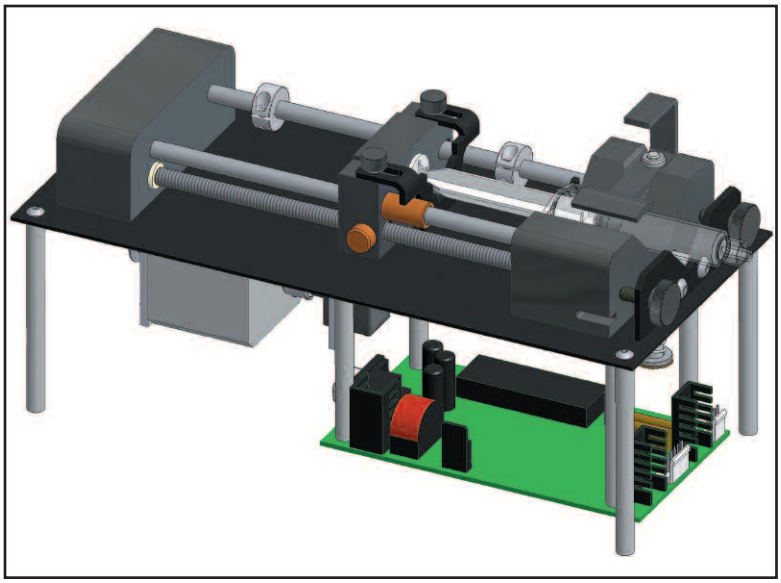
Milliliter Flow M.P.C.

Modular Pumping Component

User's Manual

MA1 70-2203



HARVARD
APPARATUS

Publication 5415-002-REV-B

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WEEE/RoHS Compliance Statement

EU Directives WEEE and RoHS

To Our Valued Customers:

We are committed to being a good corporate citizen. As part of that commitment, we strive to maintain an environmentally conscious manufacturing operation. The European Union (EU) has enacted two Directives, the first on product recycling (Waste Electrical and Electronic Equipment, WEEE) and the second limiting the use of certain substances (Restriction on the use of Hazardous Substances, RoHS). Over time, these Directives will be implemented in the national laws of each EU Member State.

Once the final national regulations have been put into place, recycling will be offered for our products which are within the scope of the WEEE Directive. Products falling under the scope of the WEEE Directive available for sale after August 13, 2005 will be identified with a "wheelie bin" symbol.

Two Categories of products covered by the WEEE Directive are currently exempt from the RoHS Directive – Category 8, medical devices (with the exception of implanted or infected products) and Category 9, monitoring and control instruments. Most of our products fall into either Category 8 or 9 and are currently exempt from the RoHS Directive. We will continue to monitor the application of the RoHS Directive to its products and will comply with any changes as they apply.

- **Do Not Dispose Product with Municipal Waste**
- **Special Collection/Disposal Required**

Table of Contents

Serial Number
All inquires concerning our product should refer to the serial number of the unit. Serial numbers are located on the underside of the mounting plate.

Calibration
All syringe pumps are designed and manufactured to meet their performance specifications at all rated voltages and frequencies.

Warranty
Harvard Apparatus warranties this instrument for a period of two years from date of purchase. At its option, Harvard Apparatus will repair or replace the unit if it is found to be defective as to workmanship or material.

This warranty does not extend to damage resulting from misuse, neglect or abuse, normal wear and tear, or accident.

This warranty extends only to the original customer purchaser.

IN NO EVENT SHALL HARVARD APPARATUS BE LIABLE FOR INCIDENTAL OR CONSEQUENTIAL DAMAGES. Some states do not allow exclusion or limitation of incidental or consequential damages so the above limitation or exclusion may not apply to you. **THERE ARE NO IMPLIED WARRANTIES OF MERCHANTABILITY, OR FITNESS FOR A PARTICULAR USE, OR OF ANY OTHER NATURE.** Some states do not allow this limitation on an implied warranty, so the above limitation may not apply to you.

If a defect arises within the two-year warranty period, promptly contact ***Harvard Apparatus, Inc. 84 October Hill Road, Holliston, Massachusetts 01746-1388*** using our toll free number 1-800-272-2775. Outside the U.S. call 508-893-8999. Goods will not be accepted for return unless an RMA (returned materials authorization) number has been issued by our customer service department. The customer is responsible for shipping charges. Please allow a reasonable period of time for completion of repairs, replacement and return. If the unit is replaced, the replacement unit is covered only for the remainder of the original warranty period dating from the purchase of the original device.

