by the main body or mounting bar. *Do not swing or carry the UltraMicroPump by its cable.*

Specifications

UltraMicroPump II

Total Number of Steps (end to end)	19,000
Dispensing Volume	0.0526 nl/step
Linear Motion	3.2 μ/step
Linear displacement per half step	3.175 μm (0.000125 in.)
Maximum step rate	700/sec (depends on syringe selected)
Weight	325 grams (11.4 oz.)
Size	Ø 32 mm x 190 mm (Ø 1.3 in. x 7.5 in.)
Power Requirements	12 VDC 2 amps, provided by Micro4

Micro4 Controller

Power Requirements	12 V (1.6 A)
Dimensions	12.7 x 15.2 x 8.9 cm (5 x 6 x 3.5 in.)
Power Requirements	12 VDC from auto-switchable power supply (100-240 VAC input)

References

S.B. Mazzone, D.P. Geraghty "Respiratory actions of tachykinins in the nucleus of the solitary tract: effect of neonatal capsaicin pretreatment" (2000) *British Journal of Pharmacology* **129**:6 pp1132-1139.

B.L. Davidson, C.S. Stein, J.A. Heth, I. Martins, R.M. Kotin, T.A. Derksen, J. Zabner, A. Ghodsi, J.A. Chiorini "Recombinant adeno-associated virus type 2, 4, and 5 vectors: Transduction of variant cell types and regions in the mammalian central nervous system" (2000) *Proceedings of the National Academy of Sciences of the United States of America* **97**:7 pp3428-3432.

A.I. Brooks, et al. "Reproduciable and Efficient Murine CNS Gene Delivery Using a Microprocessor Controlled Injector" (1998) *Journal of Neuroscience Methods* **80** pp 137-147.

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 receipt. 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, 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.

WPI makes no warranty of any kind, express or implied or statutory, including without limitation any warranties of merchantability and/or fitness for a particular purpose. WPI shall not be liable for any damages, whether direct, indirect, special or consequential arising from a failure of this product to operate in the manner desired by the user. WPI shall not be liable for any damage to data or property that may be caused directly or indirectly by use of this product.

Claims and Returns

Inspect all shipments upon receipt. Missing cartons or obvious damage to cartons should be noted on the delivery receipt before signing. Concealed loss or damage should be reported at once to the carrier and an inspection requested. All claims for shortage or damage must be made within ten (10) days after receipt of shipment. Claims for lost shipments must be made within thirty (30) days of receipt of invoice or other notification of shipment. Please save damaged or pilfered cartons until claim is settled. In some instances, photographic documentation may be required. Some items are time-sensitive; WPI assumes no extended warranty or any liability for use beyond the date specified on the container.

Do not return any goods to us without obtaining prior approval and instructions from our Service Department. Goods returned (unauthorized) by collect freight may be refused. Goods accepted for restocking will be exchanged or credited to your WPI account. Goods returned which were ordered by customers in error are subject to a 25% restocking charge. Equipment which was built as a special order cannot be returned.

Repairs

Electrodes, batteries and other consumable parts are warranted for 30 days only from the date on which the customer receives these items.

Contact our Service Department for assistance in the repair of apparatus. Do not return goods until instructions have been received. Returned items must be securely packed to prevent further damage in transit. The Customer is responsible for paying shipping expenses, including adequate insurance on all items returned for repairs. Identification of the item(s) by model number, name, as well as complete description of the difficulties experienced should be written on the repair purchase order and on a tag attached to the item.

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

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DECLARATION OF CONFORMITY

We:

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USA

as the manufacturers of the apparatus listed, declare under sole responsibility that the product(s):

Title: UMPII

to which this declaration relates is/are in conformity with the following standards or other normative documents:

Safety:	EN 61010-1:1993 (IEC 1010-1:1990)
EMC:	EN 50081-1:1992
	EN 50082-1:1992

and therefore conform(s) with the protection requirements of Council Directive 89/336/EEC relating to electromagnetic compatibility and Council Directive 73/23/EEC relating to safety requirements.

Issued on: 18th February 2000

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DECLARATION OF CONFORMITY

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USA

as the manufacturers of the apparatus listed, declare under sole responsibility that the product(s):
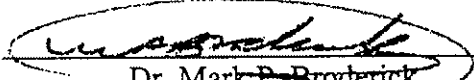
Title: UMC4

to which this declaration relates is/are in conformity with the following standards or other normative documents:

Safety: EN 61010-1:1993 (IEC 1010-1:1990)
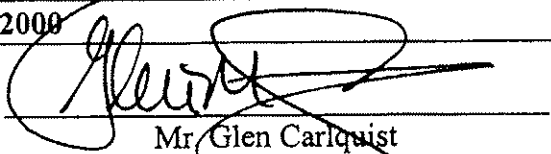
EMC: EN 50081-1:1992
            EN 50082-1:1992

and therefore conform(s) with the protection requirements of Council Directive 89/336/EEC relating to electromagnetic compatibility and Council Directive 73/23/EEC relating to safety requirements.

Issued on: 18ᵗʰ February 2000

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