This warranty gives you specific rights, and you may also have other rights which vary from state to state.

Repair Facilities and Parts
Harvard Apparatus stocks replacement and repair parts. When ordering, please describe parts as completely as possible, preferably using our part numbers. If practical, enclose a sample or drawing. We offer a complete reconditioning service.

CAUTION:
This pump is not registered with the FDA and is not for clinical use on human or veterinary patients. It is intended for research use only.

CAUTION
FOR RESEARCH USE ONLY
NOT FOR CLINICAL USE ON PATIENTS

General Safety Summary

Please read the following safety precautions to ensure proper use of your modular syringe pump. To avoid potential hazards and product damage, use this product only as instructed in this manual. If the equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

To Prevent Hazard or Injury:

Use Appropriate Power Supply

Use only an SELV approved power supply. Be sure to observe proper polarity of connections when hooking up DC supply voltage.

CAUTION: FAILURE TO MAINTAIN POLARITY MAY RESULT IN DAMAGE TO THE UNIT AND WILL VOID THE WARRANTY.

24 Vdc positive–PIN 5 of 9 Pin D-Sub
24 Vdc return–PIN 1 of 9 Pin D-Sub

(see input connections diagram)

Ground the Product

This product is grounded through a ground stud located on the under side of the base plate. To avoid electric shock, the grounding conductor must be connected to earth ground. Before making any connections to the input or output terminals of the product, ensure that the product is properly grounded.

Make Proper Connections

Make sure all connections are made properly and securely. Any signal wire connections to the unit must be no longer than 3 meters.

Avoid Contact with Heatsinks:

Some components normally operate at temperatures exceeding 70 deg C. To avoid injury, do not touch any heatsinks.

Observe all Terminal Ratings

Review the operating manual to learn the ratings on all connections.

Avoid Exposed Circuitry

Do not touch any electronic circuitry inside of the product.

Do Not Operate with Suspected Failures

If damage is suspected on or to the product do not operate the product. Contact qualified service personnel to perform inspection.

Place Product in Proper Environment

Enviromental Conditions:

- Indoor use only
- Temperature 4˚C to 40˚C (40˚F to 104˚F)
- Humidity 20% to 80% RH
- Well Ventilated Room
- Altitude up to 2000 m
- DC Voltage Fluctuation not to Exceed +/- 10% of Nominal
- Transient Overvoltage Category II
- Pump is Rated Pollution Degree 2 in Accordance with IEC 664

Observe all Warning Labels on Product

Read all labels on product to ensure proper usage.

CAUTION
Refer to Manual

Protective Ground
Terminal

Pinch
Hazard

Caution:
Hot
Surface

Caution:
ESD Sensitive
Device

Theory of Operation:

The new "ml" Modular Pumping Component is designed as a low cost, highly precise, single syringe infusion pump module capable of low to moderate back pressures. The module includes a mechanism, hardware and software and requires the addition of a power supply and user interface.

A dual "ml" Modular Pumping Component version can be produced upon customer request. Typically, the "ml" Modular Pumping Component holds one syringe of any make, from 0.5 µl to 60ml. The diameter of the syringe(s) is entered via your PC or other controller, and the internal microprocessor drives a precision stepper motor to produce accurate fluid flow. This unit is designed to operate inside an appropriately rated fire/electrical/mechanical enclosure or cabinet. The board may be removed for "remote" operation.

Features:

Two Modes of Operation:
Constant Flow Rate and Volume Dispense

The "ml" Modular Pumping Component will operate continuously in RATE mode, or accurately dispense a specific amount of fluid in VOLUME mode. When starting the pump, RATE mode will be the default mode. To operate in Volume mode, set a target volume and the pump will change modes to suit desired operation.

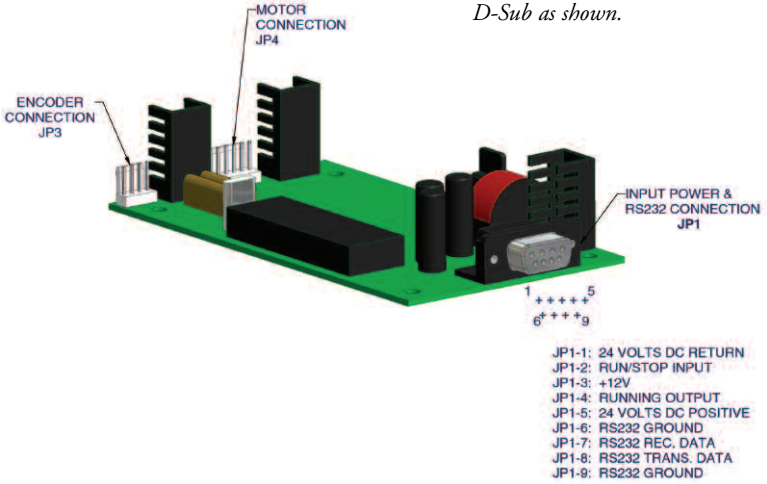
Smooth Flow

New micro-stepping pump profiles deliver very smooth and consistent flow.

CE Mark Approved

The modular pump meets all relevant European safety requirements for laboratory equipment when used in accordance with guidlines outlined in this manual.

RS-232 connection is thru 9 pin D-Sub as shown.



Defaults Settings:

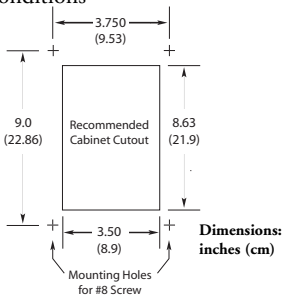
Dia: 4.61mm=1ml **Rate:** 1.0ml/hr. **Baud:** 9600
Address: 00 **Mode:** RATE

Packing List

1) Main Unit
2) 6 ft. motor/encoder extension cable
3) 6 ft. RS-232/DC power extension cable
4) 6 oz. jar of lubricant

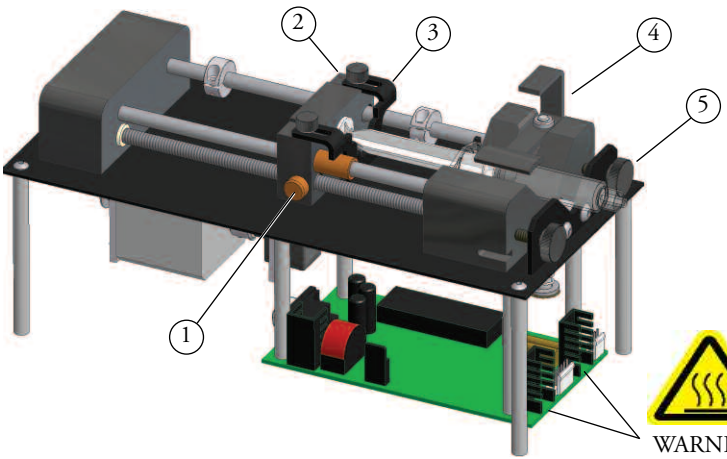
Location Requirements for the Syringe Pump

- A sturdy, level, clean and dry surface
- Minimum of one inch (2cm) clearance around the pump
- Appropriate environmental conditions
- Mount into an appropriately rated enclosure or cabinet



Loading the Syringe

1. Release the syringe pusher (2) by pressing the bronze button (1) on the side of the pusher.
2. While holding the bronze button 'in', slide the pusher to the left.
3. Raise the spring loaded syringe retainer (4) and swing it out of the way.
4. Lay the loaded syringe in the 'V' shaped holder.
5. Swing the retainer so it holds the syringe in place.
6. Move the pusher so it makes contact with the syringe plunger.
7. Adjust pusher block bracket (3) & Syringe retainer knobs (5) to capture plunger & body of syringe.



Getting started

Plug one end of the 6 ft. Power/RS232 extension cable supplied into (JP1) connection on board. Then plug the other end of the cable into your power supply and PC *(not included)*.
Refer to page 6 of this manual to reference the board connections.

Working with the pump

The safest way to use the "ml" Modular Pumping Component is in the volume dispense mode. The pump will automatically stop when target volume is dispensed.

Check Syringe Often

The "ml" Modular Pumping Component will shut itself off when the syringe is empty or is otherwise overloaded. Although this presents no hazard to the user or the pump, it is prudent to check the syringe from time to time.

Maintenance

Keep the 'ml' Modular Pumping Component clean and dry. Avoid liquid spills that may find their way into the electronics.

A small container of grease is provided for periodic lubrication of the lead screw. It is important to keep the leadscrew clean and lubricated.

To clean the exterior surfaces above the baseplate, use a lint-free cloth to remove loose dust. For more efficient cleaning, use a soft cloth dampened with water or an aqueous solution of 75% isopropyl alcohol.

If the pump does not work properly, contact Harvard Apparatus for appropriate instructions.

Protecting Small, Fragile Syringes

The 'ml' Modular Pumping Component will hold microliter size syringes down to 0.5µl size. These small syringes have fine wire plungers that may be damaged if allowed to bottom out. The 'ml' Modular Pumping Component is equipped with an adjustable stop collar on one of the guide rods. Use the provided hex wrench to position and lock the stop collar to prevent damage to small syringes.

*Remote Control Via The RS-232 Interface Using HYPERTERMINAL**

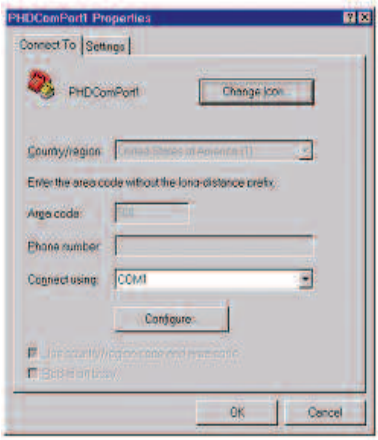
* Normally included with most Windows® operating systems.

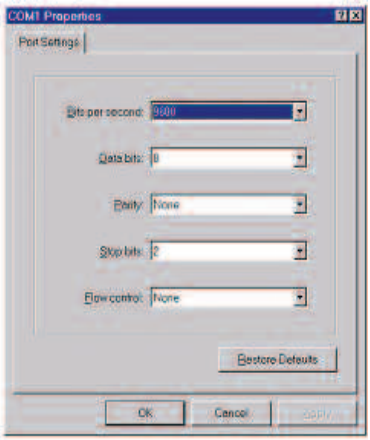
"ml" Modular Pumping Component

1. *Connect the Power/RS-232 cable (supplied) between the "ml" Modular Pumping Component RS-232 IN port and a PC's serial port.*

2. *On the PC (running a Microsoft Windows Operating System), select START – PROGRAMS – ACCESSORIES – HYPERTERMINAL – HYPERTERMINAL to start the Hyperterminal application. If Hyperterminal is not available, install it from the Microsoft Windows Operating System Install disks or CD ROM.*

3. *Set up the appropriate COMPORT for the following:*



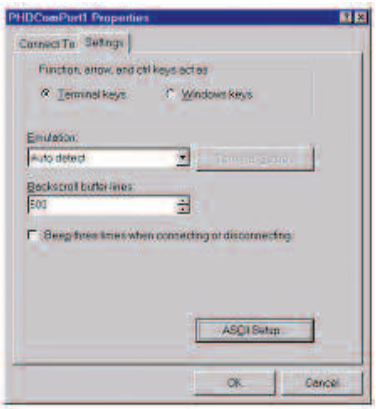


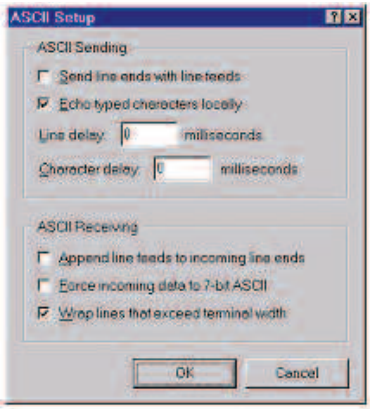
Configure:

Baud Rate :	9600
Data Bits:	8
Parity:	None
Stop Bits:	2
Flow Cntrl:	None
Emulation:	Auto Detect

ASCII Setup:

Echo typed characters locally.
Line delay: 0
Character delay: 0
Wrap lines.





You may want to save the setup information under a descriptive filename.

4. *At the PC, launch hyperterminal with the above setup specifications (if it is not already running). Type* ***VER*** *at the PC keyboard and verify that the pump module's version is displayed at the PC terminal.*

5. Type **RUN** to start the pump; type **STP** to stop the pump. After starting the pump, **0>** should be displayed, indicating address 0 pump is infusing. After stopping the pump, **0*** should be displayed.

"ml" Modular Pumping Component

Specifications:

	Accuracy:	±0.5%
	Reproducibility:	±0.1%
	Syringe Sizes:	0.5mL (min), 50/60 mL B-D Plastic (max)
Flow Rate:	Min.:	0.0014mL/hr (w/ 0.5mL syringe)
	Max.:	26.56mL/min (w/ 1mL syringe)
Linear Force:	25lbs (peak)	
Drive:	Motor:	0.9° Stepper
	Control:	L/R Drive, 0.75A per phase, micro stepping
	Drive Ratio:	2.4:1
Step Rate:	Min:	6.8 sec/step
	Max:	416.7 msec/step
Pusher Travel Rate:	Min:	2.9068 mm/min
	Max:	47.6 mm/min
Display:	None	
Keypad:	None	
Interface:	RS-232	
Connectors:	RS-232/Power: 9-pin D-sub	
Power:	+15 to +40VDC, 12W min. * use only a SELV approved Power Supply	
Dimensions:	9.50" X 4.25" X 5.30" (L X W X H) 24.1cm X 10.8cm X 13.5cm	
Mounting Dimensions:	9.00" X 3.75" (Mounting holes for 4 #8 screws) 22.9cm X 9.5cm	
Weight:	2.8 lbs (1.27kg)	
Environmental:		
	Operating Temp:	0 to +35°C (natural convection cooling)**
	Storage Temp:	-20 to +70°C
	Humidity:	20% to 80% RH non-condensing

** Note: Operating temperture range may be extended with forced air cooling.

Appendix B: Syringe Inside Diameter

Terumo

Size	Diameter
3 cc	8.95 mm
5	13.00
10	15.80
20	20.15
30	23.10
60	29.10

Sherwood–Monoject Plastic

Size	Diameter
1 cc	4.65 mm
3	8.94
6	12.70
12	15.90
20	20.40
35	23.80
60	26.60
140	38.40

Popper & Sons, Inc. "Perfektum" Glass

Size	Diameter
0.25 cc	3.45 mm
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
100	35.70

Stainless Steel

Size	Diameter
8 cc	9.525 mm
20 cc	19.130
50 cc	28.600
100 cc	34.900

Becton Dickinson Plastic "Plasticpak"

Size	Diameter
1 cc	4.78 mm
3	8.66
5	12.06
10	14.50
20	19.13
30	21.70
50/60	26.70

Air–Tite "All Plastic"

Size	Diameter
2.5 cc	9.60 mm
5.0	12.45
10	15.90
20	20.05
30	22.50
50	29.00

Unimetrics Series 4000 & 5000

Size	Diameter
10 µl	0.46 mm
25	0.729
50	1.031
100	1.460
250	2.300
500	3.260
1000	4.610

SGE Scientific Glass Engineering

Size	Diameter
25 µl	0.73 mm
50	1.03
100	1.46
250	2.30
500	3.26
1.0 ml	4.61 mm
2.5	7.28
5	10.30
10	14.57

Hamilton–Microliter Series Gastight

Size	Diameter
.5 µl	0.103 mm
1	0.1457
2	0.206
5	0.3257
10	0.460
25	0.729
50	1.031
100	1.46
250	2.3
500	3.26
1.0 ml	4.61 mm
2.5	7.28
5	10.3
10	14.57
25	23.0
50	32.6

Appendix C: Flow Rates

Harvard Apparatus "ml" Modular Pumping Component

nominal syringe size	nominal diameter (mm)	µl/hr		µl/min		ml/hr		ml/min	
		min	max	min	max	min	max	min	max
Min	**0.10**	0.0014	22.35	0.0001	0.3725	0.0001	0.0223	0.0001	0.0003
1 µl	**0.15**	0.0031	50.29	0.0001	0.8383	0.0001	0.0502	0.0001	0.0008
2 µl	**0.21**	0.0061	98.58	0.0002	1.6430	0.0001	0.0985	0.0001	0.0016
5 µl	**0.33**	0.0149	243.4	0.0003	4.057	0.0001	0.2434	0.0001	0.0040
10 µl	**0.46**	0.0289	473.0	0.0005	7.883	0.0001	0.4730	0.0001	0.0078
25 µl	**0.73**	0.0728	1,191	0.0013	19.85	0.0001	1.191	0.0001	0.0198
50 µl	**1.03**	0.1448	2,371	0.0025	39.52	0.0002	2.371	0.0001	0.0395
100 µl	**1.46**	0.2909	4,765	0.0049	79.41	0.0003	4.765	0.0001	0.0794
250 µl	**2.30**	0.7218	9,999	0.0121	197.0	0.0008	11.82	0.0001	0.1970
1,000 µl	**3.26**	1.451	9,999	0.0242	395.7	0.0015	23.75	0.0001	0.3959
1 ml	**4.61**	2.900	9,999	0.0484	791.8	0.0029	47.50	0.0001	0.7918
2.5 ml	**7.28**	7.232	9,999	0.1206	1,974	0.0073	118.4	0.0002	1.974
3 ml	**8.66**	10.24	9,999	0.1706	2,794	0.0103	167.6	0.0002	2.794
5 ml	**10.30**	14.50	9,999	0.2413	3,952	0.0145	237.1	0.0003	3.952
10 ml	**14.57**	28.97	9,999	0.4828	7,909	0.0290	474.5	0.0005	7.909
20 ml	**20.05**	54.86	9,999	0.9142	9,999	0.0549	898.6	0.0010	14.97
30 ml	**23.10**	72.81	9,999	1.214	9,999	0.0729	1,192	0.0013	19.88
50 ml	**26.70**	97.27	9,999	1.622	9,999	0.0973	1,576	0.0017	26.56
Max	**35.00**	**167.2**	**9,999**	**2.786**	**9,999**	**0.1672**	**2,738**	**0.0028**	**45.64**

Commands, Queries and Responses

After each transmission to the pump terminating with a CR character (ASCII 13), the pump enters remote mode and responds with the three character sequence:

CR LF ***prompt***

The prompt character indicates the status of the pump as follows:

prompt	**meaning**	**ASCII code**
:	When stopped	(ASCII 58 decimal)
>	When running forward	(ASCII 62 decimal)
*	When stalled	(ASCII 42 decimal)

Serial commands and their meanings:

Commands:

KEY	Return to keyboard control. Exit remote mode
RUN	Start infuse (forward direction)
STP	Stop motor
CLV	Clears volume accumulator to zero
CLT	Clears target volume to zero, dispense disabled
REV	Reverses pumping direction

Commands with numbers:

MMD	number	Set syringe diameter, units are mm. Rate is set to zero after MMD command.
ULM	number	Set flow rate and range, units are microliters per minute
MLM	number	Set flow rate and range, units are milliliters per minute
ULH	number	Set flow rate and range, units are microliters per hour
MLH	number	Set flow rate and range, units are milliliters per hour
MLT	number	Set target infusion volume, units are ml or µl depending on range

Numbers can be between 0 and 1999.

Leading zeros and trailing decimal point are optional. Any number of digits to the right of the decimal point may be transmitted. The number will be rounded.

Queries:

DIA Returns diameter value units in mm

RAT Returns rate value set in current range units

VOL Returns current accumulated infused volume, units in ml or µl depending on range

VER Returns model and version number of firmware

TAR Returns target volume, units in ml or µl depending on range

value format: nnnn.nnn

The returned value is an 8 character string with leading zeros converted to SP characters (ACSII 32 decimal). The fifth character is a decimal point (ASCII 46 decimal)

Queries with string response:

RNG Returns range message (character string either: ML/H ML/M UL/H UL/M)

Error responses:

CR LF ? CR LF prompt Unrecognized command

CR LF OOR CR LF prompt Entered value in out of range

Declaration of Conformity

Application of Council Directive(s):	*73/23/EEC*
Standard(s) to which conformity is declared:	*EN61010-1 (1993)+ A2 (1995)*
Manufacturer's Name:	*Harvard Apparatus, Inc.*
Manufacturer's Address:	*84 October Hill Road* *Holliston, Massachusetts 01746* *U.S.A.*
Type of Equipment:	*Syringe Pump*
Model No.:	*70-2202 (High Force Pump Module)*

I, the undersigned, hereby declare that the equipment specified above conforms to the above Directive(s) and Standard(s).

Place:	*United States of America*
Date:	*September 06, 2002*

CE

HARVARD APPARATUS

(Signature)

Beth Bauman

(Full Name)

VP Engineering / Operations

(Position)